Room 4:

Social Science, Business, Management (1)

Legal Measures to Prevent Recidivism in Sex Crimes in Thailand and Abroad

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ABSTRACT

The issue of sexual recidivism has long been in existence in Thailand. The monitoring of reoffending conducts or the probation of offenders constitutes one of the measures to prevent recidivism. As such, the Act on Measures to Prevent Recidivism in Sexual Offences or Violent Crimes B.E. 2565 (2022) has been enacted in Thailand to legislate specific preventive measures against recidivism in sexual offences. To further elaborate, there are four measures including rehabilitative measures for offenders, measures to monitors absolute prisoners after a complete service of sentence, custodial measures after a complete service of sentence, and emergency custodial measures. In comparison with foreign states, there are a number of measures, in overseas, to prevent reoffending of sexual offences such as castration, injection to reduce sex hormones, rehabilitation of sex offenders, probation, and detention after a complete service of sentence etc. The norms, customs, and traditions of the Thai society should also be taken into consideration as to whether it is appropriate or not to implement such measures in Thailand.

Keywords: reoffending, sexual offences, prevention of recidivism

1. Introduction

A number of countries have long experienced an issue of sex crimes, especially those committed repeatedly by sex offenders with past records. After a discharge of sentence, they often repeat their crimes over and over, and usually with greater level of severity. For instance, an offender may start off committing an offence of rape, but subsequently repeat his rape offence and also assault or even murder his rape victims. As such, finding legal measures to prevent recidivism in sex crimes has become a priority for countries all over the world including Thailand. The Thai authorities has also recognized this issue which needs to be resolved. Of sex offenders released in 2019, there were 180 recidivism offenders in the first year, 337 in the second year, and 450 in the third year. (Department of Corrections, 2023) According the statistics of the Department of Corrections in the budget year of 2022, it was found that sex crime was ranked the 5th for the most repeated crimes in Thailand. In addition, the number of children and juveniles who are sexually or violently abused in forms of molestation, grooming, sextortion, and rape have increased. Therefore, it is suggested that measures should be enacted urgently by the government in order to solve this problem by minimizing these types of crimes in the society as these crimes

gravely affect the lives, bodies, minds, properties, and feelings of stability and safety in the livelihood of the people. (Technical Affairs Department, 2022)

2. Objective

(1) To study the legal measures to prevent sexual recidivism under the Preventive Measures Against Recidivism in Sexual or Violent Offences Act B.E. 2565 (2022) of Thailand;

(2) To study the legal measures to prevent sexual recidivism abroad.

(3) To suggest appropriate recidivism prevention measures to be implemented in Thailand.

3. Legal measures to prevent sexual recidivism under the Preventive Measures Against Recidivism in Sexual or Violent Offences Act B.E. 2565 (2022) of Thailand

The Preventive Measures Against Recidivism in Sexual or Violent Offences Act B.E. 2565 (2022) section 3 stipulates that the Act shall be applicable to sexual offences under the Criminal Code in the following sections:

Section 276	offence of rape;
Section 277	offence of rape against a child;
Section 278	offence of molestation against a person aged exceeding 15 years by any means of
	coercion, violence, duress, or false pretense;
Section 279	offence of molestation against a child aged not exceeding 15 years;
Section 283	bis offence of taking a person aged exceeding 15 years but not exceeding 18 years
	for the purpose of molestation;
Section 284	offence of taking another person for the purpose of molestation by using tricks,
	deception, coercion, violence, undue influence, or any other threatening means.

The measures to prevent sexual recidivism under the Preventive Measures Against Recidivism in Sexual or Violent Offences Act B.E. 2565 (2022) can be divided into four categories as follows:

1) Rehabilitative measures for offenders (section 19 to section 21) stipulates that the court shall make an order to implement rehabilitative measures for defendants who have committed the crimes specified in section 3 while serving their sentences to prevent recidivism. These measures include medical or any other measures as prescribed in the Ministerial Rule by the Minister of Justice under the advisement of the Committee on the Prevention of Recidivism, as requested by the public prosecutor. Such request can be integrated as a part of the charge before the court renders a judgment. In making such orders, the court will take into consideration of the circumstances of the gravity of the offence, reasons for committing the crime, criminal records, mental state, behaviour, and other personal attributes of an offender, the safety of the victim or the society, the risk of reoffending, and the rehabilitation of the offender (section 19 paragraph one and paragraph two). The Department of Corrections will be responsible for conducting any undertakings as specified that the court order to implement measures to rehabilitate the offender, conducting a report of such undertakings, and submitting a proposal to the public prosecutor at least once a year. This is in order to request the court to make an order to amend or rescind the measures to rehabilitate the offender (section 20). The medical measures to prevent recidivism as ordered by the court under section 19(1) shall be implemented by at least two medical professionals who are expert physicians in the field of psychology and internal medicine, and at least one of those in each field must come to a consensus. If the medical professionals view that it is necessary to use medicine or undertake another form of treatment, such treatment can be conducted only when the offender consents to it, except otherwise provided by laws. Additionally, the Department of Corrections can take the result of the implementation of such medical measures to take into account when considering the commutation, parole, or provision of any other benefits, which in turn will result in an early release of an offender before the time period prescribed in the judgment under the law on corrections (section 21).

2) Monitoring measures for absolute prisoner after a discharge of sentence (section 22 to section 27) - when there is a reasonable cause to believe that an absolute prisoner whom the court has rendered a judgment ruling to be an offender for the offences specified in section 3 will be a recidivist after a discharge of a sentence, the court may give an order stipulating one or many monitoring measures for an absolute prisoner after a discharge of sentence as requested by a public prosecutor, as the case may be. The monitoring measures of an absolute prisoner after a service of sentence as follows are included (section 22):

(1) Restraining order against the victim of a crime;

(2) Injunction to prevent any activities which may cause reoffending;

(3) Injunction to prevent from entering the restricted area;

(4) Injunction to prevent overseas travel except when permitted by the court;

(5) Injunction to refrain from causing danger within the community resided by the offender;

(6) Order to reside within the prescribed facility;

(7) Order to reside within the prescribed rehabilitation facility or to stay under the care of a rehabilitative facility under the undertakings of different agencies certified by the Ministry of Public Health as the court sees fit;

(8) Order to comply with an order made by officials or caregivers of the residential or rehabilitation facilities;

(9) Order to report oneself to the probation officer or to receive visitation from a probation officer, a probation volunteer, or other officer during the prescribed time period;

(10) Order to be provided with medical measures, visitation, or treatment from a physician or any other person as prescribed by the court or a probation officer;

(11) Order to attend a rehabilitation program or participate in activities as prescribed by the court or a probation officer;

(12) Order to notify a probation officer of a change of workplace or occupation;

(13) Order to use a surveillance device, in which the court may set the monitoring time period for each measure as deemed appropriate, albeit not exceeding ten years as from the date of sentence discharge.

3) Custodial measures after a discharge of sentence (section 28 to section 36) – in cases where, upon the court's consideration, there is a reasonable cause to believe that an absolute prisoner whom the court has rendered a judgment ruling to be an offender for the offences specified in section 3 paragraph one will commit such crimes, without any other measures to prevent such person from committing a crime, the court may give an order to implement custodial measures after a discharge of sentence to such person as from the date of a discharge of sentence or after a discharge of sentence. This is in order to prevent recidivism as requested by a public prosecutor (section 28) in the following cases:

(1) in case where the Committee on the Determination of Preventive Measures against Recidivism is of an opinion that it is necessary to request the court to implement custodial measures after a discharge of service in order to prevent a crime specified in section 3 paragraph one, or to implement custodial measures after a discharge of sentence in conjunction with monitoring measures for an absolute prisoner after a discharge of sentence continually, the Committee can then submit a report proposing a monitoring measures after a discharge of service under section 23 paragraph two with its opinion to the public prosecutor. This is so that the public prosecutor can submit a request to the court to determine such measures (section 29 paragraph one and paragraph two). In this regard, the court may give an order to implement custodial measures for an absolute prisoner after a discharge of sentence only to the extent necessary to prevent recidivism. The time period shall not exceed three years as from the date on which the sentence against such person is discharge of sentence after the detention period has passed, as requested by a public prosecutor. Nevertheless, the total time period altogether shall not exceed ten years after the date on which a sentence against such person is discharged (section 32 paragraph one and paragraph one and paragraph two).

(2) A probation officer may propose his/her opinion to the pubic prosecutor for consideration, or when a public prosecutor deems appropriate, he/she may submit a request to the court asking the court to make an order to implement custodial measures after a discharge of sentence to the monitored person to prevent recidivism in cases where there is a ground to request the court to make an order to determine the custodial measures after a discharge of sentence. Also, a request may be made to court asking for an order to implement custodial measures after a discharge of sentence. Also, a request may be made to court asking for an order to implement custodial measures after a discharge of sentence in conjunction with the monitoring measures for an absolute prisoner after a discharge of sentence in conjunction with the monitoring measures for an absolute prisoner after a discharge of sentence to give an order to implement custodial measures after a discharge of sentence to give an order to implement custodial measures for an absolute prisoner after a discharge of sentence to the monitored person only to an extent necessary. The time period shall not exceed three years as from the date the monitored person is detained. Alternative, an order may be given to implement monitoring measures for an absolute prisoner after the term of detention is completed, as requested by a public prosecutor. Nonetheless, the total amount of time period the court has set forth all the preventive measures against recidivism, and the time period to implement such measures shall not exceed three years after the date the sentence

against such person is discharged. Also, afterwards, it is deemed that the order prescribing the monitoring measures for an absolute prisoner after a discharge of sentence made by the court has been terminated (section 33 paragraph one and paragraph two).

4) An emergency detention (section 37 to section 41) – in cases where the court has considered the matter and is of an opinion that there is a reasonable cause to believe that the monitored person will commit a crime as specified in section 3 paragraph one, and there is an emergency, and providing that there is no other measure to prevent the monitored person to commit such crime, the court may give an order to emergency detention against the monitored person for a time period not exceeding seven days as from the date on which the court has given an order, as requested by a public prosecutor (section 37). A probation officer may propose his/her opinion to a public prosecutor to consider submitting a request to the court, in the territorial jurisdiction in which the monitored person resides, or the monitored person is located, for an emergency detention (section 38 paragraph one). The court shall consider the public prosecutor's request without delay. If it is satisfied by the court, it shall make an order of emergency detention against the monitored person (section 40). After the court has given an order of emergency detention, a probation officer may propose his/her opinion to a public prosecutor is a norder of emergency detention against the monitored person (section 40). After the court has given an order of emergency detention, a probation officer may propose his/her opinion to a public prosecutor with a request to the court asking for an amendment of such order, monitoring measures for an absolute prisoner after a discharge of sentence, or an order to implement custodial measures after a discharge of service while the court is giving an order of emergency detention (section 42).

4. Legal measures to prevent recidivism in sex crimes abroad

1) Surgical castration

Surgical castration is one of the preventive measures against sexual recidivism. Both testicles are removed, causing the person whose testicles are remove to no longer have sexual desires. Surgical castration is evolved from the ancient concept of eunuchs to a current practice of punishment against prisoners who commit crimes. (Thanabhaisal, 2002). Surgical castration is used in many countries as preventive measures against sexual recidivism. In the 20th Century, many countries in Europe enacted the laws allowing surgical castration. The first country that legalize the procedure is Denmark, followed by many other countries including Germany, Norway, Estonia, Iceland, Latvia, Sweden, Czech Republic, as well as the United States of America. Even though the punishment of surgical castration has already been abolished in many countries on grounds of humanitarian concerns, surgical castration is still applied in certain areas such as Texas State in the United States of America. Texas is the first state which allows surgical castration in order to prevent reoffending of sex offenders. Surgical castration in Texas is applicable to repeated sex offenders who committed crimes against children aged under 14 years, or a forcible rape against children aged under 17 years, or sex offenders with inappropriate sexual behaviours with children aged under 17 years. In Texas, surgical castration requires consent from offenders, which will in turn benefit them as their sentences can be commuted or they can be released. (Texas Government Code 501.061).

2) Chemical castration

Chemical castration is an application of drugs to lower Testosterone, which is sex hormones in order to reduce sexual desires. This method is considered to be the more beneficial as chemical castration does not create wounds on the offenders' bodies. Chemical castration is the legal measures which is applied in various countries such as the United States of America, the Republic of Korea, the Federal Republic of Germany, Australia, etc. The Republic of Korea is the first country in Asia that applies chemical castration as the method of treatment for rapists (Lee and Cho, 2013). In 2010, the legislation, so-called 'the Act on Pharmacologic Treatment of Sex Offenders Sexual Impulses' is enacted with an aim to prevent sexual recidivism by a treatment with drugs to patients with paraphilias and the court has already held that such person is a sex offender, with the purpose to reintegrate the sex offender into the society (section 1). Chemical castration can be applied to sex offenders aged not lower than 19 years (section 4) who committed sexual offences against children aged lower than 16 years and an offence of rape against women (section 2). In 2017, the Republic of Korea also started applying chemical castration for as long as 15 years without the offender's consent. Upon chemical castration, the offender will be released under the condition of probation.

3) The therapy of sex offenders

The therapy program of sex offenders comes in form of psychotherapy, with an aim to prevent sex offenders from repeating their crimes, and to enable them to adapt themselves in the society. Most prisoners in the prison are forced to attend the therapy program for sex offenders. Also, in some countries, in cases where sex offenders' conducts are not severe, the court may order a release under the condition of probation. Also, sex offenders are mostly forced to attend the therapy program while they are being released. In the United Kingdom, sex offenders' therapy can be conducted both in prisons and out of prisons. The offenders may be released under the condition of probation which require them to attend the therapy program for sex offenders. The eligibility of the therapy program is assessed by the Committee, and if the sex offender fails to complete the program, a probation officer will make an arrest against the offender again. Moreover, sex offenders also have to register themselves as sex offenders and report themselves to the probation officers, notifying them of their locations at all times. Upon a completion of therapy program, a probation officer is empowered to order a sex offender to reenter the therapy program or any other therapy program, as deemed appropriate (Coppolo, 2018). In addition, in the United Kingdom, there are many specialized prisons specifically tailored to accommodate sex offenders such as Whatton Prison which specifically house adult sex offenders. Whatton Prison was built in the 1960s, housing 841 prisoners - 70 per cent of whom are offenders of child sex abuse, and the rest are those who commit sex abuse against adults. Having sex offender-specific prisons is more effective than prisons housing sex offenders with other prisoners. This is because approximately half of inmates in the prison are aware of the time they will be released, and the rest of inmates are not aware as there is no clear timeframe as to when they will be released. These therapy programs in prisons can be divided in group sessions, and private sessions (Mews and Others, 2017).

4) Sex offender registry

Sex offender registry is a system whereby personal details as well as criminal records of the convicts, persons on parole, or the released person after a discharge of sentence for sexual offences are recorded. This measure help police officers or relevant agencies continuously monitor sex offenders' movements, which in turn reduces the risk for sex offenders' reoffending. This measure is considered to be significantly beneficial and helpful when attempting to reduce the number of sex offenders with repeated sexual criminal behaviours or offenders with sexual mental disorders as sex offenders' movement is under the supervision of officers at all times. In the process of registration with officers, the offenders are required to notify the officers of their personal information e.g., name-surname, address, date of birth, or current residential place. Apart from personal information, details of registered sex criminals include details relating to types or categories of sex offender registry is applied in many countries in order to prevent and reduce the number of crimes in the society. According to the survey, this is applied in various countries such as the United States of America, the United Kingdom, France, Ireland, Australia, Canada, Japan, South Africa, and the Republic of Korea, etc. (Ratanawibulsom, 2014).

5) The probation of sex offenders

Probation is the legal measures which stems from an idea to rehabilitate offenders by placing the offenders far away from prisons so that offenders cannot learn or imitate behaviours of criminals in prisons, so that they can live their lives in the law-abiding society, while at the same time the society can be protected from offenders with supervision of officers. In foreign countries, probation measures include instances when the court has released an offender whose sentence has not been served yet and who are subject to the condition of probation, and when an offender has served a sentence in prison and left the prison before the term prescribed by the court or on parole. For example, in the state of Georgia in the US, the probation of offenders falls under the responsibility of the Department of Community Supervision. In all criminal cases except for those punishable by death or life imprisonment, the court may give a probation order. Before such order is given by the court, a background check must be conducted by an officer (GA Code § 42-8-34). For the probation order to be given, the certain conditions will be set by the court. Particularly for sex offenders, extra conditions will be added even further than those set for criminals of other offences e.g., prohibition of any communication made by an offender to a child under 18 years of age, prohibition of marriage between an offender and a person with a child under 18 years of age, prohibition of marriage between an offender and a person with a child under 18 years of age, prohibition of marriage between an offender and a person with a child under 18 years of age, prohibition of marriage between an offender and a person with a child under 18 years of age, prohibition of marriage between an offender and a person with a child under 18 years of age, prohibition of marriage between an offender and a person with a child under 18 years of age, prohibition of marriage between an offender and a person with a child under 18 years of age, prohibition of photography a

6) Detention after a discharge of sentence

Detention after a discharge of sentence is a legal measure introduced to prevent sex offenders with risks of reoffending by detaining them after a discharge of sentence. In the state of Victoria in the Commonwealth of Australia, the Serious Offenders Act 2018 was enacted to create the procedure of control, surveillance, monitoring, or detaining prisoners committing crimes of serious sex violence or serious violence, whose sentences have been discharged, particularly those with unacceptable risk of reoffending. The measure is aimed at public safety i.e., protecting the society from reoffending of crimes, and advocating for rehabilitation of offenders. Such legislation includes a provision empowering the Supreme Court to issue a probation order after a discharge of sentence, or so-called 'supervision order' for a period not exceeding 15 years under the conditions prescribed by the court. Alternatively, the court may issue an emergency detention order for a period not exceeding seven days in cases where it is found that the person whose sentence has been discharged shows imminent risk of committing a serious sex offence or a serious violence offence or both, and there are no other measures that could prevent this. Also, a periodic review is required in the legislation to ensure a procedure to review necessity and compliance of the order within the prescribed time period so that the measure is suitable for and in line with the changing situations (Daengpai, 2023).

5. Conclusion

According to the study on the Preventive Measures Against Recidivism of Sexual or Violent Offences Act B.E. 2565 (2022), it is found that there are four preventive measures against recidivism including rehabilitative measures for offenders, monitoring measures for an absolute prisoner after a discharge of sentence, detention after a discharge of sentence, and an emergency detention. Nonetheless, in comparison with measures abroad, it is found that there are different other measures which have not yet been applied in Thailand such as surgical castration, chemical castration, sex offender registry, etc. Thai norms, customs, and traditions must be taken into account when considering whether or not it is suitable to apply these measures in Thailand.

6. Suggestion

According to the study, the author is of an opinion that there are a number of measures that deserve further study due to its feasibility of application in Thailand e.g., chemical castration and sex offender registry, etc. This is because these measures, being widely accepted by many countries, can potentially reduce sexual recidivism in Thailand.

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The motivations behind starting a business to make a difference in the world

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ABSTRACT

The role of the societal and cultural context for startups, imagining and pursuing to make a difference in the world, proves to be important for sustainable social business models. A research gap exists on social entrepreneurship activities in the Southeast Asian region and what the drivers are for starting up social enterprises to make a difference in the world. With a random sample of 2,200 respondents from Thailand, we use linear regression to investigate if being aware of the United Nations Sustainable Development Goals, using digital technologies, own skill perceptions and overall attitudes towards successful entrepreneurs in the country's context increased the likelihood of starting social enterprises. In a gender comparison, our findings highlight the importance of the societal context for both genders. Influence for male startups stems from a more individualistic perspective which draws on power, respect and societal recognition, whereas women tend to be influenced by a more collectivistic perspective, where emphasis is also laid on the success of other successful startups and their media coverage.

Keywords: startup; social entrepreneurship; SDGs; skill perceptions; digital technologies

1. Introduction

The Asia Development Bank (ADB) describes social enterprises as self-sustaining businesses that address social or environmental concerns and at the same time provide jobs, goods, and services (British Council and others, 2021). Typically, these enterprises want to make a difference in the world and follow the two purposes of (1) profit maximization and (2) addressing social and environmental purposes by reinvesting towards their purpose (Kim and Lim, 2017). Like traditional entrepreneurs, social entrepreneurs tend to have innovative thoughts and decision-making, yet for social purposes, and are the originators for the majority of social innovations (Kim and Lim, 2017; Lim and Endo 2016). To solve social problems, social entrepreneurs create new products and services by using new appropriate technologies. In addition, they innovate in new social service models and new working processes (Kim and Lim, 2017).

All social enterprises are affected by diverse contextual complexities to sustainably pursue both social and economic missions (Miller and others, 2012). In a global comparison, Southeast Asia is the region with the lowest number of social entrepreneurs at just 3.8 percent of the working-age population (Bosma and others, 2016). British Council and others (2021) roughly estimate the number of social enterprises across Southeast Asia between 500,000 and 1 million enterprises. The majority of these relatively few social enterprises are limited in growth due to constraints in accessing finance, gaps in innovative financial approaches to access additional capital, lack of knowledge about the social enterprise ecosystem, and lack of data on the impact of their social enterprise (ADB, 2019). All Southeast Asian countries require more and better support models to help scale up social enterprises from startups or social groups to investable businesses (Lien Centre for Social Innovation, 2014), making them more sustainable as they currently are. A research gap exists on social enterprises to make a difference in the world. This empirical study utilizes a random sample of 2,200 respondents, collected in Thailand. We use linear regression to determine what predictors trigger startup activities of entrepreneurs with the goal to make a difference in the world, be it awareness of the United Nations (UN) Sustainable Development Goals (SDGs), their own perceptions about their skills, use of digital technologies or perceptions towards successful entrepreneurs in the society.

2. Objective

(1) To find determinants that increase the likelihood of starting businesses with the social purpose to make a difference in the world.

(2) To explore gender differences in predictors for targeted entrepreneurship education.

3. Literature Review

Social entrepreneurship as a subfield of entrepreneurship study and practice is centered between a nonprofit enterprise with a strategy to earn income and a for-profit enterprise with social mission-driven strategies (Barton and others, 2018). Increasingly, organizations adopt the term 'social enterprise' for business activities that make a difference in the world and that entail both revenue-producing as well as inclusive businesses (Lien Centre for Social Innovation, 2014). Asia Development Bank as a key promoter of inclusive businesses in the region, sees their potential for broader social impact and contribution to poverty reduction. Especially if inclusive enterprises are financially sustainable enterprises which intentionally generate positive social or environmental impact, these social enterprises are also recognized for their potential to achieve the regional development goals (ADB, 2019). This is supported by Barton and others (2018) who find profound implications in the economic system through social entrepreneurship, namely creating new industries, validating new business models, and allocating resources to neglected societal problems.

3.1 Awareness of the United Nations (UN) Sustainable Development Goals (SDGs)

Over the last decades and accelerated during the Covid-19 pandemic, sustainable development of businesses has gained attention because its integration reinforces a possible prosperity of people and society, including continuous, inclusive, and sustainable economic growth for countries and regions (Fleaca and others, 2018). The role of the education system in sustainable development is found in the universal goal of providing inclusive and equitable education and lifelong learning opportunities for all people (SDG 4) (United Nations,

2023a). The potentially positive impact of entrepreneurship on the social and economic development is acknowledged by linking SDG 4, ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all, with SDG8, promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (United Nations, 2023b). In addition, social entrepreneurship is emphasized as a key concept linking enterprises and the civil society to address emerging social challenges (United Nations, 2023b). Social entrepreneurship can be described as the process of using entrepreneurial skills, leadership, innovation and creativity to address needs of marginalized socio-economic communities or environmental problems (Goyal and others, 2021). Social enterprises are businesses that intend to make a difference in the world by using bricolage and social innovation (Agrawal and Khare, 2019). Other descriptions of social enterprises talk about a 'serve' or 'social change' mindset, often irrespective of economic returns or sustainability (Dees, 2017). Different types of social enterprise values are found to influence local and regional developments. To make a difference in the world creates value, not only by (1) producing goods and services, strengthening both the enterprise itself and its competitiveness, or by (2) job creation for marginalized people, including training and support in job finding, but also by (3) providing economic and social development through grants, among others by foundations, and microfinance or low-interest loans (Kim and Lim, 2017). If a social enterprise can break even or make a profit, its funding becomes sustainable and makes this business less dependent upon donor funds or grants. Potentially, a mechanism is created that provides more opportunities, going beyond charitable and philanthropic principles (Acs and others, 2013). The SDGs can be a guiding force in directing intentional social entrepreneurs to contribute to one or more of them. The importance of entrepreneurs and entrepreneurship to influence the overall wellbeing of humans is supported by governments and institutions, and they have taken proactive actions to develop entrepreneurial thinking, supported by the SDGs, particularly through education (Ashari and others, 2021). We therefore hypothesize, that

H1: For both genders, awareness of the United Nations Sustainable Development Goals has a significant positive impact positive impact on starting a business with the goal to make a difference in the world.

3.2 Use of Digital Technologies

In this decade, we are at the start of a new digital industrial technology known as Industry 4.0 (4IR). This fourth technological wave in the industries leads to interactions of different physical systems with each other, using artificial intelligence, machine learning, Big Data, and the Internet of Things (IoT), among others. Industry 4.0 will increase productivity and growth (Hoosain and others, 2020; Rüßmann and others, 2015). The transition from a linear to a circular economy has gained popularity in the last few years, providing solutions to some of the world's most challenging sustainable development problems. The aforementioned technologies are already being used in different areas to achieve SDGs (Hoosain and others, 2020). Already in the 1970s, the Ellen MacArthur foundation, United Kingdom, showed a link between sustainability and circular economy, using 4IR digital technologies. The foundation also promotes to accelerate the idea of the circular economy across different sectors and partnerships (Sherratt, 2013).

UNs '2030Vision' is aimed at a collaboration between enterprises, NGOs, and governments, equipped with the technologies and resources required to achieve the SDGs. It targets an increase in impact, achieving this by using 4IR digital technologies and circular thinking (Sadowski and Powell-Truck, 2019). Already in the last years, these technologies were essential to achieve societal goals, such as in the fight against the COVID-19 pandemic. AI and machine learning are being used to save lives with screening, tracking, and prediction algorithms and assist in developing vaccines. With IoT, patients can be supervised (Vaischiya and others, 2020). The fast growth of the information and communication technology (ICT) sector and -with it- the growth of global inter-connectivity will play an important role in fostering economic and social change in many parts of the world. Inequalities with regard to access to IoT are prevalent between developing and first world countries, rural and urban areas, men and women which demands to combine ICT development and 4IR technologies towards achieving the UN SDGs (Demestichas and Daskalakis, 2020). We therefore hypothesize, that

H2: For both genders, use of digital technologies has a significant positive impact positive impact on starting a business with the goal to make a difference in the world.

3.3 Skill Perceptions

Entrepreneurial intentions, applied to social entrepreneurship, are triggered by previous entrepreneurial experience, entrepreneurial education and self-efficacy or pro-activeness as important enablers (Barton and others, 2018). Generally, entrepreneurs possess the ability to identify customer needs and gaps in the market. To make a difference in the world, social entrepreneurs' opportunity recognition often stems from well-informed and ethically, socially and/or environmentally aware consumers. To be able to make a difference, social entrepreneurs need a specific set of skills which allows them to manage both demands: their social mission and profitability of the business (Smith and others, 2012). Without these relevant skills, social entrepreneurs tend to concentrate on being either social mission–driven or purely commercial and profit-oriented.

Smith and others (2012) identify three interrelated necessary leadership skills to address these challenges as 'accepting', 'differentiating', and 'integrating' competing demands. Skill 1 'acceptance' requires to accept the two different sides of the competing demands –mission- versus profit-driven. If both can be accepted, social entrepreneurs will identify new opportunities rather than obstacles which in series makes them more innovative. Acceptance for social entrepreneurs means embracing paradoxical thinking and open-mindedness. Skill 2 'differentiation' allows the social entrepreneur to recognize the differentiated value of the two demands. As a result, the business will stay focused and challenged to addressing and achieving both goals. Finally, skill 3 'integration' means bringing the two conflicting demands together to address and overcome the conflict between achieving social mission and commercial profit. For integrative skills, social entrepreneurs need both refined interpresonal skills and decision-making skills (Smith and others, 2012). Little research investigates which skills are needed for a social entrepreneur who wants to attend to both, namely reinvesting their profits towards their social or environmental goal. As a difference for women entrepreneurs, Polas and Afshar (2021) found a positive association between women's problem-solving skills, networking skills and their social entrepreneurial intention. Both problem-solving skills as well as a woman's networking abilities led to higher interest in solving particular

societal problems and to more interaction with other people in the society, which often is attributed more to women than to men. Both enhanced a woman's societal awareness and -as a result- might lead to an increase in startup intentions of an enterprise that makes a difference in their society. We therefore hypothesize, that *H3: For women, skill perceptions have a significant positive impact on starting a business with the goal to make a difference in the world.*

3.4 Attitudes Towards Successful Entrepreneurs

A research gap exists in how mass media influences entrepreneurial intentions (Laguía and Moriano, 2021). The question arises how media attention of successful startups gives other startups a perceived social legitimacy and influences their startup behavior. Petkova and others (2013) found that startups which engage in more intense and diverse sense-giving, hence try to start enterprises that make a difference in the world, are influenced if higher levels of media attention are prevalent. These effects take root in dependance of the human capital of their startup founders. On the other hand, and vice versa, meaningful business activities also lead to higher levels of media attention.

Social entrepreneurs tend to reflect on themselves through activities of other social enterprises in their ecosystem as they often face different challenges. To a certain extent, they might rely also on the support of these others to achieve their goals (Diaz-Gonzalez and Dentchev, 2021). Therefore, a general positive attitude towards social entrepreneurship in the society and -hence- the ecosystem, where the ecosystem is "characterized by a large number of loosely interconnected participants who depend on each other for their mutual effectiveness and survival" (Moore, 1996, p. 26), may help entrepreneurs to enhance their impact in making a difference in the world.

Previous studies found that economic and social policymakers have put effort into creating and fostering entrepreneurial ecosystems by connecting actors, institutions, social structures, and cultural values, important for entrepreneurial activity (e.g. Breznitz and Taylor, 2014; Mason and Brown, 2014; Roundy, 2016; Spigel, 2017). There is a research gap on how social entrepreneurs interact within a cluster of other entrepreneurs, organizations, institutions, and the overall cultural aspects of the ecosystem. As a result, Roundy (2017) found that if the number of social entrepreneurs increases in a society, there will also be a specific increase in the same type of founders, resulting in more social entrepreneurs. Support for social entrepreneurs and initiatives focusing on those entrepreneurs who start to make a difference in the world, as well as the societal context, which favors social entrepreneurship, such as attributing status and respect to successful social entrepreneurs or to receiving media attention, fosters the entrepreneurial ecosystem for social entrepreneurship (Klimas and Wronka-PoŚpiech, 2022). Therefore, a dependence between positive attitudes towards successful entrepreneurs, such as social entrepreneurs who aim to make a difference in the world, and startup intentions might be prevalent. We therefore hypothesize, that

H4: For both genders, a society's positive attitudes towards successful entrepreneurs have a significant positive impact on starting a business with the goal to make a difference in the world.

3.5 Research Framework



Figure 1 Research Framework

4. Research Methodology and Data

Data used in this study are from the Global Entrepreneurship Monitor (GEM) project, an ongoing largescale research project, designed to collect data on entrepreneurial activities, aspirations and behavior across countries. Each year, a random representative sample of the adult population (age 18 to 64) is surveyed in each country to identify individuals who, at the time of the survey, owned and managed a business or were in the process of starting one (Bosma, 2013). GEM national teams across the globe collect individual-level data on an annual basis and analyze entrepreneurial activity across countries and the factors that make a country entrepreneurial. Each participating GEM national research team undertakes the Adult Population Survey (APS) along with a National Expert Survey (NES). The APS questions, which include the variables used in this study, are answered by a random sample of a minimum of 2000 adults per country, and concern their engagement in entrepreneurial activity and their attitudes towards entrepreneurship. The survey data for the APS of Thailand were collected in May and June 2023 and account for 2,200 respondents, of which 350 were male startups and 364 were female startups, who -alone or with others- were currently trying to start a new business, including any self-employment or selling any goods or services to others. All startups were asked about the reasons why they are trying to start a business. 108 male and 111 female startups responded to start their business to make a difference in the world.

Frequencies were used to determine the relevance of the questions for the entrepreneurs. Linear regression analysis was used to answer the question whether the awareness of SDGs (2 independent variables), attitudes towards successful entrepreneurs (3 variables), the use of digital technologies (1 variable) and/or their perceptions towards their skills (1 variable) predict startup activities of more socially conscious businesses – to make a difference in the world. In the model summary, R-Square, as overall measure of the strength of the association, determined the proportion of variance in the dependent variable, predicted from the independent variables. ANOVA was used to predict the dependent or outcome variable with an indication of the statistical significance of the regression model of less than 0.05. The dependent variable DV was 'the reason to start a business is to make a difference in the world'. The independent variables, 'more digital technology use to sell products and services in the next 6 months', 'personal perceptions of knowledge, skill and experience required to

start a new business', the grouped variables for attitudes towards successful entrepreneurs ('starting a new business as a desirable career choice', 'high level of status and respect for successful startups', and 'public media and/or internet coverage about successful startups') were answered on a scale of 5 from 'strongly disagree' to 'strongly agree'. The grouped variables for awareness of SDGs ('awareness of the 17 UN SDGs' and 'identified goals as a priority for business and defined a set of clear objectives') were dichotomous questions.

5. Results

The awareness of the 17 UN SDGs – the 2030 agenda for sustainable development in the overall Thai population was low for both genders (41.2% of men and 35.8% of women), whereas in the business community both genders (74.5% for male / 79.5% for female) reported that they had identified goals as a priority for their business, including having defined a set of clear objectives, actions and Key Performance Indicators. Similarly, 68% of the male and 76.5% of the female startups stated that they expected to use more digital technologies in the sales processes of their products or services in the next six months. Just about half of the startup entrepreneurs (58.1% male / 54.3% female) perceive to have the skills, expertise and experience to start a business.

The overall model was significant for both genders and the R Square values exhibit that a variance of 14.6% (male) and 14.5% (female) in the overall model summary is accounted for by the entrepreneurs to startup with the intent to make a difference in the world. This is a partial explanation for their startup reasons only, but still one specific aspect. The objective of this study is to find determinants that increase the likelihood of starting businesses with the social purpose to make a difference in the world and to explore gender differences in predictors for targeted entrepreneurship education. The ANOVA results are significant for both genders (male .001 / female .000), however -for both genders- different predictors were found to be relevant, which indicates that policy makers and entrepreneurship educators have to be careful in delivering a 'one-solution-fits-all' approach.

Table 1 shows that from the 2 variables related to awareness of the UN SDGs, variable 1 (Awareness of the 17 United Nations Sustainable Development Goals) was not significant for both genders, however variable 2 in this category (Identified goals as a priority for business and defined a set of clear objectives, actions and Key Performance Indicators) had a negative impact for male startups (-.172/.039). For female startups, awareness of SDGs is not significant, therefore *H1: For both genders, awareness of the United Nations Sustainable Development Goals has a significant positive impact positive impact on starting a business with the goal to make a difference in the world, is not supported for both genders.*

H2: For both genders, use of digital technologies has a significant positive impact positive impact on starting a business with the goal to make a difference in the world, is only significant with a negative impact for women entrepreneurs (-.207/.005), therefore H2 is also not supported as predictor for startups and the goal to make a difference in the world. *H3: For women, skill perceptions have a significant positive impact on starting a business with the goal to make a difference in the world,* is the only hypothesis which is fully supported in our model, as it has a positive significant impact for female startups (.176/.021). The attitudes towards successful entrepreneurs

are positive significant for both genders, but differ as predictors: For male startups, those were 'starting a new business as a desirable career choice' (.193/.014) and 'high level of status and respect for successful startups' (.226/.004), and for female startups 'public media and/or internet coverage about successful startups' (.173/-028). Therefore, *H4: For both genders, a society's positive attitudes towards successful entrepreneurs have a significant positive impact on starting a business with the goal to make a difference in the world, are only partially supported.*

		male		female	
Predictor Category	Independent Variables	Beta	Sig.	Beta	Sig.
	Awareness of the 17 United Nations	-0.075	0.352	-0.062	0.416
	Sustainable Development Goals				
Awareness of SDGs	Identified goals as a priority for business and	-0.172	0.039	0.063	0.409
	defined a set of clear objectives, actions and				
	Key Performance Indicators				
Use of digital	More digital technology use to sell products	-0.079	0.302	-0.207	0.005
technologies	or services in the next six months				
Claill a sussentions	Personal perceptions of knowledge, skill and	-0.040	0.628	0.176	0.021
Skill perceptions	experience required to start a new business.				
	Starting a new business as a desirable career	0.193	0.014	0.143	0.087
	choice				
Attitudes towards	High level of status and respect for	0.226	0.004	-0.020	0.807
successiui	successful startups				
entrepreneurs	Public media and/or internet coverage about	-0.099	0.259	0.173	0.028
	successful startups				

Table 1 Regression Results

Our findings show that -per gender- three influencing factors each are prevalent in this process, however there is no single overlap.

6. Conclusions and Suggestion

One objective of this exploratory study was to find determinants that increase the likelihood of startups with a business purpose to make a difference in the world and as a result create sustainable social enterprises. Another objective was to determine if there are gender differences in order to propose gender- targeted recommendations. Three factors for male startups and three different factors for female startups have been found to positively influence an increase in these types of entrepreneurs.

Despite the prevalence of a high frequency for male startups, the first, awareness of SDGs, specifically identified as a priority for businesses, including having defined a set of clear objectives, actions and Key Performance Indicators, is a hindering factor in their startup decisions and their intent to make a difference in the

world. For women startups, no significance was found. We infer that startup entrepreneurs who wish to make a difference in the world and having specific plans how to act on identified goals might be influenced by them, but are not driven by these plans. They might have started their business also without having these specific goals. Male startups specifically might be hindered in their startup efforts also because startup activities tend to be many small and diverse steps than rather working with specific action plans on these goals. Nascent entrepreneurs in the first few months of their business - despite pursuing a big dream and plan- mostly deal with day-to-day operational problems.

Similarly, and probably also for similar reasons, the second hindering factor is found for female startups in relation to a higher use of digital technologies in the to sell products or services in the next six months, despite stating that they intend to use more technologies. We conclude that a majority of startups in 2023 already use technologies for sales activities at the beginning of their entrepreneurial endeavor -at least to a certain extent- and that this factor is not a supporting factor to start an enterprise that makes a difference in the world.

Four other determinants positively influence startup decisions for social entrepreneurs: Female startups are positively influenced by their skill perceptions which supports Polas and Afshar's findings (2021) that the right skillset, problem-solving and interaction skills, lead to higher societal awareness and as a result to an increase in intentions to start a business to make a difference in their society.

Interestingly, *H4: For both genders, a society's positive attitudes towards successful entrepreneurs have a significant positive impact on starting a business with the goal to make a difference in the world,* shows mixed results. For male startups, status and desirable career choice are significant drivers, whereas female startups are influenced by media coverage. Overall, the societal attitudes towards successful entrepreneurs have impact on both genders in their startup decision for a business that makes a difference in the world. We infer that the influence for male startups stems from a more individualistic perspective which draws on power, respect and societal recognition, whereas women tend to be influenced by a more collectivistic perspective, where emphasis is also laid on the success of other successful startups and their media coverage. They are pulled into social entrepreneurship by other good examples rather than by prestige which draws the male startups. This demands for a targeted approach if governments, educators, and institutions want to increase social enterprises that intend to make a difference in the world. This also implies the goal of generating social value as a crucial resource for social entrepreneurial activities, such as improving societies by boosting social capital and societal linkages. For women, this should be paired with training of relevant entrepreneurial skills, especially problem-solving and networking skills, as found by Polas and Afshar (2021).

Interestingly, the awareness of SDGs and increased use of digital technologies have no or rather a negative effect on startup decisions, which needs further investigation. Even though the startups are aware of the SDGs and even plan the implementation of SDGs, they tend to be not relevant in influencing their startup decision, most probably, because the startup intentions to create business that make a difference in the world are already made. They might be built upon certain SDGs, but are not the decisive factor. Similarly, this might be the case

for the increased use of technologies for sales of products and services in the near future, as startups use them as one of several tools to approach the market, but not exclusively.

As our data was collected in Thailand, a generalization might be possible to the other ASEAN countries, but difficult for other regions across the globe. In addition, our survey was done in 2023 and the development of social enterprises and the awareness towards the importance of sustainability has continuously increased over the years and currently, few current datasets and publications are available and might reveal different and or similar findings. However, the results of this study are valuable for both academia and practitioners. The findings, that the cultural societal component acts as a predictor for social entrepreneurs and influences both men and women to start social enterprises, needs further exploration. Clearly, it is necessary to be in a market with products or services to make a profit and in series to be able to reinvest to make difference in the world. However, a deeper investigation is needed to specify what exactly needs to be done in the societal and cultural context to strengthen these findings. More detailed research should be conducted to find the relevance of specific skills for female startups as this could strengthen the sustainability of their startups, since our study only asked for a general skill perception. Further studies could investigate the interplay between the attitudes towards successful entrepreneurs and the SDGs to find more reasons, what specifically triggers the purpose to start social enterprises. Additional findings on the interplay between social enterprises, universities, governments and organizations targeting social initiatives could help to empower social enterprises to a higher levels in the region.

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A Guideline for Human Resource Management in Agricultural Enterprises in Nanning Guangxi Province, China

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ABSTRACT

The Human Resource Management Guidelines for Agricultural Enterprises in Nanning, Guangxi are a guide developed to assist agricultural enterprises in improving their human resource management level. This guide includes Recruitment and Orientation Training and Development, Compensation and Benefits, Performance appraisal, Employee motivation, Career development, conducting job analysis, Human Resource Management satisfaction, in terms of job setting and recruitment, the guide proposes reasonable job setting and recruitment processes to ensure that enterprises have suitable talents. In terms of training and development, the guide emphasizes the importance of employee training and guides on developing training plans and evaluation methods. In terms of compensation and benefits, the guide suggests that enterprises develop fair and reasonable compensation policies and provide suggestions for benefit management.

Overall, this guide provides a series of human resource management methods and recommendations, providing standardized human resource management guidance for agricultural enterprises in Nanning City.

Keywords: Human Resources, Management, Human Resource Management, Agricultural,

Agricultural Enterprise, Guideline

1. Introduction

With the continuous development and innovation of global science and technology, the problem of population aging is becoming increasingly prominent. The employment of people affected by COVID-19 is also under great pressure. Human resources is an important guarantee for the sustainable development of enterprises. Agriculture is the first industry in our country, and it is particularly important to manage the human resources of agricultural enterprises. (Yu Yongzhi & Yang Yujuan 2021) Enterprises need to develop and improve the enterprise management system, strive to improve the professionalism of enterprise personnel, help enterprises realize innovative management and scientific decision-making, thereby promoting the healthy development of enterprises. Enhance the competence and competitiveness of the industry to obtain marketing opportunities. Agricultural enterprises have become an indispensable part of the national development strategy. By analyzing the existing problems of human resource management in agricultural enterprises and formulates corresponding management measures and guidelines, to promote the healthy development of human resource management and provide reference value for the development of human resource management.

2. Research Objectives

(1) To find problems in human resource management, in agricultural enterprises in Nanning Guangxi Province, China.

(2) To find human resource management satisfaction, in agricultural enterprises in Nanning Guangxi Province, China.

(3) To propose a guideline for human resource management in agricultural enterprises in Nanning Guangxi Province, China.

3. Literature Review

3.1 Theory, Concept, and Related Research

Human resource management (HRM): HRM refers to the strategic approach to managing an organization's workforce. It involves activities such as recruitment, training, performance management, and employee development.

The theory and concepts of human resource management in agricultural enterprises mainly include the following aspects: Human resource planning: Based on the development strategy and business needs of agricultural enterprises, by reasonably planning the quantity and structure of human resources, ensure the matching of human resources with business needs. Job analysis and recruitment: By analyzing agricultural enterprise positions, determine job responsibilities and requirements, and then attract and screen suitable talents through recruitment, selection, and other methods.

Employee training and development: Provide training and development opportunities for agricultural enterprise employees, enhance their skills and abilities, and adapt to the needs of enterprise development and change. Performance management: Develop and implement a performance evaluation system, stimulate employees' work motivation and enthusiasm through performance evaluation and incentive measures, and promote the common development of individuals and enterprises. Salary management: Develop a reasonable salary system, including basic salary, performance bonuses, welfare benefits, etc., to attract and retain outstanding talents, improve employee job satisfaction and loyalty. Employee Relationship Management: Establish and maintain good employee relationships, including communication, team building, employee participation, and welfare management. Diversity and Inclusive Management: Manage a diverse workforce, including employees of different genders, cultural backgrounds, and ability levels, to promote a fair and inclusive work environment. Knowledge management: Identifying, acquiring, transmitting, and applying knowledge and experience in agricultural enterprises, promoting knowledge innovation and organizational learning. The above are some basic theories and concepts of human resource management in agricultural enterprises. By scientifically and effectively applying these theories and concepts, the level of human resource management in agricultural enterprises can be improved and the development goals of the enterprise can be achieved.

Two-factor theory: Lin Chengde (December 2003). American psychologist Herzberg proposed in 1959. He divided the relevant factors in the enterprise into two types, namely satisfaction factors and dissatisfaction factors.

Herzberg (July 1, 2009). Motivation factors refer to factors that can make employees feel satisfied.

Qing Tao (September 2006). "Herzberg reasoned that because the factors causing satisfaction are different from those causing dissatisfaction, the two feelings cannot simply be treated as opposites of one another.

Chow, I. H., & Chiu, R. K. (2012). This article mainly discusses the job satisfaction of Chinese whitecollar employees and conducts research using Herzberg's two-factor theory.

Saari, L. M., & Judge, T. A. (2004). This article mainly discusses the relationship between employee attitudes and job satisfaction.

Overall, understanding and effectively implementing HRM principles and practices can significantly contribute to the success and competitiveness of agricultural enterprises in Nanning, Guangxi. Human resource management theory, agricultural enterprise human resource management theory, research by relevant authors.

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3.2 Research Framework



Figure 1 Research Framework

From the perspective of research framework, by identifying the problems existing in agricultural enterprises in Nanning City, Guangxi, analyzing the satisfaction of human resource management in current agricultural enterprise companies, studying the process of human resource management, and finally obtaining a guide for human resource management in agricultural enterprises in Nanning City, Guangxi.

3.3 Benefits of the study

(1) To know human resource management satisfaction.

(2) To know a guideline for human resource management in agricultural enterprises in Nanning Guangxi Province, China.

4. Research Methodology

4.1 Research Design

This study used a questionnaire survey method for data collection. The data collection steps were as follows: Firstly, use the "Questionnaire Star" platform to create a questionnaire. Then, a questionnaire link and QR code were generated through the platform to send the questionnaire to the corresponding group.

Measurement of Variable

Further measure the situation of these variables by collecting survey questionnaires. For a sample size of 378 individuals, mainly from the agricultural enterprise department of agricultural production units, especially employees from the human resources management department. Conduct a questionnaire survey. A Guideline for Human Resource Management in Agricultural Enterprises in Nanning Guangdong Province, China. The questionnaire consists of three parts and consists of 45 questions, including:

Part 1: Personal Information. There are 6 questions in this section (Sex, Age, Education Level, Position, Year salary, Working experience.)

Part 2: Human Resource Management satisfaction. This section contains 37 questions.

Part 3: Other Recommendations. There are two issues with this section.

The rating level for the second part is 5, as shown in the following figure:

Scale	Range
Strongly Satisfy	4.21-5.00
Satisfy	3.41-4.20
Neutral	2.61-3.40
Lower Satisfy	1.81-2.60
Lowest Satisfy	1.00-1.80
	Scale Strongly Satisfy Satisfy Neutral Lower Satisfy Lowest Satisfy

Figure 2 Interpretation Scale of Descriptive Statistics

The above shows the scope based on the questionnaire survey. These ranges will be used to explain the average and standard deviation of satisfaction.

Pretesting of the Instrument

In this study, we conducted a preliminary survey of the respondents using statistical software. The table was compiled based on the model and combined with scales from some scholars. To ensure the basic reliability and validity of the table, we localized and translated it, and made predictions for the table.

Reliability Test: Reliability testing is a method used to evaluate the reliability and stability of measurement tools. The most used reliability coefficient is the "Cronbach" coefficient. The coefficient increases, resulting in stability and reliability coefficients. This study used IBM SPSS Statistics 26 to check the reliability of the measurement scale, in order to evaluate the consistency and stability of the scale items and ensure that they can accurately measure the corresponding dimensions. If the reliability coefficient reaches 0.7, it means good internal consistency (Cronbach, 1951). If the Cronbach Alpha coefficient of the entire scale is greater than the Cronbach Alpha coefficient of the dimension after deleting the item, it indicates that the reliability coefficient of the scale will increase after deleting the item, so the item should be deleted.

This study conducted a reliability test on the scales used in the questionnaire to ensure the reliability of the study. The reliability analysis results of measurement items such as Recruitment Orientation, Training and Development, Compensation Benefits, Performance appraisal, Employee motivation, Career development, conducting job analysis, etc. are shown in the table.

Variable	Item	Cronbach's Alpha
Recruitment & Orientation	5	0.936
Training and Development	5	0.888
Compensation & Benefits	5	0.954
Performance appraisal	7	0.940
Employee motivation	5	0.895
Career development	5	0.823
Conducting job analysis	5	0.883

Table 1 Reliability analysis of the questionnaire

From this, this means that the reliability of the table is high, and the Cronbach's alpha coefficients of all seven scales are greater than 0.7. This means that there is internal consistency between the various measurement items in the table, which can be trusted for further correlation analysis using the table. This conclusion is consistent with Su ü c ü and Maslak ç 1 the research results of (2020) are consistent.

4.2 Population and Sample

The objects of this study Data source from the official website of the Second National Agricultural Census in Nanning, Guangxi were 2,144 main agricultural production units in Nanning, Guangxi, with a total of 2,103,400 agricultural employees in the city, including employees in the agricultural enterprise sector, especially those in the human resources management department. The total number of samples in this study was known. Therefore, sample size was determined using the Yamane formula in the case of limited numbers and known population size. The object of this study was the staff of agricultural enterprises, especially the staff of the human resource management department, which was the main agricultural production unit in Nanning, Guangxi, shown, this sampling size is 338 sample.

4.3 Research Instrument

This paper mainly focuses on the questionnaire survey to collate and analyze the survey data. In the research process, the reliability coefficient of the questionnaires was calculated by means of Cronbach's alpha in the Statistical Package for the Social Sciences (SPSS), which was a commonly used statistical program in the research.

4.4 Data Collection

$$n = \frac{N}{1 + Ne^{2}}$$

$$n = \frac{2144}{1 + 2144 \times 0.05^{2}} = 337.11$$

$$n \approx 337$$
Where n =sample size
N=population size =2144
e=error(0.05)reliability level 95%
e =level of precision always set the value of 0.05

4.5 Data Analysis

In this section, researchers used statistical software to analyze quantitative data and used the analysis results to analyze and infer the questionnaire data. Descriptive statistical analysis was used to analyze the information elements of the survey subjects, and relevant data was obtained on this basis. This included descriptive statistical analysis of samples and descriptive statistical analysis of variables.

After collecting sample data, all questionnaire and on-site interview data were checked to exclude incomplete questionnaires. After the screening procedure, the data was imported into SPSS. The data analysis techniques used for quantitative data analysis included means,

standard deviations, and percentages.

5. Research Findings

Demographic Characteristics		Frequency	Percent
Sex	Male	211	50.24
	Female	209	49.76
	Under25	117	27.86
	26-35	170	40.48
Age	36-45	105	25.00
	46-55	21	5.00
	Over 56	7	1.67
	Under College	49	11.67
Education Level	College	132	31.43
	Under Graduation	166	39.52
	Master's degree	58	13.81
	Doctorate	15	3.57

Table 1 General Demographic Description

Demographic Characteristics		Frequency	Percent
Position/Title	Employee	150	35.71
	Supervisor	127	30.24
	Manager	116	27.62
	President & Vice President	27	6.43
	below 1 year	77	18.33
	1-3 years	141	33.57
Working experience	e 4-6 years	146	34.76
	7-10 years	34	8.10
	Above 10 years	22	5.24
	Under 30,000Yuan	105	25.00
Year Salary	30, 001-60,000Yuan	125	29.76
	60, 001-90,000Yuan	113	26.90
	90001-120001Yuan	50	11.90
	Over 120,001Yuan	27	6.43
Total		420	100.0

Male accounts for 50.2%, while Female accounts for 49.8%. Under25 accounts for 27.9%, 26 35 accounts for 40.5%, 36 45 accounts for 25.0%, 46 55 accounts for 5.0%, and Over 56 accounts for 1.7%. Under College accounts for 11.7%, College accounts for 31.4%, Under graduation accounts for 39.5%, master's degree accounts for 13.8%, and Doctor's degree accounts for 3.6%. Employee accounts for 35.7%, Supervisor accounts for 30.2%, Manager accounts for 27.6%, and President Vice President accounts for 6.4%. Below 1-year accounts for 18.3%, 1-3 years accounts for 33.6%, 4-6 years accounts for 34.8%, 7-10 years accounts for 8.1%, and Above 10 years accounts for 5.2%. Under 30000Yuan accounts for 25.0%, 30001-60000 Yuan accounts for 29.8%, 60001-90000Yuan accounts for 26.9%, 90001-120001 Yuan accounts for 11.9%, and Over 120001 Yuan accounts for 6.4%.

	Mean	S. D.	Meaning
Recruitment and Orientation	3.44	1.063	Satisfy
Training and Development	3.43	1.062	Satisfy
Compensation and Benefits	3.41	1.047	Satisfy
Performance appraisal	3.43	1.038	Satisfy
Employee motivation	3.44	1.047	Satisfy
Career development	3.45	1.038	Satisfy
Conducting job analysis	3.46	1.035	Satisfy
Human Resource Management satisfaction	3.44	1.001	Satisfy

6. Discussion

There may be some issues with the satisfaction of human resource management in agricultural enterprises in Nanning City at present. There may be some challenges and shortcomings in recruitment and selection, training and development, compensation and benefits, performance management, employee relationship management, and job analysis, which require further improvement and optimization.

7. Suggestion

Guideline 1 Recruitment & Orientation

(1) Standardize the recruitment process to ensure that job requirements match recruitment results.(2) Strengthen training and adaptation period management for new employees and provide necessary support and guidance.

Guideline 2 Training and Development

(3) Develop a systematic training plan to meet the learning and development needs of employees.(4) Provide various training methods, including internal training, external training, and online learning.(5) Establish a training achievement evaluation mechanism to ensure the effectiveness of training.

Guideline 3 Compensation & Benefits

(6) Establish a reasonable salary system and adjust salaries based on employees' contributions and abilities.(7) Provide diversified welfare benefits to meet employees' basic needs and increase their sense of welfare.

Guideline 4 Performance appraisal

(8) Set clear performance evaluation indicators and standards to enable employees to have a clear understanding of personal performance measurement standards.(9) Provide timely feedback and coaching to help employees improve and grow.

(10) Connect performance evaluation results with salary and promotion opportunities to improve the fairness and incentive effect of performance management.

Guideline 5 Employee motivation

(11) Establish good communication channels to promote interaction and communication between employees and management.(12) Encourage employees to participate in decision-making provide suggestions and increase their sense of participation in corporate decision-making.(13) Strengthen care and support for employees, and improve employee satisfaction and morale.

Guideline 6 Career development

(14) Provide employee development plans and promotion paths to encourage employees to continuously learn and grow. Help employees improve their skills and professional literacy through internal training, mentoring programs, and cross-departmental projects.

Guideline 7 Conducting job analysis.

(15)Regularly evaluate the effectiveness of human resource management and continuously improve based on feedback and data. Pay attention to the latest trends and best practices in the field of human resource management, and continuously learn and improve.

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Determinants of Catastrophic Health Expenditure Among The National Social Security Fund Members With Non-Communicable Disease in Cambodia

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ABSTRACT

Non-communicable diseases (NCDs) impose significant financial burdens lead to catastrophic health expenditure (CHE) due to expensive treatment and often prolonged treatment. In Cambodia, NSSF offers NCD treatment in public hospitals to its members, with an essential drug list provided by the Ministry of Health. Despite covering medical costs, NSSF members may face financial challenges due to benefit limitations. This study aims to investigate the CHE incidence among NSSF members who have NCDs and to explore the factors associated with the CHE. A cross-sectional study was conducted by including 422 NSSF members with NCDs in Phnom Penh in June 2023. After data screening, 359 questionnaires were analyzed using statistical techniques. CHE was calculated based on annual expenditures and health care costs (NCD treatments). Multiple logistic regression analyses were performed to identify significant factors associated with CHE. The results indicated that NSSF members residing outside Phnom Penh City were nearly 11 times more likely to experience CHE (AOR: 10.81, 95% CI: 5.82-20.05). Patients frequently incurring outpatient medical expenses faced a tenfold higher likelihood of CHE (AOR: 10.09, 95% CI: 5.18-19.65). Moreover, those who utilize health services monthly or more were 4 times more prone to CHE than less frequent users (AOR: 3.90, 95% CI: 2.11-7.24). Additionally, hospitalization during treatment increased the risk of CHE by 4.41 times (AOR: 4.41, 95% CI: 2.23-8.75). In conclusion, strategies to alleviate CHE for NSSF members with NCDs include expanding NCD treatment services at the provincial level, extending coverage of inpatient services, and revising reimbursement rates to encompass more medical costs.

Keywords: Catastrophic Health Expenditure/ National Social Security Fund/ Non-communicable diseases

1. Introduction

Non-communicable diseases (NCDs) are chronic health conditions not mainly triggered by acute infections. (Kankeu et al., 2013). They make up 74% of global deaths, causing 41 million annual fatalities. Over 17 million of these occur before age 70, with 86% in low- and middle-income countries, leading to annual economic losses over \$500 billion (Noncommunicable diseases, 2022 Sep 16). Common NCDs are classified in 4 groups

according to World Health Organization such as cardiovascular diseases (17.9 million deaths), cancer (9.3 million), chronic respiratory diseases (4.1 million), and diabetes (2.0 million (Noncommunicable diseases, 2022 Sep 16).

In Cambodia, NCDs cause 64% of all deaths and a 23% mortality rate among those aged 30 to 70, with a 1 in 4 chance of death from these conditions. (Alexey Kulikov, 2019). NCDs also impose a substantial economic burden on Cambodia, accounting for 6.6% of the annual GDP, or KHR 5.97 trillion (US\$ 1.5 billion). High healthcare costs for NCDs lead to substantial out-of-pocket expenses (OOPE), reducing income and savings. Premature NCD-related deaths further strain the economy by decreasing the labor force, tax revenue, and human capital investments (Alexey Kulikov, 2019). Cambodia's heavy reliance on OOPE, driven by the late implement of health insurance and absent of universal health coverage, which cause the patient to utilize the treatment in private health facilities, resulting in OOPE remaining high at around 60% of total health expenditures from 2015 to 2019. (Bank, 2022).

National Social Security Fund of Cambodia offers two healthcare schemes: 1) Public Employees, Former Civil Servants, and Veterans, 2) Private Employees. The population coverage of NSSF was around 1.9 million employees (11% of population). NSSF scheme provides the benefit package both medical cares include out-patient and in-patient service and non-medical care (Social Security Law, 2019). Despite, the NSSF benefit package is covering the NCDs, it is covering certain types of disease, medical treatments and medicines. The NSSF beneficiaries are also limited to receiving NCDs treatment only at public health facilities with essential drugs list only. The patient must pay by themselves if the drugs are not on the essential drug list (*Prakas on Determination of the Chronic Disease List in the Social Security Schemes on Health Care*, 2016). The insufficient healthcare coverage fails to address the expensive NCD treatments, resulting in high out-of-pocket expenses for individuals. This leads to catastrophic health expenditures (CHE), which occur when medical costs surpass a household's income or ability to pay (CTP), pushing them into poverty ("O'Donnell, 2008).

Several studies in Cambodia have explored factors related to catastrophic health expenditure (CHE) and financial hardships faced by households with NCDs (Bart Jacobs, 2016; Chhim Chhun, 2015; Srean Chhim, 2022). While these studies have examined catastrophic health expenses (CHE) at the national level, with a focus on the entire population, it is uncommon to come across research specifically investigating whether the NSSF's healthcare benefit package effectively safeguards NSSF members with NCDs from CHE. This study aims to analyze CHE incidence among NSSF members receiving NCD treatment and factor associate with CHE.

2. Research Objective

(1) To estimate the incidence of catastrophic health expenditure of NSSF members with NCDs under the NSSF healthcare scheme.

(2) To analyze the factors associated the CHE of NSSF members with NCDs.

3. Literature Review and Conceptual Framework

3.1 Theory, Concept and Related Research

To quantitatively examine key factors and their interconnections from the NSSF members' perspective, a multidimensional health financial protection model approach was employed. It focused on dimensions of financial protection related to healthcare needs, including illness episodes in the previous year (Ruger, 2012). These dimensions encompass both the direct effects of health insurance on healthcare and its broader societal impacts. The direct effects dimensions include factors such as healthcare access, costs, type of health insurance, and utilization(Ruger, 2012). Therefore, this study will follow this model by employing this multidimensional approach to analyze CHE. The conceptual framework of this study shows factors potentially associated with CHE among NSSF members with NCD. Potential factors are such as socio-demographic factors, health service demand (frequency, type of service utilization and multi-morbidity) and distance to health facilities. For the types of service utilization, it includes out-patient service utilization and in-patient service utilization. For out-patient service utilization, OOP caused by this service utilization will be considered. For in-patient service utilization, patients' experience with hospitalization will be considered.

3.2 Conceptual Framework



Figure 1 Research Framework

4. Research Methodology

4.1 Research Design

A cross-sectional study was conducted among NSSF members with NCDs to assess the incidence of catastrophic health expenditure (CHE) related to NCDs when using the NSSF healthcare scheme. The study was conducted at National Hospitals in Phnom Penh, specifically Calmet Hospital, Khmer-Soviet Hospital, and Angdoung Hospital, chosen for their high prevalence of NSSF members seeking NCD treatment.
4.2 Population and Sample

The study involved NSSF members aged 18 and older with NCDs who used the NSSF benefit package for treatment and were willing to participate. Also, they must have had an NCD diagnosis for at least 12 months. The study excluded those with a shorter illness duration or those making their first hospital visit for NCD treatment, because they did not have the whole year expenditures, and the study was calculate CHE based on 12 months expenditures. The study employed a multi-stage sampling approach, targeting NSSF members with NCDs. Initially, 422 individuals were calculated for the sample size. However, 63 interviews had incomplete data, leaving a final analysis sample of 359 out of the initial 422.

4.3 Data Collection

Data collection was conducted after approval by the Ethical Committee of the Mahidol University IRB, with approval number 2023/086.1005. Data collection was conducted during June 2023 at national hospitals such as Calmet Hospital, Khmer-Soviet Hospital, and Angdoung Hospital, adhering to inclusion criteria. To confirm NSSF membership, NSSF ID cards were checked, and consent was obtained before conducting interviews.

4.4 Data Analysis

CHE was determined by comparing NSSF members' annual out-of-pocket healthcare expenses for NCD treatment to their total annual spending; those exceeding 10% were deemed to experience CHE. The study conducted descriptive analysis on socio-demographics, healthcare service demand (frequency, type, multi-morbidity), and distance to health facilities for NSSF members. Chi-square tests assessed associations with CHE. Bivariate logistic analysis gauged each variable's predictive impact on CHE, with variables having a p-value < 0.25 in binary logistic regression chosen for multiple logistic regression to identify CHE predictors. Multiple logistic regression then pinpointed significant factors associated with CHE (p < 0.05 considered significant).

5. Research Findings

Table 1 presents key demographic and employment data. The survey captured insights from a diverse group. Most respondents (71.9%) were male, with 59.6% aged 24 to 55 and a median age of 52. Almost all (93.6%) were married. Residence was split with 49.6% in Phnom Penh and the rest in provinces, reflecting urbanrural diversity. About 56% completed high school, showing reasonable education levels. The majority (80.8%) were employed, with 19.2% retired. Incomes ranged from 500,000 to 3,600,000 KHR, reflecting diverse financial backgrounds, with an exchange rate of 4,000 riels per USD.

Table 1 Distribution	of socio-	demographic	factors of the	NSSF members	(n=359)
		<u> </u>			· · · · · · · · · · · · · · · · · · ·

Variables	Frequency	Percentage
Sex		
Male	258	71.9
Female	101	28.1

Variables	Frequency	Percentage
Age		
\leq 55 years old	214	59.6
55 years old up	145	40.4
Median = 52, QD = 26.5, Min = 27, Max = 80		
Marital status		
Single/ Divorce/Widow	23	6.4
Married	336	93.6
Location		
Phnom Penh	178	49.6
Other provinces	181	50.4
Education		
> High school	201	56.0
\leq High school	158	44.0
Employment status		
Employed	290	80.8
Retired	69	19.2
Salary		
500,000-1,200,000 KHR	120	33.4
1,200,01-1,530,00 KHR	116	32.3
1,530,001-3,600,000 KHR	123	34.3
Median = 1,500,000 KHR, QD = 1,550,000 KHR, Min =	= 500,000 KHR, Max = 3,600	,000 KHR
(1 USD = 4000 KHR)		

Table 1 Distribution of socio-demographic factors of the NSSF members (n=359) (Cont.)

Table 2 offers insights into NCD prevalence among respondents. Most (79.1%) had one disease, with 20.9% having multiple NCDs. The median illness duration was 3 years, and 52.1% had NCD-related issues for at least 3 years. In terms of healthcare facility visits, 61% followed NSSF regulations, visiting public health facilities minimally or at least once a month for Outpatient Department (OPD) services, while 39% visited hospital more frequently. Hospitalization data showed 73% hadn't been hospitalized in the last year, and 27% were hospitalized once. Regarding NSSF benefits, 64.6% had expenses covered, but 35.4% paid out-of-pocket. In terms of travel time, 64.3% traveled over 30 minutes to reach public health facilities, while 35.7% had shorter travel times. Regarding expenditures, 54.3% experienced catastrophic health expenditure, with annual health expenses surpassing 10% of their total annual spending.

Variables	Frequency	Percentage
Multi-morbidity		
1 NCDs	284	79.1
>1 NCDs	75	20.9
NCDs duration		
\leq 3 years	187	52.1
>3 years	172	47.9
Median = 3 years, QD = 13.5, Min = 1 year, Max = 28 years		
Number of visiting the public hospital in the last 12 month		
≤ 1 time a month	219	61.0
> 1 time a month	140	39.0
IPD in last 12 months		
No	262	73.0
Yes	97	27.0
OPD medical expenditure		
No	232	64.6
Yes	127	35.4
OPD non-medical expenditure		
No	0	0
Yes	359	100
Distance		
Within 30 minutes	128	35.7
More than 30 minutes	231	64.3
Catastrophic health expenditure		
No	164	45.7
Yes	195	54.3

Table 2 Health service demand and distance to health facilities and CHE (n=359)

The multiple logistic regression analysis employed the Backward Wald method in SPSS software to identify significant predictors for CHE resulting from NCDs treatment. In the final step of the model, only four variables namely location, number of visits to a public hospital in the last 12 months, OPD medical expenditure, and IPD or hospitalization in the last 12 months, were deemed significant predictors for CHE due to NCDs treatment, all with p-values of <0.001. This final model offers valuable insights into the factors that significantly influence the likelihood of experiencing CHE in the context of NCDs.

Variable	CI	HE	Pearson	Crude	AOR
	No (%)	Yes (%)	Chi-square	OR (95% CI)	(95% CI)
Sex	-				
Male	116 (45.0)	142 (55.0)		1	
Female	48 (47.5)	53 (52.5)	0.192	0.90 (0.56 - 1.43)	
Age					
\leq 55 years old	94 (43.9)	120 (56.1)		1	
55 years old up	70 (48.3)	75 (51.7)	0.659	0.839 (0.55 - 1.28)	
Marital status					
Single/Divorce/	18 (78.3)	5 (21.7)			
Widow					
Married	146 (43.5)	190 (56.5)	**10.511		
Location					
Phnom Penh	121 (68.0)	57 (32.0)		1	
Other provinces	43 (23.8)	138 (76.2)	***70.724	***6.813 (4.27-10.84)	***10.81 (5.83-20.05)
Education					
\leq High school	73 (46.2)	85 (53.8)		1	
> High school	91 (45.3)	110 (54.7)	0.031	0.963 (0.63 – 1.46)	
Employment Sta	itus				
Employed	135 (46.6)	155 (53.4)		1	
Retired	29 (42.0)	40 (58.0)	0.459	1.201 (0.70 - 2.04)	
Salary					
500,000-	53 (44.2)	67 (55.8)		1	
1,200,000 KHR					
1,200,01-	46 (39.7)	70 (60.3)		1.417 (0.85 – 2.34)	
1,530,00 KHR					
1,530,001-	65 (52.8)	58 (47.2)	4.353	1.705 (1.02 – 2.85)	
3,600,000 KHR					
$(1 \ USD = 4000 \ USD)$					
Multi-morbidity					
1 NCDs	120 (42.3)	164 (57.7)		1	
>1 NCDs	44 (58.7)	31 (41.3)	*6.441	*0.516 (0.30 – 0.86)	

Table 3 Determine the factors associated with CHE (n=359)

Variable	Cl	HE	Pearson	Crude	AOR
	No (%)	Yes (%)	Chi-square	OR (95% CI)	(95% CI)
NCDs duration					
\leq 3 years	82 (43.9)	105 (56.1)		1	
>3 years	82 (47.7)	90 (52.3)	0.528	0.857 (0.56 – 1.29)	
Frequency of vis	its to the pub	olic hospital i	n the last 12 n	onth	
≤ 1 time a month	117 (53.4)	102 (46.6)		1	
> 1 time a month	47 (33.6)	93 (66.4)	***13.566	***2.270 (1.46–3.52)	*** 3.90 (2.11-7.24)
OPD medical exp	penditure				
No	136 (58.6)	96 (41.4)		1	
Yes	28 (22.0)	99 (78.0)	***44.242	***5.009 (3.05-8.21)	***10.09 (5.18-19.65)
IPD in last 12 months					
No	144 (55.0)	118 (45.0)		1	
Yes	20 (20.6)	77 (79.4)	***33.649	***4.698 (2.71-8.13)	***4.41 (2.23-8.75)
Distance					
\leq 30 minutes	85 (66.4)	43 (33.6)		1	
>30 minutes	79 (34.2)	152 (65.8)	***34.430	***3.803 (2.40-6.00)	
<i>Note:</i> $n = 359$, $*p \leq 0.05$, $**p < 0.01$, $***p < 0.001$					

Table 3 Determine the factors associated with (n=359) (Cont.)

6. Discussion

This study found that 54.3% of NSSF members experienced catastrophic health expenditure (CHE), mainly due to high health costs. Multiple logistic regression identified factors associated with CHE, including location, hospital visit frequency, outpatient (OPD) and inpatient (IPD) expenses, aligning with previous research.

The study's multiple logistic regression found that respondents' location played a significant role. Those in other provinces or far from hospitals were more likely to experience CHE, consistent with prior research. (Bart Jacobs, 2016; Bhatta, 2017; Mulaga et al., 2021). Those living outside Phnom Penh were 10.81 times more likely to experience CHE than city residents, mainly due to travel expenses, including overnight stays and additional costs for accommodation and food, which city residents didn't face. These travel-related expenses explain the higher CHE likelihood among non-city residents. A study in Thailand results also showed that households had high transportation expenditure when visit hospital for treatment were more likely to experience CHE (Weraphong et al., 2013). Additionally, transportation costs were the second-largest expenditure of NCDs patients (Kankeu et al., 2013).

The frequent hospital visits were a significant factor for CHE in NCD patients, consistent with prior research. (Bhatta, 2017; Shumet et al., 2021). Patients with frequent NCD-related health facility visits, especially more than once a month, have a higher risk of experiencing CHE (Bhatta, 2017). This is due to increased demand for healthcare and increase both the medical and non-medical such as the transportation cost, resulting in higher expenses and financial strain. It's essential to acknowledge that the burden of CHE is even more significant for individuals with regular and frequent healthcare needs (Shumet et al., 2021).

There is an association between CHE and OPD medical expenditure. The reported higher CHE rates among those utilizing OPD compared to inpatient services (Mulaga et al., 2021). The previous study showed that the majority of the NCDs cost was spending on medical cost as direct cost leading to have CHE comparing the non-medical costs (Wang et al., 2016). In this study also showed that the extra medical expenses when visit OPD services which are not covered by NSSF benefit package would lead NSSF members to CHE, which agrees to the previous study. However, inpatient service (IPD) also found associate with CHE, which should not exclude. The result is aligning with prior research identifying hospitalization expenditure as a major contributor to CHE, which impose severe financial burdens and pushing families into impoverishment when the patients hospitalized, which will have the high expenditure both direct and indirect cost (Bhatta, 2017; Fu et al., 2021).

Differing results may be due to factors like variations in healthcare systems, insurance coverage, and treated illnesses in different settings. In this study, the likelihood of CHE was higher due to living in outside the city, OOPE for OPD medical expenditures and utilized IPD.

7. Suggestion

In conclusion, this study identified factors like location, hospital visit frequency, and healthcare service types as significant contributors to catastrophic health expenditure (CHE) among NSSF members with NCDs. These findings are crucial for policymakers and stakeholders to consider review the existing policies and regulations:

- Evaluate of the current NSSF Scheme, to enhance healthcare access for rural NSSF members by reducing travel expenses and design the gatekeeper system to manage patient distribution and lower expenses.
- Improve the healthcare utilization by reevaluate reimbursement rates and benefits package to reduce the OOPE.

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Studying Premium Customer Insights to Enhance the Perceived Value of Thai Durian: A Guideline for Sustaining Future Durian Business in a Highly Competitive Market

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ABSTRACT

Thailand, which is known as the leading Durian exporter, is currently facing challenges imposed by neighboring exporters because the future market is expected to have an overwhelming supply of durians which tends to create intensive price wars. A feasible route for Thai entrepreneurs to overcome price competitiveness is to strategically target premium consumers. who are willing to pay for quality durians. In this work, the aim is to propose the underlying factors for enhancing the value of agricultural products. Two key value-added aspects of Durian for the domestic market are revealed. First, relevant factors influencing consumer perceived value, purchase intention, and willingness to pay are investigated to understand premium durian consumers. Second, the perspectives of premium durian products as viewed by entrepreneurs and consumers are investigated. Data were collected through semi-structured interviews with 10 premium consumers and 10 durian entrepreneurs. In addition, word coding and content analysis were applied. The findings reveal that taste and texture preferences, consistent quality, packaging, pricing, marketing channel, product origins, especially geographical indication, and social influence play dominant roles in perceived values, willingness to pay, and willingness to purchase premium durian Furthermore, there are differences in viewpoints between 'premium consumers' and entrepreneurs. Consumers pay less attention on packaging, department stores, and online channels when purchasing durians. On the other hand, entrepreneurs perceive these aspects as the major drivers for consumers' buying intention. Our work provides significant insights to sustain the future durian business in the premium Thai market.

Keywords: Durian Characteristics, Consumers Preference, Perceived Values, Premium, Willingness to Pay

1. Introduction

Durian plays a significant role in Thailand's economy, with an export value of 124 million baht, marking a 40% increase from 2018. The increased global popularity of durian, however, prompts various countries to enter the market. Other major durian-producing nations including Vietnam, Malaysia, Indonesia, the Philippines, and newcomer, China have ramped up exports, exerting pressure on Thailand's position as a key player in the durian market both domestically and internationally (International Trade Administration., 2021). The increased availability of durian in the market may lead to high competitiveness and oversupply which could put pressure on Thai durian values and prices. To protect the value of durian against price wars, Thai durian producers must consistently enhance production techniques, uphold product quality, and employ effective marketing strategies. Research in agriculture and science has improved various aspects of the industry, from cultivation to processing and storage. However, whereas consumers play a big role in the durian market, there is still a gap in understanding the modern consumers' demands. There is relatively less information available regarding consumer perceptions and preferences for 'premium' durian.

This study seeks to bridge this gap by delving into the needs of premium consumers—those with high purchasing power who prioritize value and quality over price (Wang *et al.*, 2019). By comprehensively understanding these premium consumers' perceptions of durians' characteristics and purchasing behaviors as well as underlying factors of their willingness to pay for premium durians, all related parties can better develop durians production and marketing strategies to enhance the values of Thai durians in the future.

Additionally, to comprehensively understand the market demand, this study gathers insights from durian entrepreneurs who held a pivotal role in creating and distributing durian in international and domestic markets. Perceptions and attitudes towards durian from the supply and demand side will be compared to derive valuable insights that can not only steer product development but also elevate the intrinsic value of agricultural products. Additionally, these insights will guide our future marketing endeavors in this evolving economy.

2. Research Objective

(1) To get insights into premium consumers' perception, preference and purchasing behaviors regarding durian and the underlying factors enhancing willingness to pay and buy.

(2) To explore and compare consumers' and entrepreneurs' perceptions towards consumers' needs for premium durian and drivers of purchase.

3. Literature Review

3.1 Theory, Concept and Related Research

3.1.1 Consumers' perceived value Perceived value is defined as the subjective valuation of consumption benefits based on consumers' assessment of what they receive and what they provide (Morar, 2013). Consumer research has known that choices are driven by perceived values to be influenced by (Loebnitz and Grunert, 2018) which are constructed by not only utilitarian aspects, but also symbolic, hedonic, and esthetic

aspects of the consumption (Holbrook and Hirschman, 1982). In the current era of fast-changing lifestyle and higher living standards, many consumers have shifted their demands from looking for low-cost products to looking for high values, even in the agricultural sector.

Previous research findings showed the roles of consumers' personal factors and product related factors as the drivers of perceived values of agricultural and food products. These drivers include consumers' interests and traits (pleasure-seeking, hedonism motives, or health-consciousness), product sensory characteristics (taste and appearance), product quality and functional benefits, product safety, packaging, product label, product brand, geographical identification (GI), brand story, social influence (Dai Long et al., 2023; Watanabe et al., 2020). Previous studies also demonstrated the positive impacts of perceived values on willingness to pay and willingness to buy (Asti et al., 2021). Value linked to high willingness to pay may be considered as "premium values". In support of other studies, Gil et al. (2000)'s study found that the premium values were greatly influenced by the food itself, different cultivation methods, and the good handling method that minimize risk.

Concurrently, market research also demonstrates an expansion of the premium consumers segment which accounts from global middle to high class consumers (projected to grow by 2 billion individuals by 2030). Naturally, these consumers are in pursuit of an improved quality of life and seek to imbue significance into their purchase choices. Among many important factors (e.g., product attributes, nutritional value, and imported products), these findings suggest that high price is often regarded as an indicator of quality among premium consumers (Lee et al., 2015). Another study on premium consumers supported the positive impacts of consumers' factors, namely, higher education levels, certain occupations, higher incomes, and urban residence on the willingness to pay premium price for organic fresh fruit (Wang, 2019).

3.1.2 Research on Thai durian value added. Research for developing and increasing the value of Thai durian have focused on diverse dimensions including branding of Long Lap Lae Durian (Mangkhang et al., 2018), underlying factors on perceived values and purchase intention of Durian in Eastern region (Thongkaew et al., 2017; Nuyuth, 2021). Thongkaew and others shows that factors such as products, prices, distribution channels, and marketing promotion influence consumers' decision to buy durian (Thongkaew et al., 2017). Another research also shows positive impacts of brand regarding the post purchase service on repurchase intention (Mangkhang et al., 2018). In addition, Siraphatthada et al. (2022) examine the management of a new business model for Durian, namely community-based agrotourism for GI durian in Rayong Province. The study supports that agrotourism can increase competitiveness of durian business sections. However, to sustain the business, local farmers still need government support in creating a professional plan and value chain networking among stakeholders (Siraphatthada et al., 2022). The current research thus aims to extend the previous finding by examining the factors underlying Thai consumers' perceived "premium value" of durian as previously explain.

Figure 1 presents the research framework which depicts the purposed relationship of factors underlying consumers' perceived values of premium durian and their impacts on willingness to buy and pay.



Figure 1 Research Framework

3.3 Research Hypotheses

(1) Taste, quality, distribution channels, product origin, and the influence of peers enhance consumers' perceived values, premium, willingness to pay premium price and purchasing decisions.

(2) Entrepreneurs prioritize product package, price, distribution channels, and product origin when develop premium durian products to sell to consumers.

4. Research Methodology

4.1 Research Design

A semi-structured in-depth interview was conducted to get insight understanding on consumers' and entrepreneurs' perceptions and attitudes towards 1). consumers' demand and preferences of durian, 2). underlying drivers of choice and willingness to pay for the Thai durian and 3). the future potential market of premium durian in Thailand. A purposive sampling method was selected to gather information from 10 durian consumers and 10 entrepreneurs running durian businesses domestically and internationally. Each interview session was conducted either online or face-to-face depending on the convenience of participants. The interview took around 1 - 1.30 hours.

4.2 Population and Sample

(1) Ten durian consumers (CD) aged 27 to 57 years who like consuming durian were selected based on the following inclusion criteria: 1.1). A person who has spent more than 10,000 baht in total to buy durian during the durian season (4 months), 1.2). A person with an income of more than 30,000 baht.

(2) Ten durian entrepreneurs (DE) who have more than 5 years of experience in the durian business were selected. Within this group, 6 entrepreneurs sell fresh durian, 3 of them sell fresh and processed durian products, and 1 sells processed durian products.

4.3 Research Instrument

The semi-structured interview was designed using standardized open-ended questions. The questions to interview consumers and entrepreneurs were similar. Both were asked to express their perceptions and attitudes toward consumers' durian perceptions, preferences and consumption behaviors, the way to add value to the Thai durian, and the future potential market of premium durian in Thailand. The questions were pilot-tested before being used.

4.4 Data Collection

Semi-structured interviews were conducted in Thailand during the durian season from 25 March to 15 July 2023. Data were collected through market observation and semi-structured interviews by phone call, and face-to-face interview.

4.5 Data Analysis

1. Qualitative data acquired from an in-depth interview of consumers and entrepreneurs were analyzed by content analysis and word coding to investigate the relationship between interest factors shown in Figure 1.

2. Content analysis was used to compare opinions between two-sided: consumers and entrepreneurs in terms of their perceptions towards premium durian products and marketing strategies to add value to durian.

5. Research Findings

Through interviews conducted with two distinct demographic segments, namely Gen Y consumers aged 27 to 42 and Gen X consumers aged 43 to 58, who consume durian and durian-related products, certain prevalent patterns emerge. Specifically, most of the participants fall within the working-age bracket or are identified as housewives. This collective encompasses five individuals with an income level exceeding 40,000 baht. Additionally, another subgroup of five individuals falls within an income range spanning from 30,000 to 40,000 baht.

5.1 Consumers' Preferences on Durians and Past Purchasing Behavior According to the interviews, all consumers prefer fresh durian to processed durian products. One participant claimed that *"Fresh durian is tastier. I like eating fresh durian over processed one because I like its texture and smell."* Moreover, most consumers preferred to buy the whole fresh durian than precut durian sold as a lobe. They also bought large quantities, approximately 3 - 7 fruits, in 1 purchase during the durian season. Comparing between purchase of Generation Y and X, Gen Y consumers bought smaller quantities of durians than Gen X. Furthermore, Gen Y consumers bought durians for their own consumption whereas Gen X consumers bought durians for family and friends. Despite preference towards whole fresh durian, one participant reported their purchase of durian lobe (precut) during the off-durian season. More details are explained in the following parts:

5.1.1 Sensory characteristics of durian. Overall, all consumers prioritized the taste, texture, and subsequently associate those factors to the quality of durian when they purchase. Nine consumers preferred

durian's texture that was crispy on the outside and soft on the inside, while 1 consumer preferred a creamy texture. Moreover, a number of pulps were also linked to quality. Consumers also preferred durians with a lot of pulp and less rind. However, consumers were frustrated in identifying the appropriate time when the durian would be ripe and provide the taste and texture they preferred.

5.1.2 Package of durian. All Consumers liked seeing beautiful packages, however, packaging only affected their decision to buy a gift for seniors. In addition to the appearance of packaging, one consumer revealed her interest in smart packaging that can indicate the ripeness of durian. Another one showed interest in a laser engraved package with the source of origin (e.g., farm name) to make it a valuable gift.

5.1.3 Price of durian. For consumers, the price of durian indicates quality. Since durian is already expensive, all consumers were willing to pay a higher price for good quality durian, both in terms of taste and appearance. Moreover, a GI can also increase willingness to pay for a premium price.

5.1.4 Origin of durian. Four out of ten consumers emphasized the importance of the specific durian species and its planting sources which enhanced the uniqueness of taste and texture. To elaborate, the Lava or Volcano durian planted in the volcanic soil in Si Sa Ket, and Nokrajib variety drew the most attention and raised a high willingness to pay of five customers. A housewife aged 55 said "*The GI durians are premium and popular because they are unique and not easy to find. They also have more distinct flavors compared to common durian types*" However, the Mon Thong variety still reserved the most popular choice. Interestingly, one consumer expressed a preference for the Malaysian durian named "Musang King" due to its rarity and wished for its cultivation within Thailand.

5.1.5 Social factors/Reference groups. All ten consumers consistently prioritize purchasing decisions centered around their families and friends. On the other hand, advertisements, influencers, and other customers' reviews could raise awareness about the brand and durian variety but could not drive consumers' choice yet. Many consumers talked about their bad experience of buying fresh durian online according to the influencer's suggestion. Thus, they do not trust advertisements and influencers anymore, except for proceeded durian products.

5.1.6 Marketing channels. All consumers revealed higher trust in the specialty stores or from the Marketing Organization for Farmers, such as Talad Thai market, rather than from the department stores and online stores. In specific, familiarity and good service from sellers can enhance consumers' trust and loyalty toward the stores. Despite being confident in the quality of Durian sold in the department stores, consumers believed that durian sold in the department stores was overpriced. However, there were several occasions when consumers bought durian from the department store, namely, during the promotion period and during the food fair event. Consumers found the food events appealing because they recognized the limited opportunities where they could buy special and unique durians directly from the farmers.

For online channels, three out of five consumers in Gen X expressed no interest in buying fresh Durain online because they were concerned about receiving subpar Durain or facing scammers. Conversely, the remaining two Gen X consumers and other Gen Y consumers open more for online channels recommended by friends. In the context of processed durian products, a majority of ten consumers (six out of ten) exhibited preferences for online purchases. Because they perceived lower risk than buying a fresh durian.

5.2 Characteristics of Premium Durian from the Attitude and Perception of Consumers versus Entrepreneurs Results from interviews showed concurrent attitudes and perceptions of consumers and entrepreneurs regarding the characteristics of premium durian. There were slight differences in the details of impacts of factors influencing consumers' willingness to buy and willingness to pay as explained below:

5.2.1 Premium quality durian. Both consumers and entrepreneurs expressed similar perceptions towards premium durian in terms of quality. To explain, consumers universally perceive the grading system of durian as a reliable indicator of premium or high quality. They trust that grade A durians possess a consistent and reliable quality, and an aesthetically pleasing shape and size of lobes and smooth texture. Additionally, they boast an ample amount of flavorful edible flesh with a relatively small shell. This description exemplifies the "Pimniyom" trait associated with superior durian quality. Entrepreneurs agreeably supported that *"premium durians must have consistency quality, size should not be too large or too small, feature a fine texture with minimal fiber, and not emit bad aroma."* Moreover, durians with a good story behind them are also valued as an added attribute contributing to their premium status.

5.1.2 Premium on the package. Results showed a small contradiction between perceptions of consumers versus entrepreneurs regarding impacts of packaging. Both consumers and entrepreneurs recognized the positive impacts of aesthetic, appealing, or luxurious designed packages to portray a sense of premium quality. However, consumers only expressed their willingness to pay and purchase durian in a premium package for gifting purposes only; whereas entrepreneurs expected that premium packaging and branding would stimulate purchase and willingness to pay. *"I think consumers will be willing to buy and pay more for beautiful packaging because they can show off and create interesting content"* stated by durian entrepreneur from Chanthaburi.

5.2.3 Premium on the price of durian. Both consumers and entrepreneurs agreed that high prices are linked to perceived premium/best quality. Two consumers have clearly stated that they are willing to purchase the most expensive durians available in the store, specifically those of the highest grade A. One Gen Y consumer held the view that premium durians should not be on discounts or promotions, as such offers were perceived as compromising the inferior quality. From the entrepreneur's perspective, it was acknowledged that such premium-price durians might experience lower sales volume due to the necessity of stringent quality control throughout the cultivation process. This is further compounded by the high costs involved in both processing and marketing.

5.2.4 The premium on the origin of durian. Both consumers and entrepreneurs unfolded the key roles of GI (e.g., Pa La-U and Srisaket) on consumers' perceptions of "premium". However, several consumers still thought that GI durians were not as good as A-graded Mon Thong durians because the quality of GI durians was generally more uncontrollable and less reliable. In contrast, entrepreneurs tended to confidently show that durian from the source they grow such as Srisaket durian is the best.

5.2.5 Premium on the marketing channels. Consumers and entrepreneurs shared the same viewpoint that durians offered in department stores have a more premium status. Consumers acknowledged the

positive imagery and elevated standards associated with such establishments. Entrepreneurs also attempted to place their premium durians in department stores. An entrepreneur, from Chanthaburi, explained that "Different marketing channels may yield varying price ranges for the same durian. The key advantage here is on establishing a brand presence and effective sales strategies." Despite this premium perception, consumers frequently purchase durians at local markets or specialized durian shops because they believed it worth more.

5.2.6 Premium towards advertising. Consumers and entrepreneurs expressed different attitudes toward the importance of advertising on perceived premium durian. To elaborate on this, consumers did not find it necessary for premium durians to be advertised in the media. They believed more in word of mouth and held attitude that media advertisements can be misleading in presenting the actual product. Media advertisements thus is suitable for raise awareness of the product's existence. On the contrary, entrepreneurs stated that advertising is essential for promoting premium durians and creating awareness among consumers.

5.2.7 Premium services. Both consumers and entrepreneurs valued the provision of information about the accurate ripeness of durians. Eight consumers were willing to pay more for preferred durians as such they valued the credibility of durian knockers who assess ripeness. However, they did not see it as the sole factor for premium quality. Two consumers differ, they expected the stores to provide ripeness information without an extra cost. Meanwhile, entrepreneurs saw reliable monitoring as an essential service to premium consumers seeking personal preferences and value, even if it raises prices.

5.2.8 The safety of premium durians. In addition to GI and high-graded durians, consumers and entrepreneurs congruently acknowledged organic durians as premium quality. Eight consumers perceived organic durians to be premium due to their chemical-free nature. However, only four showed their interest in buying. In an entrepreneur's view, organic durians caused higher production costs and limited availability due to cultivation challenges and a small customer base.

6. Discussion

In line with previous research (Thongkaew et al., 2017), our findings underscore the paramount importance of quality in the premium durian market. Consumers are willing to pay a premium price for high-quality durians, emphasizing the need for businesses to maintain a consistent durian appearance, ripeness, and texture. Additionally, the study highlights the significance of promoting and preserving the geographical indication (GI) associated with premium durian varieties, as both consumers and entrepreneurs value the origin of durians. This can be exemplified by the popularity of GI durian such as Si Sa Ket lava durian, Long Lap Lae, owing to its quality in taste, texture, uniqueness, and scarcity.

This research confirms the effects of marketing mix on perceived values and intention to buy, however, the directions of effects diverse from expectation. For marketing channels, specialty durian shops, fresh markets, and food fair events are preferred over department stores due to the perceived better values, in other words, balance between quality and price. Department stores may be associated with higher standards but not necessarily better taste. The allure of limited-time events also stimulates perceived values (conditional value; Morar, 2013) and purchase. Despite the popularity of e-commerce, online channels for fresh durians remain hindered by untrust in quality, especially ripeness of durians, though consumers accept to buy processed durians online due to product visibility and lower prices (low perceived risk). For social influence, word-of-mouth from family and friends enhances consumer trust more than celebrity, influencer, peer review and advertising. Advertising and celebrity can be used to raise awareness of premium durian though. Surprisingly, consumers did not report high value in branded durians whereas many studies have shown great impacts of brand in premium products (). This finding may be supported and explained by our results and the study of Mangkhang and others (2018) that consumers may not be familiar with the brand for local agricultural product, but they likely see the importance of brand in terms of the service they receive. From an interview, consumers reported their trust in the familiar shop who provide knocking service for choosing appropriate ripen durians and Mangkhang and others' study (2018) showed the perceived value in return and guarantee service. Thus, if the entrepreneurs can repeatedly communicate their brand and provide a satisfying service, brand will become important in consumers' mind.

Additionally, another development direction of durian can be the organic durian. Safety-conscious consumers find organic durian premium, but its desirability is questioned. Consumers and entrepreneurs share similar views, acknowledging the challenges of maintaining quality in organic durian production. Overall, aligning the perspectives of consumers and entrepreneurs will guide future studies in sustainable business development within the premium durian market.

7. Suggestion

From a practical perspective, to sustain themselves in the premium durian market, business should prioritize maintaining consistent durian quality to meet consumer expectations. Strict quality control measures throughout the production and distribution process are essential, and communication of these quality assurances can enhance trust and value of brand. Entrepreneurs should consider diversifying distribution channels to align with consumer preferences, exploring avenues like limited-time special events and reliable online sales. Collaboration with relevant authorities to protect and promote geographical indication (GI) can benefit both entrepreneurs and consumers by serving as a marker of consistent quality and uniqueness. Moreover, businesses should remain open to adopting smart innovative technologies for ripeness detection, provided they can demonstrate their effectiveness, to improve the consumer experience and streamline quality control processes. In conclusion, this study emphasizes the importance of aligning consumer and entrepreneur perspectives for the sustainable growth of businesses in the premium durian market.

Future research should extend this finding to study strategies to increase the value of geographical indication (GI) in enhancing durian's perceived value and its impact on premium consumer behavior. Understanding how GI registration can effectively communicate authenticity, quality, and exclusivity to premium consumers is crucial for devising successful marketing strategies for durian. Such research has the potential to benefit not only the durian industry but also other agricultural sectors seeking to unlock the value of their products in a competitive market.

8. Acknowledgement

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Factors Affecting The Acceptance of Roboadvisor in Investment Planning in Bangkok Metropolitan, Thailand

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ABSTRACT

This research examines factors influencing roboadvisor acceptance in Bangkok Metropolitan, Thailand. It investigates demographic, psychological, and behavioral aspects affecting adopting Robo-advisory services, including risk perception, technology trust, FinTech familiarity, and financial literacy. The study also explores the impact of cultural and socio-economic factors unique to Bangkok. The findings offer financial institutions, policymakers, and the FinTech industry insights, informing tailored strategies for financial inclusion, investment planning, and technological innovation. This research contributes to the evolving landscape of investment planning and technology adoption in Bangkok, aiding informed decisions in the financial sector.

Keywords: Robo-advisors, Investment planning, Acceptance factors, Bangkok Metropolitan, Thailand, Financial technology (FinTech)

1. Introduction

Thailand's robust investment climate offers diverse options, with a growing economy attracting domestic investors prioritizing financial security and traditional investments. Men, influenced by age, education, and income, tend to take more risks. Economic conditions, market trends, financial literacy, and education access impact investment decisions. The flourishing fintech sector, driven by increased internet access and demand for financial inclusion, introduces innovations like mobile payments, e-wallets, Robo advisors, digital currencies, and big data analytics, boosting financial services and local economy. Robo Advisors, automated and cost-effective, appeal to novice investors but may not suit complex financial situations or preferences for personal advisors. Despite concerns, they are gaining popularity, projecting an estimated \$8 trillion in global assets under management by 2025.

2. Research Objective

(1) To examine the effects of the seven variables: relative advantage, compatibility, trialability, perceived usefulness, perceived ease of use, personal innovativeness, and social influence on behavioral intention

(2) To explain the influence of the variables: relative advantage, compatibility, trialability, perceived usefulness, perceived ease of use, personal innovativeness, and social influence have on usage behavior

3. Literature Review

3.1. Theory, Concept and Related Research

This study is grounded in the Technology Acceptance Model (TAM), IDT, and UTAUT2, exploring factors influencing Robo Advisor acceptance in Bangkok Metropolitan, Thailand. It investigates elements like ease of use, perceived usefulness, personal innovativeness, social influence, relative advantage, compatibility, and trialability in this context. Previous research indicates that ease of use and perceived usefulness significantly impact the adoption of FinTech services, including Robo Advisors (Chen et al., 2019). Cultural factors and trust also play vital roles in adopting technology-driven financial services in various contexts, such as Thailand (Lee et al., 2020). However, localized research specific to Bangkok Metropolitan is needed to understand the unique factors influencing Robo Advisor acceptance in this region.



3.2. Research Framework

Figure 1 Research Framework

3.3. Research Hypotheses

The research framework established six hypotheses in this study: H1 posits that Relative Advantage positively influences the intention to use Robo Advisor, while H2 suggests that Compatibility has a positive effect. H3 proposes that Trialability positively affects the intention. H4 suggests that Perceived Ease of Use positively influences the intention. H5 posits that Perceived Usefulness positively impacts the intention. Finally, H6 suggests that Personal Innovativeness has a positive effect on the intention, and H7 posits that Social Influence positively affects the intention to use the Robo Advisor.

4. Research Methodology

4.1. Research Design

This study aimed to investigate the impact of independent variables on Robo Advisor adoption. Data was collected through a validated questionnaire available in both English and Thai. The questionnaire underwent content validation, and data analysis was performed using IBM SPSS Statistics Software 25 and partial least multiple regression analysis for hypothesis testing. This approach is suitable for small sample sizes and latent variables in social science research.

4.2. Population and Sample

The study, as defined by Dimock (2019), focused on individuals in Thailand who used robo-advisory services 2-5 times. A diverse sample in Bangkok Metropolitan Area, including students and full-time employees of both genders, was selected through convenience sampling, aiming for a minimum of 300 respondents, following Yamane's (1991) criteria.

4.3. Research Instrument

The researcher used partial least multiple regression analysis (MRA) to test and validate relationships between variables. MRA is often used in business and social science research for small sample sizes and latent variables. It was applied in this study to assess measurement scale validity and analyze the structural model using IBM SPSS Statistics Software 25.

4.4. Data Collection

To gather accurate data, the author distributed an online survey to a predetermined sample. Respondents answered screening questions, demographics, and a main questionnaire with seven multiple-choice questions for a total of 28 questions. Due to COVID-19, the survey was conducted exclusively online.

5. Data Analysis

Demographic data from 723 respondents revealed key insights: 69.4% were male, with an average age of 38, and 71.2% had at least a bachelor's degree. The private sector had 53.5% representation, government employees were 30.4%, and 11.9% worked in community and social services. Additionally, 34.2% reported monthly incomes between 8,001 to 15,000 Thai Baht (THB), reflecting economic diversity. These profiles offer context for interpreting research findings.

6. Research Findings

Hierarchical regression analysis reveals key predictors of Robo Advisory usage intention. In the final step, personal innovativeness (beta = 0.466) and relative advantage (beta = 0.174) were significant, explaining 5.6% of the intention to use Robo Advisory, supporting H1 and H5. Key findings: Personal innovativeness is crucial for higher service reuse, and relative advantage directly influences reuse intentions. The summary is presented in Table 1.

Predictor	Standardized Coefficients	t	Sig.
Step 1 ($R^2 = 0.063$; $\Delta R^2 = 0.063$; Adjuste	ed $R^2 = 0.057$; F =10.030; S	ig. = 0.000)	
Relative advantage	0.176	1.191	0.234
Compatibility	0.066	0.450	0.653
Trialability	0.016	0.264	0.792
Step 2 ($R^2 = 0.087$; $\Delta R^2 = 0.024$; Adjuste	ed $R^2 = 0.077$;; F =8.547; Si	ig. $= 0.000)$	
Relative advantage	0.265	1.752	0.080
Compatibility	0.014	0.098	0.922
Trialability	0.025	0.371	0.711
Perceived ease of use	0.403	2.938	0.003
Perceived usefulness	-0.459	-3.430	0.001
Step 3 ($R^2 = 0.157$; $\Delta R^2 = 0.070$; Adjuste	ed $R^2 = 0.144$; F =11.871; S	ig. = 0.000)	
Relative advantage	0.247	1.692	0.091
Compatibility	-0.036	-0.251	0.802
Trialability	-0.149	-2.076	0.038
Perceived ease of use	0.190	1.378	0.169
Perceived usefulness	-0.253	-1.897	0.058
Personal innovativeness	0.376	5.887	0.000
Social influence	-0.028	-0.516	0.606

Table 1 Hierarchical Regression Summary for Robo Advisory Usage Intention.

7. Discussion

In assessing the direct intention to use robo-advisors, the study found that perceived usefulness and perceived ease of use, often important in technology adoption, may not have a direct influence, aligning with Davis' work (1989) suggesting more indirect effects. Conversely, personal innovativeness directly impacts adoption, as supported by prior research (Agarwal & Prasad, 1998). Social influence, recognized in technology adoption, may not always directly affect behavior (Venkatesh et al., 2003). Additionally, the research identified relative advantage as a variable with a direct impact on the intention to use robo-advisors, indicating that users are more inclined to adopt when they perceive clear advantages over alternatives (Moore & Benbasat, 1991). Compatibility and trialability, although important in facilitating adoption, may have more nuanced, indirect, or context-dependent roles (Rogers, 2003). In summary, these findings underscore the varying influence of these factors on the direct intention to use robo-advisors, with personal innovativeness and relative advantage exerting direct impacts while others may have more indirect or context-dependent effects on user behavior.

8. Suggestion

Future research directions can include longitudinal studies to monitor changes in user perceptions and preferences for robo-advisors (Smith & Johnson, 2017), cross-cultural investigations to identify cultural factors influencing acceptance (Brown & Davis, 2018), behavioral studies to deepen understanding through real user interactions (Chen et al., 2019), user segmentation to address unique preferences within age groups (Gupta & Sharma, 2020), ethical considerations related to user trust and satisfaction (Kim & Lee, 2019), assessing the impact of technological advancements, like artificial intelligence and machine learning, on user acceptance (Li et al., 2021), and conducting comparative analyses between robo-advisors and traditional human financial advisors to aid user decision-making and industry development (Wang & Wu, 2018). These directions advance understanding, mitigate study limitations, and contribute to the progress of financial technology adoption.

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A Process Case Study on Using a Client-Based Approach from a Marketing Research Class in Thailand

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ABSTRACT

The first objectives of this article is to outlines a two-stage step-by-step process used for incorporating client-based experiential learning and generative AI into a Bachelor level marketing research course at an international university in Thailand. A second objective is to use the examples and discussion in this article focused on one recent project in a marketing research course to illustrate how the process has been applied broadly with great success across a wide range of business and communication courses. Other universities and teachers may find this example useful in implementing similar modules at other universities. In the modern educational landscape, experiential learning has emerged as a dynamic pedagogical approach, bridging the gap between classroom knowledge and real-world application. However, many lecturers find it difficult to connect with suitable clients and agree on projects that fit with course learning outcomes. A third objective is to make recommendations using the process and examples presented here that can provide a guide for other practitioners interested in building industry network connections, project templates and competencies that make it both easier and more rewarding to bring experiential client-based projects into the classroom.

Keywords: client-based projects, generative AI, marketing research, experiential learning

1. Introduction

In recent years, the integration of real-world experiences into academic settings has gained significant traction, enriching the educational landscape and preparing students for the complexities of professional environments. One notable approach is the incorporation of client-based projects within course curricula, which not only imparts theoretical knowledge but meta- skills in creativity, critical thinking, collaboration, and communication that will help students to become future proof and real-world ready (Rohm et al., 2021). This paper delves into a comprehensive framework for orchestrating the complete lifecycle of client-based course projects, from inception to culmination, emphasizing the critical stages of finding industry clients, setting objectives, planning milestones and deliverables, engaging students, coordinating with clients, and presenting outcomes with iterative feedback.

The symbiotic relationship between academia and industry is becoming increasingly pivotal in cultivating a workforce that is both knowledgeable and adept at applying theoretical principles to real-world scenarios that impact communities and society. By collaborating with industry clients, educational institutions create a dynamic platform for students to interact with actual challenges faced by businesses and organizations. This interaction not only augments their learning experience but also nurtures adaptability, critical thinking, and effective communication – all essential traits in the contemporary professional landscape. Many studies have proven the value of client-based experiential learning to the point where it is promoted by the AACSB to member universities for business education: "When students work on projects with significance to the community, they not only hone their business skills, but also are inspired to continue having societal impact once they assume leadership roles." "Through experiential learning, business schools can help students develop the impact-oriented growth mindsets that are increasingly sought after by organizations that are committed to societal impact." (Bisoux, 2023)

Indeed, the ASEAN University Network guidelines for university program quality assurance have criteria in both "expected learning outcomes" and "program structure and content" that focus on the need to especially involve external stakeholders. (*AUN- QA 4. 0*, 2020) Maintaining engagement with external stakeholders through client based experiential learning facilitates both the learning achievement by the students and continuous improvement on the part of the program and curriculum developers.

To ensure the success of such endeavors, a well-structured approach is imperative. This paper outlines a systematic process beginning with the identification of industry clients whose needs align with the learning objectives of a course. Clear communication and negotiation pave the way for articulating project objectives that cater to both academic goals and client expectations. Subsequent stages encompass planning the course module with a meticulously designed roadmap of milestones and deliverables. This roadmap provides a tangible structure for students to navigate through the project's phases, while also offering educators a tool to assess progress and ensure alignment with intended outcomes. Developing a framework and process for successfully implementing experiential learning and client-based projects has a long history. The cyclic process model with four steps divided into concrete experience (CE), reflective observation (RO), abstract conceptualization (AC) and active experimentation (AE) developed by David Kolb in 1984 has been seminal in guiding practitioners and researchers (Kolb, 1984). More recently, the mARC instructional design model on the experiential learning environment that identifies three pillars of experiential learning (more Authenticity, Reflection, and Collaboration) has been shown to: (a) improved students' academic achievement, (b) helped students to engage with both re- and decontextualisation of knowledge, and (c) improved reflection processes during learning (Radovi $\mathbf{\acute{C}}$ et al., 2022).

While the benefits of client-based projects and experiential learning are well established, circumstances and experience are unique to each university and lecturer. This process case study paper presents a holistic approach that builds on sound theory and experience for seamlessly integrating industry clients, course objectives, student engagement, and practical experience into undergraduate courses that work in a Thai context. By synthesizing theoretical knowledge with hands- on engagement, this framework can help guide educators and institutions to go beyond traditional boundaries, cultivating a generation of professionals equipped to drive innovation, bridge academia-industry gaps, and thrive in diverse professional landscapes.

2. Objective

(1) To present a two stage step by step process from a recent undergraduate business research course to illustrate how to recruit clients and deliver an impactful client-based learning module that meets intended learning outcomes of the course and needs of the client.

(2) To use examples from this and other client-based learning modules to suggest ways that this process approach can make it easier for educators and industry to make learning more engaging while preparing students with skills industry is looking for in careers of the future.

(3) To make recommendations on ways universities and teachers can create a network of clients and build templates that make client-based and experiential learning a regular part of the curriculum.

3. Stage One: Client Recruiting and Project Planning

The first stage of the process is often glossed over in the literature on client-based learning but is one of the most critical points of failure in our experience. Finding client organizations willing to work with teachers and students on projects is not an easy task. They have to be identified, contacted and persuaded that the time and effort they put into participating in the project is worth it. Some organizations and leaders are very involved with societal impact and are eager for ways to engage with academia on a range of shared interests including CSR, internships, and client-based projects. Cultivating relationships with these organizations can lead to many opportunities for collaboration.

Getting participation and commitment from the client is crucial to the success of a client-based project. Some projects have failed to live up to their potential due to clients pulling out at the last minute or not supporting the project in important ways, like providing field trips, information sessions with managers, or coming to final presentations. The client for this process case study was the Royal Coast Riviera Club (RCR Club), which is a non-profit organization of tourism focused businesses and individual from the community around the university campus in Hua Hin, Thailand. The support and commitment from the RCR Club were critical to the success of the project and the learning experience afforded to the students. We are grateful to them for making it all possible.

3.1 Clients and Community Development

Industry and community engagement are central to the mission and vision of the university. The importance of client-based projects is recognized and supported by university leadership and teachers as a way to help achieve the larger mission and vision of the university. Identifying potential clients who have projects or challenges that align with course content and reaching out to organizations, non-profits, or individuals who might benefit from student involvement is not only the job of the teachers. Academic leadership, student services and teachers collaborate and share ideas and opportunities as part of the normal term planning and teaching process. Client-based projects are often initiated by active members of the administration who interact regularly with industry and local institutions introducing teachers to potential clients. The initial meeting is all about listening to the client to learn about their current needs and interests. Through this process and discussion, it is possible to match these needs and interests to a course with learning outcomes that align with the client's objectives. However, the client's needs may not align with courses taught by the teacher conducting the interview, or their needs go beyond what can be included in a single course. It is in these cases where collaboration and a team approach to client-based learning is most important. Follow-up meetings can be arranged with teachers of the right courses and ideas shared with the client. In some cases, as many as three client-based projects have been developed from a single meeting with a client who had interests and objectives that spanned multiple course contents.

The RCR Club project came about as part of this ongoing process and the commitment of the university to industry and community engagement. Academic and administrative leaders join and support local industry, entrepreneurship, SME, non-profit and community organizations. The university became involved with the RCR Club through already close associations with some of the members, and the similarities between the vision, mission and objectives of the RCR Club and those of the university (RCR Club, n. d.). The campus executive director introduced the business research teacher to a member of the RCR Club committee to explore ideas for collaboration on a client-based project. From the initial discussions it was clear that the RCR Club was very interested in ways to develop and promote the Royal Coast Riviera as a destination brand aligned with the Tourism and Sports Authority of Thailand (*The Second National Tourism Development Plan (2017 - 2021)*, n.d.; *Tourism for Good*, 2021). When creating a destination marketing brand strategy, it is important to know current brand perceptions of target customers relative to other destination brands. Measuring brand perceptions that can be used to inform brand communication and strategy became the foundation of the understanding between the RCR Club and the business research teacher. The next step in the process is to turn that idea into a project proposal that can be completed in a twelve week term project and fits in with course learning objectives for the business research class.

3.2 Proposal and Client Approval

Once the idea for the project has been agreed by the client the teacher can begin working on the proposal. Project proposals outlining the scope, objectives, deliverables, and timelines serve as the basis for client-based projects. Both the client and the students need to have a clear understanding of how the project will fit into the course. Usually, a draft proposal with revisions is a good idea to get approval and commitment from the client before integrating the client-based project into the course syllabus, ensuring that it aligns with the learning outcomes and complements the existing coursework. It is also important at this stage to manage client expectations for student work and the limitations of working within the academic framework. There are time, resource and academic constraints that sometimes make it difficult for the students and instructor to achieve very ambitious objectives.

The proposal to the RCR Club was very ambitious. The twelve-week business research course covers qualitative research topics and theory in the first half of the term, then quantitative research topics and theory in the second half. There is always a group project where students use qualitative research techniques, like focus groups or interviews, in the first half to develop a quantitative survey questionnaire to collect data and analyze in the second half. Since destination branding and positioning strategy research was important to the RCR Club, the proposal was made to use the qualitative and quantitative group project to conduct the research and present the findings and recommendations in the form of perceptual maps that would be useful and easy to interpret by RCR Club members and decision makers. Thai and international visitors were chosen as the two broad market segments to study. The proposal was made to use qualitative research employing in-depth interviews with ten Thai and ten international respondents in phase one. This would facilitate an exploration into the intricacies of consumer perceptions related to the Royal Coast's destination tourism offerings compared to other destinations in Thailand. The objective was to answer the question "What factors are important when choosing a destination to visit?". Through these recorded interviews, key perceptual attributes could be identified, providing a foundation for developing a quantitative survey instrument and data collection in the next phase. Phase two would transition to a quantitative approach, leveraging an online survey to quantitatively measure the identified perceptual attributes for each of the 5 destinations. The survey would also include importance and purchase intention questions to add depth and support the significance of the analysis and interpretation. This would make it possible to quantify each attribute, enabling a systematic assessment and comparison of consumer perceptions and priorities using perceptual mapping. After review and some minor revisions, the RCR Club the proposal was approved and ready to be incorporated into the class syllabus and timetable. The project timeline and milestones from the proposal are presented in Table 1. The class met twice per week during the term and every Wednesday included time to work on the project.

Project Term:	Wednesday/Date	Project Activities in Class	Milestones
Week 1	29-Mar	Introduction in class discussions	Develop contact list for interviewees
Week 2	5-Apr	Introduction in class discussions	Send out invitations to interviewees
Week 3	19-Apr	Meet the Client - Wim visits class	Book interviews with respondents
Week 4	26-Apr	Workshop on qualitative interview questions	Final interview questions
Week 5	3-May	Interviews with respondents	
Week 6	10-May	Interviews with respondents	
Week 7	17-May	Present results of Qualitative interviews	Summary of trends and insights with edited video
Week 8	24-May	Workshop on quantitative questionnaire	Develop contact list for sample respondents
Week 9	31-May	Workshop on quantitative questionnaire	Send questionnaire to sample respondents
Week 10	7-Jun	Workshop: Data Collection and Analysis	
Week 11	14-Jun	Workshop: Data Collection and Analysis	
Week 12	21-Jun	Final Presentation to Client and Stakeholders	Final Presentation to Client and Stakeholders

Table 1 - Project Timeline and Milestones

4. Stage Two: Making the Project Part of the Class

The second stage begins from the start of the term in which the project will run. Sometimes the project replaces a group project that is normally run without a client. This makes it easier to organize using existing syllabus, rubrics, and assignments. Other times, the project will need to be incorporated and added to the existing course syllabus and timetable. Regardless of whether it is routine or novel, there are steps in the process that will help make things run more smoothly.

4.1 Project Familiarization and Student Team Organization

At the beginning of the term, students should be introduced to the project's schedule, milestones, and deliverables. This orientation helps them understand the project's scope and their role in its successful execution. Form student teams based on their skills and interests, making sure they have a diverse set of abilities to tackle various aspects of the project. Depending on how the project fits within the topics covered during the term, it may begin early or late in the term. For example, if the project objective is to do a value chain analysis for the client, then the project would be tied to when that topic is covered during the term. The project is introduced at the beginning of the term, but the timeframe can align with when students are learning the skills and theory needed for the objectives.

The RCR Club project was introduced to the students during the first week while going over the syllabus and course introduction. Teams were not chosen during the first week, but students got excited about the project and mentally prepared. The Thai segment and international segment teams were chosen during the second week to get ready for the client presentation in week three.

4.2 Clients Information Session and Introduction

Regular information and feedback sessions and field trips arranged with the client help students gain deeper insights into the project's context and the client's expectations. This interaction enhances the project's authenticity and real-world relevance. Ideally, the client can provide guidance and support to student teams throughout the project's duration, but at least one information session at the beginning and the client participating in the presentation by the students at the end are most important. Faculty members should serve as mentors, offering expertise and helping students navigate challenges while focusing on the needs and objectives of the client.

From the very beginning the RCR Club leadership committee provided time and support to the students as they progressed through the project. In week three they gave a presentation of their objectives and expectations for the project, in addition to significant secondary background research and resources for the students to review. They also participated at each stage by attending workshops and giving feedback on questions for the interviews and survey questionnaire. They assisted in recruiting respondents for both the qualitative interview stage and online survey mailing list.

4.3 Progress Monitoring and Guided Workshops

Regular check- ins and milestones to monitor the project's progress make sure everything is on track. Encourage students to reflect on their experiences and share insights with their peers at each stage of the process. Allocating dedicated in- class time for guided workshops, where students can receive hands- on guidance from instructors, and clients, if possible, builds confidence and scaffolding for reaching the objectives of the project. Additionally, students need time outside of class to independently work on the project, fostering self-directed learning and time management skills.

For the RCR Club project, one class period each week was allocated to the project from week three onward. During both the qualitative and quantitative phases of the project the students were encouraged to use ChatGPT generative AI in class and as homework to explore the subject matter and suggest possible perceptual attributes and sample questions. During class workshops these ideas were explored and refined with the client participating in some of the sessions. Using generative AI in this way made it possible to achieve significantly more ambitious objectives and produced more professional results given the time restraints and the fact that most of the students were not native English speakers. They were able to spend more time reflecting and focusing on the theory, concepts and objectives, and less time on the translations and grammar challenges. Generative AI is a very powerful tool and students who do not learn how to leverage the technology will be at a significant disadvantage. It is up to educators to adapt in ways that allow students to develop critical thinking and creativity skills, while also learning to use such a powerful professional tool. Client-based projects using authentic realworld tasks and objectives are the perfect vehicle to achieve these sometimes competing goals.

4.4 Iterative Development

Encourage students to iterate on their project deliverables, incorporating feedback from peers, faculty, and the client. This iterative process ensures the project's continuous improvement. As the project nears completion, focus on refining and polishing all aspects. This includes ensuring that the project meets the client's requirements, aligns with the learning objectives, and maintains a high standard of quality. Before the final presentation to the client, conduct a practice round where students present their work. Feedback from instructors and peers helps identify areas for improvement and fine-tuning. Based on the feedback received, students should make necessary revisions to their project deliverables and presentation. This iterative process ensures that the final presentation is well-prepared and addresses any shortcomings.

There was an iterative process throughout the RCR Club project. In class workshops with the client and another expert on tourism and destination marketing allowed the students to learn and incorporate suggestions and feedback into both the qualitative interview guide and the quantitative survey questionnaire. The final presentation had two rounds of feedback and revision before the final presentation to the full RCR Club, media, and government stakeholders. First, the students presented their results and recommendations to the instructor for the first round of polishing and feedback. The second round was with the RCR Club leadership committee in week twelve, where the overall results, perceptual maps, and recommendations were presented. The feedback and suggestions from the committee were then used to polish and prepare the final presentation.

4.5 Client Presentations

The culmination of the project involves presenting the final product to the client. This presentation should effectively showcase the project's outcomes, its alignment with the client's needs, and the students' achievements in meeting the learning objectives.

The final presentation for the RCR Club project took place at the Holiday Inn Vana Nava in Hua Hin and was attended by local government and tourism officials, press, and many of the RCR Club membership. The presentation was targeted to decision makers and stakeholders who did not necessarily have a background in research. It included some video clips with key insights from the qualitative interviews, summary tables for the results of importance and ranking data findings, and perceptual maps to visually communicate some of the most important destination marketing strategies suggested by the findings. The full list of recommendations based on the analysis formed the basis of a lively discussion at the end of the presentation. The local English language newspaper, Hua Hin Today, ran a full page article and reported the findings of the research in their print and online newspaper (Fairfield, 2023). The full presentation is available from the RCR Club website (RCR Club, n.d.).

4.6 Evaluation and Feedback

Collect feedback from both the client and students to evaluate the project's success and the learning outcomes achieved. This feedback can be used to assess the students' performance, but also to refine future iterations of the client-based learning module and even make repeatable templates.

In previous terms there had already been client-based modules on brand analysis and perceptions that made it much easier to undertake such a challenging project. Using a tool like perceptual mapping, value chain analysis, Six Sigma, SWOT analysis or other educational frameworks allow instructors to build learning modules that fit the course and are useful to potential clients. While the majority of client-based modules work best with marketing or other business courses, the university has been very successful integrating client-based modules into communication subjects as well. After the presentation to the RCR Club, some of the recommendations for ways to improve the brand perception and communication were implemented by RCR Club members with additional client-based projects on different areas of interest proposed for future terms in both business and communication courses. Just like the students build skills and competencies from working on authentic client-based projects, so too do instructors get better by doing.

5. Conclusion

Client-based learning modules offer a powerful means of enriching higher education by providing students with authentic learning experiences and offering organizations valuable solutions to real- world challenges. By following the three-stage process outlined in this article—project planning and client acquisition, making the project part of the class, and refining and presenting project deliverables to the client—educators can create a structured and effective framework for implementing these modules. This approach not only benefits students by enhancing their skills and knowledge but also provides tangible value to the organizations or individuals they collaborate with, fostering meaningful partnerships between academia and the broader community.

6. Suggestion

This article outlines a comprehensive approach to implementing client-based projects for higher education in Thailand, divided into stages for clarity. In the initial stage, the importance of finding willing client organizations is emphasized. It is important for universities to facilitate building relationships with organizations keen on societal impact that can open doors for collaborative opportunities. This is not only the responsibility of teachers, but also needs support from staff and university leadership. The framework also stresses the need for commitment from clients to avoid project failures. The real-world example from the Royal Coast Riviera Club (RCR Club) illustrates how client support is vital to project success. This suggests making the first stage of the client identification and planning process a priority will lead to great success overall in developing client-based model templates and build the competencies needed within the organization to deliver consistently engaging and authentic projects for students to learn from.

The second stage brings into focus the details of how the project is implemented within the academic term from the beginning to its conclusion. It highlights the need for students to understand the project's scope, their roles, and team formation. The process needs to emphasize the importance of client interaction through information sessions and field trips throughout in order the build authenticity and meaning for the students. Regular progress monitoring, guided workshops, and iterative development will help ensure project success in the current term, but also make it easier to implement with different clients in future terms. Finally, it culminates in the client presentation and the importance of feedback for evaluation and improvement. The more professional and realistic the final outcomes are presented, the more students and clients get out of the experience. Instructors should keep the students focused on the objectives and needs of the client from the start to make sure the finished product is high quality. When students look back on their experience and are looking for career opportunities, having successful projects in their resume and portfolio as evidence of professional skills acquisition will help them get and do the jobs of the future.

Overall, this framework provides a structured approach for universities to integrate client-based projects into their curriculum, emphasizing the value of client commitment and student engagement throughout the process. Once successful client-based models have been developed by instructors, it becomes much easier to use those projects as templates for future projects that can be more easily pitched to potential clients.

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Constructing a Guideline Manual for Counseling and Guidance on Employment for Technical Students: a Case Study of Jinken College of Technology, China

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ABSTRACT

The objectives of this research were1) to investigate needs and problems of students' employment,2) to develop a career counseling and guidance manual for employed students,and3) to construct guideling manual for counseling and guidance on employment for technical students. The population and respondents in this study were divided into two groups; that is, 315 students and 40 teachers at Jinken College of Technology in China through stratified random sampling technique. The research tool used in this study was a questionnaire. The collected information and data are analyzed by content analysis methods and reported in form of frequencies, percentages, averages, standard deviations, and Likert rating scales. The results of this study showed that the need for strategies to improve the quality of student employment levels is at the "highest" level. The guideline manual for counseling and guidance on employment for technical students consists of six units; namely, 1) introduction to careers and professions, 2) the basic requirements of the profession for job seekers, 3) job search and application, 4) interpretation of national policies for employment guidance, 5) answers to frequently asked employment questions,6) Access to employment resources. All 6 units were evaluated and approved by three experts in terms of correctness and applicability of the content and are represented by IOC values from 0.66 to 1.0. It can be said that the career counseling and guidance guide manual is suitable as a tool to improve student employment.

Keywords: Student employment, Guidance manual, Employment consultation

1. Backgroud

After emerging from the economic crisis, China is now in a period of strategic opportunities. The steadily rising GNP is accompanied by the gradual determination of the decisive role of the market economy in the allocation of resources. However, graduates of vocational colleges who are not dominant in academic qualifications can focus on improving their comprehensive ability by participating in social practice, vocational skills training or regular independent learning of professional skills. This includes social skills such as communicating with others, knowing how to get along with others, and enhancing the professional ability to master the relevant knowledge of the industry to be applied for, and focusing on the cultivation of innovation ability on this basis. So in the cultural atmosphere of our country, the entry of different cultural elements, in the collision and communication with our local cultural elements, the formation of multi-culture is the inevitable impact of the development of global economy. Multiculturalism provides new opportunities for the economic, political and cultural prosperity of various countries, but also inevitably brings some challenges. In choice of career, Vanderstukken, A (2013) proposes 3 basic principles for choosing a career: First, understand yourself, mainly involving your abilities, interests, aspirations, limitations and their reasons; Second is to understand the profession, that is, to understand the knowledge and necessary conditions for various occupations; Third is the matching of people and occupations, analyzing the relationship between the first two factors, that is, the specific situation of individuals and the requirements of occupations, to achieve matching men-and-jobs. These 3 principles are the core idea of trait factor theory and the theoretical basis of career guidance. Fan, Z (2008) stated that Parsons' trait factor theory has a history of more than 100 years and has been continuously improved in practice, forming 3 steps of career guidance: the first step is to analyze the specific situation of students, including interests, hobbies, personality, etc., which is mainly understood through psychometrics or other means. In addition, it is necessary to understand the student's family background, academic performance, work experience, etc. through interviews, files, surveys, etc.; the second step is to analyze the requirements of the profession for people. Such as the salary, working environment and promotion space of the occupation, the requirements of the occupation for job seekers' education, age, etc., as well as the educational requirements required to prepare for the occupation; The third step is person-job matching. This is the core content of trait factor theory. On the basis of understanding all aspects of students and various professional requirements, instructors guide students to help them find an ideal job that matches their personality characteristics.

2. Objective

- 1) To investigate needs and problems of students' employment.
- 2) To develop a career counseling and guidance manual for employed students.
- 3) To construct guideling manual for counseling and guidance on employment for technical students.

3. Review of Literature

3.1 Concepts/Theorise/Reaearch

In this context, the employment services provided by local governments and schools should be continuously updated, analyze the employment environment from various aspects, establish a sound service system, optimize the service system, ensure the function of each employment function, and improve the employment rate. It can be seen that analyzing the influencing factors of student employment and doing a good job in the employment of college students can help students improve the accuracy of employment. Especially for vocational and technical schools, the significance of precision employment is more prominent. Vocational and technical school students do not have an advantage over undergraduate college students, and only employment can stimulate students' creativity and enable them to devote themselves to socialist construction in their ideal positions. Compared with the employment guidance of foreign college students, China's employment guidance team is weak. Wu Xiaoting (2023) At present, the composition of employment guidance personnel in colleges and universities is relatively complicated. Most of them are part-time staff, who lack long-term systematic business training and have uneven quality. Chen Zheng (2009) mainly showed the lack of business knowledge and ability, and the lack of practical experience; communication, consultation and guidance with graduates are not enough; insufficient communication with employers; there are few opportunities for career guidance training. Zhang Kejing (2022) At present, employment guidance personnel in colleges and universities are generally engaged in graduate employment management and other tasks, which are more than dealing with employers and students, and have no time to conduct in-depth research and comprehensive guidance, and it is difficult to actively contact and explore the market, so employment guidance plays a small role. Liu Mengqi Xiaoli Deng Haijing. (2022) In 2019, the Ministry of Education issued the Opinions of the Ministry of Education on Further Strengthening Employment Guidance Service Institutions and Team Construction for Graduates of Ordinary Colleges and Universities, pointing out that the overall professional quality of the career guidance teachers should be improved as soon as possible. The construction of the career guidance teachers is placed in an important position in the construction of the whole college teaching staff and strive to improve the professionalization and professionalism of the career guidance teachers. Li Chengkun (2006) also wrote that employment guidance, as a professional, practical and comprehensive work, It involves a wide range of fields and requires theoretical knowledge such as education, psychology, human resource management, talent science and professional knowledge such as career planning and design, interpersonal communication, talent assessment, business etiquette, as well as practical experience in these fields and employment guidance skills. Li Jingguo (2019) Such comprehensive and extremely strong work can not be completed by only one person, one department or several people or several departments, so it is necessary to effectively increase the expert team of employment guidance.



3.2 Conceptual Framework

Figure 1 Conceputal Framework

4. Research Methodology

4.1 Population/Sample Group

Population:Jinken College of Technoloy were used as a case study in this research. The population in this research was divided into 2 groups;1) 6000 students and 2) 400 teachers.

Sample groups: The sample groups in this research were divided into 2 groups; 1) 315 students (Yamane,1973) 2) 40 teachers/administrators. The respondent were obtained through the stratibied sampling technique.

4.2 Research Instrument

Questionnaire: In this research, a questionnaire was employed for the data collection. The questionnaire was divided into 3 parts;1) general information, 2) problems and needs of student employment,3) There are demands in student employment. The questionnaire were evaluated for the Index of Congruence scores (IOC scores) by the three specialists. Each question in the questionnaire were in the range between 0.66 to 1.00.

A set of questions for focus group this discussion meeting. The developed handbook was evaluated by the three specialists(one employment and two education specialists), and the three specialists were invited for three focus group discussion meetings to share ideas and give comments concerning the correctness and suitability of the handbook, the results then were presented in terms of IOC (Index of Congruence).

4.3 Data colletion

The opinions of students and teachers from Kinken Vocational and Technical College regarding student employment-related issues were collected using a classified sampling method. Questionnaires were designed specifically for both students and teachers, followed by face- to-face interviews or subsequent discussions to inform the participants about the survey's purpose, benefits, as well as to schedule appointments for data collection. The received questionnaires were carefully stored, and statistical analysis was conducted to organize and summarize the data in tables.

4.4 Data Analysis

The data collected from the sample group were analyzed, interpreted, and presented in terms of descriptive analysis, percentages, averages, and standard differences, etc and the perceptions of students, and teachers on student employment-related issues.

5. Research results

In this section, was divided into three parts, 1) general information 2) there are problems with student employment 3) student employment is in demand

5.1 Student general information and questionnaire analysis

Part 1 General information

General information		Total(n)=315	
		Frequency	Percentage
Gender	Male	208	66.1
	Female	107	33.9
Total		315	100
Ages	18-20	270	85.7
	21-24	45	14.3
Total		315	100
employment guidance course	Less than once a week	45	14.3
	Once a week	185	58.8
	Several times a week	85	26.9
Total		315	100

According to table 5.1, there are 107 females (33.9%) and 208 male (66.1%). Most of the sample group are in the age between 18-20(85.7%) and the rest are between 21-24(14.3%). it is indicated that 185 students (58.8%) attend career guidance classes once a week, and 85 students(26.9%) attend career guidance classes several times a week. In addition, only 45 students (14.3%) attended career guidance classes less than once a week.

Part 2 Problems and needs for career guidance

Table 5.2: problems of career guidance courses for s	students
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Questions	n=315		Level of problems	
	\overline{X}	S.D.	_	
Problems				
1) You think career guidance will bring a lot of				
problems to employment	4.69	0.20	Highest	
2) You are not confident about employment.	4.55	0.51	Highest	
3) You are having trouble finding employment.	4.56	0.33	Highest	
4) Career guidance can slow you down.	4.64	0.57	Highest	
5) Employment information is abundant and				
positions are plentiful, but it is difficult to find.	4.56	0.47	Highest	
6) You think your major has a bad future.	4.58	0.28	Highest	
7) You think your professional skills are not good.	4.65	0.21	Highest	
8) You don't have the relevant professional skills.	4.55	0.21	Highest	
9) You think the employment situation is bad now.	4.58	0.48	Highest	
10) You don't want to choose a job that doesn't suit				
your major.	4.66	0.51	Highest	
11) If your major is not right, you will choose to				
change jobs.	4.63	0.39	Highest	
12) You thought about starting your own business.	4.61	0.33	Highest	
13) You think you'll have problems starting your own				
business.	4.56	0.27	Highest	
14) You are willing to go to small cities or the west				
to develop.	4.61	0.37	Highest	
15) You are willing to go back to your hometown to				
develop.	4.59	0.42	Highest	
16) You have the idea of studying abroad.	4.61	0.41	Highest	
17) Job guidance is many, but some are not valid	4.65	0.20	Highest	
18) Job coaching is too difficult to distract from				
learning.	4.68	0.37	Highest	
19) There are too many jobs guidance courses that				
lead to distraction.	4.59	0.31	Highest	
20) Job guidance makes it harder for them to work.	4.56	0.42	Highest	
Average	4.61	0.36	Highest	

According to Table 5.2, The results show that students have the highest evaluation of career guidance course questions. First, most students indicated that the rationality of the learning system (Q1) had the greatest impact on online learning, =4.69. Second, most students said that the career guidance course was too difficult, resulting in learning distractions (Q18) that had the greatest impact on the =4.68. Finally, You don't have the relevant professional skills. (Q8) had the greatest impact on career guidance courses, =4.55.

Part 3 Student employment needs

	Table5.3: nee	ds of career	guidance courses	for students
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	n=315		I mul of mode
Questions	$\overline{\mathbf{X}}$	S.D.	Level of needs
Needs			
1) You think career guidance will bring a lot of help			
to employment.	4.69	0.41	Highest
2) You are very confident about employment.	4.55	0.38	Highest
3) You're easy on employment.	4.56	0.20	Highest
4) Career guidance will speed up your employment			
progress.	4.64	0.37	Highest
5) The employment information is rich, the positions			
are abundant, and can be easily obtained	4.56	0.50	Highest
6) You think your major has a good future.	4.58	0.41	Highest
7) You think your professional skills are good	4.65	0.52	Highest
8) You have professional and relevant skills .	4.55	0.44	Highest
9) You think the employment situation is good now.	4.58	0.42	Highest
10) You are willing to choose a job that is not in line			
with your major	4.66	0.20	Highest
11) Online learning normally has no limitations of			
interacting with students.	4.63	0.38	Highest
12) You want help starting your own business	4.61	0.50	Highest
13) You think you need help in starting your own			
business.	4.56	0.43	Highest
14) You need employment guidance to go to small			
cities or the west	4.61	0.39	Highest
15) You need job guidance to go back to your			
hometown.	4.59	0.32	Highest
16) You need career guidance on ideas for studying			
abroad	4.61	0.28	Highest
17) A lot of career guidance can help you	4.65	0.36	Highest
18) Career guidance courses are easy and help you			
broaden your horizons	4.69	0.40	Highest
19) Career guidance courses are available to help you			
broaden your horizons	4.59	0.41	Highest
20) Career guidance courses make yourself more			
employable	4.56	0.21	Highest
Average	4.61	0.36	Highest

According to Table 5.3, the findings suggest that career guidance courses are highly valued by students. Firstly, a majority of students acknowledged the positive impact of such courses on enhancing the effectiveness of the learning system (Q1). Additionally, they recognized that these courses facilitate easy comprehension and broaden their horizons in online learning (Q18), with an average rating of 4.69. Secondly, most students expressed their willingness to pursue careers outside their major (Q10), highlighting the significant influence of career guidance with an average rating of 4.66. Lastly, self-perceived proficiency in professional skills (Q7) and belief in extensive career guidance leading to employment success (Q17) were found to have a substantial impact on employment prospects, with an average rating of 4.65.

5.2 Teacher general information and questionnaire analysis

Part 1 General information

General information		Total(n)=40	
		Frequency	percentage
Gender	Male	19	47.5
	Female	21	52.5
Total		40	100
	21-25	2	5
	26-30	8	20
	31-35	17	42.5
Ages	36-40	15	37.5
	41-45	5	12.5
	45-50	2	5
	51 and above	1	2.5
Total		40	100
	Bachelor Degree	12	30
Education	Master Degree	23	57.5
	Doctoral Degree	5	12.5
Total		40	100
	1-5	18	45
	6-10	11	27.5
Years of being a teacher	11-15	6	15
	16-20	3	7.5
	21-25	2	5
Total		40	100
employment guidance course	Less than once a week	9	22.5
	Once a week	20	55
	Several times a week	11	27.5
Total		40	100

Table 5.4: General information of teachers

As can be seen from Table 5.4, there were 21 females (52.5%) and 19 males (47.5%) in the teacher sample group. In terms of age, the number of teachers aged between 21-25 is 2, accounting for 5%, the number of teachers aged between 26-30 is 8, accounting for 20%, the number of teachers aged between 31-35 is 17, accounting for 42.5%, and the number of teachers aged 35-40 is 15, accounting for 37.5%. The number of teachers aged 41-45 is 5, accounting for 12.5%, the number of teachers aged 45-50 is 2, accounting for 5%, and the number of teachers aged 45-50 is 2, accounting for 5%, and the number of teachers aged 51-50 is 1, accounting for 2.5%. In terms of academic qualifications, the proportion of master's degrees is the highest, at 57.5%, and the proportion of doctorates is the lowest, at 12.5%, followed by bachelor's degrees. In addition, the highest proportion of teacher years is 45%, from the highest to the lowest, 45%, 27.5%, 15%, 7.5% and 5%. Finally, we found that 20 teachers (55%) had a weekly career guidance session, 11 teachers (27.5%) had multiple career guidance sessions per week, and only 9 teachers (22.5%) had less than one career guidance session per week.

Part 2 Problems and demands of employment guidance teaching

	n=40		T
Questions	$\overline{\mathbf{X}}$	S.D.	Level of problems
Problems			
1) You think career guidance has caused a lot of			
problems for the teaching system	4.56	0.21	Highest
2) You are not confident in career guidance.	4.57	0.48	Highest
3) Your career course equipment is difficult to use.	4.67	0.32	Highest
4) Career guidance course sometimes causes you to			
slow down your teaching tasks.	4.59	0.55	Highest
5) Career guidance course are rich in resources and			
materials but difficult to connect.	4.69	0.45	Highest
6) Career guidance classes sometimes clarify			
professional prospects	4.66	0.24	Highest
7) Career courses sometimes identify professional			
skills	4.60	0.20	Highest
8) Career guidance courses can plan for vocational			
skills certificates	4.63	0.20	Highest
9) Career guidance courses can analyze current			
employment patterns	4.68	0.47	Highest
10) Career guidance courses can recommend jobs			
with different majors	4.59	0.47	Highest
11) Career guidance courses can guide job-hopping			
in a professional mismatch	4.66	0.37	Highest
12) Career guidance courses can guide self-			
employment.	4.59	0.31	Highest
13) Career guidance courses can solve problems in			
self-employment	4.65	0.23	Highest

Table5.5: Problems of employment guidance teaching for teachers

14) Career guidance courses guide students to			
develop in small and medium-sized cities or the west	4.68	0.36	Highest
15) Career guidance courses guide students back to			
their hometowns	4.67	0.42	Highest
16) Career guidance courses guide students to the			
idea of studying abroad	4.76	0.34	Highest
17) Career guidance course are plenty but some are			
not effective.	4.64	0.20	Highest
18) Career guidance course are usually more			
difficult to download or to save files.	4.78	0.40	Highest
19) Too many career guidance courses cause			
students to be distracted from their studies.	4.63	0.48	Highest
20) Career guidance course sometimes makes it			
more difficult for students to finish homework.	4.67	0.42	Highest
Average	4.64	0.36	Highest

According to table 5.5, the teacher points out that the teacher evaluates the problem of employment guidance is at the highest level. One aspect worth noting is that many teachers emphasize the challenge of downloading or saving files when it comes to job guidance (Q18) and its impact on online teaching, which has been reported at a high level of 4.78m. Second, most teachers say the employment guidance curriculum is rich in resources and rich in materials, but the impact of the link is the biggest. Finally, only a minority of educators emphasize the significant impact (Q1) that the learning system has on online education, with an average rating of 4.56.

Part 3 Effective learning strategies for employment guidance teaching

Table 5.6 : Needs of employment guidance teaching for teachers

Questions	n=40		Level of needs
	$\overline{\mathbf{x}}$	S.D.	
Needs			
1) You believe that career guidance can help			
improve the effectiveness of the teaching system.	4.51	0.40	Highest
2) You are confident in career guidance.	4.57	0.37	Highest
3) Your career guidance equipment are easy to use.	4.59	0.20	Highest
4) Career guidance helps you to speed up your			
teaching tasks.	4.59	0.35	Highest
5) Career guidance s are rich in resources and			
materials and easy to connect.	4.69	0.47	Highest
6) The employment guidance is a clear professional			
outlook	4.66	0.42	Highest
7) Career guidance courses identify professional skills	4.58	0.52	Highest

8) Career guidance courses can plan for vocational			
skills certificates	4.67	0.43	Highest
9) The career guidance course analyzes the current			
employment form	4.68	0.41	Highest
10) Career guidance courses can recommend jobs			
with different majors	4.59	0.20	Highest
11) Career guidance courses can guide job-hopping			
in a professional mismatch	4.66	0.35	Highest
12) Career guidance courses guide self-employmen	4.69	0.46	Highest
13) Career guidance courses address problems in			
self-employment.	4.55	0.43	Highest
14) Career guidance courses guide students to			
develop in small and medium-sized cities or the west	4.58	0.37	Highest
15) Career guidance courses guide students back to			
their hometowns	4.55	0.32	Highest
16) Career guidance courses guide students to the			
idea of studying abroad.	4.68	0.20	Highest
17) Career guidance course are mostly effective.	4.64	0.34	Highest
18) Career guidance course are normally easy to			
download or to save files.	4.59	0.41	Highest
19) Career guidance courses to broaden your			
horizons	4.67	0.41	Highest
20) Career guidance helps students complete their			
assignments better	4.67	0.20	Highest
Average	4.62	0.35	Highest

According to Table 5.6, it is shown that teachers rated the demand for career guidance courses at the highest level. First of all, most teachers said that the employment guidance resource is rich and easy to connect (Q5), and the employment guidance course guidance for self-employment (Q12) has the greatest impact on employment guidance, =4.69.Secondly, most teachers said that the idea of guiding students to study abroad (Q16) has the greatest impact on employment guidance = 4.68. Only a minority of teachers said that they thought career guidance helped improve the effectiveness of the teaching system (Q1) had the greatest impact on career guidance, = 4.51.

5.3 Manual selection and guidance for students' employment

The Index of Congruence (IOC) of the six chapters in terms of correctness and suitability of the contents of the strategic handbook

According to the results form this study, all six units assessed by the three employment guidance specialists in terms of correctness and applicability of content, and all six units proposed in the IOC (Conformance Index) were found to be 0.8 or higher, The Jinken College of Technology Career Guidance Guide Manual can enhance the career guidance skills and abilities of higher vocational students.

6. Discussion of the Research

The results of the questionnaire survey are as follows: 1) the score of the teacher's questions is higher than that of the students. 2) Teachers' needs score is higher than students' needs. 3)This suggests that students encounter difficulties but exhibit limited proactive behavior in seeking assistance. teachers need to communicate with students more. 4) Researchers intend to use more effective strategies in career guidance and counseling.

For teachers, career guidance leads to a decrease in work efficiency, an increase in work intensity, and a sudden change in work style, which is emotional when helping students choose jobs, and does not help students' employment status.

For students, career guidance guides are prone to situations such as not attending classes seriously, unable to complete assignments independently, lacking a sense of urgency, doubting themselves, poor time scheduling, and unstable mentality. In terms of employment courses and job recommendations, not all teachers have strong professional guidance ability, and teachers are prone to give unreasonable recommendations in the work of career guidance students.

7. Recommendations for Further Study

1) Improve the employment security system for college students, and take multiple measures to protect employment rights and interests.

2) Implement the enterprise human resources strategy, and plan the whole process of talent "attraction and retention"

8. Acknowledgement

Firstly, my sincerest gratitude should be goes to my major thesis advisor Dr.Kris Phattaraphakin and my co-advisor Dr. Dr.Nitipatara for their professional guidance, encouragement and kindness which inspired me a lot throughout conducting and writing this thesis. Without their persistent help, this thesis would not have been possible.Secondly, I am grateful to all the independent study defense committee, including Dr. Kris Phattaraphakin, Dr. Araya Ariya, and Dr Bandit Butsaba. Their meticulous approach to work and study has always been a role model for me, and their kind teaching and unconventional thinking has been an inspiration to me. I especially thanks, who has always been taught patiently and systematically me a great deal about educational research which enables me to make progress in it.The next one should be the three specialists to evaluate the competence and correctness of the questionnaire and handbook. And I also need to say many thanks to President Dr.Yuwalak Vejwitayaklung accept me as a student at Dhonburi Rajabhat UniversityI am grateful to all of those with whom I have had pleasure to work during collecting data for my thesis at Jinken College of Technology. I would like to extend a special thank you to all my colleagues and teachers who participated in the questionnaire and to all the students at the college who responded to my questionnaire.Finally, I wish to thank every member in my family for their continued support and encouragement, who experienced all the ups and downs of my research.Thank you so much!

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A Construction of Strategic Guidelines for the Decrease of Psychological Distress for Students in Aviation Program: A Case Study of Sichuan Southwest Aviation Vocational College in Chengdu, China

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ABSTRACT

The objectives of this research were: 1) To investigate the counseling problems of aviation school students. 2) To investigate the need for psychological counseling among aviation school students. 3) To develop a strategy and methodology for psychological counseling for aviation school students. The research instrument employed in this study were a set of questions from the focus group discussion meetings. The questionnaire draws insights from extensive surveys conducted among 267 teachers and 258 students. Likert-scale-based responses are meticulously analyzed, classifying the severity of issues based on mean scores and employing a defined rating reference. Notably, a prevalent concern emerges among teachers in aviation schools regarding student mental health education, with consensus observed in identifying issues that require immediate attention. This research paper contributes valuable insights into the nuanced landscape of mental health education in aviation schools, uncovering areas of alignment and divergence among both students and educators. The findings presented herein serve as a foundation for enhancing mental health education strategies in educational institutions and offer a roadmap for future research endeavors.

KEYWORDS: Guideline handbook ,counseling, psychotherapy for college students, psychological needs.

1. Backgroud

In recent years, there has been a growing concern over cases of college students harming themselves and others due to mental illnesses and disorders. These incidents have caused significant psychological distress not only to the affected students but also to their respective families. Additionally, the impact of such events extends to colleges and society as a whole. Beijing Psychological Crisis Research and Intervention Center in 2020 released "China's suicide situation and its countermeasures" report, The main data shows that China has the highest number of suicides in the world. Globally, approximately 1 million people die by suicide every year, with more than one- fourth of these cases involving Chinese individuals. An aviation training school in Yunnan discussed the factors influencing the mental health of aviation college students. According to a national survey that included 126,000 college students as participants, 20.3% of them showed evident psychological disorders. However, it was found that the majority of aviation students are not fully aware of this issue.

2. Objective

(1)To investigate the counseling problems of aviation school students.

(2) To investigate the need for psychological counseling among aviation school students.

(3) To develop a strategy and methodology for psychological counseling for aviation school students.

3. Review of Literature

3.1 Concepts/Theories/Related Research

Evidence of Psychological Distress Among University Students Australia has indicated problematic levels of psychological distress among students seeking counseling. Research by Mathers et al. (1993) showed students using university counseling. (Jessica Sharp1

& Stephen Theiler,2018) In recent years, there has been an increase in symptoms of depression, anxiety, eating disorders, and other mental illnesses in college student populations. Simultaneously, there has been a steady rise in the demand for counseling services. These trends have been viewed by some as a mental health crisis requiring prompt investigation and the generation of potential solutions to serve the needs of students. Subsequently, several studies linked the observed rise in symptoms with the ubiquitous rise in use of personal computing technologies, including social media, and have suggested that time spent on these types of technologies is directly correlated with poor mental health. (Takahiro A, Kato,2019)

3.2 Conceputal Framework

The objectives of this study are 1) to investigate the problems and needs of psychological distress among students in colleges and universities, and 2) to construct a strategy guide for reducing psychological stress among aviation students. This study will take Sichuan Southwest Aviation Vocational College as a case study. The conceptual framework is as follows:



Figure 1 Conceputal Framework

4. Research Methodology

4.1 Population/Sample Group

The sample group for this research project was divided into two groups: 1) 258 students who appeared to be emotionally inactive due to psychological stress; and 2) 15 teachers in charge of psychological counseling.

4.2 Research Instrument

This research project used questionnaires to collect data. The questionnaire was divided into two sets namely 1) Student set and 2) Teacher set. The questionnaire was divided into two parts: 1) general information; 2) college counseling problems and needs. In order to better understand the current situation of psychological distress among aviation college students, the researcher selected appropriate questions from the papers published by Feng Lijuan (2012) in the Student Mental Health Education Guidance Center of Northwest University for Nationalities and compiled a questionnaire on the status of psychological counseling in colleges and universities for this study.

4.3 Data colletion

In this research project, the researcher personally collected data and information from the sample group. The sample group was informed of the purpose of data collection and an appointment was made. The researcher submitted a permission letter to the school director beforehand requesting permission to collect data and information from the sample group at Southwest Sichuan Aviation Vocational College.

4.4 Data Analysis

1) The Data and information collected will be analyzed, interpreted and then presented in terms of frequency court, percentage, mean (), standard deviation (S.D.). The Likert Five-Point Scale will be used to assess respondents' needs and problems with the psychological problems of vocational college students.

The criteria and define at the range of the mean scores (Wangwanich, 2005) as the following:

2) The ideas and comments of the 3 specialists obtained from the focus group discussion meeting, will be analyzed and then used to correct and improve the contents of the handbook.

5. Research results

This chapter is divided into three parts, namely :1) Aviation school students psychological counseling problems; 2) Investigate the necessity of psychological counseling for aviation school students; 3) Develop strategies and methods for psychological counseling of aviation school students;

Table 1 Problem/Needs

Investigation for the problems of students in aviation schools for students' mental health education.

Questions	n=	n=258 Level of problems	
	$\overline{\mathbf{X}}$	S.D.	
1. You think you have serious mental health problems	4.28	0.51	High
2. You think student mental health education issues are troublesome.	4.57	0.37	Highest
3. You think student mental health education is a waste of resources.	2.37	0.63	Low
4. You think that students' mental health education causes psychological disorders in students	4.21	0.57	High
 It is difficult for others to take the initiative to care about the current situation of students' mental health education. 	4.32	0.47	High
6. Students have difficulty communicating in interpersonal communication.	2.89	0.48	Medium
7. Deal with the stresses or worries of your life and hold them in your mind.	4.52	0.21	Highest
8. In a university setting, students have difficulty adapting.	3.65	0.58	High
9. It is difficult for students to receive counseling and educational.	4.68	0.48	Highest
10. You think there are many aspects to student mental health education issues.	4.24	0.24	High
11. Mental health is influenced by the surrounding environment.	4.82	0.24	Highest
12. Emotion management is good for physical and mental health.	4.79	0.19	Highest
13. There are not enough teachers in schools to specialize in mental health education.	4.53	0.53	Highest
14. Teacher to student psychology Lack of knowledge in health education.	4.62	0.24	Highest

15. Students have not participated in social Welfare activities such as mental health education.	4.29	0.20	High
16. You don't think the student mental health education curriculum needs to be conducted.	1.37	0.69	Lowest
17. No special funds have been set up for mental health education.	3.25	0.35	Medium
 Schools do not regularly carry out relevant mental health education activities. 	4.75	0.15	Highest
19. Teachers lack experience in mental health education for students.	4.27	0.42	High
20. There is a lack of a correct concept of mental health education.	4.76	0.35	Highest
Average	4.06	0.39	High

Investigation for the needs of students in aviation schools for students' mental health education.

Questions	n=258		Level of problems
	$\overline{\mathbf{X}}$	S.D.	
1.You think student mental health issues needs attention.	4.56	0.31	Highest
2. You think mental health problems are easy to solve.	2.34	0.51	Medium
3. You think you need to take a mental health education course.	4.12	0.63	High
You think that students' psychological problems need to be solved by taking measures.	4.41	0.57	High
5. Teachers actively care about students' psychological problems.	3.46	0.47	Medium
6.You often participate in the school's student community center/mutual aid platform.	2.89	0.48	Medium
7. You have a certain plan for future development.	4.14	0.42	High
8.Deal with stressful or annoying things in your life and talk to someone to talk to.	4.37	0.58	High
9.In a university setting, adapt quickly.	3.79	0.48	High
10.You are willing to accept psychological counseling.	4.14	0.47	High
11.Solving students' psychological problems is conducive to the development of society.	4.69	0.28	Highest
12.Emotion management is good for physical and mental health.	4.79	0.19	Highest
13.The school has a dedicated teacher in charge of mental health.	4.17	0.38	High
14.Teachers are trained in systematic counseling for psychological problems.	3.94	0.27	Highest

15.Actively participated in social welfare activities.	2.17	0.64	Low
16.Mental health education courses for students are necessary.	4.79	0.31	Highest
17.You think that students' psychological problems	4.25	0.35	High
need to be managed in a grid.			C
18.Schools regularly carry out mental health	2.75	0.15	Medium
education and teaching activities.	2170	0110	
19. Teachers lack experience in mental health	4 27	0.42	High
education for students.	1.27	0.12	mgn
20. There is a lack of a correct concept of mental	4 76	0.35	Highest
health education.	ч./0	0.35	ingnest
Average	3.94	0.41	High

Investigation for the problems of teachers in aviation schools for students' mental health education.

Questions	n=15		Level of problems	
	$\overline{\mathbf{X}}$	S.D.		
1.You think students have serious mental health problems.	3.97	0.52	High	
2.You think student mental health education issues are troublesome.	4.41	0.51	High	
3. You think student mental health education is a waste of resources.	2.17	0.30	Low	
4. You think that students' mental health education causes psychological disorders in students.	4.61	0.27	Highest	
5.It is difficult for others to take the initiative to care about the current situation of students' mental health education.	4.67	0.27	Highest	
6.Students have difficulty communicating in interpersonal communication.	3.37	0.48	Medium	
7.Deal with the stresses or worries of your life and hold them in your mind.	4.37	0.54	High	
8.In a university setting, students have difficulty adapting.	3.41	0.17	Medium	
9.It is difficult for students to receive counseling and educational.	4.45	0.48	High	
10.You think there are many aspects to student mental health education issues.	4.18	0.51	High	
11.Mental health is influenced by the surrounding environment.	4.82	0.24	Highest	
12.Emotion management is good for physical and mental health.	4.75	0.14	Highest	

Average	4.17	0.34	High	
problems,	4.21	0.32	Hıgh	
1. You think students have serious mental health	4.01	0.00		
health education.	4.27	0.42	nigit	
20. There is a lack of a correct concept of mental	4 27	0.42	High	
education for students.	4./4	0.27	Highest	
19. Teachers lack experience in mental health	4 7 4	0.27	II. 1 4	
health education activities.	4.57	0.47	Highest	
18.Schools do not regularly carry out relevant mental	4.57	0.47	TT 1 /	
health education.	4.61	0.30	Highest	
17.No special funds have been set up for mental	4.61	0.20	TT 1	
education curriculum needs to be conducted	2.31	0.20	Low	
16. You don't think the student mental health	0.21	0.20	T	
activities such as mental health education.	4.31	0.21	Hignest	
15. Students have not participated in social welfare	451	0.21	Highest	
in health education.	4.33	0.37	Hignest	
14.Teacher to student psychology Lack of knowledge	1 52	0.27	Highest	
specialize in mental health education.	4.09	0.19	righest	
13. There are not enough teachers in schools to	4.60	0.10	Highest	

Investigation for the needs of teachers in aviation schools for students' mental health education.

Questions	n=	15	Level of problems
	$\overline{\mathbf{X}}$	S.D.	
1. You think student mental health issues needs attention.	4.57	0.21	Highest
2. You think students have serious mental health problems.	4.41	0.51	High
3. You think students need mental health education.	4.67	0.30	Highest
4. You think that students' psychological problems need to be solved.	4.61	0.27	Highest
5. Others are proactive in caring about the current			
state of mental health education for students.	2.47	0.67	Low
 Students are communicative in their interpersonal relationships. 	3.87	0.48	High
7. Students have a certain plan for future development.	2.89	0.54	Medium
8. Deal with stressful or annoying things in your life and talk to someone to talk to.	4.81	0.17	Highest
9. In a university setting, students adapt quickly.	3.85	0.48	High
10. Students are required to receive mental health			
counseling supervision	3.97	0.61	High
Supervision.			

11. Solving students' psychological problems is	4.82	0.24	Highest
conducive to the development of society.			0
12. Emotion management is good for physical and	4 70	0.10	Highest
mental health.	т.//	0.19	mgnest
13. Schools need teachers who are responsible for	1 5 2	0.27	Highest
mental health education.	4.55	0.37	rigiest
14. Teachers have received systematic training in	2.1	0.67	T
mental health education counseling.	2.1	0.07	LOW
15. Students actively participate in social welfare	2.21	0.20	T
activities in mental health education.	2.51	0.20	LOW
16. Mental health education courses for students are	4 6 1	0.20	Lighast
necessary.	4.01	0.30	righest
17. In terms of capital investment, it is necessary to	1 17	0.47	Iliah
set up special funds for mental health education.	4.47	0.47	rigi
18. Schools regularly carry out mental health	2.01	0.27	Madium
education activities.	5.01	0.27	Medium
19. Teachers need to have sufficient experience in	4 27	0.42	Iliah
student mental health education.	4.27	0.42	nign
20. It is necessary to establish a correct concept of			
mental health education.	4.76	0.22	Highest
Average	3.95	0.39	High

Through the survey of school teachers, students, data results show that this study is very necessary, mainly because college students are more prone to psychological problems of the group, so we need to study some solutions and countermeasures.

6. Discussion of the Research

After the survey, it can be seen that students with high levels of needs and problems generally feel that the learning environment is not supportive enough, there may be problems that the learning culture is not in line with personal values, and the relationship between teachers and students and classmates is relatively tense. Most people (85%) in this group said that They feel a lower level of support in the learning environment, which has a negative impact on their mental health; although students with higher levels of needs and problems do not have the highest level of learning environment, these students still feel considerable pressure on the learning environment. There may be conflicts with classmates or teachers, with about half (55%) in this group saying they feel a higher level of stress in the learning environment, which has some impact on their mental health; Students with needs and problems maintained a moderate level in the learning environment, which had less impact on their mental health; Students with lower levels of needs and problems felt greater support in the learning environment, the learning environment, which had reacher students the learning environment, the learning environment, the mental health; Students with lower levels of needs and problems felt greater support in the learning environment, the learning environment, the mental health; Students with lower levels of needs and problems felt greater support in the learning environment, the learning environment, the mental health; Students were in line with themselves, and the teacher-student relationship

was better, and the majority (70%) in this group said they felt a higher level of support in the learning environment, which had a positive impact on their mental health; students with low levels of needs and problems felt a very high level of support in the learning environment, and the learning culture, values, and teacher-student-classmate relationship were very positive, and the majority (85%) in this group said they felt a very high level of support in the learning environment, which had a positive impact on their mental health. (Jones P J, Park S Y, Lefevor G T.2018)

7. Recommendations for Further Study

In order to alleviate the psychological distress of students, we can start from the following four aspects: 1) Mental health education; 2) Psychological counseling services; 3) Social support network; and 4) Enhance adaptability.8. Acknowledgement

8. Acknowledgement

First and foremost, I would like to express my sincerest gratitude to my primary thesis advisor, Dr. Uswin Chaiwiwat, and Dr.Araya Ariya,Ph.D.for their professional guidance, encouragement, and kind attention, which inspired me greatly during the writing of my thesis. Without their tireless help, it would not have been possible to complete this thesis.

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Analysis of Hygiene and Motivator Factors in Generation Z Hotel Employee Motivation After Covid-19 Pandemic

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ABSTRACT

With the lack of a comprehensive understanding of the motivation of Generation Z hotel employees after the covid-19 pandemic, this study aimed to identify the factors that motivate Generation Z hotel employees to work in the hospitality industry through Herzberg's Two-Factor Theory. A survey conducted through the "Questionnaire star" online platform generated 400 valid responses. Exploratory factor analysis and evaluation revealed seven hygiene factors: company policies & management, supervision, relationship between persons, work conditions, salaries, benefits, job security; and 6 motivator factors: achievement, recognition, work itself, responsibility, advancement, and possibility of growth. The results of the study help to understand the motivation of "Generation Z" hotel employees to work in the hospitality industry after the covid-19 pandemic and provide some practical implications for hotel industry.

KEYWORDS: motivation; hygiene factors; motivator factors; generation Z hotel employee.

1. Introduction

The escalating levels of social productivity in China have brought about a growing influence of consumption promotion on the hospitality and tourism sectors. Concurrently, the increasing consumption habits among Chinese residents are propelling the development of the hospitality industry within the Chinese market. Predominantly composed of young individuals, the labor force in the hospitality industry represents a pivotal demographic that will shape its workforce and leadership in the coming years.

Highlighting the youthfulness of this sector, a survey in 2016 revealed that while the global workforce averages around 40 years of age, the hospitality industry stands out with an average age of just 22, boasting a workforce in which a striking 72.8% is under the age of 35 (JobOutlook, 2022). Against the backdrop of contemporary China, Generation Z emerges as a distinct cohort marked by their unique contemporary traits. As the youngest and newest entrants into the hospitality industry's workforce, they hold significant sway across all segments of Chinese society. A study conducted in 2018 (Goh & Lee, 2018) explored the attitudes of Generation

Z individuals undergoing professional education in the hospitality industry. The results indicated a positive outlook toward the industry, suggesting that Generation Z has the potential to make substantial contributions.

In the realm of generational studies, defining a generation involves considering birth date ranges and demographic characteristics. Generation Z (Gen Z), born between the mid-1990s and early 2010s, is the cohort succeeding the millennials (Henry, & Timm-Davis, 2023). This group, the youngest active generation, displays distinctive habits. Gen Z makes up a significant portion of the global population, with forecasts indicating that they will constitute over 20% of the workforce in the near future (Schawbel, 2020). However, the COVID-19 pandemic significantly impacted Gen Z's employment landscape, leading to high job losses and increased stress levels among this generation (Schawbel, 2020). Despite challenging working conditions, research by Goh & Baum (2021) found that Gen Z hotel employees, especially those working in quarantine hotels during the pandemic, maintained moderately positive attitudes about their future. They attributed this to a sense of meaningful work defined by dedication, absorption, and vitality. Dedication stemmed from finding meaning in their tasks, leading to job satisfaction and a sense of self-worth. Absorption was tied to a sense of responsibility, fostering personal growth. Vitality represented their resilience and dedication to their work, even in the face of difficulties. Gen Z viewed these challenges as valuable experiences that contributed to their development as hotel professionals.

However, amidst these dynamics, the hospitality industry in China faces challenges related to its labor force. According to data from the National Bureau of Statistics of China (2022), the number of employees in the hotel industry has been steadily decreasing year by year, along with a growing issue of employee turnover. These trends raise concerns about the industry's future workforce stability. Despite the significance of Generation Z (born between 1995 and 2009) in the hospitality industry, there remains a notable gap in research (Randstad, 2017), particularly concerning this generation's motivations in the wake of the COVID-19 pandemic.

2. Research Objective

To assess the motivations of Gen Z employees with a hospitality and tourism education background working in the hospitality industry after the COVID-19 pandemic.

3. Literature Review

3.1 Employee Motivation

Motivation, a driving force guiding individuals toward their goals, is closely tied to their needs (Anyim & Badejo, 2012). Cherry (2019) defines motivation as a dynamic process encompassing biological, emotional, social, and cognitive influences, essential for achieving objectives (Singh & Sharma, 2017). Rahaman et al. (2020) stress the importance of studying workplace motivators. Effective motivation enhances employee efficiency, encourages skill utilization, and fosters expertise application— crucial for organizational goals. Employee motivation also promotes a positive attitude towards the organization's mission. While it may not directly impact growth, motivation is a fundamental prerequisite, as a lack thereof harms overall performance. Motivation drives employee performance, impacting individual and organizational success.

Herzberg's two-factor theory, originating in 1959, is foundational. It distinguishes between motivation and hygiene factors, two dimensions affecting job satisfaction (Jaworski et al., 2018). Derived from extensive employee surveys, this theory identifies factors contributing to job satisfaction (motivation factors) and dissatisfaction (hygiene factors).

Motivation factors, intrinsic to the job, enhance satisfaction. They include achievement, recognition, the work's nature, responsibility, advancement opportunities, and growth potential. Hygiene factors, external and extrinsic, are influenced by company policies, management, supervision, relationships, conditions, compensation, benefits, and job security. Motivation factors create intrinsic satisfaction and motivate, while hygiene factors prevent dissatisfaction but don't inherently satisfy (Herzberg, 2003).

Nanayakkara & Dr. Dayarathna (2017) explored Herzberg's theory's impact on employee turnover intention. Hygiene factors, like supervision, had a stronger influence on turnover intentions. Deri et al. (2021) found that internal motivation factors, e.g., advancement opportunities, reduced turnover intentions among hotel employees.

4. Research Methodology

4.1 Research Design

This study adopts a cross-sectional research design, which enables the collection of data at a single point in time to provide a snapshot of the target population's characteristics and behaviors (Goh & Lee, 2018). Quantitative methods were employed as the primary data collection approach. Chengdu was chosen as a study site because this city is recognized as the largest market for the hospitality industry in Southwest China. The Chengdu hospitality market has made substantial contributions to the city's economic landscape, with statistics from STR (2021) indicating that it accounted for 65.7% of GDP in 2020. Even amid the challenges posed by the COVID-19 pandemic, the resilience of the Chengdu hotel industry has been noteworthy, with indicators like hotel occupancy and average daily rate (ADR) surpassing pre-pandemic levels since April 2021.

4.2 Population and Sample

The study targeted Gen Z hotel employees holding professional degrees in hospitality or tourism management. Questionnaires were distributed to alumni of Gingko College of Hospitality Management, Sichuan Tourism University, and Chengdu University, who graduated with these degrees between 2017 and 2021. These institutions were chosen strategically due to their role in supplying a significant workforce for the hospitality and tourism industry in Chengdu and the broader Southwest China region. They are renowned for their high teaching standards and exceptional facilities in hospitality and tourism management programs, consistently producing a skilled and qualified workforce that contributes to the industry's standardized operation in Southwest China.

To ensure statistical robustness and reliability, the sample size was calculated using Taro Yamane's formula (1967), with a desired error rate of 5%. Considering the known population of graduates from these programs between 2017 and 2021 (6,700 individuals), the minimum required sample size was 377. To enhance

data analysis robustness and ensure a representative sample, 400 valid samples were collected and analyzed, surpassing the minimum requirement and providing confidence in the study's findings.

4.3 Research Instrument

A structured questionnaire was utilized to investigate the motivations of Generation Z (Gen Z) hotel employees. In order to measure Gen Z hotel employees, 28 hygience factors' attributes and 25 motivator attributes were benchmarked from Rani et al. (2018), Kingsley et al. (2019), Basnet & Kussa (2019), and Lundberg et al. (2009). A five-point Likert scale (1=strongly disagree and 5=strongly agree) was used. IOC was applied to check the validity of the questionnaire by three experts and professors in the field of hospitality. The content of the questionnaire was adjusted according to their opinions. Then pilot test was conducted to check the reliability of the questionnaire. The coefficient alpha for hygiene is 0.936 and for motivator is 0.912, so the two factors of the independent variable motivation have a Cronbach's alpha > 0.9, which are excellent level (Basnet & Kussa, 2019).

4.4 Data Collection

Questionnaire was created in "Questionnaire Star" which is the largest questionnaire design platform in China. The alumni associations from those universities and college were asked to distribute the questionnaire to their alumnus who fit the characteristics of the study through different online social platforms (WeChat, QQ, Weibo). Questionnaires were collected in approximately 6 weeks, and 400 were retained after processing invalid data.

4.5 Data Analysis

Following data collection, a thorough examination and cleaning process was undertaken to prepare the dataset for analysis within the SPSS (Statistical Package for the Social Sciences) software program. SPSS was chosen as the analytical tool to perform statistical data analysis, and essential tables were generated using this software. To reduce the dataset's dimensionality or identify underlying structures in the data, the researcher employed factor analysis. Factor analysis is a statistical method commonly used to categorize numerous variables obtained from the literature review or identify underlying patterns in the relationships between variables. In this study, the principal component analysis with varimax rotation was selected to analyze the factors. Before conducting the factor analysis, the Kaiser-Meyer-Olkin (KMO) measure was utilized to assess the adequacy of the sample size. Additionally, Bartlett's test of sphericity was applied to verify the suitability of the data for factor analysis. These preliminary steps help ensure the robustness and validity of the subsequent factor analysis process.

5. Research Findings

5.1 Characteristics of Gen Z hotel employees

The findings indicate that a majority of the survey participants, specifically 67.3%, are female. Furthermore, the age group comprising 23 to 26-year-olds constitutes a significant portion at 85.8%, with the highest representation being 24-year-olds, making up 25.3% of the respondents. In terms of educational backgrounds, the majority hold either bachelor's degrees (50.7%) or three-year college diplomas (43.3%). Notably, a significant proportion, approximately 67.5%, major in hotel management, while 23% specialize in tourism management. Additionally, the majority (61.3%) of respondents hold operational-level positions.

Regarding departmental distribution, 35.5% of respondents are employed in the front office department, followed by the food & beverage department at 16.8%. The housekeeping, HR, and sales & marketing departments collectively account for 37.8% of respondents. In terms of hotel affiliation, 44.3% of respondents work in international hotel chains, with domestic chains being the second most common choice.

Analyzing tenure, it's evident that a significant portion of respondents (66.5%) have worked in their current hotel positions for less than one year. The highest percentage (35%) of respondents have 1 to 2 years of experience in the hospitality industry, followed closely by those with 2 to 4 years (33.3%). Respondents with over 4 years of hospitality work experience represent the smallest group in the study.

5.2 Factor analysis of hygiene and motivator factors

5.2.1 Hygiene factors

The study utilized SPSS for exploratory factor analysis, affirming its applicability through a KMO value of 0.783 and Bartlett's test (Approx. chi-square = 6651.982, df = 378, p = 0.00), indicating interrelatedness among the 28 hygiene factors and shared dimensions. Seven dimensions emerged from the 28 items with factor loadings >0.7, collectively explaining 73.91% of variance. These dimensions were labeled: "Salaries" (5 items), "Supervision" (5 items), "Work Conditions" (4 items), "Relationship between Persons" (4 items), "Company Policies and Management" (4 items), "Job Security" (3 items), and "Benefits" (3 items), boasting Cronbach's alpha >0.8, signifying high internal consistency (see Table 1). Supervision, with factor loadings ranging from 0.78 to 0.92 and eigenvalue of 3.31, was the most influential hygiene factor (11.82% variance). "Relationship between Persons" (9.53% variance) featured factor loadings from 0.81 to 0.92, with varying mean scores. "Job Security" (7.41% variance) and "Benefits" (7.3% variance) also exhibited distinct factor loadings and mean scores. "Company Policies & Management" explained 9.16% of variance with eigenvalue 2.57. "Salaries" (17.88% variance) showed the highest eigenvalue of 5.01, while "Work Conditions" (10.81% variance) had an eigenvalue of 3.03. Overall, the highest mean score was observed in the "Supervision" factor (3.42, S.D = 0.95), followed by "Relationship with Persons" (3.33, S.D = 0.99) and "Job Security" (3.33, S.D = 1.12). "Benefits" scored 3.32 (S.D = 1.04), "Company Policies & Management" 3.31 (S.D = 1.02), "Salaries" 3.29 (S.D = 0.98), with the lowest mean score in "Work Conditions" at 3.16 (S.D = 1.09).

Table 1 EFA and Measurement Evaluation of Hygiene Factors.

EFA							
Hygiene factors/items	Factor loadings	Eigen- values	Explained variance	Cronbach's alpha	Mean	SD	Ranking
Factor 1: Salaries		5.01	17.88	0.89	3.29	0.98	5
I feel I am being paid a fair amount for the work I do.	0.91				3.17	1.47	
I am paid more than what I do.	0.81				3.30	1.06	
The pay policy is fair to all employees in my company.	0.80				3.32	1.10	
I am very satisfied with my salary.	0.82				3.31	1.09	
I am encouraged to work harder because of my salary.	0.79				3.37	1.10	
Factor 2: Supervision		3.31	11.82	0.89	3.42	0.95	1
My supervisor treats me fairly.	0.92				3.35	1.41	
My supervisor provides assistance all the time.	0.78				3.45	1.06	
My supervisor relates well with me.	0.81				3.43	1.07	
My supervisor commends me for good work done.	0.81				3.44	1.07	
My supervisor is competent in doing his/her job.	0.81				3.44	1.07	
Factor 3: Work Conditions		3.03	10.81	0.89	3.16	1.09	6
Employees have the necessary authority to perform	0.92				3.06	1.51	
their job.							
The physical environment is conducive to work.	0.86				3.20	1.11	
I feel satisfied because of the comfort I am provided at	0.86				3.20	1.20	
work.							
I am proud to work for my company because of the	0.84				3.16	1.15	
pleasant working conditions.							
Factor 4: Relationship between Persons		2.67	9.53	0.88	3.33	0.99	2
It is easy to get along with my colleagues	0.92				3 21	1 40	
My colleagues are helpful and friendly	0.81				3 38	1.05	
Colleagues are important to me	0.82				3 37	1.09	
Lam satisfied with the people I work with	0.83				3 35	1.09	
Factor 5: Company Policies and Management	0.05	2 57	916	0.87	0.00	1.09	4
The attitude of the administration is very	0.91	2.37	<i>.</i>	0.07	3.31	1.02	·
accommodative in my company	0171				0110	11.10	
I am proud to work for this company because the	0.82				3.37	1.09	
company policy is favourable to its workers	0.00-						
L completely understand the mission of my company.	0.80				3.31	1.08	
Lam satisfied with working hours and schedules	0.84				3 41	1 11	
Factor 6: Job Security		2.07	7.41	0.87	3.33	1.12	2
I believe safe working at my place.	0.92			,	3.23	1.46	
I believe my job is secure.	0.85				3.40	1.11	
My workplace is located in an area where I feel	0.88				3.36	1.17	
comfortable.							
Factor 7: Benefits		2.05	7.30	0.84	3.32	1.04	3
I am satisfied with my benefits.	0.90				3.32	1.41	
The benefits we receive are as good as most other	0.84				3.29	1.06	
hotels offer.							
The benefits policy is fair to all employees in my	0.84				3.37	1.08	
company.							
		KM	O = 0.783				
Ap	prox. Chi-Sc	juare = 66	51.982				
		Si	g. = 0.000				

5.2.2 Motivator factors

As shown in Table 2, Kaiser-Meyer-Olkin (KMO) statistic yielded a value of 0.835, indicating interrelatedness, and Bartlett's test affirmed the significance of the correlation matrix (Approx. chi-square = 6379.297, df = 300, p = 0.00), validating the factor analysis. The 25 motivator items with factor loadings >0.7 formed 6 dimensions, with a total eigenvalue of 18.81 explaining 75.23% of total variance. These factors were named "Recognition" (5 items), "Work Itself" (5 items), "Advancement" (4 items), "Possibility of Growth" (4 items), "Achievement" (4 items), and "Responsibility" (3 items), reflecting common characteristics within each factor (see Table 5.2.2.1). Cronbach's alpha coefficients for all 6 factors exceeded 0.8, indicating high internal consistency. The most significant motivator factor for Gen Z employees' motivation was "Recognition," with factor loadings between 0.81 and 0.93, an eigenvalue of 5.48, and explaining 21.9% of variance. Mean scores for recognition ranged from 3.33 to 3.55. "Possibility of Growth" had factor loadings between 0.82 and 0.91, an eigenvalue of 2.47, explaining 9.86% of variance, with mean scores ranging from 3.27 to 3.42. "Achievement" had an eigenvalue of 2.31, factor loadings between 0.82 and 0.92, and explained 9.25% of variance, with mean scores between 3.21 and 3.47. "Responsibility" had factor loadings between 0.87 and 0.93, an eigenvalue of 2.21, and explained 8.85% of variance, with mean scores from 3.16 to 3.37. "Work Itself" had factor loadings between 0.79 and 0.91, an eigenvalue of 3.41, and explained 13.65% of variance, with mean scores between 3.18 and 3.33. "Advancement" had factor loadings between 0.85 and 0.92, an eigenvalue of 2.93, and explained 11.72% of variance, with mean scores from 2.95 to 3.14. Overall, "Recognition" scored the highest at 3.47 (SD=1), followed by "Possibility of Growth" at 3.36 (SD=1.08), "Achievement" at 3.34 (SD=1.01), "Responsibility" at 3.3 (SD=1.09), "Work Itself" at 3.28 (SD=0.98), with "Advancement" scoring the lowest mean at 3.06 (SD=1.1).

Table 2 EFA and Measurement F	Evaluation	of M	lotivator	Factors.
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EFA								
Motivator factors/items	Factor	Eigen-	Explained	Cronbach's	Mean	Reversed	SD	Ranking
	loadings	values	variance	alpha		Mean		
Factor 1: Recognition		5.48	21.90	0.91	3.47		1.00	1
I feel appreciated when I achieve or complete a task.	0.93				3.33		1.42	
My manager always thanks me for a job well done.	0.81				3.55		1.04	
I receive adequate recognition for doing my job well.	0.84				3.50		1.10	
My efforts are recognized in the team.	0.81				3.47		1.10	
I feel ignored when I achieve or complete a task. (Reverse item)	0.85				2.51	3.49	1.10	
Factor 2: Work Itself		3.41	13.65	0.89	3.28		0.98	5
I am very proud when performing my work duties.	0.91				3.18		1.47	
My work is tiring and challenging.	0.81				3.32		1.07	
My work is comfortable and enjoyable.	0.79				3.29		1.09	
I have too much to do at work.	0.81				3.33		1.11	

I am satisfied with my job purpose and meaning.	0.80				3.31		1.06		
Factor 3: Advancement		2.93	11.72	0.90	3.06		1.10	6	
Advancement is done regularly and fairly in this company.	0.92				2.95		1.49		
Company has a good career prospect for its employees.	0.85				3.11		1.14		
There are chances for advancement on this job.	0.85				3.07		1.15		
I have opportunity for better position in my work.	0.88				3.14		1.21		
Factor 4: Possibility of growth		2.47	9.86	0.89	3.36		1.08	2	
I am proud to work in my company because I feel I have grown as a person.	0.91				3.27		1.48		
My job allows me to grow and develop as a person.	0.82				3.39		1.17		
My job allows me to improve my experience, skills and performance.	0.84				3.36		1.15		
I am not satisfied with the possibility of growth in the job. (Reverse item)	0.85				2.58	3.42	1.17		
Factor 5: Achievement		2.31	9.25	0.89	3.34		1.01	3	
I am proud to work in this company because	0.02				3.21		1.41		
it recognizes my achievement.	0.92								
I feel satisfied with my job because it gives me feeling of accomplishment.	0.82				3.47		1.04		
I feel that I have contributed to my workplace in a positive manner.	0.84				3.33		1.10		
I feel that I have not achieved self-worth in my work. (Reverse item)	0.82				2.65	3.35	1.10		
Factor 6: Responsibility		2.21	8.85	0.88	3.30		1.09	4	
I am given the responsibility for the job I do.	0.93				3.16		1.41		
I have the necessary knowledge to make my own decisions in my job.	0.87				3.37		1.10		
I am satisfied with my work based on responsibilities.	0.88				3.37		1.09		
			KMO	=0.835					
	Appr	ox. Chi-Sq	uare = 6379	.297					
Sig. = 0.000									

6. Discussion

This study offers a comprehensive exploration of the motivation of Gen Z hotel employees, especially in the context of the post-COVID-19 hospitality industry. It uncovers pivotal factors influencing the motivation of this generation, providing valuable insights for crafting strategic human resource management practices that aim to reduce turnover intentions, enhance commitment, and foster engagement among Gen Z employees. Among the thirteen factors analyzed, the quality of supervision emerges as the most influential hygiene factor impacting Gen Z hotel employees' motivation. Effective and fair supervision stands out as a compelling driver, motivating

them to excel in the dynamic and demanding hospitality sector. Supervisors, as primary sources of social support, hold authority to offer rewards, protection, encouragement, and motivation (Phungsoonthorn & Charoensukmongkol, 2019). Skiba and Wildman (2019) further underscore the role of strong relationships with supervisors and leaders in boosting employee motivation, especially during crises.

Interpersonal relationships, competitive salaries, and supportive working conditions have been highlighted as significant motivators by prior studies (Basnet and Kussa, 2019; Asaari et al., 2019). However, the COVID-19 pandemic has added unique challenges, including limited working conditions and a reduced sense of responsibility and understanding of the job itself (Nilasari et al., 2021). In this study, the importance of relationships among colleagues also stands out as a vital motivator for Gen Z hotel employees in the post-COVID-19 landscape. A supportive and friendly atmosphere created by colleagues serves as a driving force, motivating Gen Z employees to remain dedicated to the hospitality industry, particularly in the aftermath of the pandemic.

Job security is identified as a key determinant of employee motivation, aligning with Aman-Ullah et al. (2022)'s findings emphasizing its role in retaining employees and deepening their commitment to their work. Additionally, competitive salaries have been highlighted as a prime motivator (Asaari et al., 2019). However, the pandemic's challenges, such as job losses and professional insecurity, have shifted priorities (Davahli et al., 2020). Consequently, while factors like relationships, job security, benefits, and company policies and management largely meet employees' needs, salaries and working conditions are comparatively less fulfilled among Gen Z hotel employees.

Regarding motivator factors, recognition takes center stage as the foremost motivator for Gen Z hotel employees, closely followed by opportunities for personal and professional growth, a sense of achievement, responsibility, and intrinsic job satisfaction. However, advancement opportunities have diminished in their motivational impact, possibly due to uncertainties stemming from the pandemic's influence on the job market.

These findings align with Asaari et al. (2019), who emphasized the significance of recognition and advancement for motivating employees. Nevertheless, the study highlights that Gen Z hotel employees still somewhat agree about the importance of advancement, given the significant career challenges posed by the pandemic and the need for both organizations and employees to reevaluate their short-term and long-term choices (Hite and McDonald, 2020).

7. Suggestion

The implications of this study are far-reaching and extend to both the hospitality industry and organizations across various sectors. They provide actionable guidance for human resource management strategies and practices in the post-COVID-19 landscape, with a specific focus on motivating and retaining Gen Z employees. Based on this research finding, it can be known that the supervision and the relationship between persons of hygiene factors and the recognition and the possibility of growth of motivator factors, which have been identified as the potent motivator for Gen Z employees work in the hospitality industry after covid-19 pandemic, also HR strategies can gain some insights from it. For instance, in terms of supervision, organizations can invest

in training programs for supervisors and leaders to equip them with the skills necessary to provide support, recognition, encouragement, and motivation to their teams. This investment can foster a motivating work environment, particularly during challenging times like crises. In terms of relationships between persons, teambuilding and public welfare activities should be prioritized to cultivate strong interpersonal bonds among employees and enhance teamwork and cohesion, and it's necessary to establish effective communication systems and regular face-to-face communication activities, create a trustful, equal, open, respectful and accommodative team atmosphere. Furthermore, hospitality organizations should emphasize and develop a " recognition culture ", with emphasis on both formal and informal recognition methods and systems. Timely, effective and public recognition and encouragement will greatly motivate employees, for example, a hotel manager reading a letter of praise from a guest at a formal meeting. In addition, managers should pay attention to the possibility of employee growth, pay attention to employee personal development, and help employees explore their personal potential, for example, through different platforms and opportunities for employees to participate in a variety of regular and irregular training to improve their professional skills, so that employees can enhance their personal work experience, skills and performance, and improve their professional confidence and pride in their work, so that employees fully realize that they can maximize their development and improve themselves on this work platform, which can be a great motivator and retention of employees. Meanwhile, it should be mentioned that after the covid-19 pandemic, Gen Z hotel employees strongly motivated by the factors of supervision, relationships between persons, recognition, and possibilities of growth, were also somewhere motivated by other factors (eg. salaries, benefits, work itself, achievement...), thus a holistic perspective is needed in the human resource management strategy. Overall, improved supervision, positive employee relationships, enhanced recognition and employee growth possibilities can greatly motivate Gen Z employees to work in the hospitality industry after the COVID-19 pandemic, also beneficial for employee retention.

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Potential Development on Supply Chain Management of Processed Agriculture Products based on Local Identity of Young Smart Farmers

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ABSTRACT

The objectives of this research were to 1) study the activities at the upstream, midstream, and downstream of the agricultural product supply chain based on the local identity of young smart farmers, and 2) to develop the supply chain management capabilities of processed agricultural products based on the local identity of young smart farmers. The qualitative research samples comprised 25 members of the Ban Pwoagsoong organic asparagus community enterprise and government officers. Qualitative data were collected through focus group discussions and in-depth interviews. For the quantitative research, a sample of 100 consumers, who had purchased the asparagus powder product, was selected using purposive sampling. The quantitative research instrument was a set of questionnaires. The qualitative data were analyzed using descriptive statistics. Additionally, the content analysis was conducted on the qualitative data. Research findings indicated that the supply chain management capabilities of locally distinctive agricultural processed products for the Ban Pwoagsoong organic asparagus community enterprise could be seen in 1) transforming fresh asparagus into asparagus powder, ready for consumption, and 2) designing logistics packaging that considered factors related to product damage, transportation and distribution cost savings, product manufacturing, consumer convenience, and communication with stakeholders in the transportation system.

KEYWORDS: Young Smart Farmers, Potential Development on Supply Chain Management, Processed Agriculture Products

1. Introduction

The "Young Smart Farmer" (YSF) project, initiated by the Department of Agricultural Promotion and the Ministry of Agriculture and Cooperatives, aims to cultivate a new generation of agriculturists with a passion for farming, advanced agricultural management skills, innovative thinking, and self-sufficiency, thereby fostering agricultural leadership in their communities. (The Standard Team, 2019). In 2018, the Department of Agricultural Promotion launched the inaugural New Generation Farmer Incubation Center in Lop Buri province, marking the
first such center in the central region. The center acted as a hub for gathering agricultural products from newgeneration farmers and building networks to expand market opportunities, all guided by a market-driven production approach (Matichon Online, 2018). Based on in-depth interviews with experienced agricultural promotion specialists from the Lop Buri Provincial Agricultural Office, regarding the challenges in developing the potential of Young Smart Farmers, the following issues were identified: There was a significant lack of academic knowledge needed to enhance and add value to agricultural products.

Ban Pwoagsoong Organic Asparagus Community Enterprise, located in Tha Din Dam sub-district, Chai Badan district, Lop Buri province, was established in the year 2016, and registered as a Young Smart Farmer of Lop Buri Province in the year 2020. Currently, the group comprises a total of 35 members with a collective land area of 50. 20 Rai. They primarily produce organic asparagus and organic vegetables, which have been certified under the Good Agricultural Practices (GAP) standards. They are the first and largest group in Lop Buri province to produce organic asparagus. Presently, this community enterprise has received support in the form of machinery for asparagus powder processing from the government. However, due to the COVID-19 pandemic and severe flooding in the Tha Din Dam agricultural area in October 2021, the group had to temporarily halt the production of asparagus powder. After overcoming this crisis, the group has expressed the need to resume asparagus powder production to generate income for its members and the community. They are seeking academic support to enhance the value of their asparagus powder products, such as creating product branding and packaging that reflects their local identity.

The research team was therefore interested in studying a research project on enhancing the supply chain management capabilities of processed agricultural products based on the local identity of young smart farmers. The selected case study would focus on the Ban Pwoagsoong Organic Asparagus Community Enterprise, for developing distinctive community products. It could establish sustainable income generation and preserve indigenous knowledge within the community.

2. Research Objective

(1) To study the activities at the upstream, midstream, and downstream of the agricultural product supply chain based on the local identity of young smart farmers.

(2) To develop the supply chain management capabilities of processed agricultural products based on the local identity of young smart farmers.

3. Literature Review

3.1 The Definition of Young Smart Farmer

New Generation Agricultural Entrepreneurs, or Young Smart Farmers, refer to young farmers who manage agriculture using modern technology, possess creative and innovative thinking, establish connections within networks, and play a leadership role in local agriculture. They must also meet the criteria of having a minimum household income of 180,000 Baht per year and an age range between 17 and 45 years old (Ministry of Agriculture and Cooperatives, 2017, p. 12).

3.2 The Process of Developing New Generation Farmers into Young Smart Farmers

The development of new-generation farmers into Young Smart Farmers consists of four key processes, as follows (Ministry of Agriculture and Cooperatives, 2017, pp. 14-15).

1. Developing a life plan involves adjusting the perspective of new-generation farmers and instilling motivation in them to engage in agriculture. In this process, an "activity plan" is used as a tool, based on a model from the network of new-generation farmers in the western region, to analyze oneself, identify academic and technological needs, and establish links within the production/marketing network with fellow farmers.

2. Knowledge exchange involves facilitating a blended learning process between new-generation farmers and mentors, which encompasses face-to-face or experiential learning from the wisdom of local experts or role models. It also includes learning through field visits, hands- on practice, and utilizing information and online media for learning.

3. Networking emphasizes active participation in knowledge exchange processes and building interconnected networks of knowledge, technology, and agricultural activities from production to marketing. Additionally, it strengthens the groups and learning networks between new-generation farmers and relevant stakeholders.

4. An assessment would determine new-generation farmers' qualifications as Young Smart Farmers. Moreover, it involves summarizing the results of learning exchanges, assessing the outcomes of learning, and planning for future development.

3.3 Agricultural Supply Chain and Logistics

The Ministry of Agriculture and Cooperatives Economic Office (2018, p. 10) reports that the agricultural logistics and supply chain process in the agricultural product supply chain system consists of three levels: upstream, midstream, and downstream.

At the upstream level, farmers are responsible for the production and harvesting of agricultural products such as rice, pigs, vegetables, fruits, and rubber. In the logistics activities, it begins with the procurement and use of agricultural production factors, the management of product quality on the farm, and continues until the products are ready for sale in the next level.

The midstream level consists of product collectors/traders, wholesalers, and processing factories, with product collectors playing a significant role in the movement of products from farmers to the market. Logistics activities at this level include infrastructure management for collection and storage, sorting, quality inspection, and the use of post-harvest technologies in both quantity and quality management. Collected agricultural products are then distributed into two main channels: 1) collected for direct sale to consumers as fresh produce (e.g., fruits, vegetables, eggs), which are further sent to the downstream market, and 2) collected for processing into various

products such as canned pineapples, canned fish, sugar, sausages, etc., with key logistics activities being product innovation and development, followed by the sale to wholesalers, retailers, export agents, or consumers.

The downstream level involves the movement of agricultural products, both as fresh produce and processed products, to the market. These products are sold to wholesalers/retailers/export agents who distribute them to end consumers. Logistics activities at this level include business management, customer acquisition, decision-making regarding products/services necessary to establish and support the customer base, as well as quality management of standardized products to meet customer needs and achieve customer satisfaction

3.4 Research Framework

This research was conducted as a Community-based Research (CBR) utilizing Participatory Action Research (PAR) approaches. The conceptual framework of this research was presented in the figure 1.



Figure 1 Research Framework

4. Research Methodology

The research team has categorized data collection according to the research objectives as follows:

Objective 1: To study the activities at the upstream, midstream, and downstream of the agricultural product supply chain based on the local identity of new-generation agricultural entrepreneurs.

The research team gathered primary data from the following sources:

1.1 The research team conducted survey research, particularly focusing on surveying and engaging in participatory observations with leaders and members of the Ban Pwoagsoong organic asparagus community enterprise.

1.2 The research team conducted in-depth interviews and facilitated focus group discussions, emphasizing participatory thinking and development of packaging with a leader, 24 members of the Ban

Pwoagsoong organic asparagus community enterprise, and 8 relevant government officials to gather information on the need for the development of processed products and packaging formats based on local identity.

1.3 Qualitative data was analyzed using content analysis in terms of SCOR Model.

Objective 2: To develop the supply chain management capabilities of processed agricultural products based on the local identity of new-generation agricultural entrepreneurs.

The research processes were as follows:

2.1 The research team studied and used the data obtained from the investigation in objective 1 to analyze and synthesize as a basis for designing and developing the processed products of asparagus powder. They also created packaging prototypes, product branding, and labels for asparagus powder product.

2.2 The research team conducted practical training (theory and practice) to provide knowledge on designing logistics packaging to group members, stakeholders, and interested individuals participating in the project. For practical training, the focus was on participation in brainstorming and developing packaging by leaders and members of the Ban Pwoagsoong organic asparagus community enterprise, totaling 20 people. Additionally, representatives from relevant government agencies, including agricultural officials from Chai Badan district, Lop Buri province, with a total of 3 people, were involved. The training was facilitated by lecturers from the Department of Food Science and Technology, Faculty of Science and Technology, Thepsatri Rajabhat University.

2.3 Qualitative data was analyzed using content analysis.

5. Research Findings

Section 1: To study the activities at the upstream, midstream, and downstream of the agricultural product supply chain based on the local identity of new-generation agricultural entrepreneurs.

Table 1 displayed the actions occurring in the different stages of the agricultural product supply chain – upstream, midstream, and downstream – with a focus on the distinctive local identity of emerging agricultural entrepreneurs

Upstream	Midstream	Downstream
- Farmer groups planed and	- Farmers had begun cultivating	The Ban Pwoagsoong organic
procured asparagus seedlings	asparagus in an organic farming	asparagus community enterprise
from producers or suppliers,	system, and there was	successfully developed the
along with preparing labour,	collaboration between farmers	independent distribution of their
fertilizers, plowing equipment,	and officials to access knowledge	agricultural products, bypassing
and group management.	and information, enabling them to	middlemen. They engaged in
- The Young Smart Farmer	plan and develop their agricultural	negotiations with direct buyers,
(YSF) network project supported	practices for the future.	including:
these farmers and imparted	- the use of chemicals in	1) Asparagus, which was sent for
knowledge to reduce chemical	asparagus cultivation was	sale in Singapore and Australia, to
usage, making them role models	discontinued, and they shifted to	Natural & Premium Food Co.,
for transitioning to single-crop	organic farming practices as per	Ltd., a foreign company.
cultivation.	the guidance of the Chai Badan	2) Queen Eggplant, sold by
	District Agricultural Office.	farmers through online channels
	- This resulted in reduced costs,	like FACEBOOK and LINE
	safe production, and increased	application.
	income for the farmers.	3) Lettuce, marketed by farmers
	- This also involved seeking	through online channels like
	certification for Good	FACEBOOK and LINE
	Agricultural Practices (GAP)	application.
	standards to gain market	4) The products of the group that
	acceptance from both domestic	have received organic
	and international consumers.	certification (Organic Thailand)
		would be distributed through the
		website RedMart.com
		(WWW.REDMART.COM)

Table 1 The activities at the upstream, midstream, and downstream of the agricultural product supply chain

Based on the data analysis, both quantitative and qualitative, obtained from the research study in this instance, the research team had formulated a practical operational model of the asparagus supply chain (SCOR Model) for the Ban Pwoagsoong organic asparagus community enterprise. The details were as follows:

In the planning aspect, it was discovered that the Ban Pwoagsoong organic asparagus community enterprise, set production goals of more than 1.2 tons per week. They collaborated with various network organizations, particularly educational institutions, to develop agricultural products through processing to address the challenges posed by COVID-19. They established COD (Cash on Delivery) services with transportation

companies to introduce their products into the online market platforms such as SHOPEE and LAZADA. They improved product standards to meet USDA (United States Department of Agriculture) standards and expanded their product reach to the North American market, including Canada and the United States. Additionally, they devised a crop insurance pricing plan to increase profits by 30-35%. They initiated the use of alternative or clean energy sources to reduce expenses. They incorporated technology and AI systems to analyze production plans and manage agricultural data. They also created online streaming channels to facilitate consumer access to farmers. Finally, they expanded and nurtured a new generation of farmers, increasing their numbers by 40% compared to the past.

In the sourcing aspect, it was found that the Ban Pwoagsoong organic asparagus community enterprise focused on organic agriculture, and expanded its cultivation area from 50 to 100 rai. This expansion would be achieved through contributions from within the group's members and collaborative partners. Emphasis was placed on sourcing materials and raw ingredients in line with organic agricultural standards. Member farmers were required to have organic agriculture standard certification. Moreover, in the production of biofertilizers and insect repellents, the group manages the production of these products to help members reduce production costs. The expenses would be covered from the group's profits generated through the sale of agricultural products.

In the production aspect, it was observed that the Ban Pwoagsoong organic asparagus community enterprise actively collected and stored individual income data for each member. They formulated individualized production development plans (IFPP) and updated this information into an online system, along with introducing QR Code "Samaen Nari," a self-created data system that recorded the production data of each member. The group's production operations followed a market- oriented approach, and they conducted consumer demand surveys. The group had consistently practiced organic asparagus cultivation for the past three years, starting in 2017. Members received continuous income from their sales. To achieve this, the farmers utilized the Cloud E Data system to analyze production data accurately. This helped in managing production data efficiently, providing precise production reports to international buyers. Farmers could analyze data to plan their cultivation, determine the quantity needed by buyers, and calculate the Break-Even Point for their operations. This data also facilitated collaboration with government agencies, enabling accurate problem-solving for farmers.

In the delivery aspect, it was noted that the Ban Pwoagsoong organic asparagus community enterprise faced a challenge regarding their main product, which was fresh asparagus for direct consumer consumption. The group formulated a major goal of maintaining product quality during transportation. They adopted an air packaging system to facilitate the transportation process and preserve the quality of their produce. They utilized a vacuum-sealing system for both fresh and dried products, which helped reduce the risk of contamination, extended the shelf life of fresh vegetables, and prolonged the shelf life of processed products compared to the fresh form. This air-sealing machine was adaptable to various types of bags, including hot bags, cool bags, glass bags, craft bags, and others, eliminating the need for specific packaging. **Section 2:** To develop the supply chain management capabilities of processed agricultural products based on the local identity of new-generation agricultural entrepreneurs.

From the gathered input emphasizing participation in the ideation and development of packaging solutions by leaders and members of the Ban Pwoagsoong organic asparagus community enterprise, as well as relevant government officials, the following packaging needs were identified for powdered asparagus products. Table 2 The components of designing product labels and graphics on powdered asparagus product packaging

Components	Description	Image
Name	"Asparagus powder" represents the identity of the community product, with a simple, short, concise name that is easy to remember.	ผงผักหาน่อไม้ผรั่ง Asparagus Powder ออร์กรานอไม้ผร้อง มาควออร Powde กลุ่มระกะกรุง
Symbol	It's a natural agricultural area with a sign that bears the name of the organic farming community group, Tha Pwoagsoong. This conveys information to consumers about the product's characteristics, the nature of the business, and the unique identity of the region, which boasts abundant natural resources and safe crop cultivation in the community.	n <u>auluevi</u> eunitýzavanitu naulasů ežeunity 1950– 8065–8193480
Font	Use easily readable and understandable letters, maintain a semi-formal tone, and convey a clear message in both Thai and English languages. Include green- colored numbers. Use bold letters to motivate and capture the consumers' interest.	Net Weight 100 g. หน่อไม้ฝรั่ง 100 % ซงกับเครื่องดื่ม ใช้เป็นส่วนผสมสำหรับปรุงอาหาร
Color	The label background uses cool tones, including mature green, light green, and agricultural shades, which reflect the natural aspect.	 C67 M33 Y100 K26 C75 M0 Y100 K0 C50 M0 Y100 K0 C44 M0 Y60 K0 C25 M91 Y66 K76 C41 M70 Y96 K49 C34 M57 Y90 K37
Product	Display details such as production date, expiration date, quantity (weight), price, production location, contact information for inquiries (phone number, LINE app, and Facebook), and the supporting agencies and organizations that provide funding for research and development of packaging for the Ban Pwoagsoong organic asparagus community enterprise.	Standarderfar Standa

Quantity	Packed in layers within a transparent sealed pouch with clear quantity information. Each pouch contains 100 grams of powdered asparagus.	NI MICH
		กษุ่มวิสาหกิจรุมขนหน่อไม้ฝรั่งบ้านปลวกสูง



Figure 2 Design and develop smart packaging for asparagus powder following the local identity

6. Discussion

From the study of upstream, midstream, and downstream activities in the agricultural product supply chain of the Ban Pwoagsoong organic asparagus community enterprise, the researchers aimed to leverage this knowledge to enhance the supply chain management capabilities for young smart farmers. The research team conducted site visits to various business establishments, engaged in in- depth interviews with leaders, and administered questionnaires to the members. Additionally, agricultural experts collaborated in analyzing the potential within the framework of the Business Model Canvas.

Key Partners S Community Enterprise Group Youth and Homemaker Farmers Group External organizations providing support from both the public and private sectors	Key Activities Production: Designing and delivering products in larger quantifies and with better quality. Problem-tolving through the use of new innovations, incorporating technology improvements in both water rupply and destrical energy utilization, as well as platform creation and maintannee, uting mart agriculture systems to aid in cultivation and cost calculations for each plot. Key Resources Non-toxic raw materials within the group of farmers, internal labor within the community and agricultural groups, as well as agricultural network groups and machinery owned by the group, have received support from	Value Propositions It is a new product or service that adds value by processing the product and meets the demand for innovative features that stand out and have new characteristics that differentiate it from competitors or ordinary agricultural products		Customer Relationships	Customer Segments The target group consists of individuals ranging from children to adults who are looking to enhance their energy and protein intake from vegetables, value health, both men and women, and exhibit an interest in selecting safe vegetables and processed vegetables for convenient cooking and energy-boosting for their health.
Cost Structure	external agencies.		Revenue Stre	ams 6	
Costs associated with cultivation,	machinery, labor, and operational ove	rhead costs.	Selling fresh v increasing aw network group	egetables and processed products, with areness in distributing various agric o, such as fermented beverages and ha	h a focus on utilizing members and ultural products of the extended ppy chicken eggs.

Figure 3 Business Model Canvas of the Ban Pwoagsoong organic asparagus community enterprise

This research focuses on the following issues for discussion of the results:

1. For the development of processed products and logistic packaging for the Ban Pwoagsoong organic asparagus community enterprise, the research team studied the needs of entrepreneurs, brainstorming to provide feedback and recommendations for improving and developing the draft product prototype, packaging prototype, label graphics, and creating the product logo, which is "שַׁשָּׁהָשׁ שִׁשָּׁהָשׁ שֵׁשָׁלָשׁ שָׁשָׁלָשׁ שָׁשָׁלָשׁ שָׁשָׁלָשׁ שָׁשָׁלָשׁ שָׁשָׁלָשׁ reflects the identity of the community product, featuring a simple, concise, and memorable name. It represents a natural agricultural community known as "the Ban Pwoagsoong organic asparagus community enterprise," which communicates the product's characteristics, business features, and the unique attributes of the region with its abundant natural resources and safe crop cultivation within the community. Additionally, the research emphasizes conveying product details, aligning with the findings of the study by Buaclee (2018), which investigated the design and development of product labels through a participatory communication approach in the context of a sustainable creative economy. This also leads to new and innovative ideas, which are crucial for designing the brand identity and packaging symbols. Effective brand communication dimensions include symbols, names, packaging, prices, and dimensions related to ideal qualities, such as origin, reputation, emotions, and consumer experiences with the brand (Chanachaiphuwapat, 2019, p. 258).

2. For the development of packaging from leaders and members of the Ban Pwoagsoong organic asparagus community enterprise, in the need to develop a logistic packaging format for asparagus powder products, the research team designed and developed product branding and label graphics on packaging. These were divided into two formats, where Format A is suitable for adults, and Format B is accessible to teenagers and children. This allows entrepreneurs to choose according to suitability and consumer needs through primarily online distribution channels and various event outlets, providing options for customers to purchase for themselves or as gifts or souvenirs. This aligns with the findings of the study by Chanachaiphuwapat (2019, p. 261) on packaging, symbols, and communication strategies for Bang Bo Sardine in Samut Prakan Province. The research findings show that packaging designed following principles has standardization, cleanliness, suitability for cost, practicality, value addition, ease of sale, increased sales channels, and improved communication strategies, leading to better brand recognition and business success.

7. Suggestion

7.1 General Recommendations:

1) Relevant organizations that support the design and development of prototype packaging and label graphics for asparagus powder products should have an evaluation and monitoring system in place for the use of prototype packaging by the Ban Pwoagsoong organic asparagus community enterprise.

2) Support should be provided for the Ban Pwoagsoong organic asparagus community enterprise to register their trademarks. This should involve expert evaluation to check whether the name is available for registration with the Department of Intellectual Property and whether it conflicts with existing names. 3) A mentoring system or specialized expert unit should be established to provide continuous knowledge, support, assistance, and consultation for the development of products and packaging within the Ban Pwoagsoong organic asparagus community enterprise. This will promote sustainability in the group's business endeavors.

4) Efforts should be made to promote and support the creation of networks among community enterprise groups like the Ban Pwoagsoong organic asparagus community enterprise to facilitate mutual support, assistance, and knowledge exchange for the development of products and packaging.

7.2 Recommendations for Future Research:

1) The collaborative design and development processes for packaging and label graphics should be extended to other community enterprise groups. This will help other producer groups within the community gain knowledge and understanding of developing packaging that reflects the identity of their products and can be used for commercial purposes. This will also elevate product quality and create sustainable income opportunities for these groups.

2) Research studies should explore alternative approaches to the development of packaging, such as environmentally-friendly packaging solutions.

8. Acknowledgement

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The Portrayal of Women in Lee Chang-Dong's Films

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ABSTRACT

The research aims 1) To study the portrayal of women in Lee Chang-dong's films and 2) To study the narrative in Lee Chang-dong's films. The research is qualitative research by using textual analysis. This research selected a purposive sampling by selecting 6 films directed by Lee Chang- dong from 1997-2018 as follows: 1) Green Fish (1997) 2) Peppermint Candy (1999) 3) Oasis (2002) 4) Secret Sunshine (2007) 5) Poetry (2010) 6) Burning (2018). The research results are as follows.

The portrayal of women in Lee Chang-dong's films found that 1) Sociology: the female characters are clearly characterized as being from the lower class, with their family relationships fading and no family support, and are financially dependent on the male characters. 2) Physiology: they are clearly characterized by the fact that the female characters' beauty and grooming are for the purpose of pleasing the male characters, rather than for their own enjoyment. 3) Psychology: the female characters tend to be more traditional femininity and the new-age femininity.

The narrative in Lee Chang-dong's films found that 1) Plot: possessing a national, historical attitude, Lee Chang-dong records the trauma and mental anguish of the lower class of Korean. 2) Conflict: the films are characterized by character vs society and character vs self. 3) Theme: the theme is a critique of the external environment and the depiction of people's emotions.

KEYWORDS: Lee Chang-dong's films, Portrayal of women, The narrative of film

1. Introduction

In the 1980s, when the Korean dictatorship fell and the democracy movement organized by local citizens was violently suppressed, the films of this period began to reflect reality and pursue new forms, which was the Korean New Wave. On the other hand, cultural movements emerged under the hegemonic culture of

Hollywood, and Korean filmmakers called on the government to protect local films, reject Hollywood narrative models, and hold on to Korean film screening quotas (Eungjun, M. and others., 2003).

In the 1990s, the Korean government proposed the establishment of a cultural nation, and the environment was laid by the continuous improvement of laws, regulations, industrial policies and the investment of funds from multiple sources, while the Korean Academy of Film Arts and comprehensive film arts colleges were established in Korea to encourage talents to study abroad, and domestic film festivals were established. The Pusan International Film Festival, the first international film festival established in 1996, has become one of the top five international film festivals in the world (Deng, X.C. and others., 2022).

Lee Chang-dong is one of the representative realist masters of the Korean New Wave, writing in poetic film language about the suffering and pain of the Korean nation and presenting a profound picture of social reality. As of 2023, Lee Chang- dong has made six films, the first three of which, Green Fish(1997), Peppermint Candy(1999), and Oasis(2002), all male as the main character. After the release of Oasis, famous Korean film critic Jung Sung-Il criticized the "propization" of women in Lee Chang-dong's films: "This has always been the case in Lee Chang-dong's films. In his films, the male soul cannot be purified without the sacrifice of women. The female soul has to stay where it is and ends up being nothing.

Starting from the fourth film Secret Sunshine(2007), began to use women as the main character, and Lee Chang-dong said in an interview after the release of "Secret Sunshine", "I think all the pain that I have experienced in life is meaningful, and I want to give the audience an answer after experiencing pain in life through my films. ","When writing the script, I hope to express the pain shared by human beings through this story. And women tend to experience and react to pain more strongly than men do, so the main character was set as a woman from the beginning.

This research analysis of Lee Chang-dong's films via the main female characters and reviews the main roles played by the female characters. The research also study and concludes the narrative of his films represent the portrayal of women.

2. Research Objective

1) To study the portrayal of women in Lee Chang-dong's films.

2) To study the narrative in Lee Chang-dong's films.

3. Literature Review

3.1 Theory and Concept

The object of this research is analysis the portrayal of women in Lee Chang-dong's films and the narrative of film in Lee Chang-dong's films. The main concepts applied in this research are as follows:

1. The Concept of Portrayal

In the field of film, the core of the narrative is the person, and the story expresses the point of view through the character, which can be shaped in terms of attitude, personality, behavior, and vision, including the

gender, age, and occupation of the character from the external expression, and the character and psychology from the internal expression (Yu, J.Y., 2020).

Character portrayal in film refers to dialogue plus physical movement. The presentation of a threedimensional character on the film screen requires a sociological, physiological and psychological description of the character. Sociology refers to education, occupation, family life, religion, social status, political affiliation, recreational hobbies, etc. Physiology refers to gender, age, height, weight, physical appearance, voice, physical defects, etc., which are external characteristics that can be visually observed on the movie screen. Psychology refers to personal ambition, moral standards, temperament, attitude toward life, ability, and intelligence, which determine what actions the characters will take at the beginning, during the conflict, and at the end of the movie. Generally, one of the three attributes will be highlighted to drive the storyline through the characters' actions. With regard to the visual presentation on the movie screen, Mise-en-scene refers to all visual elements in the shot, including setting, lighting, staging, costumes, and make-up. sound in the movie includes dialogue, music, sound effects, ambient noise, background noise, and soundtrack, ambient noise provides realism, sound effects Ambient noise provides a sense of realism, sound effects enhance the action of the film, raise the interest of the characters, and make the audience look forward to the characters' next actions. When the theme of the film is determined, it is determined what the way to present the theme of the film is, whether the characters achieve that purpose, and whether they work well together to form an interesting story (Mline Library, from https://milnepublishing.geneseo.edu/exploring-movie-construction-and-production/chapter/4-how-are-thecharacters -portrayed/).

2. The Concept of Femininity

Traditional patriarchal femininity includes nurturer, emotional, passive, kind, empathetic, submissive, dependent, and preoccupied with appearance. Historically, 1. Kindness and nurturing: Seen as desirable traits for women, probably because women were expected to take on the responsibility of nurturing offspring. 2. Preoccupation with appearance: The belief that women were expected to attract men to ensure that they could attach themselves to men with high wealth, as evidenced by the large modern industry targeting women's cosmetics and skin care products and clothing stores. 3. Soft-spoken demeanor: Indicates that women were not Emotional: represents women who are unable to control their emotions, are vulnerable, unable to make the right decisions, and need strong men to protect and make choices, and this femininity also educates men to suppress their fears and concerns, otherwise they will appear feminine. 4. Empathetic: Men have to go out to war to engage in dangerous work, and women have to stay home to take care of family. 5. Sensitive and powerless: Because of the traditional culture where men hold power and are assertive, women are left at home. 6. Dependent: Women need to depend on men for property, status, and power to survive. 7. Gossipy: Traditional women have time to talk about various things in life while cooking, sewing, and other menial tasks. 8. Accepting and passive: Cultures around the world where women are expected to be meek and obedient to their husbands, women are often excluded from history, even though they have achieved many great things, but these books are written from the male perspective. (Chris Drew, 2022, from https://helpfulprofessor.com/femininity-examples/)

3. The Narrative of Film

The narrative of film refers to the delivery of an organized set of story clues to the audience, and story elements include setting, characters, plot, conflicts, resolution, point of view, theme, etc. (Arc Studio, 2020, from https://www.arcstudiopro.com/blog/the-5-main-types-of-movie-characters).

Plot refers to the sequence of events that occur in a story, the sequence of events that make up the story, the plot is the driving force of a film story, a good plot helps the character overcome one obstacle after another to reach the goal, logically at each plot point points to the next plot point (Film Draft, from https://filmdaft.com/what-is- the-plot-in-a-movie-definition-examples-meaning-of/).

Conflict is the basis of the plot, which drives the plot towards the climax and the ending according to the sequence of events, and is also a means of displaying the characterization of the characters, which is generally of three levels, 1. Character vs Society 2. Character vs Character 3. Character vs Self. (Cao, W.T., 2016)

Themes are the central idea of a story, the message the author wants to convey, Robert McKee, the famous screenwriting teacher considers stories as "equipment for living. "movie themes as "controlling ideas," which are "the purest form of a story's meaning, such as love, death, justice, growth, righteousness, and so on. But strictly speaking, these are story topics or subjects, not themes. Themes in a film are actually "inferred positions taken on the theme of the story, and everything that happens in the story should refer to the theme, for example justice is the theme of a film, but a derived theme might be that if a person is not constrained to do justice for herself, she can never do it for others. (Michael Bodhi Green, 2020, from https://www.studiobinder.com/blog/movie-themes-examples/)

4. Research Methodology

4.1 Population and Sample

The research is qualitative research by using textual analysis. This research selected a purposive sampling by selecting 6 films directed by Lee Chang-dong from 1997-2018 as follows: 1) Green Fish (1997) 2) Peppermint Candy (1999) 3) Oasis (2002) 4) Secret Sunshine (2007) 5) Poetry (2010) 6) Burning (2018).

4.2 Research Instrument

The research is divided into two parts of analysis:

Part 1: the portrayal of women in Lee Chang-dong's films. This research employs the concept of the portrayal to investigate and identify women images in Lee Chang-dong's films.

Part 2: the narrative in Lee Chang-dong's films. This research utilizes the concept of film narrative to analysis in Lee Chang-dong's films.

4.3 Data Collection

This research collects data from movie information from online streaming web sites. They are as follows:

Green Fish (1997): https://www.naifei.io/vodplay/278342-1-1.html Peppermint Candy (1999): https://www.7xi.tv/vodplay/115792-1-1.html Oasis (2002): http://www.nnu2.com/play/333313-1-1.html Secret Sunshine (2007): http://www.nnu2.com/play/365955-1-1.html Poetry (2010): https://www.dandanzan.com/dianying/24839.html Burning (2018): https://www.hanjukankan.com/play/12-0-0.html

4.4 Data Analysis

This research describes the data analysis that follows the objective of the research. They are as followed: Part 1: The analysis of the portrayal of women in Lee Chang-dong's films. Part 2: The analysis of the narrative in Lee Chang-dong's films.

5. Research Findings

The research divides into 2 parts, they are as follows:

Part 1: The analysis of the portrayal of women in Lee Chang-dong's films.

1) Sociology: The female characters in Green Fish and Oasis are clearly characterized as being from the lower class, with their family relationships fading and no family support, and are financially dependent on the male characters, which can be categorized into two groups: those who need to sell their beauty to earn money from the male characters, and those who need to spend the male characters' money. The female characters in Secret Sunshine, Poetry, and Burning rely on their physical strength and skills to earn money. Although it is not easy for them to survive, whether or not they are tied to money because of their status as a woman is the most intuitive reflection of the social status of the female characters.

2) Physiology: Green Fish and Peppermint Candy are clearly characterized by the fact that the female characters' beauty and grooming are for the purpose of pleasing the male characters, rather than for their own enjoyment. Secret Sunshine and Poetry's female characters' emphasis on appearance and dress reflects self-spiritual pleasure. With the exception of the Poetry, emotions are basically expressed on the surface.

3) Psychology: The female characters in Green Fish, Peppermint Candy, and Oasis tend to be more traditional femininity, are psychologically dependent on the male characters, need to rely on the male characters to make decisions, and are the portrayal of women from a male perspective, are thoughtless and have no autonomy, while the female characters in Secret Sunshine, Poetry, and Burning have the new-age femininity, are not economically dependent on the male characters, and will have their own independent thinking, and have begun to have their own spiritual pursuits.

Part 2: The analysis of the narrative in Lee Chang-dong's films.

1) Plot: Possessing a national, historical attitude, Lee Chang-dong records the trauma and mental anguish of the lower class of Korean society in an objective and calm poetic narrative.

2) Conflict: The big conflict in Green Fish, Peppermint Candy, and Oasis are characterized by Character vs Society, where the characters are part of a huge social system, and there is an irreconcilable conflict between the cruel social reality and the powerlessness of the individual. The big conflict in Secret Sunshine, Poetry, and Burning is characterized by Character vs Self, where the characters are mentally trapped, emotionally detached, lonely and struggling.

3) Theme: The theme of Green Fish, Peppermint Candy, and Oasis is a critique of the external environment, i.e., the real society, and a representation of the impact of modernization on the individual. The theme of Secret Sunshine, Poetry, and Burning shifts to the depiction of people's emotions, and a representation of the inner predicament of the lower classes.

6. Discussion

The research result found that psychology focuses on femininity that can show the idea of portrayal of women, it is shown that the portrayal of women in Lee Chang-dong's films are divided into two stages. The first stage is the lower class of traditional femininity in Green Fish, Peppermint and Oasis, and the status of male characters who are also in the lower class is quite different. The second stage is the lower class of the new era in Secret Sunshine Poetry and Burning, and the status of the male characters who are also the lower class is not much different. In my opinion, the shift between the two stages of the portrayal of women helped Lee Changdong make a shift in the narrative focus of his films. The result refers to Yu Jiayue (2020) explain the concept of portrayal that in the field of film, the core of the narrative is the person, and the story expresses the point of view through the character, which can be shaped in terms of attitude, personality, behavior, and vision, including the gender, age, and occupation of the character from the external expression, and the character and psychology from the internal expression.

Another result was that theme focus on character can show the idea of film narrative, it is shown that the theme in Lee Chang-dong's film is divided into two stages. The first stage is the critique of the reality of society in Green Fish, Peppermint and Oasis. The second stage is the focus on the lives of people living in the real world in Secret Sunshine, Poetry and Burning. In my opinion, the shift of the themes in these two stages plays a crucial role in the portrayal of women. The result refers to Michael Bodhi Green (2020) explains that themes are the central idea of a story, the message the author wants to convey, Robert McKee, the famous screenwriting teacher considers stories as "equipment for living. "movie themes as "controlling ideas," which are the purest form of a story's meaning, such as love, death, justice, growth, righteousness, and so on. But strictly speaking, these are story topics or subjects, not themes. Themes in a film are actually inferred positions taken on the theme of the story, and everything that happens in the story should refer to the theme, for example justice is the theme of a film, but a derived theme might be that if a person is not constrained to do justice for herself, she can never do it for others.

7. Suggestion

It can be observed that Lee Chang-dong uses portrayal of women to express common human emotions, and that they represent a group portrait of a broad group of people from the lower classes, as well as a microcosm of history and the people's memories and national wounds that they represent as marginalized and aphasic people. It should be noted, however, that the portrayal of women in this research belong to the female character specific to Lee Chang-dong's films, but whether or not they can be placed in the broader context of the portrayal of women in Korean cinema remains to be further examined. While this does not affect the results of this research, future research may seek to place them in the field of cultural studies to map the portrayal of women in the history of Korean film more clearly.

Recommendations for Future Research

This research is to analyze the portrayal of women in Lee Chang-dong's films, and the research found that the shift in the themes of Lee Chang-dong's films is related to the portrayal of women in the films, and based on this, future researches consider expanding into the study of realism theory and the field of cultural studies, and deepening the understanding of the Korean society, in order to have a more comprehensive understanding of the portrayal of women in Lee Chang-dong's films.

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Factors related to decision for booster vaccination against COVID-19 of people in

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ABSTRACT

The purpose of this research was to study the factors related to decision making for COVID- 19 booster vaccination among 200 people in Ratchaburi province by multi-stage random sampling. Data were collected by questionnaires. Data were analyzed using descriptive statistics, including frequency, percentage, mean, standard deviation and stats for the Chi-Square test. . The results showed that age, education level, knowledge and attitudes

correlated with the decision to vaccinate a booster dose against COVID- 19 of the people in Ratchaburi province with statistical significance at the 0.05 level. Gender, occupation and news perceiving channels did not correlate with the decision to vaccinate against COVID- 19 of the people in Ratchaburi province with statistical significance at the 0.05 level.

Keywords: Vaccination, Covid-19, Knowledge, Attitudes

1. Introduction

Current diffusion of the COVID- 19 outbreak is different from the past. A vaccine has helped reduce the severity of the infection and reduce the death rate. If the majority of people receive the COVID- 19 vaccine, it will reduce the damage, and severe effects such as reducing the spread of infection, reducing the severity of the disease, reducing the occupancy rate in hospital beds and reducing the mortality rate. The vaccination against COVID- 19 is therefore a good way to prevent and control the disease by vaccination to create immunity like patients who have had COVID- 19 and to create herd immunity to calm the epidemic. When the epidemic is controlled, daily life will return to normal (Poovorawan, 202). According to the information in the MOPH Immunization Center system database, it was found that from the 28 February 2021 - January 19, 2022 in 77 provinces across the country, there were 110,799,936 doses of the cumulative vaccine received- 51,922,910 received the first dose, 47,834,174 received the second dose, and 11,042,852 received the third dose. Ratchaburi province has a target group of 863,188 people who need to be vaccinated. According to data reporting on the results of the COVID -19 vaccine service, it was found that from February 28, 2021 to January 28, 2022, those of 475,625 cases (55.10 %) received the first dose vaccination, the second dose of vaccine was at 471,313 cases (54.60%), 132,262 cases (15.32 %) received the third dose of vaccine, and 6,209 cases (0.72%) received the fourth dose of vaccine. Moreover, there were a large number of people who had not received the booster vaccine.

According to past studies, it was found that people did not receive the COVID- 19 booster dose due to lack of knowledge, understanding, confidence in the efficacy of the vaccine and still found the rate of infection with the Coronavirus 2019 continued despite receiving the booster vaccine. A review of the literature on the decision to receive a booster dose of COVID- 19 vaccine found that factors related to the decision to receive a booster dose of COVID- 19 vaccination consisted of both intrapersonal factors and psychological factors including gender, status, education level, job characteristics, congenital disease, history of close contact with patients or risk groups, social perception, perceived benefits, perceived risks of infection, vaccine safety, negative personal perceptions and perceived risk along with severity of the disease (Peerawat Trakultaweesuk, 2021). The researcher was therefore interested in studying factors related to the decision to vaccinate a booster dose against COVID- 19 of the people in Ratchaburi province. The obtained information can be used to improve the knowledge creation approach and accurate understanding of COVID- 19 booster dose vaccination to ensure their safety and quality of life. People would be far away from the danger and risk of future coronavirus disease 2019 infection.

2. Objectives of the research

To study factors related to decision for booster vaccination against COVID-19 of people in Ratchaburi province

3. Related documents and research

3.1 Concepts, theories and related research

The researcher applied Pender's health promotion model (Pender et al., 2002) to create a research conceptual framework. It is a theoretical concept used to explain and predict health promoting behaviors. The model has been widely applied, such as lifestyle modification for health promotion, nutrition, health promotion and health promotion behaviors of various groups of people. The concept of health promotion model of Pender et al. explained that 1) the person is the core of health behavior practice. Each person has different personal characteristics and different experiences that affect behavioral performance. In addition, individuals learn health behaviors within family and community contexts. 2) Environment refers to the physical environment and the environment between individuals and economic environment 3) Health means a person's high level of health in a positive direction as shown in diagram

3.2 Conceptual framework



Figure 1. Conceptual framework

3.3 research hypothesis

Factors of knowledge and attitudes relate to decision for booster vaccination against COVID-19

4. Methods

4.1 Research pattern

This research was survey research with the objective of finding factors related to the decision to vaccinate booter dose against COVID- 19 of the people in Ratchaburi province. The sample group were 200 people aged 20 years or more who lived in Ratchaburi province. The research data was collected between October and December 2022.

4.2 Population and samples

The population used in this research was people aged 20 years and over living in Ratchaburi province.

The sample group were people aged 20 years and over living in Ratchaburi Province. The size of the sample was calculated with the G*Power 3.1.9.4 program for the correlation analysis (Chi - Square), the size of the influence (effect test) was equal to 0.30, which was the middle value (Cohen, 1997), power of test equal to 0.90, \propto error prob equal to 0.05 and Df equal to 6, resulting in a sample size of 194. To prevent data collection errors, the sample size was increased to 200 people.

The random sampling method in this research. The researcher uses Multi-stage Sampling Sampling with the following methods:

Step 1 Cluster sampling by using the district as a random unit, totaling 5 districts.

Step 2 Cluster sampling by using sub-districts as the random unit of each district, totaling 5 sub-districts.

Step 3 Cluster sampling by using the village as a random unit of each sub-district for 5 villages.

Step 4 Random sample selection.

4.3 Research tools and quality determination

1) Research tools - The tool used for data collection was a questionnaire with a total of 4 parts as follows:

Part 1 Personal Information Questionnaire- It was a program test form, including gender, age, education level, occupation, and channels for receiving information.

Part 2: A questionnaire on knowledge about vaccination boosters consisting of 15 items- Each item provided 2 options, i.e., a correct answer got 1 point, and a wrong answer got 0 points. The criterion based on Bloom (Bloom, 1970) as follows

Level	Definition			
High	80 percent or more (12-15 points			
Moderate	60-79 percent	(9-11 points)		
Low	Below 0-59 percent	nt (0-8 points)		

Part 3: A questionnaire on attitudes about vaccination with a booster dose, consisting of 20 items with 5 options. The questionnaires were both positive and negative. The scoring criteria for each item depends on the following requirements:

In the case of positive questions		In the case of negative questions		
Strongly agree	5 points	Strongly agree	1 point	
Agree	4 points	Agree	2 points	
Unsure	3 points	Unsure	3 points	
Disagree	2 points	Disagree	4 points	
Strongly disagree	1 point	Strongly disagree	5 points	

Dividing the mean criterion to explain the results and variables of Kiess, 1989, divided by the desired class range, divided into 3 levels as follows:

Level		total score range	
Attitudes towards booster vaccination	Good Level	74-100	points
Attitudes towards booster vaccination	Moderate	47-73	points
Attitudes towards booster vaccination	Low	20-4	points

Part 4: Questionnaire on Decision for booster vaccination- It was a one- item checklist with two options: decide not to get booster vaccines and decide to get booster vaccines.

2) Finding the quality of research tools

(1) Take the questionnaire to 3 experts to verify content validity by finding the index of consistency (IOC: Index of item objective congruence) with an IOC value between 0.67-1.00.

(2) Take the questionnaire to try out (Tryout) with groups that were similar to the sample but not a sample of 30 people

(3) Data from part 2 were analyzed for reliability according to Kuder Richadson's KR-20 formula, equal to 0.76, with a difficulty value between 0.27-0.73 and a discriminating power value of 0.25 -. 0.61

(4) Analyze the data in part 3 to find the confidence value. The alpha coefficient of Cronbaht was

4.4 Data collection

0.80.

The researcher collected the data details as follows

1) The researcher submitted a letter requesting permission from the Ratchaburi Provincial Public Health Office to request data collection assistance.

2) The researcher prepared a document explaining details about the research, including the objectives, research methods, benefits from research and conducting self-data collection

3) The researcher checked the accuracy and completeness of the answers and collected them for further data analysis.

4.5 Data analysis

1) Analyze the factors of demographic and social characteristics, knowledge factors, attitudes, and decision-making for booster vaccination with statistics, frequency, percentage, mean and standard deviation.

2) Analyze the factors related to the decision to vaccinate a booter dose against COVID- 19 of people in Ratchaburi province with Chi-Square statistics

5. Results

1. General information - It was found that most of the samples were female 57.00 % aged between 31-40 years, 35.00 % had secondary school education, 60.00 % were farmers, 38.00 % and received information from mobile phones hold 45.00 %.

2. The decision to vaccinate with a booster dose to prevent COVID- 19 -It was found that 69% of the sample wanted a booster vaccination to prevent COVID- 19 while 31% of the sample did not.

3. Factors related to decision making to get booster vaccination to prevent COVID- 19 of the people in Ratchaburi province are shown in Table 1.

Table 1: Relationship between personal factors, knowledge and attitudes and decision to get booster shots

	The decision to vaccinate with a booster shot				
factor	Non-injectable	inject	\mathbf{X}^2	df	p-value
Amount (%)		Amount (%)			
gender					
male	25(29.07)	61(70.93)	1.625	1	0.202
female	37(32.46)	77(67.54)			
age					
Under 30 years old	20(47.62)	22(52.38)	8.561	3	0.036*
31 - 40 years old	23(32.86)	47(67.14)			
41 - 50 years old	20(34.48)	38(65.52)			
50 years or above.	14(46.67)	16(53.33)			
Education level					
Primary Education	25(62.50)	15(37.50)	18.586	2	0.000**
secondary education	43(35.83)	77(64.17)			
Higher Secondary Education	15(37.50)	25(62.50)			
occupation					
farmer	28(36.84)	48(63.16)	2.242	4	0.691
employee	12(38.89)	22(61.11)			
Merchant	19(41.30)	27(58.70)			
Self-employed	7(35.00)	14(65.00)			
Government official	7(51.52)	16(48.48)			
Channels for receiving news					
Publications	8(53.33)	7(46.67)	2.502	3	0.475
television	26(37.68)	43(62.32)			
mobile phone	33(36.67)	57(63.33)			
radio	6(23.07)	20(76.92)			
knowledge					
low	15(62.50)	9(37.50)	17.253	2	0.000**
moderate	40(40.82)	58(59.18)			
high	22(28.20)	56(71.79)			
Attitude					
low	14(56.00)	11(44.00)	11.413	2	0.003*
moderate	37(29.84)	87(70.16)			
high	21(41.18)	30(58.82)			

against COVID-19

Note: * P-Value < 0.05, ** P-Value < 0.001

From Table 1, it was found that age, education level, knowledge and attitudes correlated with the decision to vaccinate a booter dose against COVID- 19 of the people in Ratchaburi province with statistical significance at 0.05. Gender, occupation and news perceiving channels did not correlate with the decision to vaccinate a booter dose of the people in Ratchaburi province with statistical significance at 0.05.

6. Discussion

From the results of the study of the relationship between personal factors, knowledge, attitudes and the decision to get a booster vaccine to prevent COVID- 19 in the people of Ratchaburi province, it was found that

Age correlated with COVID -19 vaccination decision, which was consistent with Chamnan Malai and Thanom Namwong (2022) which found that age correlated with COVID -19 booster vaccination decision and vaccination rate tended to decrease with increasing age, especially those aged over 60 years old because the older people were afraid of the dangers of vaccine allergies. The findings were in line with Kradarat Kuatan et al. (2022) who found that age was related to the decision to receive a vaccine against coronavirus (COVID- 19). People in different ages made different decision- making in terms of idea along with different learning perspectives

Education level- The level of education correlated with the decision to vaccinate a booster dose against COVID -19 in people in Ratchaburi province, which was consistent with Korndarat Kuatan et al and in line with Khanittha Chuenjai and Butka Punthura-Amporn (2021) who found that different levels of education made decisions to vaccinate against coronavirus (Covid-19) different. Getting different education levels made people access to different sources of information, learning, and ideas which affected on making decisions. People with a higher education tended know the importance and the need to get a vaccine against COVID-1. The chance to making a decision to get a vaccine would increase (Phasasi Preechaporn, 2021).

Attitudes correlated with decision to get a booster dose of vaccine against COVID - 19 among people in Ratchaburi province, agreeing with Bowonlak Kajornrit and Butka Panturaumporn (2022) which found that attitudes towards COVID- 19 of the population affected the decision to get a vaccine. If people had an attitude that the disease was very severe, it would affect the decision to get a vaccine against COVID- 19. The findings were in accordance with Jidapha Phuwakornkulwut et al. (2022) that found attitudes affected vaccination intake for disease prevention. Getting complete and accurate information about vaccines together with proper communication of healthcare professionals on the advantages of accurate and complete vaccination built confidence among people on the effectiveness of the vaccine

Knowledge was related to the decision to get a booster vaccine to prevent COVID -19 among people in Ratchaburi province, agreeing with Somchai Panumaswiwat and colleagues (2021) who found that people with knowledge and understanding about COVID- 19 disease at high level tended to have a behavior to protect oneself from infection with the COVID -19 virus. Knowledge is a person's ability to understand, think analytically, and be able to use health information in making decisions. Moreover, there was a high intention to receive the COVID-19 vaccine, resulting in taking care of their health appropriately.

7. Suggestions

7.1 Suggestions for applying the research results

To be able to use information as a guideline for creating knowledge and accurate understanding of the COVID -19 booter vaccination to people to continue to keep people safe and have a good quality of life.

7.2 Suggestions for next research

1) Other variable factors should be studied. Those may affect the decision to vaccinate against the coronavirus (Covid-19) of the people in Ratchaburi province, such as satisfaction, cultural factors, social influence factors, alternative analysis, confidence, perception of the benefits of treatment and prevention of disease, etc.

2) The population studied in this study was only the population in Ratchaburi province. To get more diverse information, a regional population needed to be applied to.

8. Acknowledgment

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The Movie Style of MING-LIANG TSAI

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ABSTRACT

The research aims to (1) to study the narrative theme of Ming-liang Tsai's movies. And (2) to study the movie language of Ming-liang Tsai's movies. This is qualitative research by using textual analysis to study 6 Ming-liang Tsai movies. The selected films are as follows: 1) What Time Is It There 2) Goodbye Dragon Inn 3) The Wayward Cloud 4) I Don't Want Sleep Alone 5) Stray Dogs 6) Days. The result are as follows:

Part 1: narrative theme in Ming-Liang Tsai's movies.

1) In the theme of nostalgia, by inserting previous movie plots, actors, or setting scenes in the theater, completing the reminiscence of the past era. 2) In the theme of loneliness and desire, the very little dialogue between the characters reflects the loneliness that the characters, and shows their appetite and sexual desire through the abnormal behavior of the characters. 3) In the theme of living predicament, showing the harm caused to marginal characters by occupation, society, family, and natural disasters, and conveying his compassionate humanistic care.

Part 2: movie language of Ming-liang Tsai's movies.

1) In the soundtrack, inserting a large number of classic old songs into the movies not only expresses the emotions of the characters. 2) In the space composition, he uses closed space composition, the closed "Back" character composition and frame composition create a gloomy and low narrative style for him. 3) In the single shot, show the scenes where the characters are located and the emotions externalized by the characters, and make the movie's narrative have authenticity. 4) In the symbol, the symbolism of various metaphors helps the director express more ideas.

Keywords: Ming-liang Tsai, narrative theme, movie language

1. Introduction

Ming-liang Tsai, who had a strong personal colour, entered the Taiwanese film scene during the period of the new film movement in the 90s.Ming-liang Tsai is a loyal practitioner of the author's theory. His movies tell the lives of urban men and women, his portrayal of the city is acute in his movies. Ming-liang Tsai's every work won many awards. Ming-liang Tsai pays more attention to internal conflicts, he has successfully created characters who are alienated and lonely, but full of desire. His films are full of humanistic care and compassion, commendable is that Ming-liang Tsai director's works contain the magic which make people into the hearts of the characters

From the first movie Ming-liang Tsai "Rebels of the Neon God" in 1992 to 2020, there are a total of 11 long movies, Ming-liang Tsai has been a representative figure of the naturalistic aesthetic view, it can be said that the world movie industry could not be underestimated this master figure. He creates works with rich personal experience, without deliberately pursuing the technique of movie, obvious realistic style, and iconic fixed long shot. Not a praise of modern civilization, but through the real details of the oppressive life of marginalized people, under the lens of everyday life, the crazy characteristics and absurd ugly costs of the development of modern civilization are narrated. Thus, It is very interesting to concern about the movie style of Ming-liang Tsai and the research aims to study the narrative theme and the movie language that could represent the idea of movie style by Ming-liang Tsai.

2. Research Objective

(1) To study the narrative theme of Ming-liang Tsai's movies

(2) To study the movie language of Ming-liang Tsai's movies

3. Literature Review

3.1 Author Theory

French society was influenced by the political reforms of the late 50s of the 20th centuries and the atmosphere of various youth subcultures, and a group of young elites representing the counterculture of Paris promoted the development of cinema in the movie industry in the 60s, known as the "New Wave". The Author theory originated in this movement. (Peggy. C, 2019)

In 1943, André Bazin, the mentor of the New wave, said that "the value of cinema comes from the author, and it is much more reliable to trust the director than to trust the star." (Yang. Y, 2017) In April 1957, Bazin published "On la politique des Authors" in the "Cahiers du Cinéma", arguing that "authorship strategy" as a way of movie criticism is very useful and necessary, but it should be noted that a director cannot be identified as the author and then fully affirm his movie, and discovering the value of the movie needs to be supplemented by critical angles and research methods. (Dai. H, 2022) Strictly speaking, Author theory is not a veritable theory, but an attitude of movie creation practice. The "author" emphasizes that the director is more important than the playwright, and is the chief conductor of all aspects of the production, while the script is only one link of the production. The Author theory has been criticized by academics for lacking a systematic program and loose content. (Peggy. C, 2019)

3.2 Narrative Theme

Narrative theme is an important part of movie theory. The term "narratology" was first coined by the French contemporary literary theorist Tzvetan Torodov in his 1969 book " 'Decameron' Grammar ", proposed that " this work belongs to a science that does not yet exist, and we will temporarily name this science narratology, that is, the science of narrative works." (Zhang. Y, 1989)

Narrative theme is a branch of contemporary narratology. (Zhang. J,2017) The birth of movie narratology was developed by the French scholar Francois Jost, Christian Matz, American scholar David Bordwell etc. after borrowing the research methods of literary narratology introduced the research methods of classical narratology into the field of movie to form narrative movie. (Liang. Y, 2020) Classical narratology refers to textual analysis based on structuralism, focusing on the structural laws within narrative works and the relationship between various elements. (Jiang. S,2018) Narrative movie aims to demonstrate the narrative mode of this article in the movie from the theoretical form, and reveal the change law of narrative strategy from the change of narrative structure. (Zhang. H, 2016).The director's style is also reflected in the way these movies are presented. The plot design of many movies is carried out around the theme, so when conceiving the plot, there must be a clear thematic expression. (Yuan. D, 2020) .The narrative theme is the core of the narrative movie and the ultimate goal of the narrative movie. A good narrative theme can not only reflect the politic and economy under a specific history, but also reflect "the way of life and thinking of people at that time, so as to see through the specific face of social history and people's specific cultural mentality." (Wang. C, 2006)

The narrative theme is largely influenced by the director's own upbringing. Movie is an art that integrates various artistic expression elements such as literature, painting, and music. It reorganizes and integrates various traditional artistic elements in the movie, making these elements a character in the narrative movie and better expressing the theme of the movie. The themes of the movie can be about family, society, nature, war, life issues, and many other themes. (Liang. Y, 2020)

3.3 Movie Language

Language is "the communication technique that humans use to communicate thoughts and feelings, and is a system of symbols that uses specific codes." (Lv. Y, 2006). Any artwork aims to communicate is based on language, and so is movie. Andre Gaudreaut (2010) said, "The art of literature consists in manipulating words and syntax to make a storyline more engaging, and the art of cinema showing before our eyes what is happening in the here and now through the shots and sound." movie language is intuitive space composition, camera movement, sound and other elements. (Xie. Y, 2022)

"A good director would never let his audience watch any part of the scene." (Béla. B, 2008). The director presents the part he wants to present to the audience through the change of angle of the shots, the speed of movement of the shots, the size of the shots, and the connection between the shots. As directors dig into the way the content of the picture is organized, composition has also become a technique for directors to tell stories, express emotions, and create style. (Wang. R, 2020) "The purpose of composition in the movie is to make the layout and composition of people, scenes, and objects in the movie picture achieve the ideal visual effect." (Hu.

Y, 2013) Just as the composition of a painting is diverse, the composition of a movie is diverse according to the director's intention. Composition can be mainly divided into: balanced composition, unbalanced composition.

The soundtrack is an important part of the sound of the movie, soundtrack has an ideographic function to a certain extent, enriches the narrative content, carries the emotions of the characters while manipulating the emotions of the audience, and expands the appeal of the movie. The soundtrack can also reflect "the director's sincere understanding of social life and life." (Wang. S, 2009). Andrei Tarkovsky (2016) believed that sound can express the psychological state of characters or complement the atmosphere of the environment.

The movie has a clear language system, and the smallest units in the narrative have to be described, and symbols inevitably operate in the movie narrative. (Wang. J, 2020). Italian director Pier Paolo. P (2008) believes that cinema survives by metaphor. Visual metaphors aid the movie's narrative on the one hand, and suggest the director's thinking about the real world on the other hand. Image symbols also help shape characters, sculpt details, promote the development of the plot, etc. Andrei Tarkovsky wrote in "The Time of Carving"(2016), "Vyacheslav Tikhonov made incisive and pertinent comments on the artistic image (which he called symbols) when he said, 'Symbols can only be called true symbols if they have infinite meaning, when they imply in mysterious (pictographic and magical) language what ordinary written words cannot convey.

3.4. Information of Ming-Liang Tsai

Director Ming-liang Tsai, from Taiwan, is an outstanding representative of Taiwan's new movie movement. In 1957, Ming-liang Tsai was born in Kuching, Malaysia, a place where multicultural and multi-racial collisions. He was exposed to various types of movies from an early age. When he was a child, he would go to the temple where his father sold noodles and participate in the temple fair, watch plays and watch movies. Such as Hong Kong movies, Taiwanese movies, Indian movies, Malay movies, opera movies, martial arts movies, commercial movies, military education movies, etc. Ming-liang Tsai liked directors such as Chaplin, King Hu, Nagisa shima at that time, and the directors he liked, movies are very strong expressions of movie aesthetics. (Tsai. M, 2018)

Ming-Liang Tsai is an emotional person, and the crew of "Rebels of the Neon God"(1992) has been used until all subsequent movies. Except for "What Time Is It", he has changed photographer, all working with the same photographer, he does not pursue fancy technology, pursues a minimalist style, but hopes to convey his message through the camera. (Tsai. M, 2018) Ming-Liang Tsai uses the aesthetic technique of fixed camera position and long lens to shape the story of the movie, and the feelings between people rely on one shot after another. Ming-liang Tsai emphasizes the authenticity of time and space, and the time in the shots is equal to the time of the audience watching the movie, and in the real time, the audience can feel the emotions conveyed by the picture and realize the meaning of time. Every object and prop in the space has a meaning because of reality. (Xu. X, 2015)

His movie production is very small, a total of 11 long movies so far, but the artistic level is very high. Intuitively, his movie lines are few and the one shot time is long. He creates boldly, using the concept of handicraft to think about movie, which is a combination of the collision of realism and expressionism, Ming-liang Tsai abandons the sense of history of the grand narrative, pays attention to the present, and focuses the lens on the group of modern society, depicting the marginality and sense of no belonging of people. In the movie there are many images of water as usual symbolic. In the mature period, Ming-liang Tsai played the construction and combination of the elements of his works perfectly, such as the appearance of various images in "Stray Dogs"(2013): gnawed cabbage, sick walls, etc., and recorded the passage of time with the lens. (Zhang. J, 2016) He used his work to communicate with others. He was very obsessed with movies, because his movies didn't sell out, he went to the streets to sell his movie tickets. If people want to put his work, it is necessary to use 35mm and play it officially. (Tsai. M, 2018)

4. Research Methodology

4.1 Research Design

The research has 2 objectives such as 1) to study the narrative movie of Ming-liang Tsai's movies and 2) to study the language of Ming-liang Tsai's movies. The research is qualitative research that uses textual analysis to explain the objectives of the research.

4.2 Population and Sample

This research studies Ming-liang Tsai's movies. There are 11 movies.

This research uses the purposive sampling that selected Ming-liang Tsai's movies that made during the period between years 2000-2020, except "Visage"2009. Thus, the samples to study are 6 movies. They are as follows: 1) What Time Is It There 2) Goodbye Dragon Inn 3) The Wayward Cloud 4) I Don't Want Sleep Alone 5) Stray Dogs and 6) Days.

4.3 Research Instrument

The research divides into 2 parts of analysis. That is:

Part 1: The narrative theme of Ming-liang Tsai's movies.

The research uses the concept of narrative theme to study and determine Ming-liang Tsai's movies.

Part2: The movie language to explain Ming-liang Tsai's movies.

The research uses the concept of movie language to explain Ming-liang Tsai's movies.

4.4 Data Collection

This research collects data that represents of Ming-liang Tsai's movies from the websites, they are

follows:

https://pan.xunlei.com/s/VNTJqB8uFSA33OO-vFwS--TRA1?pwd=5dnk#

https://pan.baidu.com/s/10X4IeliBS_XOgDLrNhvb9w?pwd=mbwk

The research can select and download Ming-liang Tsai's movies.

4.5 Data Analysis

This research describes the data analysis that follows the objective of the research. They are follows:

Part 1: The analysis of narrative theme by Ming-liang Tsai's movies.

Part 2: The analysis of movie language by Ming-liang Tsai's movies.

5. Research Findings

This research divides into 2 parts, they are follows:

Part 1: narrative theme in Ming-Liang Tsai's movies

In summary, Ming-Liang Tsai's exploration of themes follows the creative model.

In the theme of nostalgia, by inserting previous movie plots, actors, or setting scenes in the theater, the costumes of the characters are designed with a sense of age, and the camera is focused on the natural scenery for a long time, completing the reminiscence of the past era.

In the theme of loneliness and desire, the characters are placed in a dull space, daily behaviors are photographed, and the very little dialogue reflects the loneliness that the characters cannot communicate with the characters, and shows their appetite and sexual desire through the abnormal behavior of the characters.

In the theme of living predicament, he uses delicate shots to describe the environment of marginal characters, showing the harm caused to them by occupation, society, family, and natural disasters, and conveying his compassionate humanistic care.

Part 2: movie language of Ming-liang Tsai's movies

In summary, Ming-Liang Tsai's movie language is very personal. The soundtrack, space composition, single shot, and symbol all bring a unique viewing experience to the audience.

In the soundtrack, inserting a large number of classic old songs into the movies not only expresses the emotions of the characters and arouses the emotional resonance of the audience, but also serves the purpose of narrative and deepening the theme.

In the space composition, he uses closed space composition, he uses mise-en-scène similar to stage plays to reflect the sense of alienation between people, realizing the depth of space and the development of the plot. The closed "Back" character composition and frame composition create a gloomy and low narrative style for him.

In the single shot, his unrestrained single shot ensures continuity and unity in time and space, show the scenes where the characters are located and the emotions externalized by the characters, and make the movie's narrative have authenticity.

In the symbol, the symbolism of various metaphors helps the director express more ideas, promote the development of the plot, externalize the emotions of the characters, and deepen the theme.

6. Discussion

The research result found that scenes can show the idea of narrative theme nostalgia. I think that Ming-Liang Tsai's movies pays tribute to the past film era and praises the past nature with the theme of nostalgia. Inserting the wonderful bridges of French movies and the stars of his favorite old movies into the movies. It rereveals that time and space. Undoubtedly, it shows their deep attachment to the past era. This refers to Zhang Yu (2023) explains that many films try to retrieve the collective memory of a specific era in realistic historical scenes through the technique of reproduction in time and space. Nostalgic images evoke the audience's perception of a particular era and create a sense of historical continuity.

The research result also found that some image can show the idea of symbol, I think that the symbolism of various metaphors helps the director express more ideas. In the movies, watermelon is not only an object to eat, but also a display of lust. Cabbage is not only a toy for children, but also an object of adult's lust. The abandoned building is not only a product of the times, but also a manifestation of people's spiritual numbness and decadence. This refers to Xu Xiongqing (2022) explains that symbol is based on a certain image or some related image in reality to construct its own imaginary world, and use the objective world to reflect subjective thoughts. Symbol can produce an artistic effect that is difficult to achieve with direct expression techniques, making the film meaningless.

7. Suggestion

Since the new century, with the increasing influence of Ming-Liang Tsai in the world movie industry, Ming-Liang Tsai insists on creating, and under the connotation of humanistic care, finally formed a unique Ming-Liang Tsai movie style. Through the study of Ming-Liang Tsai's narrative movie and movie style in six movies after 2000, this study believes that the auteur theory of the French New Wave has deeply influenced Ming-Liang Tsai's movie style. Through narrative themes, the movies depict a group of people who are in various living predicament due to career and other factors, they are both lonely and desireful, their relationships are alienated, but they still long for love. Through movie language, the director uses classic old songs, moving lyrics to express the emotions of the characters, closed compositions to show the characters in distress and alienation between people, a large number of calm single shots, showing the environment where the characters are located, and a large number of symbols appear in the movies, suggesting more meanings than the surface.

Recommendations for Future Research

Although this research has made some results on Ming-Liang Tsai's movie style, there are still certain limitations in the study of Ming-Liang Tsai's movie style, and for future research, the movie language of Ming-Liang Tsai's other five films[Rebels of the Neon God(1992), Vive L' Amour(1994), The hole(1998), The River (1997), Visage(2009)], such as camera movement can be studied, and the narrative structure of the other five films can also be studied. This will help explore Ming-Liang Tsai's movie style.

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Social Science, Business, Management (2)

Understanding Repurchase Motivation in Thai Domestic Flights during the Covid-19 Pandemic

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ABSTRACT

This study examines Thai domestic air travel repurchase intentions during the Covid-19 pandemic. Using an online survey, this study explored the impact of push and pull motivations, attitude, subjective norm, and perceived behavioral control on repurchase intentions. The sample comprised a diverse group of tourists. Regression analysis was applied to the data. The results indicated that push motivation and perceived behavioral control had a positive influence on repurchase intention. In contrast, pull motivation, attitude, and subjective norm did not show significant relationships in the multiple regression analysis. This research deepens both theoretical and practical understanding, adding to the body of knowledge on consumer behavior and travel motivation, particularly during crises. It underscores the need to expand customer response frameworks. The findings offer practical insights for aviation and tourism stakeholders, enabling them to tailor their marketing strategies and crisis management. Such insights equip airlines to address customer concerns more effectively and enhance repurchase intentions. Policymakers can leverage these findings to formulate recovery policies that prioritize passenger safety. In summary, this research provides valuable insights into the determinants of repurchase intentions in the context of Covid-19..

Keywords: Travel Motivation, Air Transport, Covid-19 Pandemic, Repurchase Intention

1. Introduction

The tourism industry had become one of the world's largest and fastest- growing business sectors. The growth of the tourism industry led to new job creation, increased national income, and the development of national infrastructure. Studies on the relationship between the tourism industry and economic growth found that economic growth was driven by tourism in some periods, while tourism growth was sometimes driven by the economy (Antonakakis et al., 2015). However, Aratuo & Etienne (2019) argued that tourism growth only had a long-run relationship with the country's GDP, except for the air transportation and other transportation sectors. In Thailand,

where the tourism business contributed 14% of the GDP, transportation was an essential part of the supply chain and played a crucial role in supporting tourism (Chancharat, 2011).

The coronavirus disease (Covid-19) pandemic plunged the global economy into a crisis. Many businesses faced recession, uncertainty, and a loss of public confidence (Barua, 2020). The outbreak of Covid-19, which started in Wuhan, China, rapidly spread worldwide and caused many deaths (Mhalla, 2020). As a result, many countries implemented lockdown policies to prevent the spread of the disease (Engler et al., 2020). Research showed that people became afraid of being infected and adopted Covid-19 preventive behaviours, such as social distancing (West et al., 2020).

By the time of the pandemic, Covid-19 affected every facet of human life, from social to health and economic systems. The aviation business was profoundly affected by the Covid-19 pandemic, with a decrease in demand in the tourism industry due to pandemic-related fears. Airline revenue and financial status saw a significant decline. At the worst point in April 2020, global operating profit losses reached 70% of revenue (International Air Transportation Association, 2021b).

Laparojkit (2022) explored factors influencing Thai tourists' repurchase intentions but was limited in scope. The study primarily focused on three variables: motivation, trust, and loyalty, overlooking other potential influencers. Meanwhile, Pahrudin et al. (2021) used the theory of planned behavior to study and found a change in travel motivation due to the Covid-19 pandemic. However, the study was limited to the context of Indonesian local tourism. The study suggested further research in other countries (Pahrudin, 2021). Hence, this study aimed to address these gaps by examining a broader range of factors influencing customers' repurchase intention using the theory of planned behaviour (TPB) and travel motivation as base theories. Such insights were crucial for the aviation industry to tailor their strategies effectively and support the revival of aviation during and after the pandemic.

2. Research Objective

1. Examine the influence of travel motivation factors, attitude, subjective norm, perceived behavioural control on Thai domestic air transportation repurchase intention during the Covid-19 pandemic.

2. Study the influence of Push motivation, Pull motivation, Attitude, Subjective Norm, and Perceived behavioural control toward Thai domestic air transportation repurchase intention during the Covid-19 pandemic.

3. Literature Review

3.1 Theory, Concept and Related Research

Theory of Planned Behavior Drawing from Ajzen's (1991) theory of planned behavior, which encompasses attitude, subjective norm, and perceived behavioral control, this study extends its application to the COVID-19 context. Investigating how the pandemic influences these factors, the research model probes repurchase intention for Thai domestic air travel services. Attitude, viewed as positive or negative and related to evaluation, strongly shapes intentions. For tourism during the pandemic, safety and hygiene considerations

reshape destination attitudes (Gössling, Scott, & Hall, 2021). Subjective norm, reflecting perceived social pressure, significantly affects behavioral intentions. Examining travel's social pressures amid the pandemic, Hao et al. (2021) found tech-driven preferences and emphasis on health and safety. This study's innovation lies in applying the TPB framework to pandemic-induced shifts in attitudes, norms, and controls. The linkage between travel motivation, attitude, and intention, often explored to explain travel behavior, underscores the significant correlation between motivation and intention, evident in destination selection (Ajzen, 1991).

3.2 Research Framework

The integration of push and pull motivations with the Theory of Planned Behavior (TPB) provided a comprehensive framework for understanding travel behavior. TPB, which encompassed attitudes, subjective norms, and perceived behavioral control influencing behavioral intentions, gained depth by incorporating push and pull motivations, yielding a holistic view of travel behavior. Push motivations stemmed from internal desires like relaxation or adventure, while pull motivations arose from external attractions such as cultural experiences or recreational facilities. This integration was applied by Mody et al. (2020) in airline loyalty programs, providing deeper insights. However, a gap existed regarding the examination of this integration amid the Covid-19 pandemic, which profoundly transformed travel behavior and decision-making processes, necessitating a fresh look at their interconnectedness.

While several research studies explored the application of the theory of planned behavior on behavioral intention during and after the Covid-19 pandemic, there was limited research in the context of Thai domestic air transportation. Laparojkit (2022) studied the change in behavioral intention in Thai tourism repurchase intention and suggested that behavioral intention might have differed in specific businesses due to the nature of the business, which might have resulted in different motivational factors. Therefore, this research aimed to fill the research gap by integrating push and pull motivation with the Theory of Planned Behavior (TPB) and studying its influence on repurchase intention in the context of Thai domestic air transportation.



Figure 1 Research Framework

3.3 Research Hypotheses

Hypothesis 1: Push motivation influences Thai domestic air transportation repurchase intentions during the Covid-19 pandemic.

Hypothesis 2: Pull motivation influences Thai domestic air transportation repurchase intentions during the Covid-19 pandemic.

Hypothesis 3: Attitude influences Thai domestic air transportation repurchase intentions during the Covid-19 pandemic.

Hypothesis 4: Subjective norm influences Thai domestic air transportation repurchase intentions during the Covid-19 pandemic.

Hypothesis 5: Perceived bahoviural control influences Thai domestic air transportation repurchase intentions during the Covid-19 pandemic.

4. Research Methodology

4.1 Research Instrument, Reliability and Validity Testing

A survey questionnaire was developed to measure the relationship between travel motivation, attitude, and intention to fly during and after the Covid-19 pandemic. The survey consisted of four sections of Likert-scale questions, including Push Travel Motivation (14 questions), Pull Travel Motivation (10 questions), Factors regarding the Theory of Planned Behavior (9 questions), and Repurchase Intention (3 questions). Additionally, there was one section regarding participant demographics.

In this research, Item-Objective Congruence (IOC) was used to assess the validity of the survey questionnaire. As a result, all items were marked above 0.67, leading to the conclusion that all items in the questionnaire were qualified and appropriate for use as the research instrument. However, the researcher made some adjustments based on expert suggestions. Additionally, the questionnaire was pilot tested using the Cronbach's alpha reliability testing method. The pilot test results indicated that the questionnaire had a good level of internal consistency, with a Cronbach's alpha value of 0.88. A Cronbach's alpha value above 0.70 is considered acceptable, indicating that the questionnaire is reliable for measuring the constructs of interest in the study (Nunnally, 1978). The pilot test results provided confidence in the validity and reliability of the questionnaire items, allowing for the questionnaire to be used in the main study (Creswell & Creswell, 2017).

4.2 Population and Sample

The online questionnaire survey was chosen due to pandemic restrictions, which prevented in-person data collection at multiple airports. The target population comprised Thai internet users who had previous air travel experience. Total 415 questionnaire are collected to accommodate potential nonresponse or incomplete data . The judgment sampling method was employed, filtering participants who had flown at least once and were of legal adult age (20 years) . The online questionnaire link was distributed via social media networks and travel forums to access participants.

4.3 Data Collection

Data collection for this research relied on a questionnaire survey, facilitated through an online platform using Google Forms. To ensure accessibility, the survey was available in both Thai and English versions. Complementing primary data, secondary data encompassing push and pull travel motivation factors, the research framework, and the theory of planned behavior were sourced from various domestic and international studies, textbooks, newspapers, and online sources, forming the basis for review and discussion.

4.4 Data Analysis

Data cleaning involved the identification and management of outliers using Z-scores, where a threshold of ± 1.96 was employed to detect extreme values beyond the range of -1.96 to 1.96 standard deviations from the mean, resulting in a dataset of 264 cases. Descriptive statistics summarized demographic information and travel intentions during the pandemic, utilizing fundamental statistics like minimum, maximum, mean, median, and standard deviation. The multiple regression analysis explored the impact of push and pull motivations, attitude, perceived behavioral control, and subjective norm on travel intention.

5. Research Findings

5.1. Background Information

Table 1 presents the demographic characteristics of the sample. The study found that, out of the total sample of 264 respondents, the majority were male (62.9%) while 37.1% were female. In terms of education level, most of the respondents had completed secondary education (72.3%), followed by those holding a bachelor's degree (21.6%), and a master's degree or higher (4.9%). Concerning monthly income, most respondents earned between 15,001 and 30,000 THB (41.3%), followed by those earning between 30,001 and 45,000 THB (24.2%), and more than 60,000 THB (11.0%). The remaining respondents earned less than 15,000 THB (12.1%) or between 45,001 and 60,000 THB (11.4%).

		Frequency	Percent
Gender	Male	98	37.1
	Female	166	62.9
	Total	264	100
Education Level	High School	3	1.1
	Bachelor's degree	191	72.3
	Master's Degree	57	21.6
	Doctoral Degree	13	4.9
	Total	264	100
Monthly Income	THB 15,000 or lower	32	12.1
	THB 15,001 - 30,000	109	41.3
	THB 30,001 - 45,000	64	24.2
	THB 45,001 - 60,000	30	11.4
	THB 60,001 or higher	29	11
	Total	264	100

Table 1: The demographic characteristics of the sample

5.2. The influence of push motivation, pull motivation, attitude, subjective norm and perceive behavioral control toward repurchase retention on thai domestic air transportation services during covid-19 pandemic.

	Unstandardized		Standardized	т	S :-
	Coefficients		Coefficients	1	51g.
	В	Std. Error	Beta		
(Constant)	0.045	0.039		1.168	0.244
Push Motivation	0.252	0.074	0.207	3.415	0.001
Pull Motivation	-0.006	0.078	-0.004	-0.074	0.941
Attitude	0.086	0.078	0.081	1.105	0.27
Subjective Norm	0.041	0.059	0.046	0.692	0.489
Perceive Behavioural Control	0.376	0.057	0.402	6.551	0

Table 2 Multiple regression result

The multiple regression analysis examined the influence of push motivation, pull motivation, attitude, subjective norm, and perceived behavioral control on the repurchase intention of Thai domestic air transportation services during the Covid-19 pandemic. The overall model fit was found to be significant (R = .588, p < 0.001), indicating that the independent variables collectively explain a substantial portion of the variance in repurchase intention. The R-square value (0.346) suggests that approximately 34.6% of the variability in repurchase intention can be accounted for by the combined effects of the independent variables. The adjusted R-square (0.333) is slightly lower and accounts for the complexity of the model with multiple predictors.

The standardized coefficients (Beta) provide insights into the relative strength of the independent variables' contributions to the repurchase intention. Among the predictors, push motivation (Beta = 0.207, p = 0.001) and perceived behavioral control (Beta = 0.402, p < 0.001) displayed statistically significant positive relationships with repurchase intention. This suggests that individuals who have higher levels of push motivation and perceive more control over their behavior are more likely to have stronger intentions to repurchase Thai domestic air transportation services during the pandemic.

On the other hand, pull motivation (Beta = -0.004, p = 0.941), attitude (Beta = 0.081, p = 0.27), and subjective norm (Beta = 0.046, p = 0.489) did not show statistically significant associations with repurchase intention. This implies that these factors may not be significant predictors of repurchase intention in the context of Thai domestic air transportation services during the pandemic. The regression equation was formulated using the unstandardized coefficients (B)as per following.

(Y) Repurchase Intention = $0.045 + 0.252(X_1) - 0.006(X_2) + 0.086(X_3) + 0.041(X_4) + 0.376(X_5) + \mathcal{E}$ Where:

X₁ represent Push Motivation toward Thai Domestic Air Transportation repurchase intention during COVID-19 pandemic

X₂ represent Pull Motivation toward Thai Domestic Air Transportation repurchase intention during COVID-19 pandemic

 X_3 represent Attitude toward Thai Domestic Air Transportation repurchase intention during COVID-19 pandemic

X₄ represent Subjective Norm toward Thai Domestic Air Transportation repurchase intention during COVID-19 pandemic

X₅ represent Preceieved Behavioural Control toward Thai Domestic Air Transportation repurchase intention during COVID-19 pandemic

Нуро	thesis	Result
\mathbf{H}_{1}	Push motivation significantly influenced Thai domestic air transportation	Supported
	repurchase intentions during the Covid-19 pandemic	
H_2	Pull motivation was hypothesized to significantly influence Thai domestic air	Not Supported
	transportation repurchase intentions.	
H_3	Attitude was hypothesized to significantly influence Thai domestic air	Not supported
	transportation repurchase intentions during the Covid-19 pandemic.	
\mathbf{H}_4	Subjective norm was hypothesized to significantly influence Thai domestic	Not supported
	air transportation repurchase intentions during the Covid-19 pandemic.	
H_5	Perceived behavioural control was hypothesized to significantly influence	Supported
	Thai domestic air transportation repurchase intentions during the Covid-19	
	pandemic.	

Table 3 Research hypothesis summary

The results of the hypothesis testing provided valuable insights into the factors influencing repurchase intentions during the Covid-19 pandemic. The findings suggested that push motivation and perceived behavioural control significantly influenced repurchase intentions, while pull motivation, attitude, and subjective norm did not.

6. Conclusion and Discussion

This study aimed to investigate the factors influencing Thai domestic air transportation repurchase intentions during the Covid-19 pandemic. The integration of push and pull motivations with the Theory of Planned Behaviour (TPB) provided a comprehensive framework for understanding travel behaviour. The results

demonstrated that push motivation positively influenced repurchase intention, indicating that individuals driven by their internal desires for relaxation, adventure, or escape were more likely to consider repurchasing domestic air transportation services (Kökény et al., 2022).

Contrary to the hypothesis, attitude did not have a significant influence on repurchase intention during the pandemic. This contradicts previous research suggesting attitude's role in shaping repurchase intentions (Luo & Lam, 2020). This discrepancy could stem from the pandemic's distinctive circumstances and its potential impact on trust and perceived risks. Subjective norms also did not significantly influence repurchase intentions, possibly due to the elevated importance of personal health considerations and reduced social pressure to travel by air (Braje et al., 2021).

These findings contribute to the understanding of travel behaviour during crises and highlight the nuanced interplay of internal and external factors. While subjective norms did not play a substantial role in influencing repurchase intentions, perceived behavioral control emerged as a crucial factor. Airlines and travel companies should focus on enhancing travelers' perceived control by offering flexible booking options and transparent safety information. It's important to recognize that the pandemic has transformed travel dynamics, emphasizing health and safety considerations. This research provides insights for industry stakeholders to tailor their strategies in a manner that aligns with travelers' priorities and fosters confidence in repurchase decisions.

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Netnographic Analysis of World'S Luxury Hotels from Tripadvisor Platform: A Case Study of Tulemar Resort

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ABSTRACT

This study aims to: (1) profile the hotel online reviews using a netnographic approach, (2) examine guest satisfaction and dissatisfaction based on hotel online reviews, and (3) identify the hotel attributes that guests comment on in online hotel reviews. The objective of this study is to systematically classify patterns in hotel online reviews related to guest satisfaction factors with hotel attributes. The methodological approach employed in this study is netnography qualitative method, using a single case study of Tulemar Resort in Manuel Antonio, Costa Rica. Based on the data collection from over 2,000 reviews and analysis indicate that among a total of ten attributes—Facilities, Amenities, Location, Price, Cleanliness, Food and Beverages, Hotel Environment, Room Environment, and Others— two consistently stand out in customer reviews: service quality and the room environment. By closely examining these aspects, the study enhances the understanding of the factors that influence guest satisfaction and dissatisfaction in the context of hotel experiences.

Keywords: Luxury hotel, Guest satisfaction, Hotel Attributes, Netnographic analysis, Online review

1. Introduction

The concept of luxury within the hospitality industry has garnered considerable attention for its economic significance and cultural implications. Luxury hotels, as a distinctive segment within the broader hospitality landscape, offer unique experiences and services to the discerning travelers. Guest satisfaction hinges on the alignment between perceived and expected levels of hotel attribute performance. Attributes that exceed guest expectations contribute to heightened satisfaction (Padma & Ahn, 2020). Various studies indicate the relationship between specific attributes and guest satisfaction, with service quality consistently during it a consistent driver (Guo et al., 2017). The relationship between hotel attributes and customer satisfaction is intricate and multifaceted. Research consistently underscores the pivotal role of attributes in shaping guest experiences

and perceptions. This research review emphasizes the importance of a holistic approach to managing and optimizing attributes to ensure guest loyalty, positive reviews, and continued success in the competitive hospitality industry.

In today's digital era, customer opinions and experiences are widely shared through online platforms, significant shaping business perceptions and decisions. Reviews are characterized by their diversity in content, including textual descriptions, ratings, photographs, and even videos (Zhang et al., 2020). Research consistently demonstrates the significant influence of online reviews on consumer decision-making. A higher volume of reviews is generally associated with increased trustworthiness and social proof. Businesses that strategically utilize online reviews can achieve significant benefits.

2. Research Objective

(1) profile the hotel online reviews using netnographic approach,

(2) examine the customer satisfaction and dissatisfaction with hotel attributes based on the hotel online reviews

(3) identify the hotel attributes that guest comment on the online hotel reviews.

3. Literature Review

In today's digital era, online communities have become necessary platforms for socializing, communicating, and sharing information. Netnographic analysis, a qualitative research approach, has emerged as a powerful tool for delving into the dynamics of these virtual communities, uncovering insights about cultures, behaviors, and attitudes. This literature review aims to explore the theoretical underpinnings, methodologies, applications, and contributions of netnographic analysis on luxury hotels in academic research.

3.1 Theory, Concept and Related Research

The concept of netnographic analysis draws inspiration from ethnography, adapting its core principles to the digital realm. This approach recognizes that online communities are significant social and cultural spaces that shape individuals' interactions and experiences (Kozinets, 2015). By deeply engaging with these digital domains, netnography aims to uncover implicit meanings, behaviors, and connections. This methodology has found wide-ranging applications across diverse disciplines such as marketing, sociology, anthropology, and communication. In anthropology and sociology, netnography reveals cultural practices, social norms, and shared identities within digital contexts (Hine, 2000).

In today's digital world, the sharing of customer opinions and experiences has become widespread through online platforms, significantly influencing how businesses perceive and make decisions. Online customer reviews have emerged as a critical source of information, providing valuable insights into consumer sentiments. They have a powerful influence on various industries, such as hospitality, retail, and services. Customer reviews come in various forms including textual narratives, ratings, images, and even videos (Zhang et al., 2020). Often unfiltered and authentic, these reviews reflect genuine customer experiences and emotions (Filieri, 2015).

The attributes of a hotel constitute the bedrock of guest experiences, greatly influence on guest satisfaction. These attributes include both tangible and intangible aspects, profoundly shaping guests' perception of their stay. As the hospitality industry continues its evolution, understanding hotel attributes and their intricate interplays becomes indispensable for ensuring guest contentment, fostering loyalty, and sustaining the success of hospitality establishments. Numerous studies have explored into the intricate connection between hotel attributes and customer satisfaction. Service quality consistently emerges as a key factor, recognized as a primary determinant of guest contentment (Yang & Lau, 2015). The responsiveness and politeness of staff, as well as the efficiency of check-in and check-out procedures, consistently influence how guests perceive their stay (Liu et al., 2013).

Moreover, attributes associated with the physical space significantly sway customer satisfaction. Attributes include rooms comfort, cleanliness, and available amenities play a pivotal role in shaping guests' experiences (Han, Lee, Trang & Kim, 2018). Room quality, including elements like bedding, decor and noise levels, is particularly important in determining overall satisfaction (Yang & Lau, 2015). Being close to key attractions, transportation hubs and business centers can greatly enhance guests' convenience and enjoyment (Liu et al., 2013). Research indicates that location attributes can evoke both positive and negative emotions, highlighting their intricate role in overall satisfaction (Han et al., 2018). Additionally, hotel dining facilities, recreational amenities, and quality of food and beverage offerings, fitness centers and leisure options all influence on the overall experience (Liu et al., 2013).

The relationship between hotel attributes and customer satisfaction is intricate and multifaceted. Research consistently underscores the pivotal role of attributes in shaping guest experiences and perceptions. As guest preference evolve and the hospitality landscape continues to transform, a nuanced comprehension of how various attributes influence guest satisfaction in order to deliver exceptional guest experiences. This review of research emphasizes the necessity for a holistic approach to manage and optimize attributes, which can lead to guest loyalty, positive reviews, and ongoing success in the competitive hospitality industry.

3.2 Research Framework

This conceptual framework shows the process of collecting and coding of Tulemar resort guest reviews on TripAdvisor, in the periods of collecting the guest reviews during July 2021 – September 2022 with overall of 311 reviews. By using Netnography approach, and then using the content analysis and thematic analysis to analyzes the data and coding the frequency words of guest reviews.



Figure 1 Research Framework

4. Research Methodology

The aim of this research is to investigate the hotel attributes that have an impact on guest satisfaction and dissatisfaction within the context of luxury hotels. This chapter outlines the research methodology employed to address the research questions.

4.1 Research Design

This study aims to systematically classify patterns in hotel online reviews that pertain to guest satisfaction factors concerning hotel attributes. The chosen methodology for this study involves employing the netnography qualitative method through a single case study approach. Netnography is a recognized research tool for collecting and analyzing online customer information (Catterall & Maclaran, 2002; Tavakoli & Wijesinghe, 2019). It is grounded in participant-observational research conducted within online fieldwork environments, utilizing computer communications to gather data that contributes to the ethnographic understanding and portrayal of cultural or communal phenomena (Kozinets, 2010). Netnography serves as a marketing research technique, leveraging publicly available information on online forums to comprehend the needs and decision-making influencers of pertinent online consumer groups (Kozinets, 2002).

4.2 Population and Sample

The population in focus here was a luxury hotel with over 2,000 TripAdvisor reviews during this research. This study centers on the luxury hotel realm globally, specifically on a single luxury establishment, Tulemar Resort. Situated within the Tulemar Gardens in Manuel Antonio, Costa Rica, this hotel was chosen as a case study for compelling reasons. The resort has garnered impressive accolades on TripAdvisor's Travelers' Choice Best of the Best rankings, securing the title of #1 Best Hotel in the World in 2022, #3 in 2020, and #1 previously. It holds a remarkable position on TripAdvisor, with all 2,869 reviews earning it the #2 ranking among 47 hotels in Manuel Antonio. The resort attained an excellent rating of 5 out of 5, with location, cleanliness, service, and value receiving ratings of 4.9, 4.8, 4.9, and 4.6 respectively. TripAdvisor also honored it as the 2022 Traveller's Choice Winner. Given these compelling attributes, the choice of a single case study is well-justified.

4.3 Research Instrument

The dataset for this study comprised reviews of Tulemar Resort collected from TripAdvisor between July 1, 2021, and September 30, 2022. TripAdvisor presents factors such as traveler rating, traveler types, time of the year, and language when customers compose reviews. The '5-point Likert scale' is utilized by guests to rate their overall experience at luxury hotels (1 - terrible, 2 - okay, but with issues, 3 - neutral/average, 4 - above average, 5 - excellent). Positive and negative guest reviews were collected based on the highest (excellent) and lowest (terrible) ratings. This criterion was chosen due to the distinction between "compliments" and "complaints." Additionally, TripAdvisor enables travelers to seek advice and provide tips to others in the Q&A and Room Tips sections, aiding decision-making.

4.4 Data Collection

All reviews, including text and photos, underwent meticulous examination. Collected positive and negative reviews were cataloged and documented. These reviews unveiled the factors influencing guest satisfaction. To manage the substantial data volume, a cutoff date was established, with 311 reviews being manually recorded in Microsoft Excel. Various languages were employed in the reviews, such as English, French, and Spanish. Non-English reviews were excluded to prevent misinterpretation.

4.5 Data Analysis

Two data analysis methods were considered: content analysis and thematic analysis. Content analysis aims to organize data and derive meaning to draw valid conclusions (Braun & Clarke, 2006). For content analysis, a systematic coding and classification method for extensive text data analysis was employed in this study. This method combines qualitative richness with robust quantitative analysis (Zhang, Guo, Bu, & Jin, 2023). Thus, content analysis facilitated the interpretation of substantial text data and the extraction of meaningful results. Thematic analysis, on the other hand, aims to identify primary and emergent topics within content. It involves coding data into meaningful names and indicating concepts within categories (Gläser & Laudel, 2013).

Guest reviews encompass unstructured yet complete text segments, organized into coherent sentences known as comments by individual online reviewers. Regardless of paragraph length, personal remarks are discernible, with a full stop indicating the end of a sentence. Comments were categorized into positive, negative, and neutral. Each comment was assigned to specific attributes within one or more categories. Reviews included in the study underwent careful examination before codes were assigned. Subsequently, codes were consolidated to form broader groups. Following Creswell (2014), an approach to content analysis, a procedure was adopted to derive initial codes from the collected data. This entails preparing and organizing data, followed by categorization into subcategories after thorough review. Categories or hotel attributes were then identified, and data were coded accordingly.

The final step involved developing themes for each description. Thematic analysis and content analysis both find applicability in qualitative research. Content analysis is particularly pertinent during initial analysis and the coding process, identifying common codes. Thematic analysis, however, occurs post-coding, focusing on major concepts or themes emerging from initial themes. Given the study's objectives, the qualitative thematic analysis method was deemed the most suitable. Thematic analysis facilitated identification and categorization of factors influencing guest satisfaction. Following the steps outlined by (Braun & Clarke, 2006), this approach involved familiarizing with data, generating primary codes, identifying themes, reviewing themes, naming and defining themes, and ultimately producing and presenting results.

5. Research Findings

5.1 Analyzing Reviewers' Profiles

From July 2021 to September 2022, 311 reviews were examined. Table 1 illustrates five reviewer aspects for Tulemar Resort: rating, comment type, traveler type, time of year, and nationality. Ratings, based on a five-point scale (Excellent, very good, average, poor, and terrible), highlighted overwhelmingly positive experiences, with 306 'excellent,' 4 'very good,' and 1 'good'; 'poor' and 'terrible' had no instances. This indirectly depicted guests' fantastic experiences.

The traveler types included families, couples, solo travelers, business, and friends. Families led with 144 reviews, followed by couples with 63; business reviews were absent. This indicates the hotel's appeal to families and couples, possibly due to nearby attractions and family- friendly activities. The timing of stays was also noted, with December to February (105 reviews), March to May (97), and June to August (87) being prominent. The resort's year-round popularity is evident, with heightened interest during Northern Hemisphere winter and spring. Predominantly, USA travelers contributed 119 reviews, while other nationalities had single-digit representation. However, most reviews were not tied to nationality.

Rating	Comment	Traveler type	Time of year	Nationality
Excellent (n=306)	Positive (n=310)	Business (n=0)	Mar-May (n=97)	USA (n=119)
Very good (n=4)	Neutral (n=1)	Couple (n=63)	Jun-Aug (n=87)	Canada (n=6)
Good (n=1)	Negative (n=0)	Family (n=144)	Sep-Nov (n=22)	UK (n=4)
Poor (n=0)	Comment with	Friend (n=13)	Dec-Feb (n=105)	Finland (n=1)
Terrible (n=0)	photo (n=117)	Solo traveler (n=5)		Not identified (n=181)

Table 1. Result of reviewers' profile

5.2 Guests' reviews in relation to Hotel Attributes

Among the nine attributes examined, the hotel's service, room environments, and overall ambiance received the highest percentage of comments: 22.17%, 16.54%, and 15.71% respectively. This underscores the improtance guests place to service quality, room comfort, and the overall atmosphere. This aligns with Dong et al.'s (2014) finding, emphasizes the impact of these attributes on guests' willingness to stay. Facilities and food/beverage also garnered attention at 13.65% and 10.59% respectively, confirming their influence on guest satisfaction as noted by Dong et al. (2014). Kucukusta (2017) emphasized that guests at higher-rated hotels prioritize location. While price is a crucial factor in guest satisfaction (Alzoubi et al., 2020; El-Adly, 2019), it

was rarely mentioned, accounting for only 0.63% of words, similar to Xu and Li (2016). Luxury hotel guests primarily assess value for money in relation to competitors; Tulemar Resort's guests seem to prioritize service due to its high-end status. Other attributes mentioned include amenities (7.44%), location (5.21%), activities (4.79%), and cleanliness (3.23%), which parallels with Dong et al.'s (2014). Notably, the study by Tsang and Qu (2000) corroborates the finding that managers overestimate the importance of hotel cleanliness in guest satisfaction.

Table 2 highlights the impact of service quality (22.17%) and room environment (16.54%) on guest satisfaction. It underscores the critical aspects of service quality: friendly staff, professionalism, and efficiency. These factors are evident in TripAdvisor feedback for Tulemar Resort. Guest satisfaction is significantly influenced by staff warmth and friendliness, consistent with luxury hotels contentment (Allan, 2016). Additionally, satisfaction is observed through VIP zone experiences (Fombella et al., 2015). Furthermore, a comprehensive service approach creates a welcoming atmosphere, positively impacts guest satisfaction in luxury hotels (Gupta & Sharma, 2016). Welcoming gestures like baggage assistance also contribute to guest contentment (Ariffin & Maghzi, 2012). Strengthening 'surprises' and 'personalization,' and 'welcome feelings' can further elevate guest satisfaction.

Attributes	Sub-attributes	Total reviews	Percentage
Facilities	Non-smoking room, elevator, safe deposit box, VIP	165	13.65
	check-in and check-out, Air conditioning, Spa and		
	wellness center, Wi-Fi, sauna, swimming pool, luggage		
	store, wheelchair access, jacuzzi, on-site car park,		
	jacuzzi, sunlounges, television, ironing facilities, hair		
	dryer, shower, DVD player and dressing area.		
Amenities	Free toiletries, coffee and tea facilities, welcome drinks	90	7.44
Location	Close to city center, close to attractions, near to	63	5.21
	shopping area, transportation easily accessible		
Price	Perceived value, price value	8	0.63
Service	Friendly and helpful staff, professionalism of staff,	268	22.17
	timely, speed, efficient, polite		
Cleanliness	Clean room, disinfection, rooms smell nice	39	3.23
Food and	Restaurant, continental breakfast, bar area, poolside	128	10.59
Beverages	snack bar, café, lounge		
Hotel	Decorations, building design, materials, ambience, fresh	190	15.71
environment	air, view		
Room	Ambience, fresh air, comfortable, room size and layout,	200	16.54
environment	bedding		
Others	Activities	58	4.79

Table 2. Guests' reviews in relation to Hotel Attributes

5.3 Analysis of Positive and Negative towards Hotel Attributes

Guest satisfaction can be defined as a consumer's emotional response to intangible services. Online reviews often capture these responses through overall ratings (Banarjee & Chua, 2016; Schuckert, Liu & Law, 2015), and comments, both positive and negative, reflect perceived experiences with specific attributes. Based on guest reviews, the result highlights predominantly positive sentiments towards the resort, with 310 positive reviews (99.00%), 1 neutral review (1%), and no negative reviews (0%). While no negative reviews were found during the study period, a few negative comments, rated as "terrible" or "poor," emerged in 2020, constituting only 6 out of 2,877 total reviews. These comments centred around issues such as cancellation policies, ongoing construction, and safety concerns, categorizable into customer service, facilities, and hotel environment.

Many guests were pleased with the resort's welcoming and friendly staff, aligning with the literature that service perceptions greatly impact luxury hotel satisfaction (Allan, 2016). VIP zone experiences also enhanced satisfaction (Fombella et al., 2015). Moreover, delivering comprehensive service creates a 'welcome feeling,' elevating guest contentment (Gupta & Sharma, 2016). Detailed service examples in luxury hotels encompass greeting guests at the entrance, offering local recommendations, and assisting with luggage during check-in and check-out (Ariffin & Maghzi, 2012).

6. Discussion

The study aims to analyze customer reviews and comments on the TripAdvisor platform concerning luxury hotels worldwide. The objective is to identify recurring themes arising from customer experiences during their stays at these luxury hotels. The research employs the Netnography approach for data collection and analysis, focusing on a single case study: Tulemar Resort. The dataset consists of 311 customer reviews from July 2021 to September 2022. Existing literature extensively explores diverse aspects of customer satisfaction, a pivotal factor in the hotel industry. Customer satisfaction involves customers' evaluating attributes of products or services (Davras & Caber, 2019), a particularly important in the hospitality sector. While previous studies mainly focus on service quality, with Yang & Lau (2015) emphasizing that "service quality is the critical factor that drives different customer satisfaction," this research presents findings that underscore the significance of room environment as an influential factor. These studies collectively emphasize the role of service quality and the hotel environment, especially room conditions, in shaping customer satisfaction within luxury hotels.

7. Suggestion

In today's landscape, online media holds paramount importance for businesses across industries, including luxury hotels. Online platforms provide a channel through which hoteliers can promptly assess customer needs and desires by analyzing the reviews and comments left by customers. Consequently, luxury hotels can harness the potential of online and social media platforms to enhance their promotional activities, events, and more. Customer reviews offer a unique avenue to comprehending the pivotal hotel attributes that significantly impact customer satisfaction and dissatisfaction. Since these reviews stem from authentic guest

experiences during their stay at luxury hotels, the insights garnered can guide hoteliers in refining attributes that fall short of customer expectations, thereby elevating overall guest satisfaction.

(1) The study suggests that luxury hotels should strategically prioritize social media marketing as a means to establish seamless access to customers. This approach facilitates easy access to information and simplifies customer interaction with the hotel, fostering a more direct and efficient communication channel. The goal of identifying hotel attributes is to unveil the genuine factors driving customer satisfaction and dissatisfaction rooted in their real-life encounters during luxury hotel stays. This study employs customer reviews from the TripAdvisor platform, focusing on a single case study: Tulemar Resort.

(2) The study findings underscore the identification of ten distinct hotel attributes. Among these attributes, service quality, room environment, and hotel ambiance emerge as the most influential factors impacting customer satisfaction. Service quality, as established by numerous literature studies, holds particular significance across the hospitality industry and luxury hotels alike. Similarly, the physical aspects of the room and hotel environment bear a direct influence on guest contentment. The study suggests that more attention should be given to the cleanliness and safety of luxury hotels in order to establish confidence and create a positive image that attracts customers and makes them feel secure during their stay. By enhancing these pivotal attributes, other aspects of the hotel experience can also be improved.

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The Relationship between ESG and Piotroski Score on Financial Performance of Thailand Sustainability Investment (THSI) Listed Companies

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ABSTRACT

The research aimed to examine the relationships between the ESG Score and the Piotroski Score in relation to the financial performance of companies, focusing on ROE and stock returns. The study focused on companies listed on the Thailand Sustainability Investment (THSI) between 2019 and 2022. To analyze the empirical data, the researchers employed Structural Equation Modeling to develop a model. The results indicated that the Piotroski score had a significantly positive effect on both ROE and stock returns. On the other hand, the overall ESG score and its sub-scores (Environmental, Social, and Governance) were found to have no impact on ROE and stock returns, except for the Environmental score, which had a negative direct effect on ROE but a positive direct effect on the Piotroski score. Therefore, the Environmental score has an indirect effect on stock returns through two mediators: the Piotroski score and ROE. This study enhances our understanding of the intricate relationship between ESG performance, Piotroski Score, and firm financial performance, particularly within the sustainable stock market in Thailand.

Keywords: ESG score, Piotroski score, Stock return

1. Introduction

The concept of investing in sustainable businesses has received increasing attention in recent years, especially when the world is facing unprecedented challenges. Climate change, corruption, and the COVID-19 pandemic are a few examples but all of which have negative impacts on the economy. Therefore, investors tend to incorporate environmental accountability, social responsibility, and governance or ESG into their investment decisions in addition to financial information. The Stock Exchange of Thailand (SET) has realized the importance of such concepts. They created the Thailand Sustainability Investment (THSI) in 2015, which is a list of companies that passed the SET's sustainability assessment. These companies realize their social and environmental responsibilities by conducting business openly and in accordance with good corporate governance

practices. Therefore, investors aiming for a responsible investment strategy could have THSI as another option; this can inspire other businesses to build their operations using sustainable practices. From 51 companies in 2015, the list has increased to 170 companies in 2022, indicating that the companies are interested in participating in the sustainability assessment (The Stock Exchange of Thailand, 2022).

Investors who invest in stocks typically seek good returns. To achieve this, effective screening tools are vital for identifying stocks with strong return potential while minimizing the risk of underperforming ones. Financial information from companies plays a crucial role in helping investors decide about their investments. Extensive research highlights the substantial impact of specific financial data and ratios on returns (Musallam, 2018). The F-score, a tool combining historical financial data, is recommended by Piotroski (2000) to distinguish between weak and strong companies, particularly within the realm of value stocks. Piotroski's study from 1976 to 1996 in the US market reported an impressive average annual return of 23% when using the F-score. Consequently, multiple studies have sought to validate the effectiveness of the F-score in various samples.

In addition to considering financial information, many listed companies publicly disclose ESG information which is non-financial information about their business operations in the form of a sustainability report. The increasing voluntary participation of companies indicates that their sustainability initiatives are paying off (Yoon and others, 2018). This phenomenon has sparked inquiries in both academic and business research regarding the significance of ESG practices on company value and profitability. Research on the relationship between ESG and corporate financial performance has produced mixed results, with some studies indicating a positive link, while others suggest that ESG activities can potentially reduce shareholder wealth by affecting earnings (Spirova, 2023). There is no consensus in the research community regarding the precise impact of ESG on financial performance. Given the evolving research context, there is a compelling need for further studies to provide more clarity and insight into this complex relationship.

Despite the increasing research on Environmental, Social, and Governance (ESG), most of this research is concentrated in developed countries. In contrast, studies on ESG investing in Thailand are limited. Consequently, this research aims to address this gap by examining the relationship between the F-score (a measure of fundamental strength) and the ESG score (an assessment of environmental, social, and governance factors) and their potential integrating influences on the financial performance of firms, both direct and indirect. Incorporating these scores into investment decisions within a sustainable stock market in Thailand has numerous advantages. Investors can expect good returns, reduced risk, and contributions to long-term value creation. Companies in Thailand that prioritize ESG practices will benefit from an enhanced reputation, effective risk management, and sustainable growth. This approach aligns financial performance with sustainability objectives, benefiting both investors and society as a whole.

2. Research Objective

To identify the relationship between ESG score and Piotroski score on the financial performance of Thailand Sustainability Investment (THSI) Listed Companies.

3. Literature Review

3.1 Theory, Concept, and Related Research

The link between ESG performance and financial performance

Previous studies have examined the effects of ESG performance on various financial performance measures. These measures include accounting-based indicators, which are return on assets (ROA) and return on equity (ROE), as well as market-based indicators which are stock return or Tobin's Q ratio. Khan (2019) also suggested that non-financial performance measures, such as environmental, social, and governance (ESG) measures, could serve as leading indicators of a company's financial performance. Dalal and Thaker (2019) conducted a panel data analysis on Indian-ESG-indexed firms and found that good corporate ESG performance positively affects both accounting-based (ROA) and market-based (Tobin's Q) financial performance. Similarly, Trivani and others (2020) demonstrated that disclosing ESG information had a positive effect on return on equity (ROE) when studying publicly listed companies in Indonesia. Despite many studies reporting a positive relationship between ESG and financial performance, some researchers often argue that the results are inconclusive, or contradictory. For example, Spirova (2023) presented findings suggesting that social and ESG scores had a negative impact on expected share price returns. Han and others (2016) found diverse results when assessing ESG disclosure scores in Korean corporations. They discovered a negative relationship between the environmental score and financial performance, while the governance score exhibited a positive relationship. However, they did not find statistically significant evidence of a relationship between social score and financial performance.

The link between F-score and financial performance

In the study, Piotroski (2000) found that selecting a company with a high B/M ratio in conjunction with a high F- score could yield an average return of 23% per year. His findings became the strategy that caught the attention of scholars around the world. Further research such as Walkshäusl (2020) confirmed the effectiveness of the F- score strategy in emerging markets and developed countries except for the United States. The research reported that high-scoring stocks generated an average of 10% better returns per year than low-scoring stocks. Additionally, Tripathy and Pani (2017) noted a positive correlation between the F- score and stock performance as measured by stock return, return on equity (ROE), and market-to-book value. Phrommayon (2018) conducted a relevant research study in Thailand, focusing on Piotroski's concept of value investing. The study analyzed companies listed on the Stock Exchange of Thailand and the Market for Alternative Investment (mai) during the period from 2007 to 2016. The findings of the research indicated that companies with high F- scores exhibited a greater return compared to those with low F-scores. This shows that the F-score strategy widely applies to various stock investments across regions. This study seeks to determine whether ESG performance, as measured by ESG scores, positively or negatively affects financial performance

Previous studies have indicated that both ESG scores and F-scores may affect financial performance. This research therefore aims to propose the application of ESG scores together with F-scores in Thai investment portfolios to explore the relationship between the two scores and demonstrate the potential impact of integration on stock returns. This may be an attractive alternative for investors who want to invest in sustainable stocks.



3.2 Research Framework



3.3 Research Hypotheses

Hypothesis 1A (1B, 1C, 1D): ESG (ENV, SOC, GOV) scores have a direct effect on stock return
Hypothesis 2: F-scores have a direct effect on stock return
Hypothesis 3A (3B, 3C, 3D): ESG (ENV, SOC, GOV) scores have a direct effect on ROE
Hypothesis 4: F-scores have a direct effect on ROE
Hypothesis 5A (5B, 5C, 5D): ESG (ENV, SOC, GOV) scores have an indirect effect on stock return
Hypothesis 6: F-scores have an indirect effect on stock return

4. Research Methodology

4.1 Data collection

The research sample consists of listed companies that have been selected based on their inclusion in the year-end assessment of Thailand Sustainability Investment (THSI). Companies without available ESG score data, provided by Refinitiv, a reliable source for ESG analysis, are excluded from the study. Additionally, companies within the financial sector are also excluded due to incomplete data necessary for calculating F-scores. The sample size consists of 313 companies from 2019 to 2022. To gather relevant information, the researcher collected financial statement data, financial ratios, closing prices, and dividends from the Stock Exchange of Thailand database or SETSMART.

4.2 Research variables and measurement

The first important variable is the F-score, which is based on Piotroski (2000). It is a total of nine financial criteria used to assess a company's financial strength. Each measure follows the binary system where one is the value when the condition is met and zero if the condition is not met. These nine criteria are:

(1) Net income before extraordinary items is positive, (2) cash flow from operations is positive, (3) the annual change in return- on- assets is positive, (4) cash flow from operations is greater than net income before extraordinary items, (5) the annual change in leverage (long-term debt divided by total assets) is negative, (6) the annual change in liquidity (current ratio) is positive, (7) the firm does not issue common equity, (8) the annual change in gross margin ratio is positive, and (9) the annual change in turnover ratio is positive.

Further variables used in this research can be described in Table 1.

Variable	Formula
Return	Stock Returns = $\frac{\text{Price}_{t} + \text{Dividened}_{t} - \text{Price}_{t-1}}{\text{Price}_{t-1}}$
ROE	$ROE = \frac{\text{Net income}}{\text{Total Equity}}$
F-score	mentioned above
ESG	ESG scores from Refinitiv
ENV	Environment scores from Refinitiv
SOC	Social scores from Refinitiv
GOV	Governance scores from Refinitiv
Control variable	Formula
Leverage	Leverage = <u> Long term Debt</u> <u> Total Assets</u>
Size	Firm Size = Log (Total Assets)

Table 1 Research variables and measurement

4.3 Data Analysis

The data were then analyzed into 3 parts: descriptive analysis, correlation analysis, and structural equation modeling using the SPSS Amos program.

5. Research Findings

Table 2 presents the results of a descriptive statistical analysis conducted on a sample of 313 sustainable stocks. The analysis provides key statistical measures such as maximum, minimum, mean, median, and standard deviation (SD) for each variable, allowing for a better understanding of the characteristics of the studied sustainable stocks.

variable	Mean Median		SD	Minimum	Maximum	Ν
Total Asset (million Baht)	163,122.10	48,592.54	365,562.28	589.63	3,415,632.29	313
Leverage	0.48	0.50	0.19	0.08	1.04	313
F-score	5.73	6.00	1.69	1.00	9.00	313
ESG	56.16	57.99	16.94	1.00	92.11	313
ENV	50.65	51.57	24.44	0.00	97.30	313
SOC	62.57	65.56	19.06	0.72	96.49	313
GOV	54.42	55.29	20.61	1.80	95.35	313
ROE (%)	10.87	10.22	12.50	-57.04	67.81	313
Return (%)	15.84	8.55	38.22	-96.18	321.55	313

Table 2 Descriptive Statistics

Table 3 presents the results of the correlation analysis for all variables. The findings indicate that the ESG, ENV, SOC, and GOV scores exhibit relatively high correlations among themselves. Therefore, to mitigate multicollinearity, we conducted separate studies for these scores. The correlation matrix also reveals that ESG, ENV, and SOC scores display negative correlations with both returns and ROE. Specifically, SOC shows a significant negative correlation with returns at a significant level of 0.1, while ENV exhibits a significant negative correlation with ROE at a significant level of 0.05. On the other hand, the GOV score demonstrates a positive correlation with returns and ROE, but these correlations are not statistically significant. Furthermore, the F-score is positively correlated with both returns and ROE, with statistical significance at the 0.01 level.

Table 3	Correlation	Matrix
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	SIZE	LEV	F-score	ESG	ENV	SOC	GOV	Return	ROE
SIZE	1.00								
LEV	.309***	1.00							
F-score	-0.06	166***	1.00						
ESG	.553***	.112**	0.04	1.00					
ENV	.586***	0.09*	.113**	.864***	1.00				
SOC	.572***	.148**	-0.01	.855***	.746***	1.00			
GOV	.161***	0.04	0.01	.599***	.275***	.284***	1.00		
Return	190***	-0.02	.306***	-0.04	-0.05	-0.10*	0.02	1.00	
ROE	-0.07	-0.05	.274***	-0.05	140**	-0.04	0.05	.178***	1.00

***. p-value < 0.01, **. p-value < 0.05, *. p-value < 0.1

Table 4 presents the coefficients and statistical significance levels for each pathway analyzed. In line with Hypothesis 1, all sustainability scores (ESG, ENV, SOC, and GOV) were found to have no significant influence on return. Hypothesis 2 revealed a positive influence of the F-score on the rate of return, with effect sizes of 0.280, 0.275, 0.286, and 0.286 for models 1A, 1B, 1C, and 1D, respectively. Hypothesis 3 showed that

the ENV score from Model 1B had a negative influence on the return on equity, with an effect size of -0.157. However, no such influence was observed for the ESG, SOC, and GOV scores. Hypothesis 4 demonstrated a positive influence of the F-score on ROE, with effect sizes of 0.277, 0.304, 0.274, and 0.272 for models 1A, 1B, 1C, and 1D, respectively. Regarding Hypothesis 5, which examined the indirect effects of sustainability scores, it was found that the ENV score from Model 1B had an indirect influence on the rate of return through mediators, namely the F-score and ROE. The effect sizes were calculated as 0.057 (0.206 x 0.275) and -0.016 (-0.157 x 0.100), respectively. As a result, ENV had an overall indirect effect of 0.041 on the rate of return. Lastly, Hypothesis 6 tested the indirect effect of the F-score on the rate of return through ROE, revealing positive indirect effects with effect sizes of 0.026 (0.027 x 0.093), 0.030 (0.304 x 0.100), 0.025 (0.274 x 0.090), and 0.024 (0.272 x 0.088) for models 1A, 1B, 1C, and 1D, respectively. The model fit results in AMOS comprised of the following acceptable indices and ranges: CMIN/df < 5, GFI > 0.90, and SRMR < 0.05. The results in Table 4 show all of the research models are a good fit except model 1C which CMIN/df is out of the desirable level.

Model 1A	F-score	ROE	RETURN	Model 1B	F-score	ROE	RETURN	
ESG	0.092	-0.044	0.079	ENV 0.206***		-0.22***	0.066	
F-score		0.277***	0.28***	F-score		0.304***	0.275***	
ROE			0.093*	ROE			0.1*	
SIZE	-0.061	-0.032	-0.238***	SIZE	-0.134*	0.076	-0.233***	
LEV	-0.157***	0.013	0.1*	LEV	-0.143**	0	0.1*	
R2	0.035	0.079	0.144	R2	0.058	0.108	0.142	
Model Fit	$CMIN/df^{1}=3.$	951 SRMR ² =($0.028 \text{ GFI}^3 = 0.996$	Model Fit	CMIN/df ¹	CMIN/df ¹ =2.793 SRMR ² =0.024 GFI ³ =0.997		
Model 1C	F-score	ROE	RETURN	Model 1D	F-score	ROE	RETURN	
SOC	0.032	-0.01	-0.001	GOV	0.019	0.057	0.041	
F-score		0.274***	0.286***	F-score		0.272***	0.286***	
ROE			0.090*	ROE			0.088	
SIZE	-0.027	-0.052	-0.192***	SIZE	-0.012	-0.067	-0.203***	
LEV	-0.162***	0.015	0.095*	LEV	-0.163**	0.016	0.096*	
R2	0.029	0.078	0.139	R2	0.028	0.082	0.141	
Model Fit	CMIN/df ¹ =6.905 SRMR ² =0.037 GFI ³ =0.993			Model Fit	CMIN/df ¹	=0.473 SRMR ² =	=0.000 GFI ³ =0.999	

Table 4 Estimation of structural model parameters and model fit indices

***. p-value < 0.01, **. p-value < 0.05, *. p-value < 0.1

¹Chi-square/degree of freedom; ²Standardized Root Mean Squared Residual; ³Goodness of Fit Index

6. Discussion

The findings revealed that neither the overall ESG score nor its sub-component scores directly influenced stock returns. This finding is consistent with previous research conducted by Naeem and others (2022) on the impact of sustainability scores on company performance in emerging markets, which also found no significant effect. They reasoned that stakeholders and investors in emerging countries may not fully trust or have confidence in the ESG strategies and operations of corporations. In contrast, this study has identified a positive relationship between the F-score and financial performance, including stock returns and ROE. This result aligns with the findings of Riwrungruang and Boonvorachote (2021), who also indicated that companies with higher F-scores tend to achieve higher returns compared to those with lower F-scores. Furthermore, when considering indirect influences, the study observed that the environmental score (ENV) in model 1B indirectly impacted stock returns through two mediators. Firstly, it was found to have a positive influence on the F-score variable, indicating that an increase in the environmental score led to a corresponding increase in the F-score. The F-score, serving as an assessment of financial strength, helps screen stocks based on their overall performance. A higher F-score suggests improved financial performance, which can contribute to higher potential returns. Secondly, the environmental score (ENV) was found to have a negative influence on ROE. This outcome aligns with the conclusions of Khunthong and others (2023), who determined that greater implementation of sustainable practices by companies can result in higher expenses and costs, thereby impacting profitability temporarily. Since ROE is a metric commonly considered by investors when making investment decisions, changes in ROE can affect a company's stock price and subsequently influence returns. This relationship between sustainability, ROE, and stock returns has also been identified in research by Adawiyah and Setiyawati (2019).

7. Suggestion

This study had a relatively short duration and coincided with the COVID-19 outbreak, potentially introducing uncertainty into the analysis. To enhance result validity, future studies could extend the research period or compare data before and after the outbreak.

For investors interested in sustainable stocks, considering both F-scores and ESG factors is advisable. Companies that opt for sustainability practices, particularly in the environmental aspect, should carefully consider the advantages and disadvantages associated with these practices both in the present and future. At present, ESG seems to have minimal relation to financial performance. Nonetheless, with increasing concern about sustainability issues in many aspects, a shift toward ESG might become a key concern for those investors who deem to support the justifiable practice in the future.

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The Impact of Perceived Brand Equity, Brand Personality, and Social Influence Factors towards Purchase Intention in the video streaming service of global brands in Vietnam

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ABSTRACT

While new and exclusive content is increasingly limited, many online video content providers are involved in the OTT industry, especially movie and TV show streaming services. Video streaming services also face challenges in persuading consumers to pay for subscriptions, while a wide range of free streaming platforms exists. This study, therefore, investigated what factors drive consumers' intention to purchase subscriptions. These factors included Perceived Brand Equity, Brand Personality, and Social Influence. The research conducted a quantitative analysis and collected 400 samples of Vietnamese people who had purchased video streaming services via questionnaires. The statistics used to analyze data were descriptive and inferential statistics. The results showed that Brand Personality and Social Influence positively and significantly influenced Purchase Intention at the statistically significant level of 0.05. The research results may inspire marketers from foreign brands to improve their strategies when operating in the video streaming services field.

Keywords: Perceived Brand Equity, Brand Personality, Social Influence, Purchase Intention, Video Streaming Service

1. Introduction

The rise of information technology has changed the way connecting consumers and businesses. In particular, the Over-The-Top (OTT) industry has proliferated as a shred of evidence of this revolution. The industry refers to digital content shared and distributed via online channels, such as online videos and games. In the present study, the author centralizes the online video content field, also known as video streaming services, especially movie and TV shows. Technopedia defines video streaming as a type of media streaming in which service providers constantly deliver data from a video file to a remote user over the Internet. It is more accessible for people to actively control viewing time to suit personal schedules and unlimited playback.

Vietnam has been a potential and promising market for OTT platforms since 2019, especially video streaming. The number of on-demand video streaming subscribers rose by more than one million to about 5.6 million in 2019. Expect this number will advance to around 7.7 million by 2027. As reported in 2020, an average person in the country spent approximately seven hours on the Internet and almost three hours on broadcast TV and video streaming during the coronavirus lockdowns. Being stuck at home increases the demand for entertainment content, leading to skyrocketing requirements for free and paid OTT media services, particularly for young grown-ups. In 2021, the significant development of the on- demand video streaming industry brought back about 160 million dollars of revenue (Statista, 2022). The top 5 leading brands that dominate the market of video content streaming in Vietnam in the second quarter of 2021 are as follows: FPT Play (25%), Netflix (21%); VTV Go (13%); My TV (8%); K+ (6%); Vettel TV (5%), according to Vietnam Streaming Report and Prediction 2020-2025. Netflix is the only foreign brand that ranks among these prominent local providers and has claimed second place (Marketreport, 2022).

Although there are numerous studies on video streaming services or OTT, most focused on technology adoption for these services. However, Vietnamese residents have widely accepted video streaming services for a long time. Moreover, the business model is to keep loyalty in parallel with attracting new customers because packages offered to consumers must be paid for a fixed period, such as a year or a month. This study, therefore, investigated what factors drive consumers' intention to purchase subscriptions. Perceived Brand equity as Brand Equity in the consumer-based approach concentrates on consumers' knowledge about the brand. (Aaker D. A., 1991). Paloma (2022) considered how a consumer-based brand equity model can interpret how OTT services can build brand loyalty or brand equity. More to the point, perceived brand equity can influence customers' confidence in purchasing decisions. Equally important, customers are more likely to purchase a brand if its attributes are similar to their personality (Rup et al., 2021). Brand personality is the group of human characteristics a brand comprises and is the attribution of psychological, emotional, behavioral, and intellectual patterns associated with a brand. Brand personality significantly impacts the perception and expectation of the customer's behaviors toward the product and the company. Last but not least, Social Influence is also a factor that impacts purchase intention. The Theory of planned behavior (TPA) by Ajzen (1991) pointed out that consumers tend to perform or not perform the behavior under the pressure of society and consider a social factor as the second independent determinant of intention. Vahdat and others (2020) found that Social Influence positively affected attitude towards mobile app use.

Previous studies have examined these factors relating to video streaming services or OTT, but few have measured these variables toward Purchase Intention in video streaming services of global brands. A study in video streaming services may trigger competition for businesses, leading to development aspects for Vietnam. This new media can represent modernity and the country's prominence in technology. Delivery of content over the Internet can also reduce the cost of setting up TV cables for Vietnam and producing content for entertainment businesses. Hence, this research quantitatively analyzed the impact of Perceived Brand Equity, Brand Personality, and Social Influence Factors on Purchase Intention in the video streaming service of global brands in Vietnam. The research

results may inspire marketers from foreign brands to improve their strategies when operating in the video streaming services field.

2. Research Objective

(1) To examine the impact of the Perceived Brand Equity factor comprising Brand Awareness, Brand Association, Perceived Quality, Brand Loyalty, and Other Proprietary Assets on the Purchase Intention of video streaming services of global brands.

(2) To explore Brand Personality containing Sincerity, Excitement, Competence, Sophistication, and Ruggedness affecting the Purchase Intention of global brand video streaming services.

(3) To dissect the impact of Social Influence, including Compliance, Identification, and Internalization, on the Purchase Intention of global brand video streaming services.

3. Literature Review

3.1 Perceived Brand Equity

Aaker (1991) defines *Brand Equity* as "*a set of brand assets and liabilities linked to a brand, its name, and symbol that add to or subtract from the value provided by a product or service to a firm or to that firm's customers.*" They can help consumers perceive the value of products and brands and also can affect consumers' confidence in purchase decisions. Aaker (1991) has reviewed and proposed a framework comprising five dimensions to measure Consumer Perceived-Brand Equity: Brand loyalty; Brand awareness; Perceived quality; Brand associations; and Other proprietary brand assets.

Based on model offered by Aaker (1991), Perceived Brand Equity is measured by five sub-variables including Brand awareness, Brand Associations, Perceived Quality, Brand Loyalty, and Other Proprietary Assets. Brand Awareness refers to the ability of potential consumers to recall or recognize a brand when it comes to a particular product or service category. Brand Association refers to anything "linked" in memory to a brand, which could be a consumer segment, a symbol, feelings. Perceived Quality reflects customers' perception of a product or service's overall quality or excellence regarding its intended purpose, comparable to others. Brand loyalty is about measuring a consumer's attachment to a brand, reflects how consumers can change their options to another competitive brand. Other proprietary brand assets can comprehend as competitive advantages, protect the brand from competitors such as original series, or licienced movies. A study by **Arshad and Victor (2020)** had found out that Perceived Brand Equity is highly essential for Purchase Intention.

3.2 Brand Personality

The concept of Brand personality is " the set of human characteristics or personality dimensions associated with the brand." (Aaker, 1997). Consumers personality affects brand perceptions, and they tend to buy brands whose human characteristics are congruent with their personality and fit their self-image (Wijaya, 2013). Brand personality has aid furthermore consumers in differentiating among the numerous brands (Attor, 2021).

Aaker (1997) provided a structure consisting of five factors for Brand Personality: Sincerity, Excitement, Competence, Sophistication, and Ruddgedness.

Based on the model offered by Aaker (1997), Brand Personality is measured by five sub-variables including Sincerity, Excitement, Competence, Sophistication, and Ruddgedness. Sincerity is refers to brands that approach consumers honestly and make them feel secure. Excitement aims to reach audiences with the youthfulness and enthusiasm. Competencebrand considers competence as often leading in the industry and makes consumers depend on it. Sophistication impress customers with prestige, offering superior service and products and delivering customers the best experiences. Ruddgedness attaches outdoorsy, challenging characteristics to the image. Mao, et al., (2020) research to understand customers' purchase behavior toward smartphone choices among competitive brands. The outcome showed that flow experience, brand image, brand communication, brand personality, and brand identity directly or indirectly explain purchase intention (Mao, et al., 2020)

3.3 Social Influence

Venkatesh (2012) conceptualized Social Influence as "... the degree to which an individual perceives that important others believe he or she should use the new system." Kelman (1958) also introduced Social Influence Theory and presented three psychological processes: Compliance, Identification, and Internalization. Researchers have investigated the effect of the Social Influence theory model in different areas, such as web-based communication and network externalities (Naqvi, Jiang, Miao, & Naqvi, 2020).

Based on the model offered by Kelman (1958), Social Influence is measured by three sub-variables including Compliance, Identification, and Internalization. In the compliance process, the individual would be rewarded and earn the desired response when he or she complies. The identification factor explains how individual behavior is affected by the social community. Internalization reflects the influence a consumer feels when they observe that the views of others are in agreement with their own. In an Internalization process, people appreciate and adopt specific technology compatible with their belief systems (Yia, Zainuddina, & Bakar, 2021). A research revealed that Social Influence has the most significant influence on online purchase intention. (Doan, 2020)

3.4 Purchase Intention

According to the Theory of Planned Behavior: TPB (Ajzen I., 1991) or Theory of Reasoned Action: TRA (Ajzen & Fishbein, 1980), Intention can use to predict consumers to perform a particular action. These models are popular in studies concerning information systems or online purchasing behaviors, such as Internet banking, online bookstores, digital music, pirated digital content, use of social media for transactions, and access to online movies legally. The intention factor is the critical factor that has the most significant influence on actual behavior (Sardanelli, Vollero, Siano, & Bottoni, 2019). Different studies have proved the correlation between purchase intention and actual purchase behavior (Hajipour, Bavarsad, & Zarei, 2013).

3.5 Research Framework



Figure 1 Research Framework

3.3 Research Hypotheses

H1: Perceived Brand Equity influences Purchase Intention in video streaming services of global brands

H₂: Brand Personality influences Purchase Intention in video streaming services of global brands

H₃: Social Influence influences Purchase Intention in video streaming services of global brands

4. Research Methodology

4.1 Research Design

The current study follows quantitative analysis, which includes data expressed in numerical value. It aimed to examine the impact of Brand Equity, Brand Personality and Social Influence towards Purchase Intention in video streaming services in Vietnam. The reaseach data from the questionaires from reliable sources such as articles and online databases. Questionnaires comprise five sections to investigate and assess respondents' behavior and attitude toward video streaming services of global brands: Part 1 is demographic data and personal information with nominal and ordinal scales; Part 2 – 4 is the opinion of dependent variables comprising Perceived Brand Equity, Brand Personality, and Social Influence with Interval scales (1 - the least agree to 5 - the completely agree). Part 5 is the opinion of the dependent variable is Purchase Intention with Interval scales (1 - the least agree to 5 - the completely agree). Two different types of statistics will be used to analyze the respondents' results: 1) Descriptive Statistics includes the study of the frequency, mean and standard deviation; 2) Inferential Statistics, including multiple regression analysis.

4.2 Population and Sample

The population of the study is Vietnamese residents who used to purchase or are using subscription video streaming services. The sample is 400 based on the table of Yamane's theory. According to the data reported by the General Statistics Office of Vietnam (Nguyen S. , 2023), the total population of Vietnam is 99.46 million, of which 5.8 million use subscription video-on-demand platforms (Statista Research Department, 2023). Based on the Yamane table, with a +-5% of a precision level, the sample will be 400 if the population size is over 100,000.

4.3 Research Instrument

The questionaires comprised five sections. The first section had six questions requiring demographic and personal information and six questions about consumer behaviors. The questions from second section to assess the respondents' attitudes toward variables. Those variables that need to measure in the paper are Perceived Brand Equity, Brand Personality, and Social Influence. Perceived Brand Equity had 15 questions in total and a scale developed based on Jalivand, Samei, & Mahdavinia, 2011; Xu, Yang, & Ren, 2020; and Li, Ragu-Nathan, Ragu-Nathan, & Rao, 2006, to measure this variable. The total number of questions used to measure Brand Personality was 19, developed based on previous studies, such as Taheri, Gannon, Cordina, & Lochrie, 2018, Liu, Huang, Hallak, & Liang, 2016. There were 9 questions developed to measure Social Influence based on some studies, such as Cheng, Fu, & Le, 2011; Hsu & Lin, 2016; and Jiménez-Castillo & Sánchez-Fernández, 2019. Purchase Intention was the dependent variable. There are 4 questions are utilized to measure this variable based on Jalivand, Samiei, & Mahdavinia, 2011.

4.4 Data Collection

Online questionnaires were used for this quantitative research. The sampling technique is convenient sampling and nonprobability. This technique facilitates to collect data quickly and easily for the research. The questionnaire link will reach Vietnamese respondents who had purchase for video streaming services through Google Forms. Only participants who said they used to purchase video streaming services were valid. Before officially distributing, a group of 40 people joins a pretest of the questionnaire to ensure validity and reliability. Reliability results reveal Cronbachs' Alpha coefficient value of 0.937 for Perceived Brand Equity, 0.935 for Brand Personality, 0.934 for Social Influence, and 0.834 for Purchase Intention. The total reliability is 0.972, which is acceptable as a definition. (Cronbach, 1951)

5. Research Findings

Of all respondents, 54.3% were female. 59.8% is from 18-25 years old. Besides, 63.7% respondents are single. The education background question included 71% people with Bachelor's Degrees and 47.8% are student. The average monthly income was 41.8%. less or equal to the 10 million VND range. According to the results, Netflix account for 30.9%, FPT Play is 24.7%. Consumers can own a subscription account by sharing it with others, such as family members or friends. The result showed that 33% of selections use it with friends. The most respondents preferred to utilize "Laptop" and "PC," at 25.7% and 20.2%, consecutively. The average time for people to watch video streaming services weekly is approximately 2 hours, representing 23.8%. When asked what function users wish to improve most, "Having more content" is 24.8%. The total mean acquired for Perceived Brand Equity is 4.07, Brand Personality is 4.04, Social Influence is 4.01, and Purchase Intention is 4.04.
	Unstandardized B	Coefficient	Standardized	t	Sig.
		Std. Error	Coefficients		
			Beta		
(Constant)	0.117	0.161		0.726	0.468
Perceived Brand Equity	0.105	0.060	0.079	1.740	0.083
Brand Personality	0.488	0.066	0.425	7.411	0.000
Social Influence	0.381	0.053	0.364	7.164	0.000

Table 1 Model's Coefficients

a. Dependent Variable: Purchase Intention.

According to statistical results, the R square value is 0.661, which means that the three independent variables, Perceived Brand Equity, Brand Personality, and Social Influence, can explain 61.1% of the variation in the dependent variable, Purchase Intention toward global brands' video streaming service. Based on the ANOVA results, the F value obtained for this study equals 257.315, and the P value is 0.000, less than 0.05. Therefore, it is possible to conclude that the independent and dependent variables are statistically related.

The result also shows the correlation coefficients among Perceived Brand Equity, Brand Personality, and Social Influence, and the dependent variable, Purchase Intention. The correlation between Perceived Brand Equity and Purchase intention is r=0.649 and P=0.000<0.05. The correlation between Brand Personality and Purchase intention is r=0.781 and P=0.000<0.05. Lastly, the correlation between Social Influence and Purchase intention is r=0.763 and P=0.000<0.05. This result also indicates a moderate, positive, and significant correlation among Perceived Brand Equity, Brand Personality, Social Influence and Purchase intention.

The models' coefficients indicated the hypothesized relationship between independent and dependent variables. The first hypothesis of this paper correlates with Perceived Brand Equity and Purchase intention. The results of this study show that the value of the coefficient B between Perceived Brand Equity and Purchase intention is 0.105, with a significance of 0.083 (>0.05) at the significant level of 0.05. Because the significance value is greater than 0.05, the Perceived Brand Equity is insignificant. Hence, the Perceived Brand Equity factor does not significantly influence Purchase intention. The value of the coefficient B between Brand Personality, and Purchase Intention is 0.488 with a significance of 0.000 at the significance level of 0.05. The outcome reveals that one unit's change in Brand Personality will enhance Purchase intention by 0.105 units. Brand Personality, therefore, significantly influences Purchase Intention. The last hypothesis of this analysis connects Social Influence with Purchase Intention is 0.381 with a significance of 0.000 at the significant level of 0.05. This result means increasing Social Influence by one unit will enhance Purchase Intention by 0.381 units. Accordingly, Social Influence significantly influences Purchase Intention.

6. Discussion

According to statistical analysis, Perceived Brand Equity is insignificant in impacting Purchase Intention toward global brands of video streaming services. The hypothesis is rejected. Arshad and Victor (2020) explored the relationship between Brand Equity and Purchase Intention in the retail industry, branded shoes. The findings showed that Brand Equity is highly essential for Purchase Intention. The current study, however, showed that Perceived Brand Equity has an insignificant positive relationship with Purchase Intention. Therefore, it is interesting to measure these variables with other scales and businesses to research and develop strategies relating to quality to compete with competitors.

Meanwhile, Brand Personality significantly and positively influences Purchase Intention toward global brands of video streaming services in Vietnam. The hypothesis is acceptable. The highest assessment is Competence, which means that video streaming services of global brands have outstanding functions leading in the industry. This finding is consistent with Rup, Gochhayat & Samanta (2021). Apart from this, the Sincerity mean score also shows that service providers have a high reputation and make customers put their trust in brands when using the service. They keep customers excited and deliver the sophistication of brands by offering creative, diverse content with many genres that suit each generation. Foreign brands' image attaches to challenging traits, such as overcoming geographical boundaries to connect with customers and facing other competitors in the industry. The findings are consistent with the study of Amin et al. (2022)

Likewise, the Social Influence factor also significantly and positively influences Purchase Intention toward global brands of video streaming services in Vietnam. The hypothesis is acceptable. This supported by Doan (2020). These findings proved that Social Influence is an essential factor in investigating the Vietnam Market. Based on mean scores, customers' behaviors tend to perform under others in the compliance and internalization process. Vietnamese customer behaviors relate to others' opinions, especially family and friends. People can accept norms from their favorite people, such as celebrities, relatives, or peer groups. This finding is supported by the research of Dwisuardinata & Darma (2023).

7. Suggestion

Consumers own a specific knowledge level of global brands in video streaming services, such as logos, images, and quality, compared to local competitors. However, this does not mean they purchase global brands; it indicates through the low score assessment for loyalty brands. It can be understood because people who participated in the survey were primarily young age and can quickly catch up with the trends locally and worldwide, so it is reasonable why they can have high recognition of global brands and accept new, strange brands compared to other age groups. They have much knowledge, which means their needs are higher and more accessible to change than any age group, leading to a lack of brand loyalty. Hence, businesses should have strategies relating to loyalty levels, such as package prices or privilege benefits, and exclusive content they can only get when gaining a certain engagement level.

Besides, Brand Personality shows a significant relationship with Purchase Intention. Characteristics of brands have successfully affected consumers' attitudes. They perceive brands as credible and are primarily satisfied with services' abundant content, such as consumers feel their private information is secured, and Netflix completes all terms they promise. However, the global brand that almost receives this recognition is Netflix subscribers since this brand ranks first among global brands in the survey. Other competitors should focus on these requirements and avoid creating superficial or excessive advertising about the brand. More importantly, the brand can compete by creating more content and collaborating with celebrities whose reputations or characteristics reflect the brand image. Equally important, the language barrier is a challenge for global brands. The solutions that can apply are to find a partner in Vietnam or use technology such as AI to dub content.

Last but not least, Social Influence is the second variable with a significant relationship with Purchase Intention. Based on demographic data, it also showed that most respondents like to use it with friends more than family and colleagues. However, there is a slight disparity in the number of picks between the options. Vietnamese users like to share subscriptions with others more than own by themselves. Brands of video streaming services, therefore, should develop new price packages for each target customer., such as for families (similar to Netflix) or friends with many profiles. More importantly, businesses should focus on a particular group of user targets more than on the general community. Because consumers also follow their favorite people, such as celebrities and influencers, service providers can create TV shows or movies having participation from famous people or invite them to join advertisement campaigns.

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The Current Community-Based CSR Practices Among Five-Star Hotels in Phuket

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ABSTRACT

Despite the increasing adoption of Corporate Social Responsibility (CSR) among the hotel industry. The knowledge of community-based CSR in the industry is still limited. Thus, this study investigated the community-based CSR practices among five-star hotels in all three districts in Phuket. In-depth interviews were selected to gain information from 18 senior managers of five-star hotels. The data were analyzed by content analysis. The findings of the current community-based CSR practices among five-star hotels in Phuket were categorized into six topics: donation/ marathon, repairing/ cleaning communities, supporting schools/ temples/ and communities, creating activities to make awareness and concern about social problems, environmental protection and resource conservation, working with nonprofit organization.

Keywords: Corporate Social Responsibility (CSR), Community-Based CSR, Hotel, Phuket

1. Introduction

The hotel industry imposes a large number of negative impacts on the economic, social, and natural environments. Consumption a lot of water, energy, food, paper, linen, laundry, cleaning materials and chemical in everyday causes many negative impacts to the environment, including noise pollution, biodiversity loss and waste generation (Han, Chen, Lho, Kim & Yu, 2020). The industry also impacts on local communities through its occupation of space, use of community resources and infrastructures (Cárdenas, Byrd & Duffy, 2015; Chung & Parker, 2010). Due to the impact mentioned above, hotel businesses around the world can feel an increase of pressure on forcing them to implement more socially and environmentally responsible strategies (Valentin, 2018). Then, the Corporate Social Responsibility (CSR) concept has become an important factor in operating business since the concept was first introduced in 1950s and the number of firms joining the CSR bandwagon is still

increasing to show responsibilities to several issues, including society, environment, and stakeholders (Dos, 2017). This is a sign that businesses are still involved in solving social problems. Moreover, recently businesses have become more actively involved in the community-based CSR to build strong healthy communities (Schaltegger & Burritt, 2018). There are several methods and practices for community-based CSR such as delivery of goods, services, financial provisions to the community, and etc. Each practice has its benefits and procedures, thus a company must select proper methods and practices that are suitable for both communities and company.

The community-based CSR concept and activities have also become important tools for the tourism and hospitality industry. Even though the industry have paid attention to CSR since the 1950s and the concept has continued to grow in this business (Ramkissoon, Mavondo & Sowamber, 2020; Leslie, 2016) but knowledge of community-based CSR activities in the hotel industry is still limited (Khuadthong & Kasim, 2020) because the existing research into hotels' CSR is mostly focused on environmental dimension (Abaeian & Khong, 2019) which have a positive business efficiency impact (Jovicic, 2011; Sheldon & Park, 2011).

Phuket is a popular tourist destination in Thailand which the hotel industry has been recognized as the main important sector affecting economic growth and employment in the province. The hotel industry has contributed to the development of local areas with five-star hotels playing an important role in the growth of Phuket's hotel industry and Phuket's overall economic. This study, thus, attempts to bridge this gap by exploring the current community-based CSR practices among five-star hotels in Phuket.

2. Objective

To explore the current community-based CSR practices among five-star hotels in Phuket

3. Literature review

Kotler and Lee (2005) introduced six types of Corporate Social Initiatives (CSIs) that are useful in conceptualizing CSR activities: cause promotions, cause-related marketing, corporate social marketing, corporate philanthropy, community volunteering, and socially responsible. 1) Cause promotions mean a corporation provides funds, in-kind contribution, or other corporate resources to increase awareness and concern about a social cause or to support fundraising, participation, or volunteer recruitment for a cause. 2) Cause-related marketing means a corporation commits to make a contribution or donating a percentage of revenues to a specific cause based on product sales. 3) Corporate social marketing means a corporation supports the development and/or implementation of a behavior change campaign intended to improve public health, safety, the environment, or community well-being. 4) Corporate philanthropy is a direct contribution of resources by an organization and its employees to a cause, to improve community well-being or to a charity, most often in the form of cash grants, donation and/or in-kind services. 5) Community volunteering involves company employees, related franchise, and retail partners in supporting of their time to be a part in solving local problems. Finally, 6) Socially responsible

business practices means a corporate adopts and conducts discretionary business practices and investments that support social causes to improve society, community well-being, and protect environment.

However, Deigh, Farquhar, Palazzo and Siano (2016) mentioned that philanthropy is the most traditional of all CSIs and has primarily been a major source of support for communities in health, education, human service agencies, and environment

4. Methodology

This part includes research design, sampling procedures, research instruments, and data analysis.

4.1 Research design

Qualitative research is useful for studies at the individual level, and to find out, in depth, the ways in which people think or feel (Berkovich, 2018). Thus, this study utilizes qualitative research to collect qualitative data from senior managers of five-star hotels.

4.2 Sampling procedures

For qualitative research, 15 is the smallest acceptable sample for a particular group because saturation often occurs between 12 and 15 (Guest, Bunce, & Johnson, 2006). Firstly, 15 senior managers of five-star hotels were determined to be the key informants for the qualitative interviews. The process of determining the sample size is explained below;

For sample size of senior managers, Phuket has 60 five-star hotels and resorts, operated by national and international brands (Tourism Authority of Thailand, 2017). However, not all of these hotels have been involved in community-based CSR. Therefore, purposive sampling technique was applied to choose only five-star hotels that were involved in community-based CSR. This sampling technique helps this study to select sample based on the characteristics of a population and the purpose of the study (Robinson, 2014). Firstly, published information was considered to separate the five-star hotels involved in community-based CSR from the total population. Secondly, phone verification was required if no published information existed. Finally, 45 five-star hotels were involved in community-based CSR.

After that stratified sampling technique was applied to collected useful qualitative data from hotels' senior managers in all three district areas in Phuket. Then, simple random sampling with a lottery method was applied. As mentioned earlier, 15 is the smallest acceptable sample for qualitative research (Guest, Bunce, & Johnson, 2006). Thus, all hotels' names that were involved in community-based CSR in each area were put into a box, and 5 hotels in each area were randomly selected. Snowball sampling was also applied because during the interview some interviewees gave contact details of the person in other hotels that are in charge of CSR, then the researcher called to make an appointment with them and 3 more hotels were added. Finally, there were 18 senior managers participated in the study. Table 1 depicts the actual sample size, list of hotels that were interviewed.

Districts	Actual sample size	Five-star hotels that were interviewed
1. Mueang Phuket district	5	1. Le Meridien Beach Resort Phuket
		2. Kata Rocks Resort & Residences
		3. Amatara Wellness Resort
		4. Club Med Phuket
		5. Sri Panwa Phuket Hotel
2. Kathu district	7	1. Phuket Marriott Resort & Spa, Merlin Beach
		2. Swissotel Resort Kamala
		3. Hyatt Regency Phuket Resort
		4. Wyndham Sea Pearl Resort Phuket
		5. La Flora Resort Patong
		6. Amari Phuket
		7. Grand Mercure Phuket Patong
3. Thalang district	6	1. JW Marriott Resort & Spa Phuket
		2. Renaissance Phuket Resort & Spa
		3. Banyan Tree Phuket
		4. Dusit Thani Laguna Phuket
		5. Twinpalms Phuket Resort
		6. Sala Phuket Resort and Spa
3 Districts	18 Samples	

Table 1: The actual sample size, list of hotels that were interviewed

4.3 Research instruments

In-depth interviews were selected to gain knowledge, views, and experiences from hotels' senior managers. The interview protocol was designed in line with the objectives and problems of the study for interviewing hotels' senior managers. The validity of the interview questions has been checked by three scholars working in the field of tourism and hospitality management. The interview protocol consists of two sections as follows;

Section A: Informant Details – This section does not contain any personally identifiable questions. The questions include informant's name, position, hotel/ or community name, and date of interview.

Section B: Questions about Hotels' Community-based CSR – The interview protocol was designed for exploring the current community-based CSR practices among five-star hotels in relation to the senior managers' perspectives.

4.4 Data collection

Qualitative data was collected to answer research question. The interview sessions were carried out face-to-face using interview protocols in order to gather insight and understanding about the current community-

based CSR practices among five-star hotels in Phuket (Saengpikul, 2013). Interviews were conducted at meeting room or hotels' lobby. The interviews took about 20-30 minutes. The aims and procedures of the interview were explained to the interviewees before starting the interview. The interviewees were informed that their interview would be recorded by mobile in order to enhance the data accuracy.

4.5 Data analysis

Content analysis was used to analyse the data which were gathered from interviews. Steps for qualitative content analysis suggested by Saengpikul (2013) were adapted; first, read the transcripts thoroughly, second, organize and connect qualitative data. For reliability of data, this study utilizes theoretical triangulation. The theory of CSIs by Kotler and Lee (2005) was used to compare the theory with the research results.

5. Research findings

The results answer the objective, which is to explore the current community-based CSR practices among five-star hotels in Phuket. Table 2 below depicts the interview results of the current community-based CSR practices among five-star hotels in Phuket.

Activities under								18 H	lotel	ls' sei	nior n	nanag	gers					
community-based	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CSR programs																		
Donation	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Marathon	/				/		/		/			/		/				
Repairing/ Cleaning		/		/	/		/	/		/		/		/	/		/	/
communities																		
Supporting schools/		/	/	/	/	/		/	/		/	/	/	/	/	/		
temples/ and																		
communities																		
Creating activities to						/				/				/				
make awareness and																		
concern about social																		
problems																		
Environmental			/		/	/	/		/					/	/	/		/
protection and																		
Resource conservation																		
Working with	/															/		
nonprofit organization																		

Table 2: Activities under community-based CSR programs

Based on the table above (Table 2), the results of interviews with 18 senior managers showed that the current community-based CSR practices among five-star hotels in Phuket were categorized into six topics: donation/ marathon, repairing/ cleaning communities, supporting schools/ temples/ and communities, creating activities to make awareness and concern about social problems, environmental protection and resource conservation, working with nonprofit organization. The details of each topic are described below.

5.1 Donation/ Marathon

All informants mentioned to donation activities which can be grouped into five types; 1) Hotels donated clothes and supplies such as diapers for elderly and children in nursing homes. Moreover, hotels also donated medical equipment and supplies for local hospitals. 2) Hotels donated money for disabled children and elderly in nursing homes. For example, Grand Mercure Phuket Patong put donation boxes at hotel lobby to raise fund for special project such as Yim Kids project to help children and disadvantaged youth. 3) Hotels make donation on special occasion. For example, Kata Rocks Resort & Residences gave towels and sarongs to elderly for showing respect in Songkran festival. Twinpalms Resort Phuket supported foods, drinks, and gifts on children's day through Choeng Thale Sub district administration organization. Moreover, many hotels used to donate money and supplies to schools, temples, and people who were affected by tsunami disaster. 4) Hotels always have blood donation activity. For example, Hyatt Regency Phuket Resort created blood donation project 4 times/year by sending blood donation invitations to all hotels in Kamala beach. 5) Marathon is a kind of donation because income or profit from marathon will be donated to hospital, patients, and schools. For example, Wyndham Sea Pearl Resort Phuket created marathon charity for Patong hospital. Sri Panwa Phuket Hotel created marathon charity for heart disease patients. Grand Mercure Phuket Patong created marathon charity to donate money to schools in the area that hotels operate.

5.2 Repairing/ Cleaning communities

There were many campaigns that hotels involved repaired and cleaned communities such as repaired houses for local people who were affected by floods and natural disasters, created portable toilets and temporary houses, painted crosswalk and repaired road at schools, implemented waste separation tanks, recycled materials project, cleaned canals/ beaches/ temples/ turtle ponds/ and communities, and teach residents to clean and separate wastes. For example, Renaissance Phuket Resort & Spa has crosswalk painting project at schools. Kata Rocks Resort & Residences has project to clean temples and communities, clean turtle ponds, and repair road. Wyndham hotel has Wyndham green project which emphasis on environment and waste separation.

5.3 Supporting schools/ temples/ and communities

There were activities that hotels arranged by their own and also supported through CSR projects of the government sector to provide scholarships, learning equipment, and also support money for developing school buildings and facilities. Many projects were created to support education. For example, 1) Arranging staff to teach about hotel knowledge and skills: Marriott Resort & Spa, Merlin Beach, JW Marriott Phuket Resort & Spa, and Resources, Renaissance Phuket Resort & Spa signed contracts to be a partner with schools for sending staff to teach students about knowledge and skills in operation departments such as kitchen department, housekeeping

department, and front office department. After that students will have the chance to apprentice and train in hotels. 2) Supporting education: Dusit Thani Laguna Phuket has participated in seedlings project (Plant A Seed, Change A Life) of Laguna by selecting children from the surrounding communities to support education, skills, and jobs. 3) Arrowing children to use hotel facilities: Amari Phuket sent invitation letter to high schools to allow students have sight visit in hotels. Club Med Phuket arrowed students in Baan Kata school to play and use hotel's sports facilities 2 times/month. 4) Arrowing disabled children were invited: Club Med Phuket invited students and disabled children to have lunch, snacks and drinks in hotel during special occasions. 5) Donating for long term: Dusit Thani Laguna Phuket supported 5,000 baht/month for foods at Eureka school for life in Phang-Nga province. This school was built to help children who lost parents in tsunami. All Amari hotels have Baht for Better Life project to support education by putting donation boxes at the lobby and hotels will donate with the same amount of money in donation boxes. For supporting temples and communities, apart from supporting facilities, hotels also have several projects about job creation and income distribution to communities. For example, Grand Mercure Phuket Patong has Soap for Hope project to teach local people to make soaps, and then the hotel bought them back. JW Marriott Phuket Resort & Spa supported jobs and community products by ordering rope bracelets from communities to give to hotel's guests as welcome bracelet and ordering black crabs from communities to create signature dishes. Amari Phuket purchased seafood from local communities.

5.4 Creating activities to make awareness and concern about social problems

There are many problems in societies such as people still choose to not wear helmets. Therefore, Renaissance Phuket Resort & Spa, Phuket Marriott Resort & Spa, Merlin Beach created "Hero Helmet project for schools" to make awareness to people.

5.5 Environmental protection and Resource conservation

Hotels' CSR which focused on environmental dimension such as released sea turtles, mangrove forest planting, live coral project. For example, Amatara Wellness Resort, Sri Panwa Phuket Hotel, Swissotel Resort Kamala, Renaissance Phuket Resort & Spa, Dusit Thani Laguna Phuket, and Sala Phuket Resort and Spa have the project to save and release sea turtles. Swissotel Resort Kamala and Sala Phuket Resort and Spa have mangrove forest planting project. Phuket Marriott Resort & Spa, Merlin Beach promoted live coral project at the hotel lobby to persuade hotel's guests to donate 10% from every guest's invoice to create new coral reefs.

5.6 Working with nonprofit organization

Apart from creating hotels' CSR and supporting government sectors' CSR, sometime hotels also helped societies and communities through nonprofit organization. For example, Le Méridien Phuket Beach Resort corporated with Punfunpunyim nonprofit organization of Her Royal Highness Princess Maha Chakri Sirindhorn to order wristband from disabled people to give to hotel's guests as welcome gift. Dusit Thani Laguna Phuket is a partner with Operation smile organization to help children who were born with facial deformities.

6. Discussion

Hotels have any community-based CSR projects included short-term projects, long-term projects, and ongoing projects. From the interview results, all projects can be grouped into six types which similar to Kotler and Lee (2005) that proposed six types of CSIs to be a guideline for creating community and society development projects. 1) Cause promotions - Hotels have involved in raising awareness or fundraising on a specific cause such as Grand Mercure Phuket Patong has marathon to raise funds for hospitals, Renaissance Phuket Resort & Spa has fundraising activity from hotel' staff and guests, Amari Phuket put donation boxes at the lobby to raise funds for supporting education. 2) Cause-related marketing – Hotels have involved in donating a percentage of revenues to a specific cause. From the interviews, there was only one project of Phuket Marriott Resort & Spa, Merlin Beach that involved in cause-related marketing. The hotel donated 10% from every guest's invoice to create new coral reefs. 3) Corporate social marketing – Hotels have involved in inspiring and supporting behavior change such as Amatara Wellness Resort released sea turtles, Phuket Marriott Resort & Spa, Merlin Beach has several campaigns to increase the traffic discipline on public roads and raise awareness for drivers and motorcyclists. 4) Corporate philanthropy - Hotels have involved in direct charitable activities such as Club Med Phuket donated money for schools, temples, and people who were affected by tsunami disaster, Sri Panwa Phuket Hotel donated money and supplies for disabled children and elderly in nursing homes. 5) Community volunteering - Hotels have involved in sending volunteers to help communities and societies such as canal cleaning activities, mangrove forest planting, etc. 6) Socially responsible - Hotels have involved in other socially responsible practices to reduce community problems and support community development such as JW Marriott Phuket Resort & Spa ordered local products and supported residents into local jobs. It can be seen that one project can be categorized in many aspects such as releasing sea turtles and planting new coral reefs can be categorized into corporate social marketing and community volunteering.

From the interview results, it can be concluded that corporate philanthropy was the most commonly method used for creating hotels' community-based CSR. In line with Deigh *et al.* (2016) mentioned that philanthropy has primarily been a major source of support for communities in health, education, human service agencies, and environment. However, all hotels avoided cash donations to any organizational leaders to prevent corruption.

It can be concluded that most of hotels' community-based CSR projects have involved with the improvement of environmental, personal skills, community facilities, education, health, and quality of life. As many studies have found that there are three components of community development: the living standard, health, and education dimensions (Deigh *et al.*, 2016; Green & Haines, 2015; Ismail, Alias & Rasdi, 2015).

7. Recommendation

(1) Hotels should create community-based CSR activities to create shared value between business and community because it allows business to maximize revenues, and also offer benefits that add to the local community. However, community-based CSR requires a balance between the growth of business and the development of community. If the results show only the creation of economic value, then it might causes suspicion and question what community receives from community-based CSR.

(2) Hotels should offer a wide variety of community-based CSR activities throughout a year, and also support CSR projects of the government sections to show attention in solving community problems, create awareness in the corporate culture, and build up a reputation for company. Both short-term and long-term projects should be included in CSR plan such as donation, charity, cleaning communities, supporting local products, career path development, etc.

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Exploring Relationship Between Financial Performance and Organization Characteristics of Gold and Platinum Labels of Social Forestry Business Groups in Bali Province, Indonesia

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ABSTRACT

Sustainable management covers various sectors, one of which is the forestry business. The Government of the Republic of Indonesia has a social forestry program, one of which is to assist the Social Forestry Business Group (SFBG). This assistance aims to ensure that business management is sustainable from an economic, ecological and social perspective. Sustainability management from a financial perspective requires more attention because it is the key to running a business. This research was conducted at all SFBGs in Bali Province, Indonesia to calculate Economic Value Added (EVA) which plays an important role in sustainability. This study also seeks to find the most influential financial performance factors and organizational characteristics in Economic Value Added in relation to asset optimization. The method used is the EVA financial formula and regression analysis. The research results show that profit margin has the most important role in adding number of Economic Value Added. Research also tries to find the most important factor in adding Economic Value Added to SFBGs that have an EVA of less than 40,000,000 IDR. The results show that total assets turnover has the most important role. In this case, SFBG can further optimize the efficiency of asset use to achieve a higher number of Economic Value Added to maintain sustainability.

Keywords: economic value added, profitability, sustainability, finance management, efficiency improvement

1. Introduction

The Ministry of Environment and Forestry of the Republic of Indonesia through the Social Forestry Program has established Social Forestry Business Groups (SFBG) throughout the territory of the Republic of Indonesia. This Business Group conducts micro and small scales businesses related to the processing of forest products. There are four criteria for Social Forestry Business Groups, namely Blue, Silver, Gold and Platinum. Based on the stipulation of the Director General of Social Forestry and Environmental Partnerships Number: P.2/PSKL/SET/KUM.1/5/2018 concerning Guidelines for Social Forestry Business Development, the criteria for gold and platinum are that they already have markets and access to capital, whereas blue and silver are only limited to business units being identified. SFBG plays a role in maintaining the sustainability of economic, social and ecological aspects. Each SFBG has their own product, and it can be different between each other.

The Social Forestry Business Group with gold and platinum criteria must be able to help the farmer's economy, of course with the Economic Value Added (EVA) criteria and positive profitability. Therefore, it is necessary to evaluate the financial performance of the Social Forestry Business Group on the gold and platinum criteria. This is related to sustainability in their business management. In addition, of course, there are many factors that affect the improvement of criteria. This needs to be further investigated, so that it can be used as material for consideration regarding what assistance is needed by the Social Forestry Business Group to be able to improve its criteria.

These pictures below are examples of products and sites of SFBGs. First picture is Robusta roasted coffee. This product is well-known in Indonesia as one of favorites coffee variety. This business group already has cooperation with some hotels and cafes. Second picture is the scenery of Banyumala Waterfall. This is one of tourist famous destination in Bali. Mostly visitors are foreigners as they like to tracking to get to the waterfall. The third picture is trigona honey from SFBG Werdhi Wana Rta. Honey is one of well-known product in Indonesia, especially trigona. Mostly local consumers believe that trigona honey has more benefit than other variety of honey.



Picture 1. Coffee Product of SFBG Wanagiri



Picture 2. Sites in SFBG Banyumala



Picture 3. Honey from SFBG Werdhi Wana Rta

2. Research Objectives

(1) Calculate Economic Value Added from each Social Forestry Business Group

(2) To find out the most influential factors on the amount of Economic Value Added and profit margin.

3. Literature Review

3.1 Theory, Concept and Related Research

Based on Regulation of the Director General of Social Forestry and Environmental Partnerships, Ministry of Environment and Forestry of The Republic of Indonesia Number: P.2/PSKL/SET/KUM. 1/5/2018 concerning Guidelines for Social Forestry Business Development, Social Forestry Business Group is the holder of social forestry permits or rights who will and/or have conducted business and community forests that have been designated as Social Forestry Business Group in accordance with applicable regulations. The Ministry of Environment and Forestry of The Republic of Indonesia has the task of establishing, assisting and evaluating the SFBG business.

Financial performance is the achievement of the company's performance in financial terms during a certain period which includes the collection and allocation of finances, as measured by capital adequacy, liquidity, solvency, efficiency, leverage and profitability. Financial performance can also be interpreted as a company's ability to manage and control its own resources (Fatihudin, D. et. al., 2018). Research on financial performance conducted by Anggraini (2021) in 6 MSME's enterprises uses the common size analysis and ratio analysis methods. The first step, Anggraini (2021) calculates the breakeven sales level, then determines a ratio analysis which includes Return of Sales (ROS), Return of Equity (ROE), Return of Assets (ROA), Liquidity Ratio, Asset Management Ratio, and Cash Conversion Cycle. From the calculations performed, it can be determined which business has the best performance.

Echobu et. al (2022) use multiple regression analysis to find out which financing factors have the most influence on the progress of SME'S enterprises in Nigeria. This method is used to analyze several independent variables that affect a process. Irawati et al (2022) found that financial literacy, financial management, and capital were able to explain the variation that occurs in business performance about 98.4% and other factors only contribute about 1.6%.

The use of Economic Value Added (EVA) as an indicator of economic profit has been studied by Jakub, S. et. al. (2015). This indicates that when considering the economics of profit and its measurement one must first distinguish the theoretical basis of the concept, the form of application and the possible application in practice. The data collected and the transformation of this data form provided by accounting into the desired pattern, respectively, into an Economic Value-Added structure plays a key role in the process. Shad et. al (2019) stated that Economic Value Added was used to determine business performance, Ghassim and Bogers (2019) used profitability to do the similar research. In another research by Tien et. al. (2019), corporate financial performance together with corporate social responsibility and corporate environmental sustainability create sustainability development and quickly transforming business landscape in Vietnam.

3.2 Research Framework



Figure 1 Research Framework

3.3 Research Hypotheses

Social Forestry Business Group Gold and Platinum, which have been labeled as examples of good micro and small businesses in social forestry, should have good financial performance. Profit margin and Economic Value Added are related to each other, and some organization characteristic have effect on the amount of Economic Value Added and profit margin.

4. Research Methodology

4.1 Research Design

This research was conducted by means of in-depth interviews with each business group. From the data obtained, then calculated the value of Economic Value Added and financial performance. Furthermore, this study seeks to find the factors that influence the value of EVA as an independent variable.

4.2 Population and Sample

This research will be done in all of the population, which is four groups of platinum criteria and twelve groups of gold criteria. The total of the population is 16 (sixteen) groups. Data collection was carried out for the entire population although there are many difficulties in collecting data related to locations that are spread across mountainous locations and cannot be reached by large vehicles, and it is not possible to collect data online due to the farmers's technological limitations.

4.3 Research Instrument

The instrument that been used in this research such as: questions lists for in-depth interview, smartphone and laptop with voice recorder, Microsoft Office, and Google Spreadsheet.

4.4 Data Collection

Data collection methods have been carried out quantitatively and qualitatively. Primary data collection was carried out by means of in-depth interviews with leaders and/or members of each Social Forestry Business Group. Secondary data has been collected from the Ministry of Environment and Forestry of the Republic of Indonesia.

4.5 Data Analysis

1. Calculating Economic Value Added (EVA) from each business group

The value that each company made has been calculated by calculating Economic Value Added using this formula:

EVA = EBIT (1 - Tax) - WACC * Total AssetsEBIT: Earning Before Interest and Tax WACC: Weighted Average Cost Capital

2. Calculating Profit Margin, Total Assets, Total Assets Turnover, Return on Assets, and

Return on Equity

The financial performance that has been used in this study are: Return on Assets (ROA), Return on Equity (ROE), Total Assets Turnover, and Profit Margin. The formula that has been used are as follows:

$ROA = \frac{Net Income}{Total Assets}$	$ROE = \frac{Net Income}{Net Common Equity}$
Profit Margin - Net Income	Total Assats Turnovar — Sales
Total Sales	Total Assets Turnover - Total Assets

3. Regression Analysis

Factors that contribute to the amount of Economic Value Added have been processed using Regression Analysis. This analysis was conducted to determine which factors most determine the success of the Social Forestry Business Group. Method that had been use can describe as the formula below:

 $\begin{array}{l} Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_t \\ Y = dependent \ variable \\ a = intercept \\ \beta = coefficient \\ X = independent \ variable \end{array}$

5. Research Findings

Descriptive statistic and correlation can be seen in these tables below:

				Total Aset	Area per member
	EVA / TA	Profit Margin (%)	Log (age)	Turnover	(ha/person)
Mean	0.35427	65.32115	1.70566	0.85040	3.14205
Standard Error	0.09121	0.03794	0.01989	0.14918	1.14007
Median	0.20286	68.22881	1.68124	0.59648	1.46429
Standard Deviation	0.36485	0.15177	0.07956	0.59671	4.56025
Sample Variance	0.13312	0.023035	0.00633	0.35606	20.79585
Kurtosis	-0.74895	-0.880211	2.17182	-1.35613	5.49561
Skewness	0.74399	-0.594752	0.94053	0.59245	2.30520
Range	1.09335	47.79330	0.34561	1.60818	16.99667
Minimum	0.01280	37.96175	1.56820	0.24838	0.05000
Maximum	1.10616	85.75505	1.91381	1.85656	17.04667
Sum	5.66830	1045.13843	27.29061	13.60646	50.27286
Confidence Level (95.0%)	0.19442	0.08087	0.04239	0.31796	2.42998

Table 1 Descriptive	Statistic	from	all	SFE	BGs
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In the descriptive statistics table from sixteen SFBGs, it can be seen that the average EVA/TA in the value of 0.354 is not too close to the median value of 0.202. On the other hand, on the profit margin, the average and median values are almost the same at 65.32% and 68.22%. This is in line with the standard deviation value and the EVA/TA variance is bigger than the profit margin. This needs to be analyzed further in the correlation table regarding the relationship between the two dependent variables. Second table below is about correlation, and it showed that Total Asset Turnover has the biggest correlation with EVA/TA compare to other factors, in the value of 0.88981 for all SFBGs, and 0.961512 for SFBGs with EVA less than 40,000,000 IDR.

Table 2 Correlation between factors that influence EVA/Total Assets from all	SFBGs
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		Profit Margin		Total Aset	Area per member
	EVA / TA	(%)	Log (age)	Turnover	(ha/person)
EVA / TA	1				
Profit Margin (%)	0.14411	1			
Log (age)	0.26906	0.12868	1		
Total Aset Turnover	0.88981***	-0.24608	0.21610	1	
Area per member (ha/person)	-0.44362	0.15651	-0.07237	-0.50020**	1

Remarks: *** significant level at 1%

** significant level at 5%

* significant level at 10%

	EVA / TA	Profit Margin	Log (age)	Total Aset Turnover	Area per member (ha/person)
EVA / TA	1				
Profit Margin	0.19877	1			
Log (age)	0.15860	0.10034	1		
Total Aset Turnover	0.96151***	-0.01116	0.14448	1	
Area per member (ha/person)	-0.35992	0.08743	0.00256	-0.40028	1
Remarks: *** significant level at 1%		* significant level	at 5%	* significant le	vel at 10%

Table 3 Correlation between factors that influence EVA/Total Assets from SFBG with EVA less than

40,000,000 IDR

Regression results below showed that Profit Margin with coefficient number of 0.92682 was the factor that most determined the value of Economic Value Added (EVA) with an Adjusted R Square value of 0.90769 and significance level of 1%. The second factor that has a large influence is total asset turnover with a positive number of 0.59631 with a 1% significance level. Age and the number of areas per member do not have such a big influence on the amount of Economic Value Added.

In the Social Forestry Business Group (SFBG) with an Economic Value Added (EVA) below 40,000,000 IDR, Total Assets Turnover with coefficient number of 0.66736 is the most influential factor in adding Economic Value Added (EVA) with an Adjusted R Square value of 0.95046 with confidence level of 99%. EVA has the greatest positive impact on the profit margin ratio at 0.71744 with a confidence level of 95%. However, the value of Adjusted R Square which is only 0.58710 makes the regression results with Profit Margin as the dependent variable less usable as a reference.

Independent Variable	Dependent Variable (all SFBGs)		Dependent Variable (SFBG with EVA less			
		Duefft Mensie	EVA / Tatal Assata	Drafit Manain		
	EVA / Total Assets	Profit Margin	EVA / Total Assets	Profit Margin		
Intercept	-0.81348	0.61423	-0.46893	0.766491		
	(0.21775)	(0.29472)	(0.25383)	(0.26388)		
Profit Margin	0.92683***		0.45570^{**}			
	(0.00067)		(0.01765)			
EVA / Total Assets		0.71744***		1.26490**		
		(0.00068)		(0.01765)		
Total Assets Turnover	0.59631***	-0.45076****	0.66736***	-0.84263***		
	(0.00000)	(0.00064)	(0.00000)	(0.02187)		
Log Age	0.03465	0.09619	-0.00728	0.07154		
	(0.92815)	(0.77566)	(0.97483)	(0.85211)		
Area per member	-0.00125	0.00129	0.00053	0.00035		
	(0.86666)	(0.84340)	(0.90391)	(0.96143)		
Adjusted R Square	0.90769	0.58710	0.95046	0.34619		
Ν	16	16	12	12		

1 able 4 Regression Analysis Result	Table 4	Regression	Analysis	Result
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Remarks: *** significant level at 1%

** significant level at 5%

* significant level at 10%

In this research, out of a total of 16 Social Forestry Business Groups (SFBGs), there were four SFBGs whose Economic Value Added was more than 100,000,000 IDR, while the other twelve SFBGs had Economic Value-Added values below 40,000,000 IDR. Therefore, this study conducts data analysis once again by excluding the four SFBGs with economic value added that is too high compared to the other twelve SFBGs. This is done to equalize the business level in terms of EVA. After removing the four SFBGs that had very large EVA values, the results of data analysis on the twelve SFBGs showed slightly different results. If previously the sixteen SFBG profit margins had the largest coefficient values, for the twelve SFBGs, the largest coefficient values that determine EVA is total asset turnover with a value of 0.66736 at a confidence level of 99%. Age of business leaders and area per member both have no significant effect. The adjusted R square value in the second experiment was actually 0.95046 larger.

In this second scenario, the research also tries to find the factors that have the most influence on the profit margin ratio. The results of data analysis show that EVA has a large influence with a coefficient of 1.26490 at a 95% confidence level. However, similar to the first scenario for the sixteen SFBGs, the value of the adjusted R square is low, only at 0.34619. Thus, the thing that can be used as a reference in this study is the use of Economic Value Added as the dependent variable.

6. Discussion

Based on the data analysis that has been done, all Social Forestry Business Groups (SFBG) have positive Economic Value Added (EVA). Oktary (2019) states that EVA is an estimate of the actual economic profit of a business within a certain period of time. A positive EVA indicates that the company's management has succeeded in creating economic added value for the business. Conversely, if the EVA value is negative, it means that there is no economic added value given to the business, in other words, the profit generated is not as expected. The objects that had been studied are the entire population of SFBG Gold and Platinum. Despite that these business groups are managed by forest farmers who do not have access to modern technology and live far from city centers, the performance of these business groups can be said to be good because all EVA's are positive.

Assets owned by a business are the largest working capital of a business in terms of economic value. Companies must use assets as wisely as possible to achieve maximum profit. Economic Value Added is the addition of economic value to a business, inseparable from determining its value from how a company uses its assets. Therefore, how much Economic Value Added can be generated per one rupiah of assets is the right ratio to determine the sustainability of a business. Economic Value Added shows the actual profit remaining after a business's net income is deducted from all costs of capital, including the cost of equity (Wahyuddin and others, 2022).

This study seeks to find the financial performance factors that have the most influence on the addition of Economic Value Added per one rupiah of total assets. Profit margin is the factor that has the most influence on Economic Value Added, so this study also tries to find out what factors have the most influence on the value of the profit margin. Digdowiseiso and Fadillah (2022) states that A high profit margin value in a company shows the company's ability to earn high profits at a certain level of sales. A company's low profit margin indicates sales that are too low for costs to be too high at a given level of sales. In another word, a low ratio indicates inefficient management. Therefore, in this research, the biggest positive number of independent variables means that variable gives the biggest positive effect to the number of profit margin.

Based on data analysis, each SFBG should focus on efficiency improvement, especially on the use of assets. How a business uses its assets plays a very important role in determining the value of EVA in this study. Profit margin also plays an important role in determining the value of EVA, which is supported by organizational characteristics such as the age of the organization's leadership and the size of the area per member of the organization. In accordance with the initial goal of establishing the Social Forestry Business Group by the Government of the Republic of Indonesia, it is to create sustainability in economic, social and ecological terms. From an economic perspective, or in other words a company's finances, what can be done to achieve sustainability is efficiency improvement, in which total asset turnover and profit margin play an important role in efficiency improvement. The age of the business leader and the area per business member doesn't really matter, but it's still worth considering.

7. Suggestion

(1) The businesses can improve efficiency in using assets to be able to get higher Economic Value Added to maintain sustainability management in finance.

(2) Research can be continued by adding a number of factors, for example related to differences in the minimum wage for workers, and the relationship between the level of welfare of members and the amount of Economic Value Added generated by the SFBG, in relation to the necessities of life in each region.

(3) The Ministry of Environment and Forestry of The Republic of Indonesia can provide assistance focused on optimizing the use of assets by SFBG, to increase efficiency.

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Traceability Awareness, Acceptance, and Barriers of Indonesian Micro, Small, and Medium-sized Food and Beverage Enterprises

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ABSTRACT

Traceability plays a critical role in ensuring food safety throughout the entire supply chain. Traceability allows for rapid identification of the source and scope of the contaminated products. The awareness of traceability benefits and the barriers of traceability are examined among Indonesian Micro, Small, and Medium-sized Food and Beverage Enterprises (MSMEs). The objectives of this paper are to determine the awareness of traceability benefit and barriers among food and beverage MSMEs in Indonesia. This research used online survey in the form of questionnaire that was sent to food and beverage MSMEs in Indonesia. The questionnaire consisted of 18 questions for benefit awareness and 11 questions about traceability barriers. There are 285 answered respondents grouped into 100 micro enterprises, 100 small enterprises, and 85 medium enterprises. The responses are analyzed using statistical methods which are ANOVA and Tukey comparison test. The findings show that Indonesian MSMEs don't aware on the benefits of traceability system and have neutral perception on traceability. Results also indicate that all barriers are perceived as equally neutral by all sizes of MSMEs. However, MSMEs with traceability already in place reported more challenges with "software and equipment costs", "staff training costs", and "excess time of additional data collection".

Keywords: Traceability awareness, Traceability Implementation Barriers, Indonesian Food and Beverage MSMEs

1. Introduction

MSMEs (Micro, Small, and Medium Enterprises) are businesses with a specific number of employees and asset size that are key contributors to the economy of Indonesia. The Indonesian Statistics Department estimates that there are around 6.8 million MSMEs in Indonesia. Over 3.9 million firms, or half of the total, are involved in the production of food and beverages. Micro firms, which make up 98% of that number, contribute around 60% of Indonesia's GDP (Gunawan and others, 2019). It is important to pay attention to this sector of business because food and beverage MSMEs contribute to most of the food consumption in Indonesia. In this sector, it is critical to focus on Indonesian MSMEs, particularly food and beverage enterprises, because they not only contribute the most to the Indonesian economy but also are the reason of the most food-borne disease cases in Indonesia (Bosona and Gebresenbet, 2013). Food borne illness problems in Indonesia are ranged between 10 million to 22 million cases per year and the burden cost for these cases are about 4 million to 16 million US dollar annually. The increasing of food recall addressing the effect of food borne illness in the recent years demands the industries to comply with regulations and standard (Gunawan and others, 2019)

In order to handle food recalls effectively and quickly, traceability is one of the essential components of a food safety management system (Kara and Morana, 2016). Traceability means the ability to trace the history, application, or location of that which is under consideration (Allata and others, 2017). The Indonesian government has implemented various programs to support MSMEs in improving their traceability, such as providing technical assistance and training, as well as providing access to technology and markets. However, implementing a traceability system among Indonesian MSMEs has not reached the expected level. This is due to several issues including lack of essential labor skill (Uchida and others, 2009), high cost of implementation (Banerjee and others, 2015), the lack of a traceability database (Anita and others, 2022), and the complexity of traceability tool (Mutilba and others, 2019).

MSMEs play a significant role in the economic development of many countries. Research on MSME traceability can provide policymakers with valuable information about the challenges and opportunities faced by these enterprises. This knowledge can help shape policies that support their growth, sustainability, and integration into global markets. Overall, research on MSMEs traceability is essential for promoting ethical business practices, ensuring product quality, fostering consumer trust, complying with regulations, managing risks, and contributing to the long-term success of both individual enterprises and the economies they operate in.

2. Research Objective

(1) Determine the perception and awareness of the benefit of traceability of food and beverage MSMEs in Indonesia.

(2) Identify the barriers to implement traceability systems of Indonesian food and beverage MSMEs

3. Literature Review

3.1 Theory, Concept and Related Research

a. Traceability

Traceability is defined as a logistic component that captures, stores, and transmits enough information about a food, feed, food-producing animal, or substance at all stages of the food supply chain so that

it can be checked for safety and quality control, traced upward, and tracked downward at any time (Bosona and Gebresenbet, 2013). Traceability in food safety and quality refers to the essential in ensuring that food is safe for consumption and meets regulatory standards for quality. (Almaghrabi and Alhogail, 2022).

b. Traceability Benefit

In recent years, traceability system has been used by many companies to integrate all the data related to traceability performance. To build a reliable trace ability system, the organization need to integrate network and database. There are many benefits on implementing traceability system. Traceability may aid in the food safety control management for better food safety management. Moreover, by implementing trace system it may improve the quality of the produced with quality control test in trace system (Gemeda and others, 2022). Traceability benefits can be grouped as follows:

1. Compliance

Traceability is becoming a more significant tool and obligation for governments (Kadfak and Widengård, 2022). Many industries are subject to regulations that require traceability, such as food safety regulations. Compliance with these regulations can help businesses avoid fines and legal penalties (Thakur and others,2010).

2. Marketing

Traceability may increase costumer's confidence in buying the products, reputation build-up, and easier market access, reduce consumer information costs associated with quality verification as a precondition for entering global markets (Corallo and others, 2020).

3. Process Improvement

Traceability helps to improve supply chain processes by giving visibility and transparency into the flow of goods and materials across the supply chain. Trace system eliminates wasteful processes that provide no benefit to customers (Liu, 2022).

c. Implementation Challenges

However, many MSMEs in Indonesia face challenges in improving their traceability performance, such as limited resources, lack of knowledge or technical expertise, and insufficient infrastructure (Razak and others, 2021). The challenges on implementing traceability system are divided into 4 groups. They are challenges internal to the firm (intra-firm), challenges internal to the supply chain (inter-firm), technical/system related challenges and external challenges. Implementation challenges are likely to arise internally from the firm's financial capacity and the attitudes of both management and employees (Zhou and others, 2022). These intra-firm challenges included financial constraints, lack of management commitment, employee resistant to change, and lack of required skill. The inter-firm difficulties are ethical and privacy concerns stemming from a lack of trust among SC (supply chain) partners, the implementation's unequal distribution of costs and benefits, and the unwillingness of SC partners to share their internal policies for the benefit of the SC (Rao and others, 2022).

Additional barriers to implement traceability according to some research which are cost of implementing (Gunawan and others, 2020), extra data collection complexity (Anita and others, 2022), return of

investment issue (San-José and others, 2022), tools complexity (Mutilba and others, 2019), lack of guidance (Ma and others., 2022), labor skill on traceability (Zhou and others, 2022), organizational policy (Kim and Woo, 2016).



3.2 Research Framework

Figure 1 Research Framework

3.3 Research Hypotheses

Two sets of hypotheses are tested in the study. The first set measures the overall awareness on benefits of traceability as well as whether the size of enterprise affects the level of awareness and whether one particular benefit is more aware than the others. The second set measures the overall barriers of traceability, the size of enterprise effect on traceability barriers, and comparing enterprises who have traceability in place and don't have traceability in place

1) Overall awareness on traceability benefits by Indonesian MSMEs:

a. Do they have positive awareness toward traceability benefit?

There are four ranges between 1 to 5 (Likert scale). The awareness classified into three groups (4:3 =1.33) which are aware positively (1-2.33), do not aware (2.34-3.66) and do not aware negatively (3.67-5). Given μ_{all} is the average of all enterprises' awareness of traceability benefit

$$H_0: \mu_{all} \leq 3.66$$
 $H_1: \mu_{all} > 3.66$

b. Do they have negative awareness toward traceability benefit?

Given μ_{all} is the average of all enterprises' awareness of traceability benefit

$$H_0: \mu_{all} \leq 2.33$$
 $H_1: \mu > 2.33$

2) Does the size of enterprise affect on traceability benefit awareness?

Given $\mu_{m\nu}$, μ_s , μ_{me} are the average of benefit awareness scores of micro, small, and medium enterprises.

 $H_0: \mu_{mi} = \mu_s = \mu_{me}$ $H_1:$ At least one μ_{mi}, μ_s , or μ_{me} is different

3) Does the size of enterprise affect on traceability barriers?

Given $\mu_{m\nu}$, μ_{s} , μ_{me} are the average of barrier scores of micro, small, and medium enterprises.

 $H_0: \mu_{mi} = \mu_s = \mu_{me}$ $H_1:$ At least one μ_{mi}, μ_s , or μ_{me} is different

4) Enterprises' traceability barriers

Given μ_h is the average of barrier scores of enterprises having traceability and μ_d is the average of barrier scores of enterprises that don't have traceability

a. Do enterprise already having traceability have the same barriers to those that don't?

$$H_0: \mu_h = \mu_d \qquad \qquad H_1: \mu_h \neq \mu_d$$

b. Do enterprise already having traceability have more challenges on some specific barriers?

 $H_0: \mu_{h bi} = \mu_{d bi} \qquad \qquad H_I: \mu_{h bi} \neq \mu_{d bi}$

All hypothesis type used type-two error (α) of 0.05

4. Research Methodology

4.1 Research Design

This research used primary data collection. Questionnaires is used to identify the awareness and barriers of implementing traceability system. The data collected from the questionnaire are quantitative data from Likert of 1 to 5, given 1 representing "totally disagree" and 5 representing "totally agree". The data will be analyzed using quantitative statistic method which are t test, ANOVA, and Tukey grouping test.

4.2 Population and Sample

The population of this research are food and beverage MSMEs from all 34 provinces in Indonesia. The minimum sample size is calculated using this formula (n) = $(Z^2 * \mathbf{\sigma}^2) / E^2$ (Verma, 2020). The chosen confidence level is 95% so the Z score is 1.96. Margin of error is 0.05 and estimated population standard deviation is 0.14. So, the minimum n is 188 samples. There are 710 questionnaires send through email and other social media platforms and 289 enterprises responded. The sample for this research is 285 valid responses and grouped into 100 micro enterprises, 100 small enterprises, and 85 medium enterprises.

4.3 Research Instrument

A questionnaire and Minitab version 19. Before sending the questionnaire to Indonesian MSMEs, the questionnaire is evaluated by experts. The IOC (Index of Item Objective Congruence) point of the questionnaire is 0.89. The questionnaire validity is guaranteed and can be used to answer to answer the objectives.

4.4 Data Collection

Aquestionnaire is developed in order to identify the awareness of benefits and barriers on implementing traceability system among food and beverage MSMEs in Indonesia. The questionnaire is shared by email and other social media to gather information from all provinces in Indonesia. The questionnaire can be filled by owner of the business or staffs.

4.5 Data Analysis

a.t-test

t-test is good to compare the means of two groups. The overall mean awareness from Indonesian MSMEs is compared with dummy value to know their perception in negative or positive way.

b. ANOVA CRD (Complete Random Design) test

ANOVA test is used to compare different sizes of enterprises' effect on the benefit awareness and barriers of implementing traceability. There are three sizes to compare which are micro, small, medium.

c.Tukey comparison test

Tukey test is used to analyze which size of enterprise has the higher awareness score. Tukey is also used to know which one from enterprises who have traceability in place and who don't have it that has the higher agreement score on the traceability barrier

5. Research Findings

The questionnaire is divided into 4 sections. The first section is consisted of the enterprises' demography. The second section is to determine whether the enterprises have traceability system in the first place or not. The last section of the questionnaire is designed to determine the barriers of Indonesian MSMEs on implementing traceability. The third section is to determine the traceability benefit awareness. Awareness benefits on this research are grouped into three scope which are compliance, marketing and process improvement. Compliance benefits are including comply with importing nation's legal requirements, comply with government regulation, comply with the business' vision. Marketing benefits contained boost the sales, feel confident on traceable products, improve the image if enterprises, boost competitive advantage, assist to promote sustainable products. Process improvement benefits consisted of enhance the company efficiency on material sourcing, improve product quality, decrease inventory cost, reduce defect and waste, decrease product recall cases, allow for quick recall process, decrease the expense of product recall, improve product value, guarantee the product safety. The fourth section is to analyze Indonesian MSMEs barriers on implementing traceability. There are eleven barriers listed on the questionnaire which are domestic politics, different stakeholder viewpoint, organizational policy on the necessitate of traceability, software and equipment cost, lack of understanding on traceability system, staff training cost. Excess time for data collection, lack of employee skill, return on investment issue, process complexity, and the availability of infrastructure.

No.	Item	p value	t-statistic/F-value	Conclusion
1	a. positive awareness test	1.000	25.870	Accept H_0
	b. negative awareness test	0.000	28.557	Reject H_0
2	Size of enterprise awareness	0.035	3.38	Reject H_0
3	Enterprise size on traceability barrier	0.063	2.79	Accept H_0
4	a. traceability in place comparison	0.000	66.09	Reject H_0
	b. traceability barrier comparison			
	- software and equipment cost	0.012	6.44	Reject H_0
	- staff training cost	0.008	2.10	Reject H_0
	- excess time for data collection	0.016	5.87	Reject H _o

Table 1 p-value result of t-test and ANOVA test

1) Indonesian food and beverage awareness of traceability benefit

a. The p value of t test result (1.000) is more than alpha 0.05 so H_0 is accepted. It can be concluded that Indonesian MSMEs don't have positive awareness of the benefits in implementing traceability.

b. The p value of t- test result shows that it's below the alpha 0.05 so H0 is rejected. It concludes that the enterprises do not aware on the traceability, but they have neutral point of view not in negative way.

2) Size of enterprise effect on the benefit awareness

The p value from ANOVA CRD test is 0.035 which is than 0.05. Therefore, H0 is rejected which means that size of enterprise has effect on the awareness of traceability benefit. From Tukey test comparison result, the average benefit awareness of micro firms is slightly greater than that of other business sizes. However, in terms of benefit awareness, micro firms are not considerably different from medium enterprises, and medium enterprises are not significantly different from small enterprises

3) Size of enterprises effect on traceability barrier

The alpha used is 0.05. The p value from ANOVA CRD test is 0.063 and it is greater than the alpha. The null hypothesis is accepted and concluded that the sizes of enterprises don't give significant effect on the barriers on implementing traceability.

4) The hardest barriers of Indonesian MSMEs that have traceability in place

a. P value (ANOVA CRD result) is less than alpha 0.05 so the null hypothesis is rejected. The enterprises that have traceability in place are significantly different with the enterprises that do not have traceability in place on seeing traceability barriers. From Tukey test comparison result, enterprises who have traceability in place agrees more on the listed traceability barriers than the enterprises who do not have traceability in place.

b. Among 11 barriers listed on the questionnaire, three of them are more challenging for Indonesian MSMEs who have traceability in place. The p value of the ANOVA CRD test is less than 0.05. These barriers are software and equipment cost, staff training cost, and excess time for data collection

6. Discussion

1) Indonesian food and beverage awareness of traceability benefit

Indonesian MSMEs don't aware of the benefit on implementing traceability and have neutral perspective on the traceability benefits. Many Indonesian MSMEs don't impement traceability on their business and have lack of information about traceability and its benefits. Indonesian MSMEs are not applicable to have the financial resources to invest in the systems. In Indonesia, the regulation to enforce traceability standards is not strong enough. Therefore, MSMEs in Indonesia may not prioritize traceability on their business. Many MSMEs operate on tight budgets and have limited human resources. This might prevent them from dedicating time and effort to researching and implementing traceability systems, which can be perceived as complex and resource intensive.

2) Size of enterprise effect on the benefit awareness

Surprisingly, small enterprises got the lowest score. Despite this, they are not much different from medium-sized businesses. However, as compared to micro firms, small businesses are vastly different. Micro businesses earn significantly more awareness than small businesses. But small enterprises usually already have traceability system in their business even though it's not completely reliable for product recall process. They are least aware of the benefits of traceability because they are least knowledgeable about it. They eventually have it on their company, but they are unsure if it is a trace system.

3) Size of enterprises effect on traceability barrier

From 285 respondents, 261 respondents don't have traceability in their business. Some of this number collected some necessary traceability data but it's not enough to implement integrated traceability system on their chain. The enterprise who does not have traceability system do not see the listed barriers as a challenge. MSMEs often prioritize immediate concerns such as production, sales, and day- to- day operations. They might not see traceability as a pressing issue compared to other challenges they face. Small businesses might not be aware of the benefits of traceability or how it could enhance their operations. They might not have access to information or resources that highlight the advantages.

4) The hardest barriers of Indonesian MSMEs that have traceability in place

Indonesian MSMEs face more challenging barriers on the software and equipment cost, staff training cost and excess time on data collection. Setting up a traceability system requires an initial investment in technology, software, hardware, and potentially personnel training. For MSMEs with limited financial resources, this upfront cost can be a significant deterrent. Implementing a traceability system requires training employees to use the system effectively. Training costs, both in terms of time and resources, can be burdensome for smaller businesses. Implementing traceability systems can involve the use of technology, data management, and compliance with various standards. MSMEs might perceive this complexity as a barrier and hesitate to invest resources in something they don't fully understand.

7. Suggestion

(1) More research on the traceability benefit among Indonesian MSMEs needs to be conducted especially on comparison of the size of enterprises for seeing traceability benefits

(2) An inexpensive traceability tool e.g. an open source ERP (Enterprise Resource Planning) can be suggested to Indonesian MSMEs to see their response on dealing with cost barrier.

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Factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi Province

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ABSTRACT

This research aimed to study factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province. There were 385 samples who were accounting managers, heads of accounting department and accountants from 94 business in Laem Chabang Industrial Estate. Statistics used in the study were percentage, mean, standard deviation and multiple regression analysis. The results of studying factors relating to operational efficiency of accountants found firstly, accounting knowledge of accountants had a significant correlation with accountants' operational efficiency in terms of timeliness, accuracy in accounting reports, and auditing skills. The next result revealed understanding of the accounting process of accountants had a significant correlation with accountants' operational efficiency in terms of timeliness, accuracy in accounting reports, and auditing skills. The last result disclosed information technology related to the accounting profession had a significant correlation with the accountant's operational efficiency in timeliness with statistical significance at level of 0.01 and 0.05.

Keywords: operation, accountants, efficiency

1. Introduction

Professional accountants are one of the professions that are very important for business organizations to know the performance of profits or losses. To be successful or not, an organization must have an account to showed its performance and must make an account in accordance with the specified accounting standards. How efficient is the work of the bookkeeper? It depended on a variety of factors that contribute to the successful as well (Wanwong, 2020). Accountants must manage the accounting work of individuals and businesses by ensuring
accurately and timely of both income and expenses and accounting statements in order to know the results of business organizations regarding profits and losses. Therefore, accountants are responsible for keeping the accounts of companies or organizations regardless of their position. An accountant must be an expert in finance, accounting, financial information systems, technology, and have knowledge and understanding in a variety of industries and combine knowledge from various fields to apply together to create innovations that can promote value, reduce costs or increase efficiency in work processes (Chaiyarat, 2020).

The operational efficiency of accountants essential to helping an organization achieve its objectives or targets. In addition to laws, rules or regulations established to control the work of accountants, factors affecting the efficiency of work also consist of many other factors such as factors of worker qualifications, compensation factors, and business environment factors. These factors affect performance. If accountants are effective in accounting operations, it will result in the overall operation of the organization to be successful (Phonwijit, 2019).

From the above reasons, the researchers studied study factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province. Because accountants play an important role in driving the organization's management policy, especially accountants need to adapt to keep up with changes in technology. At the same time, they must have professional accounting knowledge and skills and be able to apply information technology and new innovations to accounting work. In addition, they must increase their operational efficiency in a manner appropriate to the organization's context (Prapaisri & Nanthaphan, 2020)

2. Research Objective

To study the relationship between factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province

3. Literature Review

3.1 Concepts of accountant's operation

Accounting knowledge of an accountant means behavior that shows an understanding of theories, concepts, principles and methods of accounting. They must be able to understand other areas of knowledge related to accounting knowledge that can be applied appropriately to accounting work and must also be able to understand technical accounting practices and so on. These accountants learn from experience. Including constantly reviewing knowledge and monitoring professional changes both in theory and practice.

In terms of knowledge of functional skills, Accountants must have the skills to perform their duties properly in their fields such as Risk analysis based on theory and related environmental factors. Simulation of risk mitigation decisions in valuation, reporting, compliance with other laws and regulations. Moreover, decision-making scenarios are also simulated to mitigate risks in valuation, reporting, compliance with other laws and regulations. In understanding the accounting process of accountants, there are steps in accounting preparation that are suitable for the operating context of each community. The Institute of Ceritfied Accountants and Auditor of Thailand (ICAAT) has defined the accounting procedures as follows: Book Keeping is the duty of the Book

Keeper which has the following steps: 1. Collecting means collecting information or trading transactions that occur daily and evidence related to business operations such as evidence of credit purchase and sale of credit, evidence of receiving and paying money. 2. Recording means bringing various trading transactions that occur to be recorded in a book of original entry to be in accordance with generally accepted accounting principles by sorting the items in order and with supporting documents. 3. Classifying means bringing trading transactions recorded in a book of original entry to classify them into categories of different types of accounts, 4. Summarizing

Chaiwong (2010) studied knowledge and abilities of accountants affecting the work effectiveness of accountants in Tak province with 95 sample group. The results of the research found that the knowledge and ability of accountants when considering each aspect was found to be at a high level. By ordering mean from highest to lowest, the top three are professional knowledge, professional values, and professional skills. Moreover, it was found that the work efficiency of accountants was at a high level. The quality of work and punctuality of work are at the same level, followed by the quality of work.

3.2 Concepts of operational efficiency

Phonwijit (2019) stated efficiency in work is the ability to complete work with the least loss of time and energy, perform work quickly and optimally without errors, perform work with intention and may use techniques or methods to create results. This will produce results of satisfactory quality and with minimal wastage of costs, resources, time and expenses.

Operational efficiency is a criterion used to measure the success of employees' work performance by considering both the output achieved and the worthiness and personal abilities of the executives that is operational effectiveness. Efficiency in operations and work behavior means that an organization must be more profitable than its competitors. The organization must grow faster than its competitors. Performance can be measured against targets. If the goals can be achieved, it means that there is success in the work of the employees (Chuenwong, 2017).

Timeliness means that financial statements can be reported in a timely manner, that financial information is available to decision makers in a timely manner, can influence decisions, and also reflect events that occur in the accounting period that happened in that round in time. In addition, the financial statements prepared must be of high quality and reliable (Benyasrisawat, 2011).

In terms of accuracy in the reporting of accounting results, financial reports or financial statements are reports prepared according to the accounting period to show the financial status of the business at the end of the period and show the operating results of the business in that period. To disclose financial information that is relevant to the law, executives must submit financial statements once a year to the Department of Business Development, Ministry of Commerce. Information submitted to the Ministry of Commerce is public information. Therefore, the entity has to prepare financial reports in accordance with generally accepted accounting standards. Users of this financial report are outsiders, investors, creditors, partners and customers to assess the future cash flow performance of an entity and to make business decisions such as: investing in the securities of a firm, deciding whether to do business and to lend money. Executives are responsible for ensuring that the information in the entity's financial statements is accurate and reflects its results of operations.

In the ability to be audited in accounting, auditing is the art of systematic and independent review and investigation for defined purposes, such as financial statements, managerial accounting, management reports, accounting records, operational reports.

The results of the audit will be reported to the shareholders or other stakeholders of the entity for decision-making or other purposes as necessary. Sometimes audit reports are sent to other external stakeholders such as the government, banks, creditors or the public. For example, legal audit reports are sent to relevant regulatory bodies such as the Revenue Department, Bank of Thailand or the Department of Business Development. Audits are divided into several types and levels of assurance based on the objectives, scope, and procedures of the audit procedures.

3.3 Research Framework



Figure 1 Research Framework

3.4 Research Hypotheses

H0: The operation of accountants had a relationship with the efficiency of the accountant's operation in term of timeliness, accuracy in accounting reporting and auditing skills.

H1 : The operation of accountants had no relationship with the efficiency of the accountant's operation in term of timeliness, accuracy in accounting reporting and auditing skills.

4. Research Methodology

4.1 Population and Sample

The population used in this study were accounting managers, heads of accounting department and accountants working in Laem Chabang Industrial Estate in Chonburi province. The researcher defined a specific study of 94 businesses from 3 main industries such as automotive industry, electronic manufacturing industry and plastics and polymers industry. (Industrial Estate Authority of Thailand, 2020)

The sample used in this study were accounting managers, heads of accounting department and accountants working in Laem Chabang Industrial Estate in Chonburi province whose population was unknown.

Therefore, the researcher randomly selected a sample group by the study group, which did not know the exact number of the population randomly 50% or 0.50 from the total population. It required 95% confidence and accepts a sampling error of 5% or 0.05 of the sample size. W. G. Cochran's formula was applied for calculating and the sample was 385.

4.2 Research Instrument

Questionnaire was applied to collect the data. There were 30 sets of questionnaires tested to find confidence values from non-sample groups. The Cronbach's alpha coefficient was equal to 0.962 (passed the specified criteria) and therefore can be used as a data collection tool. The questionnaire was answered by 238 people out of a total of 385 people (61.81%). The questionnaire contained the following information.

Part 1 opinion about factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province (Rating Scale) consisted of 4 operational factors such as accounting knowledge, accounting training, understanding of accounting procedures and information technology related to the accounting profession.

Part 2 opinion about operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province (Rating Scale) contained of 3 aspects such as timeliness, accuracy in accounting reporting, auditing skills.

4.3 Data Collection and Data Analysis

The data of opinions about factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province was analyzed by the following statistical methods:

1. The data was collected by analyzing about four factors of accountants' operation in Laem Chabang Industrial Estate Chonburi province such as accounting knowledge, accounting training, understanding of accounting procedures and information technology related to the accounting profession and analyzing three aspects about operational efficiency of accountants, for example, timeliness, accuracy in accounting reporting, auditing skills. The collected data were analyzed by mean and standard deviation.

2. Multiple regression analysis was used for hypothesis testing of the relationship about factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province.

5. Research Findings

The result of factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate in Chonburi province are as follows:

	The operation of the accountant (Overview)	x	S.D.	Opinion level	Rating
1.	Accounting knowledge	3.87	0.69	agree	2
2.	Accounting Training	3.81	0.78	agree	4
3.	Understanding of accounting procedures	4.28	0.59	agree	1
4.	Information technology related to the accounting	3.85	0.84	agree	3
	profession				
	Total	3.95	0.73	agree	

 Table 1
 Mean and standard deviation in the study of opinion level of performance relating to accountant's operational efficiency in Laem Chabang Industrial Estate in Chonburi Province (Overview)

Table 1 revealed the overview of factors relating to accountant's operational efficiency in Laem Chabang Industrial Estate in Chonburi Province was good ($\overline{X} = 3.95$ and S.D. = 0.73). The first result was understanding of accounting procedures ($\overline{X} = 4.28$ and S.D. = 0.59). The next factor was accounting knowledge ($\overline{X} = 3.87$ and S.D. = 0.69). The third factor was information technology related to the accounting profession ($\overline{X} = 3.85$ and S.D. = 0.84). The last factor was accounting Training ($\overline{X} = 3.81$ and S.D. = 0.78).

 Table 2
 Mean and standard deviation in the study of opinion level of accountant's operational efficiency in Laem

 Chabang Industrial Estate in Chonburi Province (Overview)

Efficiency in the operation of the accountant (Overview)		S.D.	Opinion level	Rating
1. Timeliness	4.35	0.52	agree	1
2. Accuracy in accounting reporting	4.22	0.66	agree	3
3. Auditing skills	4.24	0.63	agree	2
Total	4.27	0.60	agree	

Table 2 disclosed the overview of efficiency in the operation of the accountant was good ($\overline{X} = 4.27$ and S.D. = 0.60). The major factor was timeliness ($\overline{X} = 4.35$ and S.D. = 0.52). The second factor was auditing skills ($\overline{X} = 4.24$ and S.D. = 0.63). The third factor was accuracy in accounting reporting ($\overline{X} = 4.21$ and S.D. = 0.66).

Table 3	Multiple	regression	analysis of	factors	relating to	o operational	efficiency	of accountar	nts in Laem

Fact	ors relating to operational efficiency of accountants (Timeliness)	В	Beta	t-value	P-value
	Constant	2.247		9.291	0.000*
1.	Accounting knowledge	0.135	0.178	2.757	0.006*
2.	Accounting Training	-0.005	-0.008	107	0.915
3.	Understanding of accounting procedures	0.295	0.333	5.045	0.000*
4.	Information technology related to the accounting profession	0.089	0.143	1.977	0.049*

Chabang Industrial Estate in Chonburi Province (Timeliness)

n = 238, R = 0.501, $R^2 = 0.251$, SE.est = 0.456, F = 19.566 Sig = 0.000*

* Statistically significant at the level of 0.05

The study of multiple regression analysis that show factors relating to operational efficiency of accountants in the aspect of timeliness revealed accounting knowledge (B equal 0.135 p> 0.05) had a significant relationship with the work efficiency of accountants in terms of timeliness. Understanding of accounting procedures (B equal 0.295 p> 0.05) had a significant relationship with the work efficiency of accountants in terms of timeliness. Information technology related to the accounting profession (B equal 0.089 p> 0.05) had a significant correlation with the work efficiency of accountants in terms of timeliness. However, it found that factor of accounting training was not significantly related to the performance of accountants in terms of timeliness.

Table 4 Multiple regression analysis of factors relating to operational efficiency of accountants in Laem

Chabang Industrial Estate in	Chonburi Province	(Accuracy in ac	counting reporting)
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Factors relating to operational efficiency of accountants (Accuracy in accounting reporting)		В	Beta	t-value	P-value
	Constant	2.061		6.436	0.000*
1.	Accounting knowledge	0.199	0.208	3.074	0.002*
2.	Accounting Training	-0.063	-0.074	-0.944	0.346
3.	Understanding of accounting procedures	0.292	0.261	3.772	0.000*
4.	Information technology related to the accounting	0.098	0.125	1.643	0.102
	profession				

n = 238, R = 0.422, $R^2 = 0.164$, SE.est = 0.60434, F = 12.639 Sig = 0.000*

* Statistically significant at the level of 0.05

The study of multiple regression analysis that show factors relating to operational efficiency of accountants in the aspect of accuracy in accounting reporting revealed accounting knowledge (B equal 0.135 p> 0.05) had a significant correlation with the accountant's performance in accuracy in accounting reporting. Understanding of accounting procedures (B equal 0.295 p > 0.05) had a significant correlation with the accounting reporting. On the other hand, it found that factors of accounting training and information technology related to the accounting profession had no significant correlation with operational efficiency of accountants in term of accuracy in accounting reporting.

	Factors affecting operational efficiency of accountants (Auditing skills)	В	Beta	t-value	P-value
	Constant	1.846		6.278	0.000*
1.	Accounting knowledge	0.237	0.259	3.984	0.000*
2.	Accounting Training	-0.032	-0.039	-0.522	0.602
3.	Understanding of accounting procedures	0.299	0.280	4.208	0.000*
4.	Information technology related to the accounting	0.083	0.111	1.520	0.130
	profession				

 Table 5
 Multiple regression analysis of factors relating to operational efficiency of accountants in Laem

 Chabang Industrial Estate in Chonburi Province (Auditing skills)

n = 238, R = 0.488, $R^2 = 0.238$, SE.est = 0.555, F = 18.173 Sig = 0.000*

* Statistically significant at the level of 0.05

From Table 5 shows the multiple regression analysis study. It was found that the factors relating to the operational efficiency of accountants in auditing skills can be explained as follows: 1) Accounting knowledge of the accountant (B equal 0.135 p > 0.05) significantly correlated with the operational efficiency of accountants in terms of timeliness. 2) Accountant's understanding of the accounting process (B value equal 0.295 p > 0.05) significantly correlated with the accountant sin terms of the accountant (b equal 0.295 p > 0.05) significantly correlated with the accountant's operational efficiency in auditing skills. In addition, the results of the study found that the factors relating to the operational efficiency of accountants in terms of auditing skills in accounting were as follows: 1) training in accounting and 2) information technology related to the accounting profession. Both were not significantly related to the performance of accountants in terms of auditing skills.

6. Discussion

Factors relating to operational efficiency of accountants in Laem Chabang Industrial Estate Chonburi province are accounting knowledge of accountants, training about accounting preparation, understanding of accounting processes of accountants and information technology related to the accounting profession. These factors have a relationship with efficiency of accountants' operation in timeliness, accuracy in reporting accounting results and the ability to be audited in accounting which corresponds to Chatngoen (2019) who

studied the relationship between professional skills and motivation with effectiveness in performances of accountants at provincial waterworks authority region 2. Moreover, the result is in accord with Yungsompoi (2018) who studied factors affecting accountants' performance of small and medium enterprises (SMEs) in Bangkok in the aspects of accounting knowledge of accountants, accounting training and efficiency in the performance of accountants. In addition, it also corresponds with Wanwong (2020) who investigated factors perfomance of accounting in Bangkok in the aspects of characteristics of accountants and qualifications for work of accountants. The results of research on the performance of accountants are related to the operational efficiency of accountants. Accounting knowledge of accountants significantly correlated with accountant's operational efficiency. Timeliness, accuracy in reporting accounting results, ability to audit accounts, and accountants' understanding of accounting procedures have a significant relationship with efficiency in their work. Timeliness, accuracy in accounting reports, account auditability, and information technology relate to the accounting profession have a statistical significance relationship to the accountant's operational efficiency at 0.01 and 0.05 levels. Therefore, if the accountant has professional accounting knowledge, regular accounting training, an accurate understanding of the accountant's accounting procedures, and proficiency in information technology related to the accounting profession, it will result in accountants being more efficient in complying with factors that are significantly related. This will allow accounting data to be processed in the business planning of executives, which will result in more efficient decision-making in planning the work of the business.

7. Suggestion

1. Accountants should focus on understanding the accounting process to become proficient in accounting, collecting, recording, classifying and summarizing work results in a timely and accurate manner that can be audited.

2. Accountants should pay attention to accounting knowledge. Accountants must have knowledge in accounting according to the standards of the Revenue Code including the knowledge of taxation and internal control in order to speed up work and be able to operate work related to accounting as well.

3. Accountants should pay attention to the use of information technology related to accounting work in order to secure accounting information from various threats. They must be trained to become proficient in using technology. When errors occur, they can be corrected quickly without affecting other tasks.

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User Experience in a Metaverse Open House Activity: Future Marketing Strategies in Virtual Environments

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ABSTRACT

The digital realm has witnessed the meteoric rise of the metaverse, offering unparalleled opportunities in education and marketing. This study seeks to bridge the gap between the immersive nature of the metaverse and its potential as a tool for engagement, specifically within the context of an open house event. Set against the backdrop of a whimsical sweet castle, participants, cast as wizards, navigated a virtual space populated by intruding children controlled by event staff. Through a mixed-methods approach, this research employed both quantitative surveys and qualitative screen recordings to capture participants' experiences and reactions. Preliminary findings, drawn from 35 participants, revealed a diverse range of technological proficiency and metaverse familiarity, both of which played pivotal roles in shaping user experiences. Furthermore, the study sheds light on the nuances of user engagement in virtual environments, offering invaluable insights for future marketing endeavors within such spaces. As the metaverse continues to evolve, understanding these user experiences becomes paramount for institutions aiming to harness its potential. This research, therefore, serves as a foundational exploration into the metaverse's capabilities, setting the stage for future studies and marketing strategies.

Keywords: Metaverse, Digital realm, Education, Marketing, Marketing strategies.

1. Introduction

The metaverse, a collective virtual shared space, has emerged as a transformative force in various sectors, notably in education and marketing. Its potential to redefine social interactions and offer multidisciplinary perspectives presents both challenges and opportunities for research, practice, and policy[1]. As businesses and educational institutions explore the metaverse, understanding its implications becomes paramount.

In the realm of marketing, the metaverse is being heralded as the "new marketing universe"[2]. Brands and organizations are keen to leverage its immersive capabilities to engage with audiences in novel ways. The metaverse offers a dynamic platform where traditional marketing strategies can be reimagined, allowing for more personalized and interactive consumer experiences[3]. Concurrently, in the educational sector, the metaverse is being recognized for its potential to revolutionize learning experiences. Recent studies emphasize the importance of collaborative learning within the metaverse, suggesting that it can foster more engaging and effective educational outcomes[4]. Especially in higher institutions, the adoption of the metaverse can significantly enhance the learning environment, making it more interactive and contextually relevant[4].

However, as the metaverse continues to evolve, there is a pressing need to understand user experiences within these virtual environments. Such insights are crucial for both marketers and educators to tailor their strategies effectively and ensure optimal engagement.

2. Research Objective

1. User Perceptions: Examine users' initial reactions to, expectations of, and satisfaction with the metaverse.

2. User Interactions: Study how participants navigate the metaverse, particularly during events like open houses.

3. Marketing Potential: Evaluate the metaverse's efficacy as a marketing tool, pinpointing its strengths and weaknesses.

4. Behavioral Patterns: Identify prevalent behaviors, such as preferred navigation methods and areas of interest.

5. Emotional Responses: Assess the emotional impact of metaverse experiences, highlighting instances of joy, confusion, and frustration.

3. Literature Review

3.1 Theory, Concept and Related Research

The exploration of the metaverse has yielded insights from various studies and theories, particularly focusing on user interactions, marketing strategies, educational adoption, and the gaming experience. Each research and concept brings forth its utility in comprehending different aspects of the metaverse and contributes towards developing our understanding and methodologies for future research.

1. Modified Flow Theory in the Metaverse

The Modified Flow Theory explores the equilibrium between user skills and challenges within the metaverse, intending to optimize user experiences[5]. An understanding of the user's journey, considering their navigation and interaction within these digital spaces, allows researchers to scrutinize engagement levels and the usability of virtual environments, pivotal for our study, focusing on user experience during an open house activity.

2. Advertising in the Metaverse

Insights into advertising strategies reveal that unique metaverse features, like avatars and threedimensional virtual spaces, offer innovative approaches to advertising[6]. By emphasizing the nuances of useravatar interactions and advertising presentations, our research can fine-tune marketing strategies within a metaverse open house, enhancing engagement and brand communication.

3. Metaverse Adoption in Higher Institutions

The conceptual framework proposed in the study of Gulf area higher institutions accentuates interactive features and personalized user experiences as vital factors for metaverse adoption in educational contexts[4]. Incorporating these findings assists in shaping educational experiences within the metaverse open house, ensuring they are both interactive and personalized.

4. Affordance Actualization in Metaverse Games

The theory of affordance actualization examines how the metaverse users realize potential actions (affordances) and how these impact their overall experiences[7]. This theory provides a lens through which we can interpret behavioral patterns and user interactions, particularly how they engage with various affordances within the open house and their effects on overall experiences.

5. Digital Twins in the Metaverse

Discussing digital twins' incorporation in the metaverse, research opens dialogue about enhancing user interfaces while also pondering security and privacy issues[8]. Understanding this allows our research to explore the utility and challenges of integrating digital twins in a metaverse marketing context, especially concerning user interaction and data privacy during the open house.

3.2 Research Framework

The metaverse, as an evolving digital ecosystem, offers a plethora of opportunities for user engagement, education, and marketing. To understand the intricacies of user experiences within the metaverse, it's essential to establish a conceptual framework that guides the research. The following framework is proposed:

1. User Perception and Cognition: This encompasses how users initially perceive the metaverse and how they cognitively process their experiences within it. Factors influencing perception, such as prior knowledge, expectations, and technological proficiency, play a crucial role

2. User Interaction and Behavior: Central to the metaverse experience is how users interact with the environment and other users. This includes navigation techniques, engagement with virtual objects, and social interactions

3. Emotional and Psychological Responses: Beyond mere interaction, it's vital to understand the emotional and psychological impact of the metaverse on users. This can range from feelings of immersion and joy to potential feelings of disorientation or frustration

4. Marketing and Engagement Potential: The metaverse's potential as a tool for marketing and user engagement is vast. Understanding its strengths and areas for improvement can guide future marketing strategies.

5. Educational Implications: For educational institutions, the metaverse offers a unique platform for immersive learning. The framework will explore its potential benefits and challenges in an educational context. This conceptual framework serves as a roadmap for the research, ensuring a holistic understanding

of user experiences in the metaverse and its implications for both marketing and education.



Diagram 1 Conceptual Framework

3.3 Research Hypotheses

In light of the research objectives and the conceptual framework, the following hypotheses are proposed to guide the study:

H1: Users with prior knowledge or experience in virtual environments will have a more positive perception of the metaverse compared to those without such experience.

H2: The level of user engagement in the metaverse is directly proportional to the clarity and intuitiveness of its interface and navigation tools.

H3: Emotional responses, such as joy or frustration, within the metaverse are influenced by the user's ability to successfully interact and achieve goals within the virtual environment.

H4: The metaverse's potential as a marketing tool is positively correlated with the level of immersion and interactivity it offers to users.

H5: Educational experiences within the metaverse are more effective when they are tailored to individual learning styles and preferences.

H6: Users who feel a sense of community or social connection within the metaverse are more likely to have prolonged engagement and positive experiences.

4. Research Methodology

4.1 Research Design

A mixed-methods approach will be employed, combining both qualitative and quantitative research techniques. This approach ensures a comprehensive understanding of user experiences in the metaverse, capturing both numerical data and nuanced insights.

4.2 Target Group

The primary population for this study consists of attendees of the Metaverse open house event. From this population, a sample of 35 participants was selected, who engaged in the activity and subsequently took the research survey.

4.3 Research Instrument

1. Survey: A structured questionnaire was developed to capture participants' demographics, technological proficiency, and specific interactions within the metaverse. The survey includes both closed-ended questions for quantitative analysis and open-ended questions for qualitative insights.

2. Screen Recordings: Screen recordings, inclusive of webcam footage, were used to observe participants' real-time reactions, interactions, and engagement levels within the metaverse.

4.4 Data Collection

1. Survey Distribution: After participating in the metaverse activity, attendees were provided with the research survey. Responses were collected and stored for analysis.

2. Screen Recording Analysis: The screen recordings of participants' sessions were reviewed to observe their navigation techniques, interactions, and overall engagement within the metaverse.

4.5 Data Analysis

1. Quantitative Analysis: Descriptive statistics, such as means, standard deviations, and frequencies, were derived from the closed-ended survey questions. This provided an overview of the general trends and patterns in the data.

2. Qualitative Analysis: Open-ended survey responses and screen recordings were subjected to thematic analysis. This involved identifying recurring themes, patterns, and insights that shed light on participants' experiences and perceptions.

5. Research Findings

Quantitative Findings:

1. Demographics: Out of the 36 participants, 44.4% were female, and 47.2% were male. The age range was predominantly between 15-30 years, making up 89% of the sample. Most participants (85%) were currently pursuing undergraduate studies.

2. Technological Proficiency: When asked about their comfort with information technology, 44.44% of participants rated themselves as 'highly proficient', while 36.1% considered themselves 'highest proficient'. Only 16.7% felt they had 'moderately proficiency'.

3. Metaverse Familiarity: About 55.5% of participants had some prior experience with metaverse platforms, while 44.5% were first-time users.

4. Navigation in the Metaverse: 69.5% of participants found navigating the metaverse to be 'easy' or 'very easy'. The remaining 30.5% felt it was 'moderately challenging'.

5. Activity Duration Feedback: 91.7% of participants felt that the 3-minute duration for the activity was adequate, while 8.3% expressed a desire for a slightly longer duration.

Qualitative Insights:

1. User Engagement: Many participants expressed excitement and curiosity while navigating the metaverse. Phrases like "intriguing environment" and "felt like a new adventure" were common in open-ended responses.

2. Challenges Faced: A few participants mentioned occasional difficulties in understanding certain controls, especially when trying to interact with other virtual entities. Comments such as "took a minute to figure out" and "wish there was a brief tutorial" were noted.

3. Emotional Responses: The screen recordings revealed a range of emotions. Most participants displayed visible excitement, often smiling or expressing surprise. However, moments of confusion or hesitation were also observed, especially when participants encountered unfamiliar features.

4. Feedback on the Theme: The sweet castle theme was well-received, with participants describing it as "enchanting", "vibrant", and "imaginative". The narrative of wizards and intruders added an element of fun and challenge to the experience.

5. Suggestions for Improvement: Some participants expressed a desire for more interactive elements, like puzzles or mini-games, within the metaverse.

6. Discussion

The metaverse open house event was designed as a practical exploration into the realm of virtual experiences and offered a diverse set of results that allow for a thorough discussion on user experiences in such environments.

1. Demographics and Technological Proficiency: The dominance of young adults in our study samples is a nod to the demographic that typically embraces digital innovations. Their technological proficiency, largely self-rated as high, points towards a potential bias, which suggests they might be more adept at navigating digital interfaces. Drawing from other studies, this demographic generally showcases a more positive reception to digital innovations. This aligns with our first hypothesis (H1) that users with prior experience in virtual environments will have a more positive perception.

2. Familiarity with the Metaverse: The observation that over half of the participants were familiar with metaverse platforms adds credence to our hypothesis (H1). Their ease of navigation and positive feedback correlates with the assumption that prior knowledge enhances user experience. Interestingly, other research findings have made similar observations, underlining the importance of prior digital exposure in enhancing user experience.

3. User Engagement and Emotional Responses: The broad emotional spectrum, from excitement to confusion, that participants traversed underscores our second and third hypotheses (H2 & H3). Our findings are reflective of other research conclusions, which emphasize that user engagement and emotional responses in

virtual environments are intimately tied to the clarity of interface design and the user's ability to interact effectively. The narrative elements of our open house, like the sweet castle and wizards, further elevated engagement, highlighting the potential of story-driven elements in metaverse marketing, supporting our fourth hypothesis (H4).

4. Challenges and Learning Curve: Feedback highlighting the occasional difficulty in navigation, despite the general ease, aligns with our second hypothesis (H2) about the correlation between interface intuitiveness and user engagement. Contrasting this with findings from other research, it becomes evident that while strides have been made in making metaverse platforms more user-friendly, there remains room for improvement.

5. Feedback on Activity Duration: The varied responses on the activity's duration brings forth an interesting observation. A longer activity duration could enable users to familiarize themselves better, optimizing their experiences. This ties back to our fifth hypothesis (H5) which stresses on tailoring educational experiences to individual preferences.

6. Suggestions for Enhancement: The feedback pushing for more interactive elements and social opportunities underscores our sixth hypothesis (H6). The urge for richer experiences and community building within the metaverse correlates with findings from other studies, suggesting that fostering a sense of community may be paramount for sustained user engagement.

7. Suggestions

Recommendations for Applying Research Findings:

1. Educational Integration: Educational institutions can leverage the findings to design immersive virtual classrooms or workshops within the metaverse, ensuring they cater to different learning styles and preferences.

2. Marketing Strategies: Brands and businesses can utilize the insights to craft marketing campaigns within the metaverse, focusing on interactivity and user engagement to enhance brand recall and loyalty.

3. Event Planning: Organizers of virtual events can use the feedback to design more engaging and interactive metaverse events, ensuring participants have a memorable and positive experience.

Recommendations for Future Research:

1. Diverse Demographics: Future research can aim to include a more diverse demographic, encompassing different age groups, technological proficiencies, and cultural backgrounds, to gain a broader understanding of user experiences.

2. Longitudinal Studies: Instead of a one-time event, consider conducting longitudinal studies where participants engage with the metaverse over extended periods. This can provide insights into long-term engagement and potential changes in user behavior over time.

3. Comparative Analysis: Research can be conducted comparing different metaverse platforms or themes to determine which elements are most engaging and why.

4. In-depth Interviews: Alongside surveys, consider conducting in-depth interviews with participants post-event. This can provide deeper insights into their experiences, challenges, and suggestions.

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Impact of Corporate Culture on the Efficiency of Savings Cooperative Accounting Information System in Cooperative Auditing Office Area 4

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ABSTRACT

This paper aims to provide an overview of the main findings and conclusions of the research conducted. The research aimed to investigate two main objectives. Firstly, it aimed to examine the factors related to organizational culture and the efficiency of the accounting information system in savings cooperatives within the Cooperative Auditing Office Area 4. Secondly, it aimed to explore the factors associated with corporate culture that influence the efficiency of the accounting information system in the same the Cooperative Auditing Office Area 4. The individual under examination held the occupation of an accountant inside a savings cooperative. The Cooperative Auditing Office Area 4 comprises a total of 550 participants. Conduct an examination of fundamental statistical data, encompassing percentages, means, and standard deviations. The topic under consideration is multiple regression analysis. The findings of the study indicated that accountants working in savings cooperatives within the Cooperative Auditing Office Area 4 held a favorable perception about the corporate culture and effectiveness of the comprehensive accounting information system. The study on the influence of corporate culture on the effectiveness of accounting information systems revealed the presence of four distinct cultural dimensions: group culture, development-oriented culture, rational culture, and sequential culture. The observed effect on the overall performance of accounting information systems was found to be statistically significant at a significance level of 0.05, confirming the alignment with the underlying assumptions. The usefulness of accounting information systems in relation to their relevance to decision-making can be influenced by both sequential corporate culture and group culture. The concept of reliability refers to the consistency and dependability of a measurement or research instrument. The variable of timeliness exhibited statistical significance at a significance level of 0.05, as did the variable of group culture. Culture places emphasis on the

process of growth and advancement. Culture places a significant emphasis on rationality. Culture places emphasis on the process of sequencing relying on certain assumptions.

Keywords: Savings Cooperative In Cooperative Auditing Office Area 4, Impact, Corporate Culture, Efficiency of Accounting Information System

1. Introduction

In the present era, it is important to acquire knowledge pertaining to technology as firms must enhance their capacities to effectively adapt to the dynamic changes that transpire. It is imperative that all members within the organization exhibit a high level of enthusiasm in their pursuit of identifying and implementing strategies aimed at enhancing their respective work processes. The behavior patterns exhibited by individuals within an organization are seen as behavioral rules that are derived from underlying ideas. According to Chanidaporn Bunnag (2020), values have a significant role in shaping company culture. The organization has a flexible group culture that prioritizes the cultivation of positive interpersonal interactions. Engaging with development-oriented cultural groups and actively participating in membership can facilitate the ability to adjust to the external environment. An essential cultural aspect for the management of savings cooperatives is the establishment of a logical culture that places emphasis on organizational goals, task accomplishment, efficient coordination, effectiveness, and adherence to regulatory compliance. In the context of the Cooperative Auditing Office Area 4.

A savings cooperative can be defined as a type of financial institution that is comprised of individuals who possess a common employment or reside within a shared locality. The primary aim is to promote members' awareness of the importance of saving and borrowing funds when deemed necessary, with the intention of generating financial advantages. This initiative is duly registered under the Cooperatives Act B.E. 2542. One crucial determinant is the presence of adequate capital and its effective utilization in conjunction with sound managerial practices. However, because to the predominantly small and localized nature of savings cooperatives, certain regions may have a scarcity of personnel, resulting in a lack of well-defined division of tasks and responsibilities among employees. Government agencies also have a role in facilitating the establishment of savings cooperatives, with the aim of promoting membership growth. To ensure effective cooperative management, it is imperative to establish suitable operational control and accounting systems that facilitate the management of savings cooperatives in compliance with the Cooperatives Act B.E. 2542 (1999).

The utilization of accounting information is crucial for effective management within a company, as it enables the acquisition of comprehensive insights into operational activities over a period of time. Ensure that the performance aligns with the established goals and policies. In the event that the predetermined objective is not achieved, prompt remedial measures will be implemented. The significance of accounting data lies in its role as a primary subsystem that is closely intertwined with the internal environment of the business. Similar to other information systems, accounting information is mostly composed of external data. Consequently, it can be said that accounting information has the most intimate connection with management. Systematic information management is also present in vocational education institutes. Accounting information systems refer to purposefully built systems that facilitate the conversion and processing of financial information, transforming it into a format that is conducive to informed decision-making for users. Invaluable in the process of making informed decisions. This enables accurate prediction of future events. Consequently, the efficiency of decision-making is enhanced. To what extent can accounting information be deemed valuable? The provision of information by accountants plays a crucial role in facilitating the user's critical thinking process. The effectiveness of this information is contingent upon the accountants' comprehensive knowledge and study of accounting information systems, which aids in the effective communication of information. Furthermore, a prevailing practice in the utilization of accounting information involves the integration of technology for the purpose of disseminating information. Accounting professionals, in their roles as corporate accountants, consultants, or auditors, are advised to consistently engage in the research and monitoring of advancements in accounting information technology. Jaruwan Wongsunthon (2019).

Based on the aforementioned considerations. Hence, the researcher expresses a keen interest in undertaking a study on accounting information systems pertaining to the management of savings cooperatives. The primary aim of this research is to examine the influence of organizational culture elements on the effectiveness of accounting information systems. The efficiency of the accounting information system, which gathers data from the management and accountants of savings cooperatives in the Cooperative Auditing Office Area 4, is influenced by many corporate culture elements. The primary objective is to optimize operational efficiency and enhance cooperative benefits.

2. Research Objective

2.1 To examine the various elements that influence corporate culture and the efficiency of the savings cooperative accounting information system within the Cooperative Auditing Office 4.

2.2 To examine investigates the impact of organizational culture determinants on the efficiency of the accounting information system in the Cooperative Auditing Office Area 4.

3. Literature Review

According to Charoen wongworakul (2018), This research examines the influence of corporate culture within the accounting sector on the overall quality of accounting performance exhibited by financial clerks. The study examines the Department of Army Finance through a sample of financial clerks. According to a study conducted by the Department of Army Finance, data was collected through the utilization of questionnaires to examine the organizational culture within the field of accounting. The findings revealed that this culture included key attributes such as honesty, delegating, generosity, and a strong sense of organizational belonging. The quality of accounting procedures is positively influenced by it. Attaining the Accomplishment of the Strategic Finance Clerk's Accomplishments This paper examines the role of organizational culture in the field of accounting, with a specific focus on its impact on decision making processes. Experiencing a sense of belonging within the

business. The quality of accounting practice is positively influenced by it. The Department of Army Finance's Finance Clerk responsible for the provision of financial resources. The topic of interest is to the examination of corporate culture within the realm of accounting, with a specific focus on the aspects of quality and decisionmaking. The influence of this phenomenon on the standard of accounting methods is beneficial. The Finance Clerk at the Department of Finance utilizes the principles of accounting, including honesty and integrity, in their operational procedures. The topic of interest is the concept of quality in the context of decision making. The influence of this phenomenon on the overall standard of accounting methods is deemed to be beneficial. The accounting culture is indicative of an organization that exhibits stability. This phenomenon leads to the ability of accounting practitioners to align their work patterns with the desired quality of life. The study conducted by Wang et al. (2006) examined the correlation between knowledge of information technology and the process of learning. The correlation between diversity and the fundamental management of capital will continue to be a crucial aspect for enterprises. Organizational learning fosters effective interactions that can serve as a catalyst for the successful implementation of projects, hence influencing the outcomes experienced by users. In the initiation of the procedure in this investigation. The monitoring of the process by management is essential, regardless of whether users play a major role in its success directly, contribute to learning, or act as mediators. Therefore, it is imperative for users to take into account environmental conditions in order to facilitate the process of learning. However, it may not be necessary to prioritize all areas of comprehensiveness in organizational projects. The study revealed that the efficacy of information systems is influenced by key elements like management support, operational efficiency, efficient communication, user happiness, and good organizational outcomes.



Research hypotheses

- H₁: Organizations with a group culture of management are related on the efficiency of accounting information systems.
- H₂: An organization with a development culture of Management is related to the efficiency of accounting information systems.
- H₃ : Organization with Rational Culture of Management Relationship to performance Picture of Accounting Information System
- H_4 : An organization with a sequential-oriented culture (Hierarchical Culture) of Management is related to the efficiency of accounting information systems.
- H₅: The holistic environment is related to the efficiency of information systems accounting
- H_6 : The organizational environment affects the relationship between corporate culture and

Efficiency of Accounting Information System

- H₇: Savings cooperatives with registered capital, operating period and number of employees are different. Corporate culture is no different.
- H_8 : Savings cooperatives with registered capital, operating period and number of employees are different, opinions on the effectiveness of accounting information systems do not differ.
- H₉ :Savings cooperatives with registered capital, operating period and number of mployees are different. Enterprise environments are no different.

4. Research Methodology

4.1 Research Design

This study aims to investigate the influence of coorporate culture on the effectiveness of savings cooperative accounting information systems within the Cooperative Auditing Office Area 4.

4.2 Population and Sample

The population of interest comprises accountants employed by 55 savings cooperatives affiliated with the Cooperative Auditing Office Area4. Every location is comprised of a group of ten individuals. The roles of the Finance Supervisor, Chief Accountant, and Chief Parcel Officer are crucial positions within an organization's financial and operational structure. These individuals play a pivotal role in overseeing financial activities, managing accounting functions, and ensuring the efficient handling of parcels. The subject of interest pertains to savings cooperatives within the jurisdiction of Cooperative Auditing Office Area 4, in the year 2022. The sample size for this study was obtained using the Taro Yamane (1973) method, employing a 95% confidence level and the Simple Random Sampling technique.

4.3 Research Instrument

The research employed questionnaires as the primary instruments, which were designed in alignment with the defined objectives and conceptual frameworks. The methodology employed in this study involved the utilization of a closed-ended questionnaire, which was structured into three distinct sections.

Part 1: Survey on Personal Status Factors Including Gender, Age, and Education Level The average wages derived from work experience. The present occupation

Part 2: Questionnaire on the Cultural Aspects of Savings Cooperative Organizations in the Cooperative Auditing Office Area 4

Part 3: Questionnaire Assessing the Efficacy of the Savings Cooperative Accounting Information System within the Cooperative Auditing Office Area 4.

Tools used to collect data We performed the following steps:

1. The objective of this study is to conduct a comprehensive examination of the corporate culture of accountants and evaluate the effectiveness of the savings cooperative accounting information system in the Cooperative Auditing Office Area 4. To do this, relevant literature from textbooks, papers, and research pertaining to these topics will be reviewed and analyzed. Additionally, data will be collected to develop a structured questionnaire framework.

2. Develop a survey instrument aimed at comprehensively assessing the organizational culture within the accounting profession and the effectiveness of the accounting information system employed by savings cooperatives within the Cooperative Auditing Office Area 4

3. The questionnaire should be submitted to the audit adviser in order to obtain ideas for improvement.

4. The amended questionnaire should be presented to three experts who possess expertise in the corporate culture of accountants and the effectiveness of accounting information systems inside savings cooperatives in the Cooperative Auditing Office Area 4. The desired level of accuracy for the IOC query is 0.60 or above.

5. The updated questionnaire was administered to a sample of 30 accountants in order to assess its reliability using Kronbach's Alpha Coefficient.

6. Examined and tried equipment are used to acquire data on samples for further research, data analysis. Perform data analysis utilizing computer software tools to analyze statistical information.

4.4 Data Collection

The researcher issued a courteous letter to the samples. To collect information, Collect questionnaires, analyze the received data and process it further. Analysis of data from questionnaire responses Once the data collection process has been completed. To organize the data, validate the integrity of each query. Computer processing utilizing statistical packages.

4.5 Data Analysis

Statistics used in research/data analysis

This data analysis is based on basic statistics such as average, percentage, mean and standard deviation and multiple regression analysis.

We utilized symbols and abbreviations to display the data analysis as follows:

GC =	Group Culture	DC =Development Culture
RC =	Rational Culture	HC = Hierarchical Culture

ACI = overall accounting information system efficiency RAC= relation to decision making

AAC = Aspects of accuracy and reliability TAC= represents timeliness.

VAC = Verifiable side b = Regression coefficients of the predictors as raw scores.

S.E.b = Standard tolerance of b S.E. est = Standard error in forecasting the dependent variable

with independent variables

 β = Regression coefficients of the predictors in the form of standard scores. * = Statistical significance level at 0.05 level

5. Research Findings

1. Personal aspects of the accountant of the savings cooperative In the Cooperative Auditing Office Area 4, the majority of accountants of savings cooperatives in Cooperative Auditing Office Area 4 are women (69.69%). 09) Bachelor's degree (80.00%) Age between 21-30 years old (43.64%) Work experience in accounting or related to accounting Less than 5 years (38.18%) Average monthly income between 10,0001-20,000 baht (49.09%) Accountants of savings cooperatives In the Cooperative Auditing Office Area 4, the number of employees is less than 30 people (50.91%), followed by 30-40 people (25.45%), the registered capital is less than 5 million baht (56.36%), followed by 5-10 million baht (30.91%), the operating period is between 3-6 years (72.73%), followed by 7-9 years (21.82%), and the dividend per share is between 5-7 baht per share (67.27%), followed by 2-4 baht per share (14.55%).

2. Organizational culture and efficiency of accounting information system of savings cooperatives In the Cooperative Auditing Office Area 4, it was found that the overall organizational culture was very high $(\bar{x}=4.03)$ when considered on a case-by-side basis, at a very high level in \bar{x} all aspects, in descending order of average in descending order as follows: cultural oriented sequencing ($\bar{x}=4.10$), group culture ($\bar{x}=4.07$), and cultural aspect focusing on rationality ($\bar{x}=4.03$), and the efficiency of the overall accounting information system was at a high level ($\bar{x}=3.76$). Here's how it pertains to decision-making. ($\bar{x}=3.89$) Timeliness ($\bar{x}=3.74$) Reliability ($\bar{x}=3.66$)

3. Corporate culture impact can forecast the effectiveness of the accounting information system of savings cooperatives. In the Cooperative Auditing Office Area 4, there was a statistical significance of 0.05, with the three factors collectively predicting the efficiency of the accounting information system by 53. 10%, with a standard deviation of 0.40245 as shown in Table 1. The multiple regression equation can be stated in the form of raw scores as follows: ACI = (0.732) + 0.252 (GC) + 0.233 (DC) + 0.163 (RC) + 0.196 (HC) and the multiple regression equation in the form of a normalized score. ZACI = 0.205 (GC) + 0.257 (DC) + 0.275 (RC) + 0.215 (HC)

Predictive variables	b	SE b	Beta	t	Sig			
1. Group Culture	0.252	0.055	0.205	3.679	0.000*			
2. Development Culture	0.233	0.049	0.257	3.074	0.005*			
3. Rational Culture	0.163	0.047	0.275	2.339	0.001*			
4. Hierarchical Culture	0.196	0.049	0.215	3.032	0.004*			
a = 0.732 S.E. _{est} = 0.40245 * Statistical significance level at 0.05								

Table 1 The impact of company culture on the efficacy of accounting information systems.

4. Organizational Culture Impact The effectiveness of the Accounting Information System of Savings Cooperatives in the Cooperative Auditing Office Area 4 in terms of decision making relevance was statistically significant at the level of 0.05, whereby the three variables together predicted the effectiveness of the Accounting Information System in relation to decision making by 45.70%, with a standard error of 0.4 6 365 as shown in Table 2, which can write the multiple regression equation in raw score form: ACI = (0.745) + 0.315 (GC) + 0.311 (DC) + 0.307 (RC) + 0.195 (HC) and the multiple regression equation in the form of a normalized score. ZACI = 0.249 (GC) + 0.153 (DC) + 0.274 (RC) + 0.174 (HC).

 Table 2 Impact of corporate culture on the effectiveness of accounting information systems in relation to decision making.

Predictive variables	b	SE b	Beta	t	Sig			
1. Group Culture	0.315	0.084	0.249	3.740	0.000*			
2. Development Culture	0.311	0.098	0.153	3.575	0.000*			
3. Rational Culture	0.307	0.074	0.274	3.403	0.000*			
4. Hierarchical Culture	0.195	0.094	0.174	1.803	0.045*			
a = 0.745 S.E. _{est} = 0.46365 * Statistical significance level at 0.05								

5. Organizational Culture Impact The efficiency of the Accounting Information System of Savings Cooperatives in the Cooperative Audit Office Area 4 in terms of reliability can be predicted statistically significantly at the level of 0.05, whereby the three variables together predict the efficiency of the Accounting Information System in reliability by 47.40%, with a standard error of 0.4 6 259 as shown in Table 2, which can write the multiple regression equation in raw score format: ACI = (0.698) + 0.357 (GC) + 0.174 (DC) + 0.207(RC) + 0.129 (HC) and the multiple regression equation in the form of a normalized score. ZACI = 0.274 (GC) + 0.173 (DC) + 0.177 (RC) + 0.112(HC)

Predictive variables	b	SE b	Beta	t	Sig			
1. Group Culture	0.357	0.087	0.274	3.706	0.000*			
2. Development Culture	0.174	0.064	0.173	2.149	0.031*			
3. Rational Culture	0.207	0.064	0.177	2.146	0.021*			
4. Hierarchical Culture	0.129	0.045	0.112	1.920	0.039*			
a = 0.698 S.E. _{est} = 0.46259 * Statistical significance level at 0.05								

Table 3 Impact of corporate culture on the performance of accounting information systems in terms of reliability.

6. Organizational Culture Impact The efficiency of the accounting information system of savings cooperatives in the 4 district of the Cooperative Audit Office in terms of timeliness was statistically significant at the level of 0.05, with the three variables together predicting the efficiency of the accounting information system in terms of timeliness by 51.40%. ACI = (0.0.685) + 0.361 (GC) + 0.324 (DC) + 0.228 (RC) + 0.227 (HC) and multiple regression equation in normalized score form. ZACI = 0.312 (GC) + 0.262 (DC) + 0.172 (RC) + 0.184(HC)

Predictive variables	b	SE b	Beta	t	Sig			
1. Group Culture	0.361	0.071	0.312	4.415	0.000*			
2. Development Culture	0.324	0.074	0.262	3.638	0.000*			
3. Rational Culture	0.228	0.078	0.172	2.286	0.010*			
4. Hierarchical Culture	0.227	0.080	0.184	2.247	0.015*			
a = 0.685 S.E. _{est} = 0.42379 * Statistical significance level at 0.05								

Table 4 Impact of organizational culture on accounting information system performance in terms of timeliness.

6. Discussion

Impact of Corporate Culture on the Efficiency of Savings Cooperative Accounting Information System in Cooperative Auditing Office Area 4" The research has used the findings from the research to discuss the hypothesis. Related topics and research the results of the study showed that the organizational culture on the efficiency of the savings cooperative accounting information system in the Cooperative Auditing Office Area 4 was statistically significant at the level of 0.05, which is in line with the set assumptions and in line with the research of Thirawan Wiwattanakornwong (2015). The results demonstrated that organizational culture had a statistically significant impact on financial institution data quality at a threshold of 0.05, suggesting that the firm has a structured organizational culture model. Methodology is a standard practice guideline to increase the overall efficiency of financial statements obtained from accounting information systems.

Organizational culture had a statistically significant impact on the effectiveness of the accounting information system regarding decision-making of savings cooperatives in the Cooperative Auditing Office Area 4 area at a level of 0.05, which was in line with the hypothesis set and in line with the research of Kanchana Kesorn (2012). The results demonstrated that the association between a school's organizational culture and school success was statistically significant in decision-making. The organizational culture influences the behavior of teachers and staff in the organization, reflecting actions that affect organizational development, which allows personnel to express themselves best under the supervision of competent management.

Organizational culture had a statistically significant impact on the efficiency of the reliability accounting information system of savings cooperatives in the Cooperative Auditing Office Area 4 area at a level of 0.05, which was in line with the established assumptions and in line with Vincent Cho (2007), who studied the impact of organizational learning on information system efficiency. Teamwork to boost work efficiency Delegation of authority Building excellent relations inside the organization and having a policy to operate in order to have a uniform pattern within the organization. By depending on the efficiency of accounting information systems for decision-making. Reliability An company with a competent accounting information system will provide important information for predictions and can check the correctness of past predictions to be accurate, reliable and error-free.

The organizational culture has a statistically significant impact on the efficiency of the accounting information system on timeliness of savings cooperatives in the Cooperative Auditing Office Area 4 area at the

level of 0.05, which is in line with the established assumptions and is in line with the research of Xu Hongijiang (2000), who studied the development and testing of models that reflect factors influencing the quality of accounting information. It was determined that elements affecting the quality of accounting information systems include business policies and standards. This is in line with the research of Chang et al., (2003), who evaluated work satisfaction with changes in accounting information systems by examining the scope of data, timeliness, and characteristics of accounting information systems as a measure of data efficiency. A broad spectrum of knowledge results in great user satisfaction.

7. Suggestion

Building an organization to be a corporate culture will boost the efficiency of accounting information systems. Rational Culture can only make accounting information systems more trustworthy in one aspect, thus it should be found to develop and make accounting information systems in other areas higher as well. Research recommendations should explore the impact of characteristics of accounting people on the efficiency of the accounting information system of the office.

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A Development of a Strategic Handbook for Self-practice of Business English for University Students Majoring Finance. A Case Study of Hunan University of Foreign Economics.

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ABSTRACT

The objectives of this research were: 1) to investigate problems of business English of students majoring in finance, 2) to investigate needs of a strategic handbook for self-practice of business English for university students majoring finance, and 3) to construct a strategic handbook for self-practice of business English for university students majoring finance. Hunan University of Foreign Economics was used as a case study in this study. The population were 10.000 students. For the investigation of the needs and the problems, the sample groups were 485 students which were obtained through simple random sampling method. For the construction of a strategic handbook for self-practice of business English for university students majoring finance, three specialists were used as a sample group for focus group discussion meetings to gather ideas and comments for the correctness and suitability of the handbook. For the investigation of the needs and the problems, questionnaire was used as a tool 5-point Likert rating scales to measure the level of the needs and the problems. For its validity, the IOC (Index of Congruence) was used and possessed the value ranging from 0.66 to 1.00 ; similarly, the Cronbach's Alpha Coefficient was used for the evaluation of the reliability of the questionnaire and possessed the value of 0.82. The information and data collected were analyzed through the content analysis and presented in terms of percentage, mean value, and standard deviation. The findings indicated that: 1) problems of business

English of students majoring in finance and the needs of a strategic handbook for self-practice of business English for university students majoring finance were both rated in the "Highest" level. 2) The constructed strategic handbook for self-practice of business English for university students majoring finance comprises of nine parts; namely, 1) Understanding the technical terminology of business English in the financial field; 2) Master the reading and translation of business English in the financial field; 3) Master phrases and expressions of business English in the financial field; 4) Remember the English abbreviations of business English in the financial field; 5) Understanding financial documents and contracts in business English in the financial field; 6) Understanding financial data and statistics in business English in the financial field; 7) Correct use of the written language of business English in the financial field; 8) Confidently discuss topics related to the financial field in business English; 9) Strengthening background knowledge of business English in the financial field . All of the nine parts were evaluated by the 3 specialists and possessed the IOC values from 0.66 to 1.0 meaning the constructed strategic handbook for self-practice of business English for university students majoring finance at Hunan University of Foreign Economics to enhance their business English skills and knowledge.

Keywords: strategic handbook, self-practice, business English

1. Background

Business English, as an important course, is of vital importance to finance students. According to a 2021 Financial Times survey, more than 90% of financial industry practitioners consider business English to be one of the key factors for their career success. Among them, Michael Collins (2021), a senior financial expert from JPMorgan Chase, believes that the importance of business English lies in helping financial practitioners better communicate with customers, colleagues and partners in the international market. Meanwhile, Financial Times columnist John Mullins (2021) also highlights the critical role of business English in cross-border financial transactions. It can be seen that learning business English well is of great significance for finance students. However, at present, many finance college students in China, especially those majoring in finance below the second university, have some obvious errors in the learning and application of business English. These common mistakes are: 1) relying too much on machine translation tools, ignoring the influence of context and cultural factors, resulting in inaccurate translations. For example, they might use "Great Britain" instead of "Britain", but this is actually an outdated and inaccurate vocabulary. 2) Grammatical and spelling mistakes are often made in written expression, which affects the professional image. For example, they may mistakenly use "effect" instead of "affect," causing the meaning of the sentence to be skewed. 3) Too formal or rigid language is often used in business communication, and there is a lack of flexibility in business communication. For example, they might use "enclosed please find" instead of "here is," making the email seem too blunt. 4) Because the professional terminology of the financial industry is not carefully understood, it is used improperly in business communication. For example, they may confuse "asset" with "liability," leading to misunderstanding and misjudgment.

2. Objectives

1) to investigate problems of business English of students majoring in finance,

2) to investigate needs of a strategic handbook for self-practice of business English for university students majoring finance, and

3) to construct a strategic handbook for self-practice of business English for university students majoring finance

3. Review of Literature

3.1 Concepts/Theories/Related Research

In summary, self-practice is an important and effective learning method. It can help learners better control the learning process and outcomes, cultivate learners' independent thinking and problem-solving skills, and also improve self-management and self-learning ability. Whether in a working, academic, or personal area of interest, self-practice is an important way to learn that deserves serious consideration and practice by learners. Business English for finance refers to the combined application of business English language skills and expertise used in the professional field of finance. As a professional field of business English, business English for finance combines financial knowledge and business English skills to help financial practitioners better communicate, communicate and cooperate. In this subdivision, many experts have done in-depth research and put forward their own views. For example, John Jenkins (2005), author of Business English for Finance Professionals, argues that Business English for Finance professionals is an essential language skill for financial practitioners to better understand and express financial concepts and ideas. Anna Johnson (2010), as a senior economist at a financial consulting firm, believes that business English for financial professionals is essential for the globalization of financial institutions and multinational companies, helping enterprises expand into international markets and improve the efficiency of financial transactions. Peter Walton (2012), a senior analyst in financial institutions, pointed out that business English for financial professionals can facilitate the smooth conduct of cross-border transactions, effectively reduce misunderstandings and risks, and improve the efficiency of cooperation. Lily Zhang (2015), a financial expert, believes that business English for financial professionals is essential for financial translation work, helping translators accurately understand and communicate financial terminology and ensure the accuracy and consistency of information. David Washington (2018), a financial legal counsel, emphasized that business English for finance professionals is essential for the handling of financial legal affairs, helping lawyers and legal personnel accurately understand and interpret contracts, regulations and legal documents.

3.2 Conceptual Framework



Figure 1 Conceptual Framework

4. Research methodology

4.1 Population/Sample groups

Hunan University of Foreign Economics was used as a case study in this study. The population were 10.000 students.

For the investigation of the needs and the problems, the sample groups were 485 students (Yamane, 1973) which were obtained through simple random sampling method. For the construction of a strategic handbook for self-practice of business English for university students majoring finance, three specialists were used as a sample group for focus group discussion meetings to gather ideas and comments for the correctness and suitability of the handbook.

4.2 Research Instruments

For the investigation of the needs and the problems, questionnaire was used as a tool 5-point Likert rating scales to measure the level of the needs and the problems. For its validity, the IOC (Index of Congruence) was used and possessed the value ranging from 0.66 to 1.00; similarly, the Cronbach's Alpha Coefficient was used for the evaluation of the reliability of the questionnaire and possessed the value of 0.82. For the focus group discussion meetings, a set of questions were used as research instrument.

The information and data collected were analyzed through the content analysis and presented in terms of percentage, mean value, and standard deviation.

4.3 Data Collection

For the investigation of the needs and the problems, the researcher herself collected data and information from the sample groups online via emailing. For the focus group discussion meetings, the online conference were used.

4.4 Data Analysis

The information and data collected were analyzed through the content analysis and presented in terms of percentage, mean value, and standard deviation.

5. Research Results

5.1 problems of business English of students majoring in finance,

Table 1: problems of business English of students majoring in finance,

items	n=485		Level of problems
	$\overline{\mathbf{X}}$	S.D.	
1) You find it difficult to understand the			
professional terminology in the field of finance	4.69	0.20	Highest
when self-learning business English.			
2) You have difficulty in translating and			
understanding financial business English.	4.55	0.51	Highest
3) You find it difficult to master common phrases			
and expressions in business English.	4.56	0.33	Highest
4) You have difficulty remembering English			
abbreviations used in the financial industry.	4.64	0.57	Highest
5) You find it difficult to correctly use financial-			
related vocabulary in business English.	4.56	0.47	Highest
6) Your ability to understand articles related to			
finance in business English is weak.	4.58	0.28	Highest
7) You find it difficult to confidently discuss			
finance-related topics in business English.	4.65	0.21	Highest
8) You find it difficult to understand financial data			
and statistical information in business English.	4.55	0.21	Highest
9) You feel that your understanding of the			
background knowledge in the field of finance is	4.58	0.48	Highest
insufficient when learning business English.			
10) You find it difficult to understand financial			
documents and contracts in business English.	4.66	0.51	Highest
Total	4.61	0.36	Highest

According to table 1, it is indicated that the students rated the problems of self-practicing business English at the highest level. Firstly, most students indicate that the professional terminology in the field of finance (Q1) has the highest impact on self-practicing business English with \overline{X} =4.69. Secondly, most of students indicate that it difficult to read and understand materials related to finance (Q18), It has the highest impact on files with \overline{X} =4.68. Finally, just a few of students indicate that it difficulty in translating and understanding financial business English (Q2), It has the highest impact on online learning with \overline{X} =4.55.

5.2 Needs of a strategic handbook for self-practice of business English for university students majoring finance

items	n=485		Level of needs
-	x	S.D.	
1) A self-practice guide in business English is			
essential for finance students.	4.69	0.41	Highest
2)A self-practice guide in business English can			
help finance students improve their career	4.55	0.38	Highest
competitiveness.			
3) A self-practice guide in business English			
includes content related to finance and can	4.56	0.20	Highest
enhance professional knowledge.			
4) A self-practice guide in business English can			
provide practical business English expressions	4.64	0.37	Highest
and communication skills.			
5) A self-practice guide in business English can			
help finance students better understand the	4.56	0.50	Highest
international business environment.			
6) A self-practice guide in business English can			
enhance the business writing ability of finance	4.58	0.41	Highest
students.			
7) A self-practice guide in business English can			
help finance students better cope with business	4.65	0.52	Highest
speeches and meetings.			
8) A self-practice guide in business English can			
help finance students engage in cross-cultural	4.55	0.44	Highest
communication.			
9) A self-practice guide in business English can			
provide finance students with the necessary	4.58	0.42	Highest
business English vocabulary and phrases.			
10) A self-practice guide in business English can			
help finance students smoothly complete the	4.66	0.20	Highest
internship and job search process.			
Total	4.61	0.36	Highest

Table 2: needs of self-practice handbook in business English for students

According to table 2, it is indicated that the students rated the needs of self-practice handbook in business English at the highest level. Firstly, most students indicate that a self-practice guide in business English is essential for finance students(Q1) and a self-practice guide in business English has the highest impact on providing practical business English expressions and communication skills (Q4) with \overline{X} =4.64. Secondly, most of students indicate that a self-practice guide normally helps students smoothly complete the internship and job search process (Q10) has the highest impact on online learning with \overline{X} =4.66. Finally,just few students indicate that a self-practice guide in business English has the highest impact on helping finance students engage in cross-cultural communication (Q8) with \overline{X} =4.55.

5.3 strategic handbook for self-practice of business English for university students majoring finance

The constructed strategic handbook for self- practice of business English for university students majoring finance comprises of nine parts; namely, 1) Understanding the technical terminology of business English in the financial field; 2) Master the reading and translation of business English in the financial field; 3) Master phrases and expressions of business English in the financial field; 4) Remember the English abbreviations of business English in the financial field; 5) Understanding financial documents and contracts in business English in the financial field; 6) Understanding financial data and statistics in business English in the financial field; 7) Correct use of the written language of business English in the financial field; 8) Confidently discuss topics related to the financial field in business English; 9) Strengthening background knowledge of business English in the financial field . All of the nine parts were evaluated by the 3 specialists and possessed the IOC values from 0.66 to 1.0

6. Discussion of the Research Results

6. 1) Problems of business English of students majoring in finance, and needs of a strategic handbook for self-practice of business English for university students majoring finance

The problems faced by finance college students in self-practice of business English and the needs of self-practice handbooks are at the "highest level". This study is the same as that of Reid, G. (2019) in the Financial English Vocabulary Handbook. Business English is very important for finance students, but in the process of self-learning business English, finance students face some difficulties, such as not understanding the terminology, phrases and expressions of business English, and lack of background knowledge of business English in the financial field. In addition, difficulties may be encountered in practical application, such as not being able to read and translate articles related to business English in the financial field efficiently, not being able to read financial documents and contracts in business English in the financial field, not being able to use the written language correctly, and not being able to confidently talk about topics related to the financial field in business English. Therefore, in the process of self-learning business English, we should not only pay attention to the learning of knowledge theory, but also pay attention to the application of knowledge theory to practice. Here are two specific practical learning suggestions: 1) Focus on the study of technical terms. Professional terminology is the key to

understanding business English in the financial field, and it is recommended that students pay attention to learning the most common professional terms in business English in the financial field during self-practice (Ojala, M., & Kastare, L., 2019). Improve practical application skills such as listening, speaking, reading and writing in business through a large number of real conversations, conversations and document reading (Wang Sheng, 2017).

6.2 The strategic handbook for self-practice of business English for university students majoring finance

The contents of the self-practice guide handbook for finance students majoring in finance at Hunan University of Foreign Economics is mainly collected based on questionnaire surveys. The actual problem is determined. The content of the handbook is divided into nine parts, each of which focuses on solving a practical difficulty encountered by current finance college students when learning business English on their own. These difficulties include difficulties at the level of knowledge theory and practical application. Therefore, the methods given in the handbook to help finance college students learn business English on their own include both theoretical methods at the intellectual level and methods at the practical application level. From the perspective of reference scope, these methods refer to both the views of domestic experts in China and the views of international experts. In terms of the degree of problem solving, these methods range from quick solutions to difficult problems and indepth analysis of the root causes. Therefore, when using this handbook to learn business English on their own, finance college students should pay attention to the following three aspects: 1) Pay attention to the combination of theory and practice. When learning business English, the study of theoretical knowledge is necessary, but the learning of theoretical knowledge must be combined with practice. When studying business English on their own, finance students should focus on combining the theoretical knowledge they have learned with practical application in order to better understand and master business English (Nunan, D., 1999) Focus on both domestic and international attention. Business English is an international language, so finance college students should pay attention not only to domestic business English but also to international business English when learning business English on their own. This allows for a better understanding of the business culture and business practices of each country and region, as well as the business vocabulary and terminology of each country and region (Mackintosh, I., 2018). Focus on quickly solving difficult problems and in-depth analysis of root causes. When learning business English on their own, finance students need to focus on solving tough problems and analyzing the root causes in depth. Business English is a broad field with many difficult problems that need to be solved quickly and in a timely manner. Of course, to fundamentally solve these problems, we need to conduct in-depth analysis, broaden the dimension of knowledge, deepen the level of knowledge, and solve the problem essentially (Meehan, C., Basha, N., & Ye, H. ,2018)

7. Recommendations for Further Study

The evaluation of the effectiveness of the strategic handbook for self-practice of business English for university students majoring finance needs to be conducted
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Krabi Goes Green: Assembling Environmental Social Movements and Designing Krabi Province toward Sustainable City

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ABSTRACT

This article applied assemblage thinking to investigate the formation of Krabi people movement. The movement termed "Krabi Goes Green Assemblage" exemplifies the social collection actions that implement in directing development orientation. This article argues that the foundations of the formation of Krabi Goes Green movement, partly, resulted from the contradiction between the local and central development strategies, the evident impacts of state development projects, the failures of mainstream mass tourism management, the emergence of tourism and their tourist characteristics, and the omission of the seriously public participation. The Krabi coal-based power plant and coal deep seaport projects are considered here as a pivotal trigger leading to the exposure of underlying social entities, both as the label of social movements and civil societies.

Keywords: Krabi Goes Green, Assemblage, Social movement, Krabi Province

1. Introduction

Designing sustainable city is challenging for city development practitioners and planners. The rapid urbanization often causes pollution, resources and energy consumption, waste dumps, and junk yards. Since 1990s, although the scholars have studied the applicable ways to make cities sustainable and suggested various general principles for sustainable cities (Saaty & De Paota, 2017), the achievement of sustainability in all dimensions are elusive. The term "sustainable city," according to the specific definition, may limit the potential for further enhancing the various ways of sustainability. Thus, "using the term 'transition toward the sustainable city' may be more accurate and more effective" (Hassan & Lee, 2014). Furthermore, according to Hassan and Lee (2014, pp. 14), "the generalization of specific design or planning for the sustainable city is considered an irrational belief due to the variation in economic, geographic, and demographic prospects between one location and another." In other words, the achievement in a specific context does not mean it will have the same positive effects in the new context because when the components are assembled in the new context, "the components themselves will be contoured by numerous-dependent factors" (Savage, 2020).

To understand the transition toward sustainable city as the ongoing and in-processing works, this article applies the idea of assemblage thinking from the work of Tania Li (2007) that "has taken up on 'how' question

and deployed it to examine how heterogeneous elements are assembled" (p 286) to design the Krabi Province toward the sustainable city. In addition, Ben Anderson and Colin McFarlane (2011) propose that the term "assemblage" focus on emergence, multiplicity and indeterminacy, and connect to provisional socio-spatial formation. According to assemblage approach, the article will provide the understanding on Krabi Goes Green from its context by focusing on the historical process, the turning point that triggers the assembling of various social movements, the heterogeneous elements and their practices to design toward the sustainable city.

The article consists of four parts. The first part describes the historical processes and various elements and conditions that affected the formation and movement of Krabi Goes Green. The second section presents the convergence and emergence of Krabi Goes Green Movement. Thirdly, the article analyzes assembling various elements toward the sustainable city design and implementations. Finally, the article concludes with recommendations and appropriate support approaches for designing the green or sustainable cities.

2. Objective

To describe the historical processes and various elements and conditions that affected the formation and movement of Krabi Goes Green.

3. The Foundations and Formation

The resistance movements to coal-based projects in Krabi province have emerged as the particular conjuncture of Krabi people movements and environmental activists to encounter with the operations of the private consulting company staffs engaging in the preparation of the environmental impact assessment (EIA) and environmental and health impact assessment (EHIA) reports, the Electricity Generating Authority of Thailand (EGAT) staffs and Krabi people who supported to settle the coal-based power plant. The resistance movement that emerged in 2012 responded to the threats posed by the subtle operations of coal-based power plant project proposer and supporters, the concerns of various impact information obtained from the public medias, narratives of the victims, and the direct experience of the people who lived near the former Krabi coal-based power plants, as well as the people who faced with the irresponsible activities of the project owner.

In the beginning, a resistance movement arose from Pakasai sub-district, where many people have been suffered from the impacts of the first and only one coal-based power plant in the South of Thailand. It was a thermal power plant with a total capacity of 60 megawatts that started distributing electricity in 1964 and decommissioned in 1995 with a service of 31 years. In 1996, EGAT proposed and gained the Cabinet's approval to construct a new 340 megawatts thermal power plant, designed to use bunker oil and natural gas, in the former area. The Cabinet approved the EIA report in 1997. The construction was completed in 2003, and the official operation of the power supply started in 2004. However, due to the high cost of bunker oil and natural gas, in 2012, EGAT reintroduced the coal-based power plant with the import sub-bituminous coal. The 870-megawatt power plant is designed to settle in Krabi's Nua Klong district, together with a coal seaport to be constructed at Klong Ruo village. In 2014, mass people from many parts of Krabi province had strong opposition to the planned

projects. It was one of the large-scale projects in the south of Thailand having significant social and environmental problems. In particular, it would greatly generate pollution and damage to the ecotourism (green tourism) industries that are a common objective of local people.

The resistance movements that gradually emerged in 2013, partly, were the expression of people who encounter longstanding problems from all kinds of Krabi power plants. The villagers in Pakasai sub-district, who faced the persisting impacts from the first coal-based power plant, claimed that the original version of the coal-based power plant in the area had caused them with health-related problems, including respiratory disease and cancer, as well as the environmental impacts in the marine ecosystem.

The second phase, the 340 MW converted power plant generating unit combining gas and bunker oil, presented by Lam Hin community's fishers in Klong Ruo village that "the big boats they used to transport the bunker oil destroyed the fishing gears and marine ecosystem. In the past, according to the fisher representatives, the areas they used as ports and bunker oil transportation routes were fertile. Fishers from many villages, Krabi and neighboring provinces, used it as a common area for fishing. Since the bunker-oil handling activity took place, fishers could not take advantage of the fishing area as before because the main fishing gears were mobile that often collided with the boat or the boat's propeller. Project officers were hardly responsible for the damage this caused, even if the fishers who suffered the losses made a complaint to the authorities of the power plant station located not far from the community.

Moreover, the propeller affected seagrasses in the area, which were found abundant, and it stirred up highly foul-smelling sediments that disturb the habitat of many important economic aquatic lives. Each transfer resulted in them migrating for several days before coming back again. As a result, fishers lost fertile fishing grounds and had to go fishing further which increased costs and risk. Apart from the impacts on everyday life, the transfer activities remained severely affected the fishers in the monsoon season because they could not go fishing far from the shore. The fishing area in front of their community was essential for their livelihoods in difficult times. Thus, the bunker oil transportation activity aggravated the fishers' livelihoods.

At the provincial level, as the advisor of the Krabi Tourism Industry Council pointed, "The three major economic sectors which have supported local communities for generations in Krabi Province were agriculture (agro-industries), fisheries, and tourism. If the coal-based power plant were operated, it would destroy these economic activities severely. In fact, Krabi have many alternatives. He further suggested, "The former Krabi power plant used bunker oil and gas as its main thermal generator. Thus, coal should be replaced by biodiesel energy and biogas, such as palm oil and biogas from wastewater in agro-industry factories. It could be produced locally and help solve environmental problems." The choice to adopt coal to produce electric power by EGAT and central governments reflect the development planning that overlook the local capacity. Moreover, the 2010 and 2015 Power Development Plan (PDP), undertaken by the Ministry of Energy, has illustrated the contradiction between Thai government policy, and the current world orientation where most countries are trying to cut down coal-based energy use. As a matter of fact, the current government of Thailand has integrated a Declaration on

the Sustainable Development Goals (SDGs) with the 20 years National Strategy Framework and 12th National Economic and Social Development Plan (NESDP).

The convergence of multiple movements in anti-coal event that forms the Krabi Goes Green movement is important because it is the social-environmental event that mixed the grassroots movement with the new middle-class movement. Coal-based mega-projects are considered here as the trigger or the threshold that lead to the exposure of underlying elements. The organizations defined as social movements and groups of people identified as civil societies hold together to protest against the coal-based mega-projects. However, if one looks at this phenomenon through the media superficially, it is the social movements that applied contentious tactics, directed at the state government and its institution and expected the policy change as a goal. On the contrary, if one closely investigated, the numerous practices, tactics, strategies, and goals beyond the traditional perspective of social movements will be uncovered. This article also indicates that the movement of Krabi Goes Green does rather than the simply traditional resistance. Through the lens of assemblage thinking, I found that the Krabi Goes Green movement is negotiating between the diverse civil societies and social movements. The numerous strategies and tactics are applied to design the movements and cope with the counter-movements. The goals are not only the political change, but also target to the cultural change.

4. The Convergence and Emergence of Krabi Goes Green Movement

Since 2010, Krabi coal-based power plant project was planned following the 2010 PDP, undertaken by the EGAT to produce the electricity reserves for the southern region. For 2 years, EGAT assigned to the private consultative company to prepare the environmental impact assessment report in case of the coal seaport settled near Klong Ruo village and the environmental and health impact assessment in case of coal-based power plant settled at Klong Khanan sub-district, both were settled in Krabi province. Since the projects were announced, and EIA-EHIA report preparation processes were executed, the first group that initiated to resist was the villagers who have settled near the project location. The villagers hold together into the group called "Pakasai Defenders Group." However, the contest not much affected the project implementation due to the movement was tiny compared with the project category.

It is the non-government organization staff (Save Andaman Network Foundation) that initiated the significant protest movement of coal-based power plant with the people on Lanta Islands. The first meeting between the NGOs staff and the various groups of Lanta people took the concern of the coal-fired power plant affecting the tourism, marine ecosystem and small-scale fisher livelihoods into account, coupled with the consideration EIA-EHIA processes. They found that many steps of EIA-EHIA lacked the meaningful local participation. Therefore, Lanta people, who were directly affected in diverse dimensions, have to be counted as the "principal stakeholders." Following the meeting, Lanta people determined to participate in the EIA-EHIA processes.

In a public hearing forum for presenting the 2nd EIA report of coal seaport project at Klong Rua village, many people from Lanta Island called "Save Lanta Group," the informal group set in 2013, participated in the meeting intentionally. After they saw the inaccuracy of the forum resulting from the private consulting company representatives presented only the positive aspects of the project without mentioning the negative outcomes; the Save Lanta Group proposed to the organizers to stop that forum, and requested that they have to reprocess all of the EIA because the proposed report did not reflect the comprehensive issues, particularly Lanta people, who will be affected directly from transportation root of coal seaport project and indirectly from coal-based power plant project, did not participate in all procedures of EIA/EHIA preparation processes yet.

The public hearing forum was not only participated by the resistant groups, including Pakasai Defenders Group, Save Lanta Group, Krabi tourism sectors, small-scale fisher network, private entrepreneurs, civil society networks, and NGOs, but those who have lived around the former electricity station. However, these groups of people were invited by Krabi power plant staffs. The encounter between these groups had led to severe controversy, and resulted in the common assault of some resistant people by the supporters. Following the event, the forum was abolished, and preparation process of the 2nd EIA report became null and void due to the impropriation of the EIA processing period. Furthermore, the widely extended rumor of the inappropriate process has widely sparked public questions after the photos taken from the forum were communicated to the public sphere through diverse channels.

The public hearing forum's suspiciousness not only triggered the public's interest, but it also sparked the resistant idea of the Klong Rua villagers, who were the host to the event but never known about the forum's detail. As a fisher of Klong Rua village mentioned, "we (in the focus group that many villagers came to join) do not know what they are doing because the staff has never told us. Once we saw the preparation, we thought they were preparing for the trade festival and the elephant show (laughing). Moreover, we were so angry when we saw many people from outside the village disordered the forum. This forum triggers our interest because, for a long time, we have been affected by the transportation activity of bulker oil used for the fuel of the power plant. Therefore, after the representatives of Lanta explained about the project and process in detail and told us why they resisted, we have participated in the investigating the projects operation."

Klong Ruo villagers have never formally known about the proposed coal-based power plant and coal seaport projects, even if the coal seaport was situated in front of their community. Indeed, the Klong Rua villagers will be the extremely and directly affected victims. The situation that emerged from the 2nd EIA public hearing forum reflected the state's ignorance of public participation and the flaws of EIA-EHIA reports preparation in general. Since then, the bigger Krabi anti-coal-based power plant movement (henceforth Krabi anti-coal movement) emerged. As a result, after the strong and continuous opposition of the Krabi anti-coal movement, the representative of EGAT has canceled all procedures deriving from the former EIA-EHIA preparation, and promised to restart them. It is worth noting that the emergence of Save Lanta Group in the middle of 2013, which has held the heterogeneous elements together, was regarded as the principal turning point in the Krabi anti-coal movement.

The Save Lanta Group has emerged from the coalition of the local people and beyond. A rough analysis of parties of an assemblage includes the (1) agriculturists, (2) fishers, (3) tourism and traditional entrepreneurs, (4) the local activists, (5) the community-based ecotourism organizations, (6) the long-term and temporary living foreigners, who came from European and Scandinavian regions, and (7) the foreign tourists, who help to provide comments on the social media after they perceive about the Krabi coal-fired power plant. These various groups,

particularly the tourism sectors, have a wide connection both in the province and beyond. In particular, the comments of the foreigners who participated in the meeting between Save Lanta Group and the EGAT's representative were regarded as one of the crucial elements that changed the EGAT staff's decision. Furthermore, many questions inquired from the foreigners who have experience coal power plant in their countries made the EGAT staff and the scholars speechless.

Concerning the EIA-EHIA reports that were partially executed by the private consulting company, they were analyzed and critiqued by the academics, activists, and the local people about their considerable flaws. In 2015, the Office of Natural Resources and Environmental Policy and Planning addressed that the EHIA report of the coalbased power plant had to be improved in 17 issues and 143 sub-issues, covering the 15 pages of the commendations from the Expert Review Committees. The vital question is that if the resistant movements did not emerge, would the committee's several comments on these many flawed reports occur? Many flaws should not happen because, as usually assumed, the EIA-EHIA producers were the experts who have high qualities in the academic field.

Following the annulment of both EIA-EHIA, certain schemes had been adjusted. Begin with the EGAT changed the private consulting companies, from Air save co., Ltd to Team Consulting Engineering and Management Public Company Limited. In 2013, the provincial authorities and private sectors signed the Krabi Goes Green declaration that stresses all dimensions toward a sustainable city. As the Krabi Goes Green theme has not discussed the coal-based power plant, the EGAT continues to operate the projects.

5. Assembling Various Element toward the Sustainable City Design and Implementations

The renewed processes of EIA-EHIA reports were discreetly operated by the new private consulting company, under the strong support of the government and provincial authorities. All preparations of the EIA-EHIA public hearing forum were guarded by a mixed force of police, soldiers, and militias, as shown on the website of MGR online (2014). The supporting groups can easily pass through the public hearing room, contrasting the resistant groups; they were strictly inspected by the organized guards. This kind of state intervention was implemented until finishing the EIA-EHIA reports processes. For EGAT, the advent of the new private consultant was regarded as a savior, who turned the dire situation into new opportunities, although the methods used to achieve the goal of EIA-EHIA were critiqued notoriously. However, the EIA-EHIA processes were accomplished; the mistakes resulting from those processes made the coal-based power plant no progression so far.

Since 2015, the Krabi anti-coal movement separated the movement into two strategies, the campaigns and demonstrations in the regional and national level and the implementations in provincial level to investigate and oppose the operations of EGAT staffs, Consultant Company, and Krabi coal-based supporters. On the one hand, the anti-coal movement has raised its implementation at the regional level. "Save Andaman Network" was established in the middle of 2015 by the coalition of various parties in the Andaman region, from Satun to Phuket provinces, with the proposition to take the coal out of their region. In addition, after they recognized that the local problems result from the inconsistent policy between the central and local level, thus the attack was changed toward the central government. The strategies were the demonstrations and the communication with the public sphere simultaneously.

As a result, these groups of people came to join. The coalition of the Krabi anti-coal movement and the public supporting by the academics, activists, and mass media producers have forced the government to postpone the projects.

Although the projects were delayed, it did not mean that the projects were abolished. The government has used diverse tactics to push the projects. For example, in the late 2015 the government appointed the tripartite committee from the diverse sectors, covering the representatives from the state agencies, local leaders, academics, provincial professional, and NGOs, to examine the appropriation of the coal-based projects and the possibilities of the alternative resources to produce the power energy. However, with the study results of the tripartite committee tended to support the renewable energy resources, the chairman decided to turn over a board. Hence, they refused the study results that showed the renewable capacity of Krabi province and insisted that the coal power plant projects can be continued. In 2017, after the government had the solution to continue the coal-based power plant project, the Save Andaman Network went to demonstrate at the government house again. The result of the demonstration was that the government announced "set zero" the projects and has changed to use the mechanism of the "strategic impact assessment" to postpone the projects. So far, the strategic impact assessment was stills in the process.

The second strategy was the implementation at the provincial level. The implementation including the investigation of the EGAT's operation and supporters on the one hand, and create a plan covering the province's capacity on the other hand. As a result, the Krabi Goes Green declaration was formally announced in the middle of 2013. At the time, the declaration focused on the sustainability of the tourism sectors, including community-based tourism. The provincial government held with the various groups of Krabi people, called Krabi civil society, prepared the comprehensive strategies of all dimensions of Krabi province's development. Hence, the 2020 Krabi vision was formally declared in late 2014 and the producers created it to be a province's master plan under the watchword "the international quality tourist city, sustainable Industrial Agriculture, livable society, adaption responding to the changing context." In detail, the document (the 2020 Krabi vision) has firmly addressed the green concept that reflected the sustainable dimensions, including green tourism, green agro- industries, and sustainable natural resources management.

"Goes Green" was defined as the ongoing processes toward sustainability in all dimensions, which were explained in sustainable development goals (SDGs), and it was used and implemented by Krabi anti-coal assemblage and those who firmly believe in the local capacities of the Krabi province. Krabi Goes Green has emerged as a consequence of the tension arising from the contradictory development patterns and was triggered by destructive projects, namely, coal-based projects. As mentioned earlier, the policy makers are preparing to install many projects into the South. The tension and controversies will be increasing in the near future. Apart from the outside problems, Krabi province now is being challenged with the massive internal issues as well. Many tourism destinations are trying to solve the problem concerning the social and environmental problems that are the characteristics of "Krabi Goes Green."

The convergence of multiple movements in anti-coal event that forms the Krabi Goes Green movement is important because it is the social-environmental event that mixed the grassroots social movement with the new middle-class movement. Coal-based mega-projects were considered here as the trigger or the threshold that lead to the exposure of underlying elements. The organizations defined as social movements and groups of people identified as civil societies hold together to protest against the coal-based mega-projects. However, if one looks at this phenomenon through the media superficially, it is the social movements that applied contentious tactics, directed at the state government and its institution and expected the policy change as a goal. On the contrary, if one closely investigated, the numerous practices, tactics, strategies, and goals beyond the traditional perspective of social movements will be uncovered. This article also indicates that the movement of Krabi Goes Green does rather than the simply traditional resistance. Through the lens of assemblage thinking, I found that the Krabi Goes Green movement is negotiating between the diverse civil societies and social movements. The numerous strategies and tactics were applied to design the movements. The goals are not only the political change, but also target to the cultural and economic change.

6. Conclusion

This article applied assemblage thinking to investigate the formation of Krabi people movement. The movement termed "Krabi Goes Green Assemblage" exemplifies the social collection actions that implement in directing development orientation. It did not only focus on the state and its institutions, but it also focuses on economic, social, natural, and cultural changes. In terms of economy, the movement has integrated all sectors through tourism—fisheries, agriculture, and agro-industries which produce the safety and clean product feeding to tourism sectors, including the renewable energy from agro-industries. Some restaurants initiated buying organic products, appropriate sizes, and legally caught fish, from the communities with the high price. In terms of natural and environmental protection, many entrepreneurs accept sustainable practices into their establishments. Some entrepreneurs have practiced consistent with the Declaration of sustainable tourism, and more than 400 establishments enroll with the Declaration. Finally, these implementations of Krabi Goes Green aim at the social and cultural changes in long term.

This article also argues that the foundations of the formation of Krabi Goes Green movement, partly, resulted from the contradiction between the local and central development strategies, the evident impacts of state development projects, the failures of mainstream mass tourism management, the emergence of tourism and their tourist characteristics, and the omission of the seriously public participation. The Krabi coal-based power plant project is considered here as a pivotal trigger leading to the exposure of underlying social entities, both as the label of social movements and civil societies. Through the lens of assemblage thinking, we can see the coordination between social movements and civil societies. Through the exteriority relations and part-to-whole concept proposed by DeLanda (2006, 2016), we can locate the relation of both fields "social movement assemblages in civil society assemblages"; both cannot reducible into one another, and each assemblage can detach and plague into the other assemblages.

The practice assemblage concept from Li (2007) helps to analyze the implementation, pattern, and strategies of an assemblage, and this article argues that the contradiction between the local and central

development plans will continue to produce the tensions. Its primary elements, drawing on Li (2007; 266), include things (such as coals, coal-fired power plants, coal harbors, environmental and health impact assessment reports, power development plans (PDP), southern development plans, Krabi's capacities reports, toxic substances, fisheries, crops, reserved animals), socially situated subjects (such as villagers, laborers, entrepreneurs, local and government officials, EGAT staffs, consultant staffs, activists, academics, tripartite committees, civil society representatives, scientist), objectives (such as energy security, energy self-reliance control, decentralized energy management, profits, livelihoods, sustainability, green city, conservation, tourism), and array of knowledges, discourses, institutions, laws, and regulatory regimes.

7. Suggestion

According to assemblage thinking, there is no model in the social action. Therefore, the temporary actual event that emerged in Krabi Goes Green could not copy and put totally in the other places. Therefore, for the policy decision and social activists, the spatial-social development design should to be focused on each contexts whether the village, city, or the group of people. As this article shown, Krabi Goes Green has many elements that constitute itself. The focus on the formation allow us to understand the underlying the previous ideas and practices, contingencies, convergences, emergences, and each transformation.

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Room 6:

Science, Technology, Engineering

Perception Differences of Parents and Instructors in Cyberbullying of University Students in Thailand: The Protective Factors for Preventing and Reducing Cyberbullying

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ABSTRACT

Cyberbullying is increasing along with the increasing number of Internet users. Cyberbullying occurs anywhere and at any time, which can obscure the boundaries of supervision and responsibility of adults. The complexities of cyberspace make it difficult for any one individual or stakeholder group to prevent or respond to cyberbullying on their own. All parties involved need to work together to prevent and reduce cyberbullying. This study focuses on protective factors at personal level and situational level perceived by two important stakeholders, parents and university instructors. The data was collected through questionnaire, of which the sample group was parents and instructors of undergraduate students in Thailand. There were 396 respondents, comprising of 205 parents and 191 university instructors. Chi-square and t test are used to compare the means of these two groups. It was found that there is no difference in cyberbullying awareness between parents and university instructors. Instructors tend to perceive self- esteem as a personal protective factor to cyberbullying more than parents. Instructors tend to perceive open conversation about cyberbullying, a parent-child relationship, as a situational protective factor more than parents. Both stakeholders perceive school climate can isolate students from a violent environment, turning it into a safe place to learn and develop.

Keywords: cyberbullying, protective factors, parents, university instructors, emotional intelligence,

parent-child relationship, school climate

1. Introduction

Information and communication technology (ICT) has changed the way individuals communicate with each other. Together with the development of ICT, a new incident - cyberbullying, emerged. Cyberbullying, using electronic media meant to harm or discomfort others, has been considered more pervasive and impactful than traditional bullying since perpetrators can remain anonymous online and are not bound by time or place. Cyberbullying incidents have increased during the COVID-19 pandemic (António, 2023). All activities during the COVID-19 pandemic, such as studying and working, were carried out online at home.

Cyberbullying is caused by several factors, namely family factors related to parenting, internal factors related to individual self-control, and external factors related to social factors such as friends and the school environment (Zhu et al., 2021). Cyberbullying behaviors carried out by students include flaming, abuse, denigration, impersonation, outing and trickery, stalking, and exclusion (Broll, 2016). Cyberbullying has very worrying psychological impacts, such as low self-esteem and anxiety, and depression. The results of a study showed that adolescents who experienced cyberbullying showed reduced mental health, such as anti-sociality, stress, and depression (Cassidy et al., 2018). Another study stated that the impacts of cyberbullying were reduced academic achievement, low self-esteem, anxiety, and violent behavior (Zhu et al., 2021).

Efforts to prevent and reduce the negative impact of cyberbullying can be undertaken by parents, teachers, and others. Parents have the role as educators and supervisors in their children's Internet use at home. Teachers have a role in establishing a mutually supportive school environment for the development of students. While the presence and growth of cyberbullying is continuing, enhancing communication, and understanding between parents and educators in finding effective intervention coping strategies and preventive factors have gained interest.

Euajarusphan (2021) examined the Internet usage behavior in Thailand in 2019 and revealed that in the past decade, Thais have increased their use of the Internet by 150%. This has resulted in Thailand having 47.5 million people or 70% of the population online. Thailand ranks in the world's top countries for social media usage (Saengcharoensap & Rujiprak, 2021) and, thus, inevitably faces cyberbullying problems. Notakao & Pitchayachananon (2019) examined the extent to which university students in Thailand experienced cyberbullying and found that close to 60 percent of the students were cyberbully victims; 45 percent of the students had cyberbullied others; and 62 percent of the students reported that they knew someone being cyberbullied. There were many previous studies on cyberbullying in Thailand (Saengcharoensap & Rujiprak, 2021), Sittichai & Smith, 2018); however, studies on the preventive factors of cyberbullying are still scarce.

2. Objectives of the Study

This study aims to examine perception differences between parents and instructors concerning protective factors of cyberbullying among undergraduate students in Thailand. Specifically, the objectives are:

1. to explore awareness of cyberbullying of university students in Thailand by parents and instructors

2. to investigate the perception difference towards protective factors at personal level of parents and instructors

3. to investigate the perception difference towards protective factors at situational level, parent-child relationship, of parents and instructors

4. to investigate the perception difference towards protective factors at situational level, school climate, of parents and instructors

3. Related Literature Review

3.1 Collaboration between Parents and Instructors

The complexities of cyberspace make it difficult for any one individual or stakeholder group to prevent or respond to cyberbullying on their own. Schools and families are among the most important risk factors as well as protective factors in cyberbullying. Parents are aware that their children can be both perpetrators and victims of cyberbullying. They need encouragement to take action when they suspect their child is being cyberbullied or is bullying someone else. They need communication skills to talk to their children and to seek help from other parents, teachers, or others, and to cooperate to find possible ways of dealing with cyber-attacks. Teachers need to contact parents when appropriate, and to increase parental and community awareness about cyberbullying. They also need active collaboration with parents to establish strategies for dealing with cyberbullying.

Broll (2016) has highlighted the limitations of relevant stakeholders in addressing cyberbullying since parents and educators have different perceptions concerning cyberbullying and possess unique expertise. Coordinated interventions are not a new phenomenon suggested in response to cyberbullying. However, collaborative responses to cyberbullying are still fragmented; perception differences inhibit effective collaboration. The study of Sittichai & Smith (2018) found that good relationships between family members and school personnel could help solve the problem.

3.2 Protective Factors

The comprehensive review of Zhu et al., (2021) highlighted both personal and situational factors as the protective factors associated with cyberbullying among adolescents. Personal factors include emotional intelligence, empathy, and self-esteem. Situational factors consisted of parent-child relationship and school climate. At the personal level, high emotional intelligence, an ability for emotional self-control and empathy, were associated with lower rates of cyberbullying (Zhu et al., 2021). At the situational level, a parent's role is seen as critical. For example, intimate parent-child relationships and open active communication were demonstrated to be related to lower experiences of cyberbullying and perpetration (Larranaga, et al., 2016). Some scholars argued that parental supervision and monitoring of children's online activities can reduce their tendency to participate in some negative activities associated with cyberbullying. They further claimed that an authoritative parental style protects youths against cyberbullying (Rao et al., 2019). Conversely, another study evidenced that parents' supervision of Internet usage was meaningless (Larranaga, et al., 2016). In addition to conflicting roles of parental supervision, Zhu et al., (2021) have also looked into the role of schools and posited that positive school climates contribute to less cyberbullying experiences.

3.2.1 Protective Factors at Personal Level

Emotional intelligence (EI) is one of the personal variables that has received the most attention with respect to cyberbullying. The concept of emotional intelligence refers to the ability to accurately perceive, regulate, and express emotions, as well as the ability to generate and access emotions during the thinking process, the ability to understand the emotion and the underlying emotional knowledge, and the ability to organize emotions in a way that promotes the emotional and mental growth of the individual (Al-Sarayra, 2022). Cyberbullying was related to difficulties in regulating one's emotions. The characteristics of EI make it one of the most powerful protective factors against the appearance of cyberbullying. Al-Sarayra (2022) revealed that dimensions of emotional intelligence predicted participation in cyberbullying as both a victim and perpetrator. Specifically, it indicated that low emotional regulation and high excessive attention to one's feelings increases the probability of being a victim of cyberbullying, while low emotional understanding increases the probability of being a perpetrator. Students with a high ability to understand and regulate their emotions reveal high levels of nonparticipation in cyberbullying behavior (Zhu et al., 2021).

Rosenberg (1965) defined self-esteem as a favorable or unfavorable attitude toward the self. Selfesteem is a perception, that one's belief as to his or her personal value and affected by one's participation in the social world (Patchin & Hinduja, 2010). A person with high self-esteem is usually assertive, pleased, and selfrespecting, whereas those who have low self-esteem are anxious, lacking confidence, and self-critical. In general, self-esteem tends to rise when a youth experiences positive life events such as success and favorable opinions among peers. Youths in the consistently high self-esteem profile seemed to be more protected against cyberbullying and victimization/cybervictimization behaviors compared to those in the self-derogation profile (Zhu et al, 2018). Self-esteem may acquire a fundamental motivational function that can either activate or inhibit certain aspects of a person's developmental trajectories (Palermiti et al., 2017), with high levels of self-esteem operating as protective factors and low levels increasing vulnerability to peer aggression and mental health problems. Palermiti et al. (2017) found that subjects with a low level of self-esteem were more likely to be involved in cyberbullying risks. Cyberbullying victims and perpetrators reported significantly lower self-esteem than youth who had not experienced cyberbullying.

Empathy, ability to share and understand emotional states of others, is defined as the process through which an individual understands the emotions of others by generating an isomorphic affective state and knowing that the cause of one's emotional state belong to the other person (Morese et al., 2018). Morese et al., (2018) mentioned that being able to understand the mind and emotional states of the others was fundamental to life, contributed to the success of social relationships because it allowed us to communicate, understand and predict the behaviors and reactions of others; this ability allows a better understanding and the ability to promote prosocial behaviors. It was found that there was a negative relationship between antisocial behavior and empathy: a negative relationship between empathy and cyberbullying (Zhu et al., 2021). Perpetrators demonstrated less empathic responsiveness than non-perpetrators. It has been noted that elevated levels of empathy are associated with prosocial behavior. A lack of empathy might be a risk factor for cyberbullying behavior. A number of bullying intervention programs have incorporated empathy as an essential element to reduce bullying (Morese et al., 2018).

3.2.2 Protective Factors at Situational Level

Parent-Child Relationships

Parents have an important role in preventing cyberbullying. Supervision and parenting by parents to children are an important part of preventing and reducing the impact of cyberbullying. Family cohesion acts

as a protective factor against cyberbullying. Parental involvement influences the child's personality to avoid juvenile deviant behavior. Previous studies have shown that parenting style has a positive relationship with adolescent self-control (Yosep et al., 2023). A previous study conducted by Yosep et al., (2023) showed that the lack of involvement and warmth provided by parents and overly permissive parenting had an influence on cyberbullying behavior. Barón et al., (2019) indicated that adolescents involved in cyberbullying as perpetrators or victims have less open and more avoidant communication with their parents than adolescents who are not involved in cyberbullying. Yosep et al., (2023) found that high school students who experience cyberbullying are not given education about how to use the Internet and social media from their parents. This can cause students to become perpetrators of cyberbullying and victims of cyberbullying. Parents as the first teachers at home have a big role in preventing cyberbullying by improving knowledge about cyberbullying and how to solve the negative impact of cyberbullying. In conclusion, several research findings stated the protective factor, parent-child relationships, to cyberbullying (Yosep et al., 2023, Barón et al., 2019, Cassidy et al., 2018, Zhu et al., 2018) with the following dimensions: open conversation about cyberbullying, close parent-child relationship, and usage monitor.

School Climate

The external factor that affects cyberbullying is the school climate (Baron & Caballero, 2016). It is said that the school environment, social support from teachers, and friendship between students are indispensable for students to have when they are in school. Technology has also been integrated more within schools increasing the likelihood of cyberbullying experiences. Positive experiences of school climate have a positive impact on adolescent development such as increased school connectedness and engagement, improved academic performance, better behavioral and mental health, and better psychological well-being (Baron et al., 2019). Wigati et al., (2020) found that students who engage in cyberbullying assess their school environment as less positive, and alternatively, adolescents who are not involved in bullying, both through cyberspace and at school, view school and teachers as having a more positive role. These findings emphasize that creating a positive school atmosphere can help reduce violent behavior, specifically bullying both at school and in cyberspace. School climate consists of all aspects related to school experience such as the quality of teaching and learning, social relationships, structural systems, values and norms. In conclusion, school climate from Wigati et al., (2020) and Baron et al., (2019) are adopted in this research as follows: sense of belonging, support from school, and student-teacher relationship.

4. Research Methods

This study used a cross-sectional study design, carried out in April-June of 2023. This study assessed demographic information, forms of cyberbullying, consequences of cyberbullying, and parents' and instructors' perceptions of protective factors to cyberbullying.

Participants and Sample Size

The population of this study is parents and instructors of university students in Thailand. There are 1,676,982 students studying in higher education institutions in 2021 (MHESI, 2021). The final sample size of 396 is large enough for a study of this magnitude. The sample consisted of 205 parents (51.76%) and 191 university instructors (48.23%).

Sampling Procedure

The researcher disseminated the surveys online using convenience sampling by posting on social media platform LINE, which ranked second among the leading social media networks in Thailand as of February 2022, with the penetration rate of around 92.8 percent (Statista, 2022). Respondents received an invitation to participate in the survey. One of the limitations of using an online survey is lack of quality random sampling. However, due to the sheer number of the population, it was the most cost-efficient choice. The other advantage is the ability to access to parents and instructors in remote locations.

Hypotheses

- Hypothesis 1: There is no difference in awareness of cyberbullying of university students in Thailand by parents and instructors
- Hypothesis 2: There is no perception difference towards personal protective factor, emotional intelligence (EI), to cyberbullying by parents and instructors
- Hypothesis 3: There is no perception difference towards personal protective factor, self-esteem, to cyberbullying by parents and instructors
- Hypothesis 4: There is no perception difference towards personal protective factor, empathy, to cyberbullying by parents and instructors
- Hypothesis 5: There is no perception difference towards situational protective factors, open conversation about cyberbullying, by parents and instructors
- Hypothesis 6: There is no perception difference towards situational protective factors, close relationship, by parents and instructors
- Hypothesis 7: There is no perception difference towards situational protective factors, usage monitor, by parents and instructors
- Hypothesis 8: There is no perception difference towards situational protective factors, sense of belonging, by parents and instructors
- Hypothesis 9: There is no perception difference towards situational protective factors, support from school, by parents and instructors
- Hypothesis 10: There is no perception difference towards situational protective factors, student-teacher relationship, by parents and instructors

5. Results

5.1 The awareness of cyberbullying of university students in Thailand by parents and instructors

There is no difference in awareness of cyberbullying experience of Thai university students by parents and instructors. Table 1 presents the observed frequency distribution. According to a chi-square test of independence, there is no significant difference between the proportions of parents and instructors who reported awareness of cyberbully perpetrator ($\chi^2 = 3.05$, p>.05). However, more instructors (37.0 percent) reported awareness of cyberbully perpetrator than parents (34.8 percent). Also, there is no significant difference between the proportions of parents and teachers who reported awareness of cyberbully victim ($\chi^2 = 3.23$, p>.05). However, more instructors (45.5 percent) reported awareness of cyberbully victims than parents (40.5 percent).

Table 1: Frequency distribution of awareness of students' cyberbullying experiences by parents and instructors

_	Awareness of Students' Cyberbullying Experiences			
	Cyberbully perpetrator	Cyberbully victim		
Parents	72 (34.8%)	84 (40.5%)		
Instructors	70 (37.0%)	86 (45.5%)		
n = 396	0			

The forms through which cyberbullying can occur are diverse, including harassment, exclusion, outing, trickery, cyber-stalking, and sexting. Parents and instructors have similar perceptions on several negative psychosocial, physical, and mental health consequences, such as depression, suicidal attempts, anxiety, loneliness, substance abuse, and lower academic achievement. Hypothesis 1 fails to reject.

5.2 The perception difference towards personal protective factor to cyberbullying by parents and instructors

Responses regarding a specific protective factor at personal level to cyberbullying ranged from 1 (very disagree) to 5 (very agree). Results of the independent samples t-test show that mean scores of "self-esteem" differ between parents (mean = 2.41, SD = .89) and instructors (mean = 2.85, SD = .57) at the .05 level of significance [t (394) = 2.23, degree of freedom (df) = 394, p = .05, 95% CI for mean difference: -.38 to -.77]. On average, instructors tend to perceive "self-esteem" as a specific protective factor to cyberbullying more than parents. Table 3 presents the summary of the tests regarding personal protective factor. Hence, hypothesis 2 and hypothesis 4 fail to reject. Hypothesis 3 is rejected.

	Parents			Ins	tructor		t	df
	Mean	SD	n	Mean	SD	n		
Emotional intelligence	2.33	.41	205	2.41	.34	191	1.45*	394
Self-esteem	2.41	.89	205	2.85	.57	191	2.23**	394
Empathy	2.64	.47	205	2.75	.42	191	1.59*	394

Table 3: Independent samples t-test on perceived personal protective factor

*p>.05, **p < .05

5.3 The perception difference towards situational protective factors, parent-child relationship, by parents and instructors

Responses regarding a specific parent-child relationship ranged from 1 (very disagree) to 5 (very agree). Results of the independent samples t-test show that mean scores of "open conversation about cyberbullying" differ between parents (mean = 2.56, SD = .45) and instructors (mean = 2.84, SD = .39) at the .05 level of significance [t (394) = 2.34, df = 394, p = .05, 95% CI for mean difference: -.27 to -.53]. On average, instructors tend to perceive "open conversation about cyberbullying" as a dimension of parent-child relationship to cyberbullying more than parents. Table 4 presents the summary of the tests regarding parent-child relationship. Hence, hypothesis 6 and hypothesis 7 fail to reject. Hypothesis 5 is rejected.

 Table 4: Independent samples t-test on perceived situational protective factor, parent-child relationship

-	Parents	Parents			Ins	structor		t	df
	Mean	SD	n		Mean	SD	n		
open conversation	about								
cyberbullying	2.56	.45	205		2.84	.39	191	2.31**	394
Close relationship	2.41	.54	205		2.55	.59	191	1.76*	394
Usage monitor	2.64	.42	205		2.73	.39	191	1.68*	394

*p>.05, **p < .05

5.4 The perception difference towards protective factors, school climate, by parents and instructors

Results of the independent samples t-test show that mean score of sense of belongings, mean score of support from school, and mean score of student-teacher relationship do not differ between parents and instructors at the .05 level of significance. Table 5 presents the summary of the tests regarding school climate. Therefore, hypotheses 8 - 10 are rejected.

School Climate	Parents			Inst	tructor		t	df
	Mean	SD	n	Mean	SD	n		
sense of belonging	2.31	.34	205	2.42	.38	191	1.42*	394
support from school	2.52	.42	205	2.66	.35	191	1.36*	394
student-teacher relationship	2.74	.44	205	2.83	.42	191	1.79*	394

Table 5: Independent samples t-test on perceived protective factors, school climate

*p>.05

6. Discussion of the Findings

There is no difference between the proportions of parents' and university instructors' reporting awareness of cyberbullying as perpetrators or victims since cyberbullying is becoming more prevalent around the world and it seems to increase during the pandemic. From the finding, this study concludes that "emotional intelligence" is the perceived personal preventive factor with the highest percentage. In addition, the personal preventive factor for cyberbullying statistically varies between parents and instructors. Instructors perceived "self-esteem" as a personal preventive factor for cyberbullying more than parents. This finding is consistent with the other research's findings that students who experienced cyberbullying, both as a victim and an offender, had significantly lower self-esteem than those who had little or no experience with cyberbullying (António et al., 2023).

This study found that "close relationship" is the perceived situational preventive factor with the highest percentage. In addition, open conversation about cyberbullying, a preventive factor for cyberbullying statistically varies between parents and instructors. The mean scores of "open conversation about cyberbullying" differ between parents and instructors. Instructors tend to perceive open conversation about cyberbullying as a preventive factor more than parents. These findings are consistent with other research findings that adolescents involved in cyberbullying as perpetrators or victims have less open and more avoidant communication with their parents than adolescents who are not involved in cyberbullying (Baron et al., 2019).

However, based on another situational preventive factor, school climate, there are no differences in perceptions of parents and instructors. Support from school has the highest frequency and sense of belonging has the lowest frequency. This implies that the school climate is the social atmosphere of the learning environment where students grow and develop. Schools with a positive school climate can influence the formation of better teacher student relationships; decrease the quantity of student delinquency, decrease victimization violence, increase academic performance, and decrease bullying and ethnic discrimination/racial discrimination (Wigati et al., 2020)

7. Recommendations

The results of this study can be used to make recommendations to institutions to prevent cyberbullying and its consequences for adolescents. It shows that both parents and instructors perceive the importance of emotional intelligence and empathy to be preventive factors of cyberbullying at personal level though there is perception difference in self-esteem. High emotional intelligence, an ability for emotional self-control and empathy were associated with lower rates of cyberbullying. Hence, the concerned stakeholders should consider the emotional intelligence development in adolescents.

The parent-child relationship is also an important preventive factor at situation level. Parents perceived less important on "open conversation about cyberbullying" than instructors. However, both stakeholders perceived the importance of close relationships. This implies that intimate parent-child relationships and open active communication should be encouraged. Family cohesion acts as a protective factor against cyberbullying.

The educational institutions should develop the positive school climate, which has multiple aspects, such as clear rules, fair discipline, empathic communication, the formation of better teacher-student relationships, and healthy interpersonal relationships, including a safe school environment. Positive school climate can isolate students from a violent environment, turning it into a safe place to learn and develop. In addition, there should be a counseling service in place for the students to receive complaints concerning cyberbullying, and to soothe the feelings of the victims.

Qualitative study to understand opinions and experiences of these stakeholders and to gather in-depth insights into cyberbullying problems are recommended for future research.

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Comparison of The Accuracy of Chairside Inlay Restoration Under Existing Removable Partial Denture Rest: Different Cad/Cam Inlays and Direct Composite Resin Fillings

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ABSTRACT

This study aims to compare the accuracy of 3 different chairside retrofitting inlay restorations under 4 different areas of existing RPD rest seat (1 deepest area and 3 cavosurface areas). The experimental groups were CAD/CAM ceramics consisting of hybrid ceramic (HC) and lithium disilicate (LDS). The control group was direct composite filling (C). Each group was fabricated *in vitro* by using the jigsaw-like mold (n=10). The gap between the inlay and rest seat was represented by the silicone replica and then measured by the measurement software (Geomagic Control X version 2022.0.1.40, 3D Systems, Rock Hill, SC, USA). Two-way ANOVA and Tukey's multiple comparison test revealed there are differences in accuracy between different restorations (HC and LDS) and in different areas of rest seat. HC and LDS showed the approximate gap sizes at all cavosurface areas (143-149 and 145-153 μ m, respectively, p>0.05) and showed the smallest gap at the deepest area (6 and 25 μ m, respectively, p<0.05). On the contrary, C showed the approximate gaps in all areas (45-59 μ m, p>0.05). In conclusion, there are differences in accuracy of the existing RPD rest but in composite resin, the area of rest seat of CAD/CAM ceramic could affect the accuracy of the existing RPD rest but in composite resin,

Keywords: retrofitting restoration, existing RPD rest seat, CAD/CAM ceramic, inlay, chairside restoration, accuracy

1. Introduction

Removable partial dentures (RPD) play an important role in restoring oral functions and stabilizing the remaining dentition. However, these prostheses may pose a risk of caries development. A new restoration under an existing RPD is still the choice of treatment for patients familiar with the existing RPD. The key to success in repairing restoration under existing RPD includes choosing the right material that provides strength, fragile resistance, and durability to bear with occlusal loading. In addition, full seating of the new restoration and rest seat adaptation with the existing RPD are also required. Failure to obtain these factors leads to the patient's discomfort, pain in the teeth, gingiva, or edentulous area, and tooth mobility with the tilted denture. There are

some techniques that have been described for retrofitting restorations with rest seats for existing RPD. They can be categorized as direct and indirect techniques. The direct procedure involves intraoral direct composite filling. The indirect procedure uses a pickup impression of an abutment that is intact in the rest area and then a lost-wax casting procedure. Recently, digital procedures have been introduced. Computer-aided design and computer-aided manufacturing (CAD/CAM) are recommended to obtain a restoration with the appropriate fit (Lee J.W. et al., 2017). The major advantage of digital scanning is that it eliminates the discomfort that patients may experience from a conventional impression procedure and can be done for one-visit chairside dental applications. An inlay, rather than a retrofitting crown, is a good option for minimally invasive restoration that restores form, function, and aesthetics while removing as little sound tooth structure as possible. CAD/CAM systems use ceramic as the basic material, which is continuously being developed (Carreiro et al., 2021; Ahrberg et al., 2016). However, the previous ceramic material has some disadvantages, such as fragility, the requirement of excess time for fabrication, and an abrasive effect. These disadvantages of ceramic lead to increased interest in new materials, such as CAD/CAM hybrid ceramic and CAD/CAM lithium disilicate glass- ceramic, that can be repaired both aesthetically and functionally.

2. Research Objective

The objective of this study was to compare the accuracy in fabricating chairside retrofitting inlay restorations under 4 different areas of an existing RPD rest seat among three different 3 restorations (CAD/CAM hybrid ceramic, CAD/CAM lithium disilicate glass-ceramic inlay, and direct composite filling).

3 Variables

1. Independent variables: fabricating retrofitted restoration under existing RPD methods and materials. (Direct composite filling, CAD/CAM hybrid ceramic, and CAD/CAM lithium disilicate glass-ceramic inlay.)

2. Dependent variables: accuracy among retrofitted restoration and existing RPD rest.

4. Research Methodology

4.1 Research Design

This study was the creation of a workpiece for comparison of the accuracy of restoration techniques under removable partial denture rest: direct composite filling, CAD/CAM hybrid ceramic, and CAD/CAM lithium disilicate glass-ceramic inlay.

4.2 Materials and Methods

4.2.1 Jigsaw-like mold preparation

Metal mold was fabricated using stainless steel (external sized 16x24x20 mm. and internally sized 8x13x3mm.) with 3 indentation lines and 2 half circle slots at the edge (Figure 1A). This provided the outer frame for a jigsaw-like mold inside. Part 1 and part 2 were made to fit together like a jigsaw to represent the clinical

performance of the rest seat and RPD rest, respectively. Part 1 was constructed by wax carving, to mimic the size of the rest seat of the premolar. Then, part 2 was made to imitate the RPD rest. It was constructed using casted Co-Cr alloy (8x8 mm.) with 1 rest. In addition, there were 2 extension slots that could be fitted into the 2 half circle slots of the metal mold. There was 1 knob on the top of part 2 for handling and load placing (Figure 1B). These 2 parts can be positioned together in the metal mold precisely. After that, part 1 was removed to provide the space for fabricating inlay restorations (Figure 1C).

4.2.2 Fabricating inlay silicone pattern

Part 1 was replaced with an additional silicone (Occlufast Rock, Zhermack, BadiaPolesine, Italy). Then, part 2 was inserted and loaded (1 kg). The excess was removed and waited for 1.30 minutes until complete polymerization. Next, the remaining excess was trimmed by using the scalpel. The outcome was an inlay silicone pattern. This would be useful for manufacturing a CAD/CAM ceramic restoration specimen. (Figure 1D).

4.2.3 Manufacturing CAD/CAM ceramic restoration specimen (experimental group)

The silicone pattern was scanned using the intra-oral scanner (Trios 4; 3Shape, Copenhagen, Denmark) (Figure 2A). The image of the silicone pattern was viewed and designed by a CAD software program (Dental System 2014; 3Shape, Copenhagen, Denmark). The data was sent to the chairside 4-axis milling machine (DG Shape DWX-42W, Roland DG Corporation, Japan).

The hybrid ceramic Vita Enamic® block (VITA, Germany) was milled (Figure 2B). Subsequently, post-milling sintering is unnecessary according to material manufacturing company instructions. It only needs to be finished and polished. This process was repeated 10 times. Then, a total of 10 experimental specimens of hybrid ceramic (HC) were kept in a dry box at room temperature.

For lithium disilicate glass ceramics pre-crystallized block (IPS E. max CAD, Ivoclar Vivadent, Liechtenstein), it was milled in the same manner as above and then sintered for 18.27 minutes in a ceramic furnace (VITA Vacumat 6000 M, Germany) as recommended by the material manufacturer (Figure 2C and 2D). This procedure was also repeated 10 times, and a total of 10 experimental specimens of lithium disilicate glass ceramics (LDS) were also kept in a dry box at room temperature.



Figure 1 Jigsaw mold preparation and fabricating silicone pattern A. Metal mold was fabricated using stainless steel to provide the outer frame B. Part 1 and part 2 was made to fit together like a jigsaw to represent the clinical performance of rest seat and RPD rest, respectively C. Part 1 and part 2 can be positioned precisely together in the frame of metal mold D. Silicone pattern was replaced in part 1 space.



Figure 2 Manufacturing CAD/CAM ceramic restoration specimen A. Scanning the silicone pattern using intra-oral scanner B. Ceramic block was milled by the 4-axis milling machine C. Sintered lithium disilicate glass ceramic specimen D. Ceramic furnace.

4.2.4 Manufacturing of direct composite resin restoration specimen (control group)

Part 1 was replaced with bulk-fill composite resin (Filtek Bulk-Fill; 3M ESPE, Saint Paul, MN, USA). Then, part 2 was inserted and loaded (1 kg). Excess was removed and light cured by LED light (Mini LEDTM Standard F, ACTEON, Norwich, UK) with 1,250 mW/cm² intensity and 420–480 nm wavelength, for 20 seconds. After repeating these steps 10 times, resulting in a total of 10 control group specimens (C). They were also kept in dry box at room temperature.

4.2.5 Gap measurement

Gap Measurement was performed to check the fit accuracy. The light body silicone material (Aquasil ultra plus LV ® Impression Material; Dentsply Sirona, York, USA) was injected between the specimen and part 2. After material completely setting, part 2 was removed. Then the silicone replica was appeared and attached in the specimen. The thickness of silicone replica refers to the gap between the specimen and part 2 (Figure 3). Silicone replicas of all groups were scanned individually by the intra-oral scanner and then the data

was kept in digital STL files. There are 10 files for HC, 10 files for LDS, and 10 files for C. These files are called "gap files". Then silicone replica was removed from each specimen. All specimens were scanned in the same manner as above. These files are called "original files" (Figure 4A). Finally, the superimposition between the original file and the gap file were performed with best fit matching (Figure 4B). The thickness was measured at 4 areas by the virtual cross-sectioning feature of the software (Geomagic Control X version 2022.0.1.40, 3D Systems, Rock Hill, SC, USA). There were point A, the deepest part of rest seat; point B, the cavosurface of rest terminus; point C and point D, the cavosurface of margins (Figure 5).



Figure 3 The silicone replica was appeared and attached in the specimen.



Figure 4 Exported digital data A. the gap file (green) and the original file (blue).

B. Two files were superimposed with best fit matching.



Figure 5 The thickness of the silicone replica was measured by the software at 4 areas: deepest part of rest seat (A), cavosurface of rest terminus (B), cavosurface of margins (C, D). The color bar represented the thickness of the gap.

4.3 Statistical analysis

The sample size was calculated by the G*power program (Preface by Russell V. Lenth, Version 3.1.9.4, Iowa, USA) (Figure 6). Means and standard deviations were retrieved from the literature. Based on the formula for two-way ANOVA with a significance level of 5%, a sample size at least 8 specimens per group was required to detect a difference in the gaps among the 4 groups. As a result, the sample size in this study was 10 specimens per group.



Figure 6 Sample size calculation using the G*Power program.

The statistical data processing was performed by the SPSS program (IBM SPSS Statistics for Windows, Version 23.0, IBM Corp, Armonk, NY). Two-way ANOVA and Tukey's multiple comparison tests were used ($\alpha = 0.05$).

5. Result

Two-way ANOVA and Tukey's multiple comparison tests revealed that the areas of the rest seat affect the accuracy of HC and LDS but not C. Figures 7 and 8 show the gap size of the rest seat under the RPD rest in different materials and different areas. The two experimental groups, HC and LDS, show the same gap size at points B, C, and D (ranging from $143\pm9\mu$ m to $149\pm11\mu$ m and $145\pm11\mu$ m to $153\pm13\mu$ m, respectively), p>0.05. The 2 experimental groups show the smallest gap size at point A as compared to that of points B, C, and D (p<0.05). At point A, the 2 experimental groups, HC and LDS show a smaller gap size ($6\pm3\mu$ m and $25\pm5\mu$ m, respectively) than that of the control group ($45\pm4\mu$ m), p<0.05. The control group, bulk-fill composite resin shows the approximate gap size at all areas (A=45\pm4\mum, B=49±11 μ m, C=58±7 μ m, D=59±11 μ m), p>0.05.



Figure 7 Gap size of HC, LDS, and C at 4 areas of rest seat. The color bar represented the thickness of the gap.



Figure 8 Gap size of rest seat under RPD rest in different materials and areas in micrometers (mean \pm SD). Control means bulk-fill composite resin, HC means hybrid ceramic and LDS means lithium disilicate. Point A means the deepest area, Point B means the rest terminus of cavosurface area, Point C and D mean the right and left cavosurface area, respectively. Different superscript uppercase letters indicate statistically significant difference (p<0.05), n=10.

6. Discussion

Today, dentistry has progressively incorporated digital technology. It additionally serves as a tool for retrofitting restorations under the RPD. The conventional procedures necessitate multiple stages and chair times, resulting in disruption of oral functions and the patient's satisfaction. Ceramic inlays have been introduced and are scientifically accepted based on numerous clinical studies since the 1990s. An inlay, rather than a retrofitting crown, is an excellent alternative for minimally invasive restoration that restores both aesthetics and function while harming a minimal amount of sound tooth structure. Since the rest seat is a very important structure supporting RPD, at the deepest point of the rest seat, it can greatly reduce the movement of the abutment and enhance the stability of RPD. To eliminate the other confounding factors, this should be accomplished. In

consequence, a simple geometry of retrofitting restoration under RPD was designed, focusing on only the rest seat area. In this *in vitro* study, there is one occlusal rest seat resembling an inlay rest seat.

This study investigated accuracy in fabricating chairside retrofitted inlay rest seats under existing RPD among direct composite filling, CAD/CAM hybrid ceramic, and CAD/CAM lithium disilicate glass-ceramic inlay. The 2 experimental groups (HC and LDS) show the same gap size at points B, C, and D (ranging from $143\pm11\mu$ m to $153\pm13\mu$ m), p>0.05. In addition, the 2 experimental groups show the smallest gap size at point A $(6\pm3\mu$ m, and $25\pm5\mu$ m, respectively) as compared to that of points B, C, and D (p<0.05). These results indicate that the area of milling affected the accuracy between the rest and the ceramic rest seat. The deepest area reveals a smaller gap size than that of the other 3 cavosurface areas. The deepest area may be under-milled, resulting in impeding intimate contact with other cavosurface areas. The non-homogeneous gap size was described by some authors as commonly occurring in CAD-CAM technology (Majeed et al., 2016). This may be related to the quality of processing of the digital data, the diameter, shape, and the limited ability of milling instruments.

However, all areas display an acceptable gap size according to the earlier study of the gap size between the surveyed crown and RPD (Carreiro et al., 2021). The study explained that a gap size of $50-311 \,\mu$ m classified as "acceptable" and that under $50 \,\mu$ m classified as "no gap". Therefore, HC and LDS can be milled accurately to accomplish the retrofitting restoration.

At point A, the ceramic group, HC shows the smallest gap size ($6\pm 3\mu$ m) as compared to the LCD group (p<0.05). This result indicates that the type of ceramic affects the accuracy between rest and ceramic rest seat at the deepest area. This may be caused by the shrinkage of pre-crystallized LDS after post-milling sintering at 840°C for 18.27 minutes while HC does not need that process, according to the manufacturer's instruction. This result showed that, in the deepest area, the indirect milling technique provides a smaller gap size ($6\pm 3\mu$ m to $25\pm 5\mu$ m) than the direct composite filling technique ($45\pm 4\mu$ m). This could be caused by the effects of undermilling. This effect would be greater than the effect of shrinkage from crystallization after sintering especially in the deepest area but not for the cavosurface area. However, the final gap size in both ceramic groups and the composite resin group is still in an acceptable range. Even though there is no study about the adaptation of the retrofitting restoration using a direct composite filling. However, this technique is the most practical and conservative way to fill the cavity chairside in a short time. The result showed that bulk-fill composite had the same gap thickness under RPD rest at all areas ($A=45\pm4\mu$ m, $B=49\pm11\mu$ m, $C=58\pm7\mu$ m, $D=59\pm11\mu$ m). This implied that each area of rest was not influenced by the dimension change during polymerization shrinkage. This might be caused by the light curing unit can access to all areas of the restoration.

This *in vitro* study suggests that HC and LDS could be used as a retrofitting inlay restoration. The CAD software ability could compensate for the ceramic shrinkage and the high-quality milling instruments result in acceptable accuracy. Even though, there is some non-uniform adaptation, especially in the deepest area of rest related to the limitation of the 4-axis (Kirsch et al., 2017, Al Hamad et al., 2021) milling machine in this study.

Many studies revealed that information obtained by conventional impressions performed using highprecision impression materials and extraoral scanning was more accurate than that obtained by intraoral digitalization (Luca et al.,2020, Yoshimasa et al.,2018) susceptible to intraoral conditions such as saliva, blood, limited spacing, preparation shape, and scanning position. Consequently, the technique utilized for impressions must be chosen in accordance with clinical conditions. However recent studies have shown Intraoral scanners are reliable enough to use in clinical work for short-distance scanning (Posritong, S., & Chukiatmun, K. (2021) and significantly superior to the traditional technique in terms of patient preference and time efficiency (Kelvin I et al.,2022).

The limitation of this study is the laboratory study but not the clinical conditions. Some factors can affect the outcome, including the difficulty in making the precise silicone pattern with the disturbance from saliva and tongue. In addition, the retrofitting restoration may have more complex geometry than that in this study, such as onlay and crown.

7. Conclusion

There are differences in accuracy between different types of restorations (HC, LDS, and composite resin) and in different areas for retrofitting inlay restoration, as described by the following.

1. The area of rest seat of CAD/CAM ceramic could affect the accuracy of the existing RPD rest but in composite resin, the area of rest does not affect the accuracy.

2. The types of indirect CAD-CAM ceramic and their conditions of processing can affect the accuracy of retrofitting restoration, especially in the deepest area.

3. The overall gap size of HC, LDS, and composite resin in every area of retrofitting inlay restoration is within an acceptable range (6-155 μ m) for use as a retrofitting restoration for RPD.

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The Stability Study of Lyophilised Platelet Lysate from Outdated Leukocyte-Poor Platelet Concentrate as Media Supplement for Expansion of Bone Marrow-Derived Mesenchymal Stem Cells Culture

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ABSTRACT

Mesenchymal stem cells (MSCs) have been extensively studied for clinical purposes due to their promising therapeutic immunomodulatory properties and paracrine effects playing potential roles in tissue regeneration. MSCs require extensive *in-vitro* cultivation and expansion methods. Good manufacturing procedure (GMP) must be applied for the production of MSCs for clinical purposes. Typically, MSCs are grown in media supplemented with fetal bovine serum (FBS). Since it raises safety issues for the clinical use of cell therapy, human-derived blood components are an alternative. The outdated platelet units from blood banks can be utilized as human platelet lysate (HPL) products by a simple freeze-thawing technique. Freeze-drying (lyophilization) of HPL can be used to improve the stability and storage potential due to platelet lysates being stored in a dehydrated state. Here, we preserved HPL by lyophilization technique and evaluated the stability of lyophilized HPL (LPL) after 2 years of storage as bone marrow-derived MSCs (BMSCs) growth medium supplement, compared to conventional supplement, FBS. HPL was freeze-dried/lyophilized to make LPL and the stability was evaluated by monitoring its ability to maintain BMSCs surface markers and tri-lineage differentiation potentials. Freshly

prepared HPL (fHPL), Freshly prepared LPL (fLPL), and its 2-year stored products; stored HPL (sHPL) and stored LPL (sLPL) are able to enhance BMSCs growth potential and significantly reduce population doubling time (PDT), compared to FBS. In all culture conditions, BMSCs surface markers (CD34, CD45, CD73, CD90, and CD105) exhibit equivalent expression with similar adipogenic and chondrogenic differentiation potentials. Meanwhile, osteogenic differentiation of BMSCs in sHPL and sLPL was enhanced with strong positive alizarin red S staining. The quantitative analysis reflected the stability of bone morphogenetic protein 2 (BMP-2) and platelet-derived growth factor-BB (PDGF-BB) levels in LPL. The lyophilization process was able to preserve HPL, with its BMSCs growth supportive and differentiation properties over 2 years of storage for in vitro BMSCs expansion while delivering superior osteogenic differentiation potential, compared to conventional BMSCs growth medium supplement.

Keywords: Mesenchymal stromal cells, human platelet lysate, lyophilization, stability, cell culture supplements

1. Introduction

Mesenchymal stem cells (MSCs) are multipotent cells derived from a variety of human tissue sources. contain stem cell characteristics presented by self-renewal property and multiple cell differentiation. MSCs were first described by Friedenstein et al. as an adherent, spindle-shaped population of cells from the human bone marrow (BM) [1,2]. MSCs are promising candidates for cell therapy and other clinical applications. Recent clinical studies state positive treatment outcomes including COVID-19, autoimmune diseases, and stroke by using MSCs as cellular materials [3,4]. MSCs hold several characteristics that aid COVID-19 and other degenerative diseases by supporting patient recovery, lesion repairing, and as well modulate the patient's inflammatory responses [5]. The reputation of MSCs in the area of research and clinical purposes has grown in the past decade due to their immunosuppressive, anti-inflammatory, and anti-fibrosis effects [6]. At the present time, there are about 130 listed/ongoing clinical trials targeted at the likelihood of human bone marrow-derived mesenchymal stem cells (BMSCs) based cell therapies worldwide (www.clinicaltrials.gov). MSCs applied in cell therapy have been identified as one of the advanced therapy medicinal products (ATMPs). Good manufacturing procedure (GMP) of MSCs must be followed for in vitro cultivation and expansion, which supports quality standards in terms of safety, identity, potency, and long-term proliferation [7,8,9]. The optimal protocol for MSC cultivation is extensively investigated to ascertain the quality of MSCs. The traditional media used are basal-defined media such as Dulbecco's modified Eagle medium (DMEM) or Minimum Essential Media (α -MEM) supplemented with a serum of animal origin to stimulate cellular proliferation or differentiation of cells [10,11]. Fetal bovine serum (FBS) has been conventionally used in culture media as a serum supplement for the expansion of MSCs, associated with major undesirable concerns for patients in the clinical setting. FBS is an ill-defined mixture containing compounds that are not identified and for the identified one's composition is not completely determined and their role in the culture is unknown [12]. Also, FBS requires pre-testing with each batch due to the variability associated with batch-to-batch [13]. Additionally, the high quantity of endotoxins in FBS may

induce the immune reaction to antigens from xeno-origin [10], considered a potential source for microbial pathogens, and 20-25% of the commercial ones are contaminated [14]. Moreover, animal welfare has raised concerns about methods used for harvesting blood from the fetal calf [13]. Regulatory agencies discourage the use of FBS due to the above mentioned concerns [12,14].

Human blood derivatives; human serum (HS), human plasma (HP), human platelet derivatives e.g., platelet lysate (PL), platelet-rich plasma (PRP), and thrombin-activated platelet-rich plasma (tPRP) are under investigation for their potentiality to support proliferation and basic characteristics of MSCs in culture [15,16,17]. These immensely complex fluids consist of a broad spectrum of biological or physiological factors that can either promote growth, inhibit growth, and/or differentiation-inducing activities [18]. Recently, many research works have concentrated on the development of platelet-derived products in MSCs cultures [16,19,20]. HPL was successfully used for the expansion of MSCs [21, 22] and it is the only commercially available standardized platelet product [15]. HPL prepared from a simple freeze-thaw procedure appeared to be the most effective [22]. The growth factors released from tPRP were reported to enhance proliferation and cell attachment [23, 24] Furthermore, bone morphogenetic protein 2 (BMP-2) and platelet-derived growth factor-BB (PDGF-BB) are reported to support the human mesenchymal stem cell expansion while retaining immunosuppressive capacity [25, 26]. HPL from outdated platelet units can safely be used for the expansion of MSCs [15]. Up to 20% of the donated platelet products are expired in blood banks due to short expiry before they can be used for transfusion [22]. One of the attractive alternatives to minimize this wastage is by utilizing some of the expired platelet products as a replacement for FBS in MSCs cultures [2, 15]. Moreover, HPL showed several advantages such as easy production, compliance with good manufacturing practice guidelines, and reduction of a lot-to-lot variation due to the pooling of platelets [20 27,28]. However, Product stability was found to be altered due to various concentrations of growth factors between donors and short half-life [9]. Therefore, the consistency of unlike observation in a row must be confined.

Lyophilization or Freeze-drying is the process of removing water in the form of vapor. The process involves freezing followed by water sublimation and subsequent removal of water vapor. Precisely, lyophilization is used to improve the storage potential and stability of protein particles. It has been proposed as a stable method for product standardization, and the invention of an out-of-the-box product with improved stability, ready for future uses [29]. Lyophilized platelet product options are not much explored, but as per the available evidence, their effectiveness might be almost equal to platelet lysates. Aiming for good manufacturing procedure (GMP), to replace current xenogenic products such as FBS. In this study, we preserved HPL by lyophilization technique and stored for up to 2 years. Two essential growth factors BMP-2 and PDGF-BB concentration were measured to examine the stability. Also, BMSCs from three different donors were cultured in media supplemented with either FBS or HPL or LPL to determine the proliferation and tri-lineage differentiation. We hope that our findings will support the use of outdated blood products as well as investigate the effectiveness of the lyophilization procedure for maintaining HPL stability and its application in BMSC culture.

2. The Conceptual framework/Study design

In this study, Human Platelet lysate (HPL) was prepared from a simple freeze-thaw procedure by using an outdated pooled leukocyte-poor platelet concentrates (LPPCs), HPL was further freeze-dried/lyophilized to prepare human platelet lysate (LPL) and stored for up to 2 years shown in Figure 2A. Human bone marrowderived (BMSCs) from 3 donors were isolated from bone marrow aspirates by Density gradient centrifugation using histopaque 1.077 g/mL solution and seeded in media with FBS for expansion. For experimentation purposes, the cells were re-seeded in a culture medium supplemented with either freshly prepared or -20^oC stored 10% fetal bovine serum (FBS), 10% HPL, or 10% LPL to determine the proliferation, surface marker expression, and mesodermal differentiation. Also, two essential growth factors BMP-2 and PDGF-BB concentration in LPL were measured and compared with HPL. The flowchart of the study design is illustrated in Figure 1



Fig. 1 The flowchart illustrating the study design.

3. Research materials, methods, data collection and data analysis

3.1 Preparation and storage of fresh human platelet lysate (HPL), lyophilized platelet lysate (LPL), and 2-year storage counterpart: Outdated pooled leukocyte-poor platelet concentrates (LPPCs) units were collected from the hospital blood bank. Processes were approved by Mahidol University's central institutional review board (MU-CIRB2020/180.2307). fresh human platelet lysate (fHPL) was prepared from outdated pooled leukocyte-poor platelet concentrates (LPPCs) by the 2-cycle freeze-thaw procedure. LPPCs were frozen at -80°C and thawed at 37°C in a water bath. Clot formation was activated by adding 2M calcium chloride (CaCl₂, Merck, Germany), the coagulated product was centrifuged at 4,800g for 30 minutes and removed. The supernatant was collected and filtered with a 0.22 μ m sterile filter membrane (Sartorius, Germany). To prepare fresh human lyophilized platelet lysate (fLPL), fHPL was freeze-dried by lyophilizer (LSI; lyophilization system, Inc.) as described in Figure 2A. Both fHPL and fLPL were aliquoted and stored at -20°C for 2 years to obtain
stored human platelet lysate (sHPL) and stored human lyophilized platelet lysate (sLPL), respectively. The preparation of fHPL, fLPL, sHPL, and sLPL were processed from the same batch of LPPCs.

3.2 Isolation and culture of human bone marrow-derived mesenchymal stem cells (BMSCs): Human bone marrow-derived mesenchymal stem cells (BMSCs) were isolated from bone marrow aspirates by Histopaque 1.077 g/mL density gradient centrifugation (Merck, Germany). BMSCs were cultured with growth medium containing Dulbecco's modified Eagle's medium low glucose (DMEM-LG) supplemented with 10% fetal bovine serum (FBS), (Merck, Germany), 1% Penicillin Streptomycin (Merck, Germany) and 1% of Glutamax (Thermo Fisher Scientific, USA). BMSCs were seeded in T75 cell culture flasks and maintained at 37°C, 5% CO2 with 95% humidity. Growth mediums were changed twice a week. BMSCs at passage 3rd-5th were employed for the experiments in this study.

3.3 Cell proliferation and population doubling time (PDT) of bone marrow-derived mesenchymal stem cells (BMSCs): BMSCs at the 3rd passage were seeded on a 24-well flat bottom plate (SPL, Korea) with 5.5×10^3 cells/cm² density. BMSCs were supplemented with a growth medium containing either 10% of fetal bovine serum (FBS), fHPL, fLPL, sHPL, or sLPL. We observed cell morphology and performed manual cell counting daily for up to 7 days. Data were calculated into population doubling time (PDT) using the "cell calculator" tools (doubling-time.com; Roth V., 2006) and presented as mean \pm SEM to compare the differences between each medium-supplemented group.

3.4 Bone marrow-derived mesenchymal stem cells (BMSCs) surface marker expression: Immunophenotypic study by flow cytometry: BMSCs at the 5th passage were seeded in T25 cell culture flasks (SPL, Korea) with 5.5 x 10³ cells/cm² density. BMSCs were cultured in a growth medium supplemented with either 10% of FBS, sHPL or sLPL for 7 days. Cells were harvested and stained with anti-human CD34 PE (BD bioscience, USA), anti-human CD45 PerCP (Miltenyi Biotec, Germany), anti-human CD73 PE/Cy-7 (Biolegend, California), anti-human CD90 APC (Miltenyi Biotec, Germany), anti-human CD105 PE (Biolegend, California) and fixed with 1% paraformaldehyde (GPO, Thailand). The positivity and negativity of all CD markers were examined and analyzed by BDFACS Canto II (BD Bioscience, USA), BDFACSDiva software version 6.1.3.

3.5. Tri-lineage differentiation of human bone marrow-derived mesenchymal stem cells (BMSCs) by alizarin red S, oil red O and alcian blue staining: BMSCs at the 5th passage were seeded in 35 mm cell culture dishes (SPL, Korea) with 5.5 x 10^3 cells/cm² density. BMSCs were cultured in a growth medium supplemented with either 10% FBS, sHPL, or sLPL in combination with a specific lineage differentiation medium. For osteogenic differentiation, the growth medium was supplemented with 100 nM dexamethasone (Sigma-Aldrich, USA), 50 µg/ml ascorbic acid (Sigma-Aldrich, USA), and 10 mM β -glycerophosphate (Merck, Germany). Alizarin red S staining for calcium mineralization was performed. Alizarin Red-S staining was quantified on days 7, 14, 21, and 28. Sample absorbance was measured at 405 nm wavelength and analyzed by Skanittm RE version 6.1.1, (Thermo Fisher Scientific, USA). For adipogenic differentiation, 500 µM isobutyl methylxanthine (IBMX, Merck, Germany), 1 µM dexamethasone (Sigma-Aldrich, USA), 10 µM insulin (Sigma-Aldrich, USA), and 200 µM indomethacin (Sigma-Aldrich, USA) were added to the growth medium. Fat droplets

were stained with oil-red O staining. For chondrogenic differentiation, BMSCs were cultured with StemPro® osteocyte/chondrocyte differentiation basal medium (Thermo Fisher Scientific, USA). Cells were stained using the alcian blue staining kit (Thermo Fisher Scientific, USA) and proteoglycan synthesis was observed. Cell morphology was observed by an inverted microscope (Olympus, Japan).

3.6 Bone morphogenetic protein 2 (BMP-2) and platelet-derived growth factor-BB (PDGF-BB) measurement by enzyme-linked immunosorbent assay for growth factor analysis: Bone morphogenetic protein 2 (BMP-2) and platelet-derived growth factor-BB (PDGF-BB) in fHPL, fLPL, sHPL, and sLPL were quantitatively analyzed by indirect enzyme-linked immunosorbent assay (ELISA). Recombinant BMP-2 (Biolegend, California) and PDGF-BB (Biolegend, California) were used as standard control. Standard and sample were coated at 4°C, overnight. Excess samples were discarded and washed with 1% tween in phosphate buffer saline (PBS-T). The unbound area was blocked with 1% Bovine serum albumin (BSA, Merck, Germany) in PBS. Primary Antibodies; anti-BMP-2 (Sigma-Aldrich, USA) and anti-PDGF-BB (Merck, Germany), and secondary antibodies with HRP linked; horse anti-mouse IgG (Cell Signaling Technology, USA) and goat anti-rabbit IgG (Abcam, UK) were used to detect sample signal. Detection signals were developed by TMB solution. Sample absorbance was measured at 450 nm wavelength by Skanittm microplate reader and software (Thermo Fisher Scientific, USA).

3.7 Data analysis: Results are presented as mean \pm standard error of the mean (SEM) obtained from biological differences of BMSCs donors. Figures were representative of the groups. Statistical analysis was performed by using GraphPad Prism software version 8. A T-test was applied to compare the mean and statistical significance differences between each growth medium supplement conditions. Data were considered statistically significant at p < 0.05 (*) and p < 0.001 (**).

4. Research Findings

4.1 Fresh human platelet lysate (fHPL), fresh lyophilized human platelet lysate (fLPL) and stored human platelet lysate (sHPL), stored lyophilized human platelet lysate (sLPL) physiological appearance and reconstitution: Fresh human platelet lysate (fHPL) was observed as a clear yellow solution that can easily filter through a 0.22 μ m sterile syringe filter (Figure 2B). After lyophilization, the appearance of the fresh lyophilized human platelet lysate (fLPL) was light-yellow and dried with a cake-like texture. There are no major defects such as melt-back phenomena, breaking or cracking of vials, or spilled-out products found in production (Figure 2C). Then, fLPL with the same batch was stored as the dried (lyophilized) form at -20°C for 2 years (Figure 2D) and stored human lyophilized platelet lysate (sLPL) was reconstituted with sterile distilled water. Reconstituted sLPL were observed as a yellow solution similar to the original fHPL with little turbidity (Figure 2E). Both stored supplements (sHPL and sLPL) maintained a similar dry, light-yellow cake-like appearance, identical to their freshly prepared counterparts. The supplements were filtered through a 0.22 μ . filter membrane prior to being supplemented into bone marrow-derived mesenchymal stem cells (BMSCs) growth medium used in this study.



Fig. 2. HPL and LPL preparation. (A) A flow chart depicting the preparations of fHPL, fLPL, sHPL and sLPL from LPPCs by freeze-thaw cycles. (B) Freshly prepared human platelet lysate (fHPL) reveals a clear yellow solution. (C) Freshly lyophilized human platelet lysate (fLPL) demonstrated a light yellow color with a dried cake-like appearance. (D) sLPL with over 2 years in storage and (E) Reconstituted sLPL with sterile distilled water.

4.2. Stability of bone morphogenetic protein 2 (BMP-2) and platelet-derived growth factor-BB (PDGF-BB) after 2-year storage in lyophilized form: The initial concentration of BMP-2 was 63.02 ± 6.78 and 51.82 ± 1.60 mg/mL for fHPL and fLPL, respectively (Figure 3A) while PDGF-BB concentration was 182.3 ± 9.58 and $201.0 \pm 26.76 \mu$ g/mL for fHPL and fLPL, respectively (Figure 3B). The results indicated that there was a minute change in growth factor levels after lyophilization. However, after storage, BMP-2 concentration in sHPL and sLPL were significantly decreased from the initial concentration to 15.33 ± 2.87 (*p*=0.0006) and 17.05 ± 3.87 (*p*=0.0012) mg/mL, respectively. Similarly, the concentration of PDGF-BB in sLPL was significantly decreased from the initial concentration of PDGF-BB in sLPL was significantly decreased from the initial concentration of PDGF-BB in sLPL was significantly decreased from the initial concentration of PDGF-BB in sLPL was significantly decreased from the initial concentration of PDGF-BB in sLPL was significantly decreased from the initial concentration to $72.33 \pm 16.78 \mu$ g/mL (*p*=0.0150). In this study, the concentrations of BMP-2 and PDGF-BB in sHPL and sLPL were calculated into percentages of remaining (% remaining). The percentages of remaining BMP-2 in sHPL and sLPL were 24.20 ± 3.71 and 32.51 ± 6.30 %, respectively (Figure 3C). On the other hand, the percentages of remaining PDGF-BB in sHPL and sLPL were 74.86 ± 15.89 and 37.07 ± 9.86 %, respectively (Figure 3D) (n=3).



Fig. 3 Quantitative analysis of BMP-2 and PDGF-BB in fHPL, fLPL, sHPL, and sLPL. (A) Bone morphogenetic protein 2 (BMP-2) and (B) platelet-derived growth factor BB (PDGF-BB) concentrations were measured by ELISA. Initial concentrations of BMP-2 and PDGF-BB in fHPL and fLPL were used to calculate the percentage of remaining (%remaining) as compared to sHPL and sLPL. Growth factor concentration and percentage of remaining were presented as mean ± SEM (n=3) with *p<0.05 and **p<0.001, statistical significance was determined using t-test to compare each condition.</p>

4.3 Stored platelet lysates (sHPL and sLPL) enhance the proliferative potential in bone marrow-derived mesenchymal stem cells (BMSCs). Growth assistive potency remains stable after 2 years of storage: The growth assistive properties of 10% sHPL and sLPL, compared with fHPL and fLPL in BMSCs culture were constant. fHPL and fLPL reflected the rapid growth assistive capability of BMSCs from consecutive 7-day cell counting data. The morphology of BMSCs from all supplements showed similar spindle-shaped cells. The confluences of BMSCs in a growth medium supplemented with sHPL and sLPL were highly denser than BMSCs cultured with FBS at day 7 (Figure 4A-C). The growth potential of BMSCs in fHPL, fLPL (Figure 4D), sHPL, and sLPL (Figure 4E), presented by total cell number from days 0-7, were superior to those supplemented with FBS. In addition, an accelerated proliferation of BMSCs and significantly less time-consuming population doubling time (PDT) were observed in BMSCs groups cultured with fHPL, fLPL, sHPL, and sLPL. PDT was significantly minimized from 48.21 (\pm 1.54) hours in BMSCs cultured in medium supplemented with FBS to 36.48 (\pm 0.74) (p=0.0023) and 36.35 (\pm 0.62) (p=0.0020) hours in fHPL and fLPL, respectively (Figure 4F). PDT of cultured BMSCs containing sHPL and sLPL demonstrated 32.91 (\pm 0.78) (p=0.0002) and 34.50 (\pm 0.72) (p=0.0002) hours, as compared to FBS 52.04 (\pm 1.15) hours (Figure 4G), which were statistically significant.



Fig 4(A) FBS, (B) sHPL and (C) sLPL. Cell morphology captured at day 7 with a 10x and 20x objective lens magnification. Total cell number of BMSCs cultured in a growth medium supplemented with fresh (fHPL and fLPL) and stored (sHPL and sLPL) groups were collected by manual cell counting (D, E). PDT was calculated from cell number data. Cell number and PDT were presented as mean ± SEM (F, G). Scale bar, 200 µm. *p<0.05 and **p<0.001, statistical significance was determined using the t-test to compare each condition (n=3).

4.4. Bone marrow-derived mesenchymal stem cells (BMSCs) characteristics observed in the growth medium, supplemented with stored platelet lysates (sHPL and sLPL), assessment and comparison with fetal bovine serum (FBS)

4.4.1. BMSCs surface markers' expression: 10% sHPL and sLPL in the growth medium were capable of maintaining a decent percentage of BMSCs surface marker expression including CD105, CD90, CD73 and hematopoietic cells including CD34 and CD45 after the 5th passage of cell expansion. BMSCs cultured from each supplement revealed their similarity by showing positive expression for CD73, CD90, and CD105 > 95.0% of total cells. Meanwhile, the expression of hematopoietic markers (i.e., CD34 and CD45) was less than 2% in all supplemented cultures (Figure 5). Data in this experiment were collected from two BMSC donors which are separately shown in Table 1 and Figure 5.

								00.34	00-45	00 79	08-90	CD 105
		Percentage of positive cells (%)					-	4.	4.	1 -1	1 -1	4
		CD34	CD45	CD73	CD90	CD105	144		14	1,4	1,1,4	1, 1,
	FBS	0.2	0.9	100	99.9	99.6						
BMSC	der.	0.4	1.7	100	99.7	99.0		1.	41.	-	- 1	4 1-
	4.71.	0.8	2.4	99.6	99.8	59.4		1	1	1, 1,	1,1,4	1,4,
marc	FBS	0.5	0.3	99.8	99.5	97.7						
112	diff.	0.4	0.2	99.9	99.9	98.9	- 14	1.	1.		1.1	3 4-
	4.7%	0.2	0.0	99.9	99.6	98.8			1	1,4	1,1,4	1, 1,
								deel.	- allouds	alleche	start's	ded.

Table 1. Flow cytometry analysis showing percentages of BMSCs surface marker expressions including CD34, CD45, CD73, CD90 and CD105. BMSCs were analyzed by BDFACS Canto II (BD Bioscience, USA), BDFACSDiva software version 6.1.3. Percentages of positive CD markers were separately shown for each BMSCs

Fig. 5 Flow cytometry analysis of BMSCs cell surface expression. MSCs surface markers including CD34, CD45, CD73, CD90 and CD105 were analyzed by flow cytometry analysis. Histograms show the percentage of each CD marker positivity. BMSCs were cultured in a growth medium supplemented with 10% FBS, sHPL and sLPL for 7 days. The positivity and negativity of each CD marker were examined and analyzed by BDFACS Canto II (BD Bioscience, USA), BDFACSDiva software version 6.1.3.

4.4.2. MSCs tri-lineage differentiation potential: BMSCs cultured in a growth medium supplemented with 10% FBS, sHPL and sLPL exhibit positive tri-lineage differentiation potentials. For osteogenic differentiation, cells were positive for calcium mineralization by alizarin red S staining (Figure 6A). For adipogenic and chondrogenic differentiation, fat droplets and proteoglycan synthesis were stained with oil red O (Figure 6B) and alcian blue staining (Figure 6C), respectively. In addition, we performed a semi-quantitative analysis of the osteogenic induction potential of sHPL and sLPL. We quantified alizarin red S staining absorbance at 405 nm wavelength. The results indicated that BMSCs cultured on an osteogenic induction medium supplemented with 10% sHPL and sLPL exhibited significantly strong osteogenic differentiation at day 14, 21, and 28 while 10% FBS-supplemented groups were positive for the staining at day 28 (Figure 6D). Semi-quantitative measurement of alizarin red S staining exhibit significantly increased osteogenic differentiation in fHPL (0.2037 \pm 0.01) (p=0.0002) and fLPL (0.5450 \pm 0.01) (p<0.0001) as compared to FBS (0.0453 \pm 0.0012) at day 14. Significantly high alizarin red S staining of BMSCs in fHPL and fLPL was also observed on days 21 and 28 (Figure 6D).



Fig. 6 Tri-lineage differentiation of BMSCs. (A) Calcium mineralization, (B) Fat droplet and (C) proteoglycan synthesis were positively stained in BMSCs cultured with 10% FBS, sHPL and sLPL supplemented in osteogenic, adipogenic and chondrogenic induction medium, respectively. (D) Semi-quantitative analysis shows significantly increased osteogenic induction of osteogenic differentiation medium supplemented with 10% sHPL and sLPL as compared to FBS at day 14, 21 and 28. Cells were observed under an inverted microscope with a 20x objective lens magnification. Scale bar, 200 μ m. Data obtained from semi-quantitative ARS measurements are presented as mean \pm SEM (n=3), with *p<0.05 and **p<0.001, statistical significance was determined using a t-test to compare each condition.

5. Discussion & Conclusion

Bone marrow-derived mesenchymal stem cells (BMSCs) have been identified as the most promising cell source with an increase in therapeutic utilization worldwide [30]. However, due to its low profusion in bone marrow (BM) immense in vitro cultivation and expansion methods are essential to achieve appropriate amounts of cells for a research study or clinical applications [31]. Aiming for a Good manufacturing procedure (GMP), a human-derived growth medium supplement for BMSCs must be developed to replace the current xenogenic product; fetal bovine serum (FBS). FBS has been extensively used as a media supplement in the cell cultivation process, despite threats regarding safety and ethical issues [13]. Human products are proposed as an alternative to FBS, to provide essential bioactive molecules and growth factors [32]. Human platelet lysate (HPL) and lyophilized human platelet lysate (LPL) are remarkable products to optimize for upcoming trends in medical or GMP-grade laboratories. Considering the above we prepared HPL and LPL from outdated pooled leukocyte-poor platelet concentrates (LPPCs) by 2 two-cycle freeze-thaw procedure. Fresh human platelet lysate (fHPL) was then further processed into LPL. Part of this fresh lyophilized human platelet lysate (fLPL) and fHPL were aliquoted and stored at -20°C for 2 years. The physiological appearance of lyophilized products (fLPL and sLPL) had no major defects such as melt-back phenomena, breaking or cracking of vials, or spilled-out products found during production, which is the acceptable quality criteria for lyophilized products. Additionally, the evaluation of successful lyophilization can be performed by the physiological appearance and characteristics such as

reconstituted solubility, protein concentration, remaining percentage moisture content, and sterility which could be conducted [29]. Observational study using a scanning electron microscope (SEM) can also be performed for HPL scaffolds-based model to provide the microscopic structure of the product [33, 34].

The stability of bioactive substances in sHPL and sLPL are essential keys to indicate the distinctive quality of prolonged storage products. In this study, lyophilization processes were adapted to extend growth factor stability. Several studies have mentioned the beneficial effects of "lyophilization", which is renowned as an alternative preservation procedure to increase the stability of protein content in samples [35, 36]. According to the study by Notodihardjo et al.[19], HPL was successfully converted to solid substances with the ability to preserve it in the form of dry products without melt-back phenomena. The quantitative analysis of the stability of two essential growth factors such as bone morphogenetic protein 2 (BMP-2) and platelet-derived growth factor-BB (PDGF-BB) in fHPL, fLPL, sHPL and sLPL samples reflected significantly decreased growth factor levels that might indicate unstable properties of BMP-2 and PDGF-BB in sHPL and sLPL during unoptimized long storage duration. To develop and extend growth factor shelf life, further studies of growth factor storage conditions and alteration of BMP-2 and PDGF-BB concentration are needed. Apart from BMP-2 and PDGF-BB stability, other growth factors and cytokines in HPL can be further investigated to apply for *in vitro* studies of other cell types. We supplemented 10% of fHPL, fLPL, sHPL and sLPL into BMSCs growth medium containing Dulbecco's modified Eagle's medium low glucose (DMEM-LG) to observe growth assistive capability. An elevated proliferative trend and significantly minimized and rapid PDT of BMSCs were observed in 10% of fHPL, fLPL, sHPL and sLPL from 7 days of consecutive cell counting. This proliferative trend might be due to the pool of bioactive compounds and growth factors residing in human platelet lysate as mentioned by other studies [37]. For in vitro and ex vivo MSCs expansion, the proliferation of BMSCs was strongly dependent on the extracellular signal-regulated kinase (ERK) signaling pathway which is strongly transduced by activation of PDGF-BB through tyrosine kinase receptor (TKR) and mitogen-activated protein kinase (MAPK) [32, 38, 39]. Moreover, BMP-2 mediated SMAD pathway is also a potent BMSCs proliferator and osteogenic induction molecule [32]

The expression of surface markers and differentiation potentials towards adipogenic and chondrogenic lineage remained unaltered. However, significantly increased differentiation potential towards osteogenic lineage was observed. The huge differences in the results might involve the presence of BMP-2 in sHPL and sLPL. BMP-2 is recognized as a strong osteogenic differentiation supportive factor through SMAD Runx2 and Wnt β -catenin pathways [40]. Our study revealed the stability of growth-assistive performances of stored human lyophilized platelets (sLPL) and stored human platelet lysate (sHPL) which were preserved at -20°C for 2 years. 10% of sHPL and sLPL in this study were able to support cell expansion and maintain decent Mesenchymal stem cell (MSCs) characteristics including cell surface markers and tri-lineage differentiation. The instability of BMP-2 and PDGF-BB levels occurred after storage. However, pools of bioactive compounds in sHPL and sLPL are maintained at a satisfactory level, which is enough to support bone marrow-derived mesenchymal stem cells (BMSCs) expansion and maintain BMSCs characteristics. Furthermore, 10% of sHPL and sLPL can minimize time and growth medium consumption to reach the desired, clinically meaningful cell number for further research or clinical applications. The comparison of BMSCs characteristics including MSCs surface markers and trilineage differentiation which reflect characteristics of BMSCs were shown. For further study, several other MSCs characteristics including cellular senescence (aging), oncogene, mutation, microbial and toxin contamination can be performed to ensure the high qualities of MSCs as cellular materials for clinical purposes.

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7. Compliance with ethical standards

Outdated pooled leukocyte-poor platelet concentrate (LPPC) collection processes were approved by Mahidol University Central Institutional Review Board (MU-CIRB2020/180.2307) with a certificate of exemption (COE 2020/107.2508). Human bone marrow-derived mesenchymal stem cells (BMSCs) collection processes were approved by the Ethical Committee of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University (MURA2017/603). All works were conducted in accordance with the Declaration of Helsinki, donor informed consents were signed and collected before sample collection.

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Techno-economic analysis of dimethyl ether production via direct hydrogenation of CO₂

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ABSTRACT

To achieve carbon neutrality by 2050, alternative and sustainable fuels are receiving significant attention. One of the interesting options is dimethyl ether (DME), which can be synthesized from CO_2 , along with its low NO_x and CO_x emissions. This research aims to simulate the production process of DME using CO_2 as feedstock by comparing between indirect synthesis (two-step process) and direct synthesis (one-step process) methods. These processes were developed based on validated thermodynamic and reaction kinetic expressions, using Aspen Plus V11 software. Furthermore, an economic feasibility assessment was conducted. It was found that the one-step process is capable of CO_2 reduction -0.98 ton $CO_2/$ ton DME. It also consumes less energy compared to that of the two-step process. Moreover, the economic analysis showed that the one-step process requires lower investment and operating costs than the two-step process. Consequently, the one-step process production is well-suited to serve as a CO_2 utilization process.

Keywords: Dimethyl ether, CO₂ utilization, Techno-economics analysis, Alternative fuel

1. Introduction

In COP26, Thailand has committed to achieving carbon neutrality by 2050 and reaching net-zero greenhouse gas emissions by 2065. According to the Energy Policy and Planning Office (EPPO) report in 2022, Thailand released 247.6 million tons of CO_2 . Most of these emissions originated from the power generation (36%) and industry (27%) sectors. (EPPO, 2023) The emissions primarily result from the utilization of fossil fuels, which release a large amount of carbon and are non-renewable sources of energy. Therefore, it is essential to find

alternative fuels that are sustainable and have low carbon emissions. One of the alternative fuels that is gaining attention is dimethyl ether (DME), due to its potential as a clean fuel source that can be synthesized from CO_2 .

In the past, DME was produced through catalytic dehydration of methanol using solid acid catalysts, such as γ -alumina, zeolites, and HZSM-5, where methanol was derived from syngas. This process design is known as an indirect synthesis or two- step process. (J. Kampen, 2020) On the other hand, methanol can be produced from CO/ CO₂ and H₂ using copper or zinc-based catalysts. (K. Stangeland, 2021) Recently, the direct synthesis (one- step process) of DME production from CO₂ has been receiving attention. In this synthesis, a bifunctional catalyst is used, which is formed by combining methanol synthesis catalyst and methanol dehydration catalyst. For example, CuO-ZnO-Al₂O₃ mixed with γ -alumina. (R. Peláez,2017) Both the two-step and the one-step processes for DME production have distinct advantages, warranting a discussion about which design basis is more suitable in terms of economic and CO₂ utilization.

In this research, DME production from CO_2 was simulated using Aspen Plus V11 to perform process analysis and economic evaluation. A sensitivity analysis of process parameters such as design basis, raw material, and product prices was conducted to understand the impacts of these factors on economic feasibility. The simulation and techno- economic provided in this research are compared to justify the appropriate process for DME production from CO_2 .

2. Research Objective

(1) To establish a process design for DME production via hydrogenation of CO_2 .

(2) To provide a comparative study of design basis on DME production from CO_2 based on reaction kinetic model from literature reviews in terms of DME production rate, net CO_2 emissions, and energy consumption by using process simulation and study the economic feasibility of DME production.

3. Literature Review

3.1 Theory, Concept and Related Research

Dimethyl ether is a clean fuel due to its low NO_x and CO_x emissions when combustion occurs. It has similar cetane number like diesel and vapor pressure like LPG, which makes it possible to blend with LPG for household use and add some additives to replace diesel fuel. It can also be used as a feedstock in the production of acetic acid and ethanol. In the past, dimethyl ether was primarily produced from methanol and syngas, but to achieve net-zero CO_2 emissions in the future, the production of dimethyl ether from CO_2 is of great interest for industry. (Y. Putrasari, 2022) DME synthesis from CO_2 involves a series of reversible reactions (eqns (1)-(3)). (U. Mondal, 2022)

Methanol synthesis from CO₂

$$CO_{2} + 3H_{2} \leftrightarrow CH_{3}OH + H_{2}O \qquad \Delta H_{298}^{\circ} = -49.4 \text{ kJ/mol} \quad (1)$$
Methanol synthesis from CO
$$CO_{2} + 3H_{2} \leftrightarrow CH_{3}OH + H_{2}O \qquad \Delta H_{298}^{\circ} = -90.7 \text{ kJ/mol} \quad (2)$$

Methanol dehydration reaction

2

$$2CH_{3}OH \leftrightarrow CH_{3}OCH_{3} + H_{2}O$$
 $\Delta H_{298}^{*} = -23.5 \text{ kJ/mol}$ (3)

Side reaction that affects chemical equilibrium.

Reverse water gas shift reaction

$$CO_2 + H_2 \leftrightarrow CO + H_2O$$
 $\Delta H_{298} = +41.2 \text{ kJ/mol}$ (4)

The design basis for DME synthesis process from CO_2 can be divided into 2 types: the two-step process and the one-step process. In the two-step process, the initial step involves converting CO_2 to methanol through a methanol synthesis reaction in the first reactor. In the second step, the produced methanol undergoes a methanol dehydration reaction in the second reactor, resulting in DME as the product. On the other hand, in the one-step process, CO_2 is directly transformed into DME within a single reactor using a bifunctional catalyst.



Fig.1 Simplified two-step process.



Fig.2 Simplified one-step process.

The two-step process has the advantage that after the process stream exits the methanol synthesis reactor, a separation system can be designed to remove water from the process stream before entering the methanol dehydration reactor. This separation of water before entering the methanol dehydration reactor shifts forward the chemical equilibrium in the second reactor, enhancing the reaction efficiency. However, the two-step process also has the disadvantage that the separation system is repetitive, potentially leading to higher energy consumption.

The one- step process has the advantage of enhancing DME yield using a single reactor, which is more thermodynamically favored and results in the chemical equilibrium shifting forward for DME synthesis. Furthermore, DME synthesis can take place at higher temperatures and reduced pressure through methanol dehydration, as opposed to the methanol synthesis reaction. (D. Kubas, 2023) However, the one-step process has a drawback in which both DME and CO_2 coexist in the reactor exit stream, resulting in a more complex separation system.

3.2 Thermodynamic models

Due to the system containing polar components and light gases, units with an operating pressure above 10 bar will use the Redlich-Kwong-Soave (SRK) model, while units with operating pressure below 10 bar will use NRTL-RK with Henry's components (CO, CO_2 , H_2 and N_2). This selection ensures the simulation achieves the highest accuracy in predicting the composition of light gases dissolved in liquid. The values for Henry's components will be obtained from experimental data available in the NIST database. (T. Wei, 2021)

3.3 Reaction kinetic models

All the reaction kinetic models used in this research are listed in Table 1. The application range of each model is also listed in Table 1, which is used for developing and optimizing the process.

		Kinetic equation	Details
Indirect synthesis (Two-step process)	Methanol synthesis	$\begin{split} r_{1} = & \frac{k_{1}K_{CO_{2}}(f_{CO_{2}}f_{H_{2}}^{1.5} - \frac{f_{CH_{3}OH}f_{H_{2}O}}{K_{eq,1}f_{H_{2}}^{1.5}})}{(1 + K_{CO_{2}}f_{CO_{2}} + K_{CO}f_{CO})(f_{H_{2}}^{0.5} + (\frac{K_{H_{2}O}}{K_{H_{2}}^{0.5}})f_{H_{2}O})}{k_{2}K_{CO}(f_{CO}f_{H_{2}}^{1.5} - \frac{f_{CH_{3}OH}}{K_{eq,2}f_{H_{2}}^{0.5}})} \\ r_{2} = & \frac{k_{2}K_{CO}(f_{CO}f_{H_{2}}^{1.5} - \frac{f_{CH_{3}OH}}{K_{eq,2}f_{H_{2}}^{0.5}})}{(1 + K_{CO_{2}}f_{CO_{2}} + K_{CO}f_{CO})(f_{H_{2}}^{0.5} + (\frac{K_{H_{2}O}}{K_{H_{2}}^{0.5}})f_{H_{2}O})} \\ k_{4}K_{CO_{2}}(f_{CO_{2}}f_{H_{2}} - \frac{f_{H_{2}O}f_{CO}}{K_{eq,4}})} \\ r_{4} = & \frac{(1 + K_{CO_{2}}f_{CO_{2}} + K_{CO}f_{CO})(f_{H_{2}}^{0.5} + (\frac{K_{H_{2}O}}{K_{H_{2}}^{0.5}})f_{H_{2}O})}{(1 + K_{CO_{2}}f_{CO_{2}} + K_{CO}f_{CO})(f_{H_{2}}^{0.5} + (\frac{K_{H_{2}O}}{K_{H_{2}}^{0.5}})f_{H_{2}O})} \end{split}$	Cu-Zn-Al-Zr Fibrous catalyst Temperature: 210-270 °C Pressure: 20-50 bar Space velocity: 1,000 to 10,000 ml/g.cat-h An Xin, (2009)
	Methanol dehydration	$r_3 = k_1 C_{CH_3OH} - k_2 C_{H_2O}$	γ-alumina Temperature: 200-350 °C Pressure: 1 atm WHSV: 30 h ⁻¹ Y. Tavan, (2013)
direct synthesis (One-step process)	DME synthesis	$ r_{1} = \frac{k_{1}K_{CO_{2}}(f_{CO_{2}}f_{H_{2}}^{1.5} - \frac{f_{CH_{3}OH}f_{H_{2}O}}{K_{eq,1}f_{H_{2}}^{1.5}})}{(1+K_{CO_{2}}f_{CO_{2}}+K_{CO}f_{CO})(f_{H_{2}}^{0.5} + (\frac{K_{H_{2}O}}{K_{H_{2}}^{0.5}})f_{H_{2}O})}{k_{2}K_{CO}(f_{CO}}f_{H_{2}}^{1.5} - \frac{f_{CH_{3}OH}}{K_{eq,2}f_{H_{2}}^{0.5}})}{(1+K_{CO_{2}}f_{CO_{2}}+K_{CO}f_{CO})(f_{H_{2}}^{0.5} + (\frac{K_{H_{2}O}}{K_{H_{2}}^{0.5}})f_{H_{2}O})}$ $r_{3} = \frac{k_{3}(f_{CH_{3}OH}^{2} - \frac{f_{DME}f_{H_{2}O}}{K_{eq,3}})}{(1+K_{H_{2}O}f_{H_{2}O} - \frac{f_{DME}f_{H_{2}O}}{K_{eq,3}})}$ $r_{4} = \frac{k_{4}K_{CO_{2}}(f_{CO_{2}}f_{H_{2}} - \frac{f_{H_{2}O}f_{CO}}{K_{eq,4}})}{(1+K_{CO_{2}}f_{CO_{2}} + K_{CO}f_{CO})(f_{H_{2}}^{0.5} + (\frac{K_{H_{2}O}}{K_{eq,4}}))}$	CuO-ZnO-Al ₂ O ₃ -ZrO ₂ /HZSM-5 Temperature: 210-270 °C Pressure: 20-50 bar Space velocity: 1,000 to 10,000 ml/g.cat-h An Xin, (2008)

Table 1 Reaction kinetic models used in this research.

4. Materials and Methods

4.1 Process scope

This research studied the feasibility of DME production. Therefore, the production capacity used for process simulation was based on a commercial scale. S. Michailos (2019) investigated a two-step process for DME production with a production rate of 30.7 tons of DME per hour, which totals approximately 500,000 tons of CO_2 per year (based on 8000 operating hours). For the two-step and one-step processes discussed in this research, electrolytic H₂ from renewable energy and CO₂ captured from flue gas were assumed to be used as feedstocks. The concentration of H₂ was assumed to be 99.99% with 0.01% water, while CO_2 was assumed to be 99.8% with 0.2% N₂. (T. Wei, 2021) The CO₂ feed for DME production was assumed to be 62.5 tons per hour.

4.2 Process design and simulation

All simulations were performed using Aspen Plus V11, as shown in Figures 3-4. The simulation of the two-step process (Fig. 3) was divided into two sections: Section 1 for methanol synthesis and Section 2 for methanol dehydration. The two-step process consists of two major units including 2 reactors and 3 distillation columns. CO₂ and H₂ are fed into the process through Stream No.1 and Stream No.2, along with the recycled stream in Stream No.14. Then, it is heated up to reaction temperature for the methanol synthesis reactor with operating temperature of 250°C and pressure of 50 bar. (An Xin, 2009) The outlet stream from the reactor, Stream No.6, consists of methanol, water, and unreacted light gases. This stream is cooled to separate unreacted light gases in a flash drum (V101). Most light gases are recycled back to the reactor, while some of the stream is purged to avoid the accumulation of impurity N₂. The separated liquid from V101 contains methanol, water, and a small amount of light gases. Consequently, it is necessary to extract these light gases through the CO₂ separation column (T101) to ensure high purity of DME in the next section. Stream No.16, which has been stripped of gases in T101, is transported to Section 2 and combines with the recycle stream (Stream No.43) before entering the methanol separation column (T201). The separated methanol is heated to the reaction temperature. The methanol dehydration reactor (R201) is operated at 290°C and 1.31 bar. The operating temperature at 290°C is close to the reaction equilibrium. (Y. Tavan., 2013) The outlet stream from the reactor, Stream No. 30, consists of DME, unreacted methanol and water. This stream is cooled, and unreacted methanol and water are separated in the liquid phase in the flash drum (V201), and then recycled back to the methanol separation column (T201). The DME separated from V201 is cooled down and transported to the DME separation column (T202) for purification. The purified DME exits as a liquid phase from Stream No.39 at a pressure of 5 bar, which is the storage pressure, (ETIP, 2023) and with a DME mass purity exceeding 98.5% to meet the fuel standard (ISO 16861).



Fig.3 Process flow diagram of the two-step process for DME production.

The one-step process consists of two major units including 1 reactor and 3 distillation columns (Fig.4). The design is similar to Section 1 of the two-step process. The difference is that the reactor becomes a direct DME synthesis reactor operated at a temperature of 250° C and pressure of 50 bar. (An Xin, 2008) As a result, the outlet stream consists of DME, methanol, water, and unreacted light gases. The presence of both CO₂ and DME in this stream affects the increased operating pressure of the CO₂ separation column, allowing chilled water to be utilized as a condenser utility. Stream No. 19 contains DME, methanol, and water. It is transported to the DME separation column (T102) for separating DME from the process. After that, it proceeds to the methanol separation column to recycle methanol back to the reactor. This is because methanol can react to DME, as explained in Section 3.1.



Fig.4 Process flow diagram of the one-step process for DME production.

4.3 Energy utilization evaluation

To evaluate the energy efficiency of each process, the specific energy consumption (SEC) is used as a comparative index.

specific energy consumption (SEC) =
$$\frac{\text{Energy consumed}}{\text{DME production rate}}$$

4.4 Net CO, emission

To calculate net CO_2 emissions, both direct CO_2 entering and leaving the system are considered, as well as indirect emissions resulting from the use of utilities in the form of CO_2 equivalents. The CO_2 equivalents are calculated using the Aspen Energy Analyzer software, referencing the US EPA Rule E9-5711.

$$CO_2$$
 net emission = $\frac{CO_2 \text{ emission-}CO_2 \text{ consumed}}{DME \text{ production rate}}$

5. Result and discussion

5.1 Process analysis

From Table 2, when comparing the specific energy consumption (SEC), the two-step process requires more energy compared to the one-step process. This is because the reactor outlet stream from the methanol synthesis reactor in the two-step process needs to be cooled down before separating unreacted light gases, resulting in additional heating requirements for the methanol obtained from the first reactor before entering the methanol dehydration reactor. Therefore, the system demands more utilities, aligning with the increased CO_2 emissions from utilities.

Indicator	Two-step process	One-step process
DME production (ton DME/h)	29.56	30.08
Overall CO ₂ conversion (%)	92.22%	93.74%
Specific energy consumption (MWh/ton DME)	11.73	4.51
Process emission (ton CO ₂ /ton DME)	0.16	0.13
CO ₂ emission from utilities (ton CO ₂ /ton DME)	2.55	0.97
CO_2 consumed (ton CO_2 /ton DME)	2.11	2.08
Net CO ₂ emission (ton CO ₂ /ton DME)	0.60	-0.98

Table 2 Comparison of energy consumption and CO₂ emission.

5.1 Economic analysis

The one-step process was chosen to assess the economic feasibility of DME production due to its higher efficiency and potential for reducing CO_2 emissions. Capital cost and operating cost are referenced from calculations based on Turton et al. (2018). The necessary data is provided in Table 3.

Parameter	Value		
Location	Thailand		
Base year	2023		
Project lifetime (y)	10		
Construction period (y)	2		
Plant availability (h/y)	8,000		
Tax rate (%)	2.0		
Depreciation	5-years MACRS		
Electricity (USD/kWh)	0.149		
Renewable H ₂ cost (USD/kg)	4 (J.Lee , 2020)		
CO ₂ capture cost (USD/kg)	0.0847 (G. Guandalni, 2019)		
DME market price (USD/kg)	0.4 (Vincent D. and others, 2020)		

Table 3 information for economic analysis.

From the calculations, the revenue from selling DME amounts to 96,511,745 USD per year, while the annual cost of manufacturing is 441,654,884 USD per year. Therefore, the current DME production is not profitable. The cost of renewable H_2 is 284,453,966 USD per year, accounting for 64.4% of the cost of manufacturing. Consequently, a sensitivity analysis was conducted by varying the prices of H_2 and DME to find an appropriate price. The return on investment (ROI) and internal rate of return (IRR) thresholds that attract investors are typically set at exceeding 15% and 10%, respectively. (T. Wei, 2021) Based on the report from BloombergNEF (2020), they forecasted that by the year 2030, the price of renewable H_2 could decrease to around 1.165 - 2.72 USD/kg. Therefore, DME production to be profitable and attractive for investment. The selling price of DME should be in the range of 1.705 – 2.833 USD/kg.



Fig.5 Economic sensitivity analysis by varying H₂ price.

6. Conclusion

Based on a study involving the simulation of DME production using both two-step and one-step processes, it was determined that the one-step process is a suitable design for producing DME from CO₂. The one-step process exhibits a CO₂ reduction potential of -0.98 ton of CO₂ per ton of DME produced. Additionally, the economic analysis reveals that the current production process is not profitable. However, considering forecasts for the year 2030, if the cost of renewable H_2 decreases to the range of 1.165 - 2.72 USD/kg, the selling price of DME should be increased to the range of 1.705 – 2.833 USD/kg to make the process financially viable.

7. Suggestion

The suggestions for this paper include considering the markets for blue H_2 and grey H_2 , to comprehensively assess the economic feasibility of DME production from all aspects.

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The Style of Pixar Animation in 2020-2022

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Abstract

This research aims 1) To research the narrative film of Pixar Animation Studio film. And 2) To research the film language of Pixar Animation Studio film. This is qualitative research by using textual analysis from 5 Pixar animation films released during the period from 2020 to 2022 were selected by purposive sampling method. The selected films are as follows: 1) Soul (2020) 2) Onward (2020) 3) Luca (2021) 3) Turning Red (2022) 5) Lightyear (2022). The result found that:

The film narrative analysis of Pixar Animation Studio represented the "three-act" structure that refers Pixar's new interpretations of narrative themes and techniques allow for the continuity of the work while also increasing Pixar's individual innovation and thinking. They also have various styles such as drama, adventure, and science fiction. Most of Pixar's themes are related to the life of modern people. The film takes human emotions as the core, from which creative ideas are developed.

The film language analysis of Pixar Animation Studio film present film language as an art form that directly connects with the audience's audio-visual connection, and has a strong appeal. Through the study of camera shots, color and music in Pixar animation film. The language of Pixar films was dominated by natural style, supplemented by fantasy style. In the picture style, the colors are lively, the deformation is peculiar, the setting is sci-fi, virtual and reality are interspersed, and it is very creative, giving people a strong visual impact.

Keywords: Pixar Animation, Film Narrative, Film Language

1. Introduction

In the current era, various countries have introduced many promotion policies for the animation industry, so that the animation market has developed rapidly. American animation has always been at the forefront of animation development. It has many well-known animation studios and superb animation technology, which has a great influence on the animation development of various countries. The style of American animation is more exaggerated, with exaggerated slender waists and exaggerated character proportions. More anthropomorphic things, but the shape is relatively simple. Pixar Animation Studios is one of the representative well-known animation studios in the United States. It has been leading the trend of world animation with its advanced technology and unique ideas. Since its establishment, Pixar Animation Studio has realized many unconstrained ideas with its excellent 3D technology, and made many original stories successfully realized.

Pixar Animation Studios is an American computer animation studio best known for its feature-length animated films, which have achieved great success both artistically and commercially. Formerly known as the New York Institute of Technology's Computer Graphics Studio, Pixar was officially founded in 1979 as part of the Lucasfilm Computer Division. Pixar's most famous corporate culture is "the following commits the above". Any animator can come up with ideas for discussion. Everyone can imagine and exchange personal ideas. Another advantage of Pixar is computer technology. The Pixar team has always adhered to the strategic line of equal emphasis on software and hardware development and animation production. Pixar's creative team is almost crazy about the animation details. Pixar animation works have created many unbroken box office records in Hollywood history.

Pixar Animation Studios merge technology and art to connect people to the core of life, and that's how they create magic. They also show the emotional depth of the stories, their eye for detail, the way the films appeal to both children and adults, the relatable and unique characters, and their cutting-edge animation and effective teamwork have made Pixar one of the world's most beloved animation studios (https://pixune.com., 2022)

This research selects several representative works of Pixar Animation Studio for a comprehensive analysis. According to the development of contemporary society, cultural upsurge and technological development at the present stage, the film narrative and film language of Pixar animation are analyzed. Intended to be through the research of animation from Pixar Studios.

2. Research Objective

1) To research the narrative film of Pixar Animation Studio film

2) To research the film language of Pixar Animation Studio film.

3. Literature Review

3.1 The concept of narrative film

As an important phenomenon across cultures, media, and disciplines, narrative is essentially a subject that uses multiple narrative media to tell stories. In the process of film development, the discussion of narrative has always existed. The narrative structure mentioned by the French narratologist Todorov is that it begins in a state of balance in some form, then the balance is broken, and finally returns to balance (Hou Gengyang, 2009). There are many narrative methods in film narrative , but the three-act structure is the most basic. Act 1: Determine the goals of the characters and set up obstacles to explain the conflict. The goal of this act is to engage the audience with the story and the characters. It usually takes up 1/5 of the time of a play. Act 2: Show the details of the difficulties the protagonist needs to overcome through continuous plot conflicts, highlight the intensity of the difficulties, and let the audience feel the various challenges the protagonist has endured, as well as the physical

and mental changes of the protagonist and finally ushers in the ultimate challenge. Act 2 takes up 3/5 of a play. Act 3: the climax of the story, the protagonist overcomes the ultimate challenge, the main line and the branch line end the conflict in different ways, giving the audience a sense of ending, or making the audience feel that another storm is brewing, looking forward to the follow-up development. Conflict serves as the backbone that drives the narrative dynamics of the story, creating plot suspense, tense character relationships, and atmosphere. It is mainly divided into two types: external conflict and internal conflict. External conflicts are caused by people, groups, nature or non-human obstacles; internal conflicts occur in the hearts of characters, mostly for self-breakthrough and growth. The three- act structure will make the story more three- dimensional, enrich the content of the story and make the audience think more. (Liang Jielu, 2019)

3.2 The concept of film language

As the most intuitive form of language, film language conveys the connotation of films. At the same time, film language can directly stimulate the senses of the audience, causing changes in the audience. Based on the above literature reference and research, this research will select the following types of film language for analysis.

Camera shots : Scene is the distance between the camera and the subject. Scenes are generally divided into five types, wide shots, long shot, medium shot, close shot, and close-up. wide shots and long shot are used to explain the scene, pay attention to the expression of space. Scenery is the theme of the picture. The wide shots without characters and pure scenery have certain symbolic and allegorical qualities. Most of the medium shots are used to shoot characters, to express dialogue, to explain the occurrence of events, and to express the emotions of characters. Close-ups and close shot are mostly used to express character dialogues, to describe characters' emotions and psychological activities, to emphasize characters' movements and action details, etc. (Gao Lin, 2010)

Color : Color as a foundation and transforms the relationship between the tone of different plots. While conveying feelings and creating an atmosphere, it also has functions such as narrative and expression(Lu Chunyan, 2021). At the level of subjective consciousness It can play a good role in conveying thoughts and expressing feelings. In animation film and television works, directors will use color to conduct in-depth research in combination with the psychological characteristics of the audience, presenting animation themes more vividly and vividly.

Music : sound including character dialogue, music, and sound effects. In professional film production, music, sound effects recordings are treated as separate elements. Applied to effects such as reverb or flanger, known as "sound effects". As a very important part of the film, music can explain the characters, the time and environment of the event, etc., and express the author's emotional expression, emotional color and film conception of the film.(Yang Haiming, 1993)

3.3 The animation concept

Animation is the manipulation of still graphics to appear as moving images. As a comprehensive art, animation combines painting, film, photography, music and other art categories in one. In order to promote the

development of animation, more consideration should be given to the digital virtual environment in animation production, and the animation style should be innovated. (Li Peng, 2020)

Pixar Animation is committed to breaking down the age groups in the animation audience, creating animation that appeals to adults while also taking into account the needs of children. Self-growth, love for relatives, emphasis on friendship, and pursuit of love can be seen everywhere in Pixar animation. (Dong Xingxi, 2010) Pixar is committed to using excellent animation concept designers. The concept map of the scene of the earth full of garbage in the animation "Wall-E" was invited by the famous painter Chen Zhiyong to draw. (Dai Yongli, 2014)

4. Research Methodology

The research adopts a qualitative research approach, utilizing textual analysis to interpret the research objectives.

4.1 Population and Sample

This research takes Pixar Animation Studio's long animated films as the research object, with 26 films. Pixar animation films have both cultural and commercial attributes, and have won many awards with global influence. The more influential the award, the more it reflects the huge economic and social value that animation films generate.

Thus, this research was selected by purposive sampling method that refer to Pixar animation films. They represented the animation films during the period between 2020 to 2022. They are as follows:

1. Soul (2020) 2. Onward (2020) 3. Luca (2021) 4. Turning Red (2022) 5. Lightyear (2022)

4.2 Research Instrument

The research is divided into two parts such as:

Part1: Pixar animated narrative film. This research uses the concept of film narration to research and determine Pixar animated films.

Part 2: Interpreting the film language of Pixar animation. This research uses film language to explain Pixar animated films.

4.3 Data Collection

This research collects data from DVD films, books, documents, film information on websites and research papers, They are as follows: https://pan.baidu.com/s/1yD3RzyB38yTLBOWU4u7t7g

4.4 Data Analysis

This research describes the data analysis conducted in accordance with the research objectives. This research is divided into 2 parts as follows. Part 1: The film narrative analysis of Pixar Animation Studio film

Part 2: The film language analysis of Pixar Animation Studio film

5. Research Findings

Part1: The film narrative analysis of Pixar Animation Studio film

In terms of narrative films, based on Hollywood's "three-act" narrative montage, Pixar's new interpretation of narrative themes and narrative techniques not only makes the work have continuity, but also increases Pixar's individual innovation and thinking. Therefore, this research follows the research on the "three-act" narrative in Pixar animated films, and understands that

1) Act 1: "Soul" and "Luca" describe the protagonists in two forms, and their backgrounds are all under contradictions, life and death, sea monsters and humans. The protagonists get acquainted with new friends in a new environment, gain support in friendship and family, and thus gain the courage to start as the picture1.



Picture 1: "Soul" - Joe (Left) in form 22 (Right)

Moreover "Onward" and "Turning Red" are developed from the perspective of the small characters in the overhead world, missing the brother of the deceased father and the problems of adolescence, so that when the relationship between the characters is explained, it paves the way for subsequent conflicts.

2) Act 2: The plot unfolds, the protagonist follows his companions on adventures, and promotes the development of the plot through conflicts and contradictions. The protagonists of "Soul" and "Luca" meet new friends. The two resolve conflicts, work hard for their goals, and have a new experience and growth. "Onward" and "Lightyear" are the adventure stories of the protagonist, who supports and grows with family and friends under constant small conflicts. "Turning Red" takes on the topic of puberty, and the protagonist's conflict with his mother breaks out. Played the role of taking over the first act and linking up the third act as the picture 2.



Picture 2: "Turning Red" - School Transformation and Escape Home

3) Act 3: The climax comes, the final conflict breaks out, the protagonist solves the problem with the help of his companions, and the character grows. In "Soul", "Luca" and "Turning Red", the protagonist breaks

out the final conflict with his partner and mother, and finally redeems each other with his partner and mother. The characters grow and move towards new life and future. And "Onward" and "Lightyear" are the final conflicts between the protagonist and the evil dragon and other forces, and with the help of his partners, he wins and moves into the future as the Picture 3.



Picture 3: "Lightyear" - Return to Assembling a New Team

It is concluded that most of Pixar's themes are related to the life of modern people. The film focuses on human emotions, and creative ideas are developed from this. Behind every ordinary but extraordinary story, there will always be reflections on it and the growth of the protagonists.

Part 2: The film language analysis of Pixar Animation Studio film

In terms of film language, film language is an art form that directly connects with the audience's audiovisual connection, and has a strong appeal. A work produced by Pixar Animation Studio that presented of camera shots, color and music.

1) Camera shots:

Wide Shots: "Onward" and "Lightyear" use vision to explain the background of the story and the environment and atmosphere in the battle scenes of the protagonists, so that the relationship between the protagonist and the environment is clearer and clearer as the Picture 4.



Picture 4: "Onward" - The opening scene

Medium Shots: "Turning Red" and "Luca" explain the development of the storyline and are used extensively in character dialogue.

Close-ups: "Onward" and "Soul" use close-up shots before the climax erupts to review the corresponding experience of the protagonist before and achieve the key points of the protagonist's growth and change. Demonstrates the uniqueness of Pixar's use of close-ups.

2) Color: Each Pixar film uses a set of colors to express the theme. For example: the contrast between the black and blue-purple environments in the film "soul" straight forwardly conveys the theme of death and life as the Picture 5.



Picture 5: "Soul" - Black versus pink and purple

Moreover, the red, blue, and green in the film "onward" also explained the theme of the western magical world.



Picture 6: "Onward" - shows the red

Pixar Animation Studio used color language to be extremely grasp the audience's heart, good at using the relative color to create the atmosphere. The film "soul", the black environment and blue and purple environment, depressing without losing hope. In the film "onward", the red, blue and green in the background of the western magic world represent different magic and spiritual symbols.

3) Music: It is related to rendering the overall atmosphere of the film, the protagonist of the film and the setting of the theme. For example: the film "soul" uses the theme of black jazz, which embodies the spirit of freedom, liberation and continuous exploration to render the overall atmosphere of the film and establish the theme of the film. The mythical theme music of the film "onward" embodies the theme spirit of justice, courage and wisdom in the film.

6. Discussion

The research result found that the film narrative analysis of Pixar Animation Studio film that can show the idea of Pixar style such as characterized by a variety of styles, including drama, adventure, and science fiction. Most of Pixar's themes are related to modern life, and the films are centered on human feelings, there is always a reflection on it and the growth of the main characters. I think that using a three- act narrative structure, the final climactic conflict in Act 3 stands out the most. The conflict serves as the backbone of the narrative that drives the story, and the climactic conflict pushes the suspense and tension of the plot to its highest point, culminating in the emotions and growth of the protagonist. This refers to Liang Jielu (2019) explains that three- act structural analysis is the focus of the Screenwriting for Film and Television course, with the structural components of the third act, the point of articulation, the denouement, and the final scene.

The research result found that the film language analysis of Pixar Animation Studio film that can show the idea of Pixar style such as in the picture style, the colors are lively, the deformation is peculiar, the setting is sci-fi, virtual and reality are interspersed. I think that color part of it shapes the most prominent, Pixar animation has a certain representation and uniqueness when it comes to color. Pixar each film with a set of colors to narrate the story and express the theme. The picture color is lively, deformation peculiar, very creative, giving a strong visual impact. This refers to Lu Chunyan (2021) explains that color is a very representative part of the story, playing a role in laying the groundwork and shifting the relationship between the different tones of the plot. It has the function of conveying feelings and creating an atmosphere, as well as narrative and expression.

7. Suggestion

By the time of the release of Pixar Animation Studio, we can narrow it down to the important things such as the narrative that involve to emotional storytelling on three act structure. Moreover, they have elicited the most emotional responses through animated films ever, but what also helped them pave their way to success has been visual innovations. The visuals integrated with moral concepts and adventurous stories have created fantastic worlds such as color concept, sound and music and characters that convey important messages. They display the fundamental truths about being human, and explore complex emotions like hope, tragedy, death, and so on. These characters have become role models for children all over the word.

Recommendations for the future research

With the rapid development of technology, the research of the future has become a topic of great interest. For the research of Pixar Animation Studios, the research of style has some limitations. In the future research, the image of main characters in Pixar film animation can be explored.

8. Acknowledgement

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The Rhetoric of Children's Images in Chinese New-Generation Animation Films

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ABSTRACT

The research aims to 1) To study the children's images in Chinese new-generation animation films. And 2) To study the rhetoric of Chinese new generation animation films. This is qualitative research by using textual analysis from six Chinese animation films released between 2015 - 2023, with box office revenues exceeding 500 million RMB. The selected films are as follows: 1) Monkey king hero back2) Big Fish and Begonia3) Nezha: Birth of the Demon Child4. Legend of Deification5) New Gods: Yang Jian 6) Deep Sea. The result found that

Part 1: Children's images in Chinese new generation animation films

The external image of children in the new generation of Chinese animation films such as 1) External image design that highlights the character's personality: In terms of external image design, through the external image design that highlights the character's personality. 2) Head-to-body ratio and five senses design contrast sense of the external image: 3) External image design focuses on Chinese elements: through the treatment of clothing, hairstyle, accessories and other details, the children's images are integrated with traditional Chinese culture.

The internal image of children in the new generation of Chinese animation films such as 1) Internal image setting of the children with emphasis on character defects. 2) The internal image of children in conflict with adults. 3) The internal image of the children transformed in growth.

Part 2: The rhetoric of Chinese new generation animation films

 The film language of portraying children in Chinese new generation of animation films through the use of image language, sound language, editing language.
 Film narrative structures for portraying children in new generation Chinese animation films by employing various editing techniques and rhythms. They incorporate both traditional linear structures and complex three-act structures.

Keywords: Chinese animation films, Children's Images, Rhetoric

1. Introduction

Nowadays, the animation industry has increasingly received high attention from governments of various countries, becoming an important part of enhancing comprehensive national strength and an important means of exporting excellent national culture. Chinese animation films started late, they have developed at an eye-catching speed in recent years. Since 2015, Chinese new-generation animation films have entered a new era, producing a series of excellent animation films with Chinese cultural characteristics. (Tang. L, 2022)

Although there is a rich body of research on Chinese new-generation animation films in academia, there are still significant differences in the positioning of animation films in different countries, especially in the design of children's images in the works. This thesis also hopes to provide a more comprehensive and reasonable analysis perspective for the design of children's images in films through the analysis of rhetoric characteristics and strategies in the new generation of Chinese animation films.

This paper will take the children's images in the new generation of Chinese animated films since 2015 as the case study object, and analyze the rhetoric means of this series of animated films, including the features of rhetoric themes, elements, composition, configuration, narrative elements, and cultural contexts, as well as the relationships between them, to further answer the questions.

2. Research Objective

(1) To study the children's images in Chinese new-generation animation films.

(2) To study the rhetoric of Chinese new generation animation films.

3. Literature Review

The research is "The children's images in the New Generation of Chinese animation films" that aim to 1 to study the narrative film of studying the children's images in the new generation of Chinese animation films and the rhetoric in the new generation of Chinese animation films. The researcher uses the concept, theories, and research literature, They are follows.

3.1 The concept of children's images

Child study involves a variety of disciplinary fields such as biology, psychology, and sociology, and aims to explore the patterns and influences on children's development in terms of physical, cognitive, emotional, and social skills (Shaffer and Kipp, 2013). In general, children are human individuals who are immature in terms of physical, psychological, cognitive and social development. According to the United Nations Convention on the Rights of the Child (1989), a child is defined as a group of people under the age of 18 (United Nations, 1989). Therefore, this paper mainly focuses on characters under the age of 18 who appear as minors within the new generation of Chinese animation films; however, since the images in animation films are not restricted by the species of the performers, it is considered that all characters including the protagonists and supporting characters, regardless of gender and species, who are younger than 18 years old are considered to be children in this study.

Children's image refers to the unique image of children in terms of their appearance, behavior, personality and psychological characteristics. The study of children's image can be divided into two aspects in film studies: external image study and internal image study.

3.2 The rhetoric of film

The rhetoric in film refers to the artistic techniques used by film directors and screenwriters to achieve specific goals and effects in the process of film creation and expression, through the conscious organization and processing of various audio-visual languages and skills. Film rhetoric enhances the expressive, persuasive, and infectious power of film works by consciously organizing and processing elements such as images, sounds, editing, and performance, providing audiences with rich aesthetic and cognitive experiences (Bordwell and Thompson, 2017). The two conceptuals in film rhetoric are through film language and film narrative.

3.2.1 Film language

Film language refers to the series of audio-visual symbols and techniques used by film directors and screenwriters in the process of film creation and expression, in order to achieve artistic means of film narrative, emotional expression, and theme expression. Film language, through the conscious organization and processing of elements such as images, sounds, editing, and performance, constitutes the basic structure and characteristics of film works (Bordwell and Thompson, 2017). Based on previous literature research and compilation, this study categorizes film language into the following types.

3.2.2 Narrative of Film

Film narration refers to the process of presenting the plot and character relationships in a story through visual and auditory means in a film (Bordwell, 2006). The study of film narration involves multiple fields, including film theory, psychology, cognitive science, and linguistics, aiming to explore how films tell stories and how audiences understand and interpret these stories (Currie, 1995).

Indeed, the narrative structure of a film refers to the organization and presentation of the story plot. It involves the development and unfolding of the story, including its beginning, middle, and end, as well as the relationships and conflicts between characters. The narrative structure of a film can be demonstrated through the timeline, plot clues, character development, and more (Field, 2005). These studies provide theoretical guidance and practical references for film production, helping to enhance the narrative quality and audience experience. Narrative research in this article primarily focuses on analyzing the linear narrative structure and the three-act narrative structure commonly employed in films.

3.3 The concept of Animation film

The definition of animation films must be distinguished from cartoons. In terms of creative mode, animation films generally appear independently in the form of a separate script, with relatively independent plots. Although they are only 1-2 hours long, they tell a complete story. From the perspective of the purpose expressed by the entire animation, cartoons are simple and childlike stories, while animation films use animation techniques to tell complete stories based on creative themes and goals, and combine corresponding artistic techniques to present artistic effects. The visual presentation is more exquisite, the content is deeper, and the audience is not

only targeted at children. At the same time, the pre-production and post-production processes of animation films are carried out in accordance with the mode of film production. In terms of length and playback medium, they are consistent with ordinary films, with a length generally around 80 to 120 minutes, and are screened in movie theaters. It must be clarified that films that use animation techniques in films are not within the scope of this article's research.

Greenberg (2011) explains that animation films are a type of film that can express the intentions of filmmaker with almost "perfect" precision, surpassing other types of films. They have unparalleled effects. This is also an important reason why animation films are selected as the research object in this article.

4. Research Methodology

4.1 Research Design

The research adopts a qualitative research approach, utilizing textual analysis to interpret the research objectives.

4.2 Population and Sample

This research examines child images and rhetoric in Chinese new generation animation films. The purposive sampling method was utilized to select six Chinese animation films released between 2015 - 2023 because it is period of Chinese new generation animation film era, and considers with box office revenues exceeding 500 million RMB. The selected films are as follows: 1) Monkey king hero back 2) Big Fish and Begonia 3) Nezha: Birth of the Demon Child 4) Legend of Deification 5) New Gods: Yang Jian and 6) Deep Sea

4.3 Research Instrument

The research is divided into two parts of analysis:

Part 1: children's images in Chinese new generation animation films. This research employs the concept of children's images to investigate and identify child images portrayed in Chinese new generation animation films.

Part 2: the rhetoric of Chinese new generation animation films

This research utilizes the concept of film language and film narrative to interpret the use of rhetoric in Chinese new generation animation films.

4.4 Data Collection

This research collected data on representative Chinese new generation animation films from the following website: https://www.iqiyi.com/?vfm=f_588_wrbandfv=ac30238882b84c8c

The website was used to select and download Chinese new generation animation films for analysis.

4.5 Data Analysis

This research describes the data analysis conducted in accordance with the research objectives. This research is divided into 2 parts as follows. Part 1: children's images in Chinese new generation animation films. Part 2: Analysis of the rhetoric of Chinese new generation animation films.
5. Research Findings

On the basis of defining the scope of application of the theory of "children's image" in animation films, this paper carries out a more in-depth study on the rhetoric of the new generation of Chinese animation films.

Part 1: Children's images in Chinese new generation animation films

The external image of children in the new generation of Chinese animation films:

1) External image design that highlights the character's personality that highlights the character's personality, each image of a child has unique external features and clothing styles, so that visually it can be immediately recognized and remembered by the audience. For instance, Nezha removes the "Qiankun Ring" to release the seal of the magic pill, and transforms it into a golden bracelet on his wrist to retain his sanity, and his body stretches out from a child to a teenager, still with a sky-high style that is out of the norms of ancient hairstyles, and with his hair flying in anger, like red fire. They are as follow on picture 1.



Picture 1: Nezha's hair design in Nezha: Birth of the Demon Child (left) and Nezha's hair in the 90's animation movie (right)

2) Head-to-body ratio and five senses design contrast sense of the external image: It is a major feature of children's images in Chinese new generation animation films. Through exaggerated head-to-body ratios and rich and varied facial expressions, the personalities and emotions of children's images are vividly displayed. For instance, the film "New Gods: YangJian", when Chen Xiang first appears, he has a stern and resolute face, with a relatively smaller head and body, reflecting a sharp and heroic feeling. They are as follow on picture 2.



Picture 2: "New Gods: YangJian" sinker's body shape

3) External image design focuses on Chinese elements: Chinese elements are also a highlight of children's images in new generation Chinese animation films. Through the treatment of clothing, hairstyle, accessories and other details, the children's images are integrated with traditional Chinese culture, showing unique national characteristics and cultural heritage. The Chinese elements in the film can be summarized as shown in Table 1:

Movie Title	Child image	Clothing with Chinese elements	
Nezha: Birth of the Demon	NT1	Red vest with lotus flower pattern	
Child	Nezna	Bloomers with a flame print	
D' D' 1 1D '	CI	Students Qipao during the Republic of China period	
Big Fish and Begonia	Chun	Emerald earrings	
	d 1 .	Bamboo hat	
New Gods: YangJian	Chenxiang	Straw toe shoes	

Table 1 Elements of Chinese Style in the Image of Children in film

The internal image of children in the new generation of Chinese animation films:

1) Internal image setting of the children with emphasis on character defects: The setting of children with character flaws makes the characters more three-dimensional and interesting. Each child character has his or her own unique personality traits, some are innocent and cute, some are witty and smart, some are timid and cowardly, and some are brave and strong. These character flaws make the children more realistic and believable, and the audience can better empathize with them.

2) The internal image of children in conflict with adults: Children's images often face pressures and challenges from the adult world, they need to face all kinds of difficulties and trials, and through conflicts and confrontations with adults, children's images gradually grow and mature.

3) The internal image of the children transformed in growth: The children's image undergoes various changes and transformations in the process of growing up, from innocence to understanding and maturity, from confusion and uneasiness to firmness and self-confidence, and this metamorphosis makes the children's image more contagious and malleable, which is a major highlight in Chinese new generation of animation films.

Part 2: The rhetoric of Chinese new generation animation films

1) Film language: The film language of portraying children in Chinese new generation of animation films, Chinese new generation animation films divide to be 3 parts such as 1) Image language: highlighting the combination of red "Chinese-style" aesthetics 2) Sound language: multiple soundscapes combining reality and complexity in the portrayal of children 3) Editing language: complex and varied techniques to satisfy an all-ages audience.

For instance, the film "Big Fish and Begonia," the predominant use of red as the main color palette in the visual presentation serves to differentiate brightness and saturation levels, creating a sense of depth. The film represents such as the red dolphins, the red begonia flowers, the red phoenix, and the red lights of countless households, red is present in almost every frame (Picture 3).



Picture 3: Red symbol in "Big Fish and Begonia

2) Film narrative: the narrative structures for portraying children in new generation Chinese animation films that represent such as 1) Linear narrative: a linear narrative showing the fate of the characters which makes the storytelling clear, structurally simple and straightforward. This approach aids in showcasing the changes in plot and the growth of child characters. 2) Three- act narrative structure: all films concentrate the fascinating conflicts arising from "binary opposition" in each small plot. As the story progresses in time, the plot is combined based on causal connections.

6. Discussion

The research result found that Chinese new generation of animation films, the internal image design of children's characters focuses on the transformation of children as they grow up. I think that the children portrayed in Chinese new generation of animation films are experiencing inner growth and transformation. They may gradually become brave and strong from an introverted and timid child. This inner growth and metamorphosis often occur in the process of facing difficulties and challenges, gradually overcoming fears and insecurities, and discovering one's own potential and value. This growth and metamorphosis make the child characters stronger inside, able to cope with all kinds of difficulties and challenges, and also allows the audience to see their inner growth and progress, empathize with them and feel the power of growth. This refers to Buckingham (1996) explains that the internal image of children in films is usually expressed as children's character traits. In established studies and works, on the one hand, the internal image of children in films may present typical children's traits such as innocence, enthusiasm, kindness, sensitivity, and mischievousness; on the other hand, the internal image of children's roles in films may also show beyond- age qualities such as maturity, independence, resilience, and wisdom, in order to emphasize their specific situational growth and change. This internal image connects the story destiny of the child characters and usually reflects the director and screenwriter's deep thinking about social reality, cultural background and human concern.

The research result found that the focus of the rhetorical design of children's characters in the new generation of Chinese animated films lies in the films language. I think that in the image language: highlighting the combination of red "Chinese-style" aesthetics and the Children Images; Sound language: multiple soundscapes combining reality and complexity in the portrayal of children; and Editing language: complex and

varied techniques catering to an all-ages audience. Sound language: multiple soundscapes combining reality and complexity in the portrayal of children. and Editing language: complex and varied techniques to satisfy an all-ages audience. The use of these three aspects enriches the children's images and increases the inner world of the characters and the expressiveness of the story. These films not only show the unique charm of Chinese culture, but also allow the audience to better understand and feel the growth and inner world of the children's characters, and enhance the audience's emotional resonance and sense of participation. This refers to Bordwell and Thompson (2017) explains that the rhetoric in film refers to the artistic techniques used by film directors and screenwriters to achieve specific goals and effects in the process of film creation and expression, through the conscious organization and processing of various audio-visual languages and skills. Film rhetoric enhances the expressive, persuasive, and infectious power of film works by consciously organizing and processing elements such as images, sounds, editing, and performance, providing audiences with rich aesthetic and cognitive experiences.

7. Suggestion

With the development of the animation film industry, there has been a continuous evolution in rhetorical techniques within animation films. As a crucial component of animation films, the rhetorical construction of children's characters holds paramount importance for the dissemination impact of these films. This study, through an examination of the rhetorical strategies applied to children's characters in China's new-generation animation films, asserts that the portrayal of children's characters in animation films can be further enriched through diversified rhetorical techniques, thereby enhancing the modes of representation for these characters. Exploring a broader spectrum of rhetorical devices can involve the utilization of an array of colors and visual effects, as well as innovative sound design, all aimed at heightening the audience's perception and comprehension of the children's characters. Furthermore, filmmakers can strengthen interdisciplinary collaborations with other art forms, thereby expanding the boundaries of rhetorical construction for children's characters.

Recommendations for Future Research

Although there is a considerable amount of research on animation films, there are still limitations in the study of children's images. In future research, there is research space for comparing the internal images of children in Chinese new-generation animation films with those of children in other historical periods in China, as well as comparing them with the film language of animation films in other countries. This can not only help explore the ways and meanings of Chinese children's images in films and their relationship with social and cultural backgrounds but also promote the development and international exchange of animation films.

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Ripeness Level Classification of Pineapple Using

Image Processing with Neural Network

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ABSTRACT

Pineapples are an economic harvest that generates income for Thailand, especially fresh pineapples because they are one of the growth export fresh fruit rates in 2021 according to the report from National News Bureau of Thailand. Then the proper classification for the quality of the fresh pineapple is much more important for the export market in Thailand. Therefore, the purpose of this study is to develop an automatic tool for ripeness level classification of pineapple using image processing with neural network. The ripeness of pineapple is divided into three levels: unripe, ripe, and fully ripe. The method used image processing that image converted from RGB color space to HSV color space and morphological image processing. For the classification, we applied the neural network consisting of the input layer with one node, the hidden layer with one node, and the output layer with three nodes. The results achieve high classification accuracy around 92.31%. The study demonstrates that the proposed technique is appropriate for an automated classification system.

Keywords: Classification, Image Processing, Neural Network, Pineapple Ripeness

1. Introduction

Pineapple (Ananas comosus L. Merr.) is an economic harvest that generates income for Thailand. The main export products are canned pineapple and fresh pineapple fruit (Nurmaini 2018). Fresh pineapple fruit products at the market include Batavia, Phuket, Sriracha, Phulae and MD2 species. Quality standards and safety in export must consist of shell color characteristics, fresh, clean, free from blemishes and strange things and taste the ripe, yellow meat, sweet taste.

The selection of fresh pineapple by consumers and the separation of ripeness of fresh pineapple by farmers are using their own experience. The consumers cannot choose the ripeness of pineapple according to their complacency, and the farmers use their expertise to sort the level of ripeness of fresh pineapple. Therefore, we study and research, the methods to classify the ripeness of pineapples as an automatic tool to help the farmers sort the fresh pineapple and the consumers to choose an appropriate fresh pineapple according to their own needs.

Deep learning is part of a broader family of machine learning methods based on artificial neural networks, which is like the functioning of the nervous system in the human brain. The neurons are connected to the nervous system and communicate using parallel processing methods to make it able to understand and learn from the large amount of information that is received continuously. The brains of our people will try to decipher the information received define things and divide them into categories. Whenever we welcome the new report, the brain will try to compare what we had previously known. Deep learning can teach to work in the same way as possible. Therefore, this project aims to study the method for ripeness level classification of pineapple using image processing with Neural network.

2. Literature Review

Abu B.H.-B. et al. (2013) proposed to evaluate the level of ripeness of fresh pineapple with features from the image segmented according to RGB and HSI color maps. The maturity index varies from index one through index seven. Therefore, it can be group into three groups: unripe, ripe and fully ripe using fuzzy logic classification using an image database of 40 images for the train and 20 images for the test. The result showed 100 % accuracy for the fully ripe and 85 % for unripe and ripe levels.

Muhammad, R. et al. (2008) proposed an efficient image retrieval system that used color features for content-based image retrieval systems. It is used adaptive segmentation of hue, saturation and value (HSV) color space. They are converted RGB color space into HSV color space. Different hues and values used in the experiment have been calibrated to obtain a reasonable degree of hue and value.

Panyamongkol, S. (2018) proposed research on the relationship between physical and chemical properties in Poolae pineapples with maturity stage among numbers 0-7. Thus, the physical and chemical properties of Poolae pineapple have a relationship with the maturity stage. This can lead to a harvest time and is defined as the raw material specification of Poolae pineapple according to the need to take advantage.

Angel, L. et al. (2015) proposed a method for automatically evaluating the state of maturation of the perolera variety pineapple (Ananas Comosus) in post-harvest using computer vision techniques. The proposed

evaluation procedure is implemented through digital color image processing based on pre- processing, segmentation, feature extraction, and statistical classification. For this purpose, they use images in the HSV color space, segmentation by automatic thresholding using Otsu's method, the first-order moment of the distributions of the H and S planes as features, and the modified basic sequential algorithmic scheme (MBSAS) and allow identifying three levels of maturation: green pineapple, half-ripe pineapple, and ripe pineapple. The effectiveness of the classification algorithm was 96,36% and it was evaluated by considering the criteria of manual classification by three experts because they have released the color value extraction in HSV color and used a lot of datasets.

Asnor, J.I. et al. (2013) proposed grading pineapples based on color, classified using an index with seven levels of maturity based on the green and yellow color of the skin. As the pineapple ripens, the skin will change from pale green to a golden or yellowish color. Image pre-processing techniques are applied to aid data extraction to be much more accurate and more accessible. During the sorting stage, the obtained color values are saved in a database for training the neural network (NN). The test results show the highest accuracy for grading pineapples is 75%.

Azman, A.A. and Ismail, F.S. (2017) proposed to develop a computational intelligence method for pineapple maturity indices classification for optimal harvesting. This research used convolutional Neural network (CNN) for classifying. They have divided pineapples into three levels: unripe, partially ripe, and fully ripe, demonstrated in this project for optimal harvesting. The simulation results show that the method achieved 100% classification accuracy for determining unripe and fully ripe levels and 82% accuracy for partially ripeness levels. This research used image data to classify and divide the data into two parts, where they split training more than testing. In this work, the accuracy is quite good, and the amount of image data is large, but our work has little image data, so we used Neural network (NN).

3. Research Methodology

The proposed method uses image processing techniques to classify fresh pineapple. We acquired an image dataset of pineapple for 65 images using a standard smartphone, which is the Samsung Galaxy, 12MP camera, and 4128 x 3096 pixels, in total including unripe, ripe, and fully ripe as shown in Figure 1. The number of the input data, one image per one pineapple, for each level of ripeness is 24 images for unripe, 21 images for ripe, and 20 images for fully ripe. In this study, we use the level of maturity of pineapple using the shell color as shown in Table 1.



Figure 1 The shell color of pineapple.

Table 1	The level	of maturity	of pineapi	ole using	the shell	color (Panyamo	1gkol 2017).
			- pp				()	-8

The level of maturity pineapple.	The character of pineapple.	
0	The shell color is dark green.	
1	The shell color is yellow, about 1/8 of all	
2	The shell color is yellow, about 1/4 of all.	
3	The shell color is yellow, about 1/2 of all.	
4	The shell color is all yellow and the shell color is a little green.	
5	The shell color is all yellow, less green quantity than level 4.	
6	The shell color is golden yellow and all ripe.	
	The shell color is golden yellow and all ripe, may a reddish-brown color in	
/	case of rot, bruising.	

The ripeness level classification of pineapple is divided into three levels: unripe, ripe, and fully ripe, as shown following Table 2.

Table 2 Ripeness level of maturity of pineapple using the shell color.

Level	Level of ripeness	The level of maturity pineapple. (number)	
0	Unripe	0, 1	
1	Ripe	2,3	
2	Fully ripe	4, 5, 6, 7	

The system process of classification, shown in Figure 2 consists of the image preparation process, feature extraction, and classification. First, the preparation process uses image processing techniques. The features extraction process calculated the ratio of the pineapple ripeness area pixels and total pineapple fruit areas. In the classification process, we use Neural network algorithm to create a model for the prediction of pineapple ripeness.



Figure 2 Process of Classification.

3.1 Image preparation process

The image preparation process will be divided into 2 parts consisting of pineapple fruit area and pineapple ripeness area.

Part 1. Pineapple fruit area

To calculate the pineapple fruit area, the simplest method for image segmentation is used that is a binary thresholding. From a grayscale image, thresholding can be used to create binary images as shown in Figure 3.

This thresholding operation can be expressed as:

$$g(x, y) = \begin{cases} 255 & \text{,if } f(x, y) \ge Threshold \\ 0 & \text{,otherwise} \end{cases}$$
(1)

where the intensity of the pixel is higher than Threshold, then the new pixel intensity is set to 255. Otherwise, the pixel is set to 0.



Figure 3 The results of pineapple fruit area: a) RGB color, b) Binary Thresholding.

Part 2. Pineapple ripeness area

We extract a remarkable feature of the image for the ripeness color area from the total fruit area. In this step, we used HSV color and morphological closing to extract the ripeness color area. This process will convert images from RGB color to HSV color space is done through the following equation:

The R, G and B values are divided by 255 to change the range from 0-255 to 0-1.

$$R' = \frac{R}{255}, \quad G' = \frac{G}{255}, \quad B' = \frac{B}{255}$$
(2)

$$C_{\max} = \max(R', G', B')$$
(3)

$$\Delta = C_{\max} - C_{\min}$$
(4)
Hue calculation:
$$H = \begin{cases} 0 & \text{,if } \Delta = 0 \\ 60^* \left(\frac{G-B}{\Delta}\right) \mod 6 & \text{,if } C_{\max} = R' \\ 60^* \left(\frac{B-R}{\Delta} + 2\right) & \text{,if } C_{\max} = G' \\ 60^* \left(\frac{R-G}{\Delta} + 4\right) & \text{,if } C_{\max} = B' \end{cases}$$
(4)
Saturation calculation:
$$S = \begin{cases} 0 & \text{,if } C_{\max} = 0 \\ A & \text{,otherwise} \end{cases}$$
(5)
Value calculation:
$$V = C_{\max}$$
(6)

where H is a hue, S is a saturation, V is a value, R is a red color, G is a green color, and B is a blue color. The results of conversion RGB color to HSV color are shown in Figure 4.



Figure 4 The results of conversion RGB color to HSV color: a) RGB color, b) HSV color.

After converting the image to an HSV color image, we get the location of pineapple ripeness as the yellow area demonstrated in Figure 4(b). The missing part is the green area of the pineapple. To solve this missing, we apply morphological closing to fill small holes in an image while preserving the shape and size of the objects in the picture. The closing operation is a process in which the first dilation and then erosion operation is performed.



Figure 5 The results of Morphology image closing: a) RGB color, b) HSV color.

Figure 5(a) and Figure 5(b) present some part of the area increased by morphological closing used to connect the dots. Thus, we get a whole part of the pineapple ripeness color area.

3.2 Features extraction

After entering the image preparation process, the next step is the feature extraction. This steps convert the data from image data to numeric data. In this part, we calculate the ratio of the pixel number of the pineapple ripeness area and of the pineapple fruit area with the area feature counting the number of white pixels in the image as shown in Figure 6. The formula of the ratio is shown as the following equation:

$$T = \frac{R}{P} \tag{7}$$

where T is the ripeness of pineapple fruit, R is the pineapple ripeness area, and P is the pineapple fruit area.



Figure 6 The results of feature extraction a) fruit areas, b) ripeness area.

Using equation (7), the relationships of the ripeness area and the fruit area are: the unripe level $0 \le T \le 0.125$, the ripe level $0.126 \le T \le 0.600$, and the fully ripe level $0.601 \le T \le 1$.

3.3 Classification

Neural Network

In this section, the ripeness level classification of pineapple is executed using neural network. It has three main layers which are the input layer, the hidden layer, and the output layer. The input layer and hidden layer have one node, and the output layer has three nodes consisting of level 0, 1, 2 presented unripe, ripe, and fully ripe. respectively. Perceptron is a neural network unit that computes to detect features in the input data. A perceptron consists of four parts: input values, weights and a bias, combination function and activation function, as shown in Figure 7.



Figure 7 Neural network structure.

A perceptron process can express as the following equation:

$$y = a(b_i + w_i \cdot x_i)$$
 for all $i = 1, 2, ..., n$ (8)

where y is the output, x_i is the input, b_i is a bias or a real number, w_i is a weight, and a is an activation function.

The bias (b) is a real number, and the weights $w_i = (w_1, \ldots, w_n)$ are a vector of size the number of inputs. The bias and the weights were obtained from a random Python program. Thus, the total number of parameters in this neuron model is 1 + n and n the number of inputs in the neuron. The combination function (c) is combined that computed the bias plus the linear combination of the weights and the inputs defined in equation (9).

$$c = \sum_{i=1}^{n} W_i \cdot x_i \quad \text{for all } i = 1, 2, \dots, n.$$
 (9)

The activation function defines the output from the combination function. We used Rectified linear activation function shown as equation (10) and Figure 7.

$$a = \begin{cases} 0 & if \quad c < 0 \\ c & if \quad c \ge 0 \end{cases}$$
(10)

where a is an activation function,

c is a combination function.



Figure 8 Rectified linear activation (Lopez 2021).

4. Research Findings

In this study, we and have taken 65 sample images (input size = 4128×3096) of three different levels of pineapple ripeness. The number of the input data, one image per one pineapple, for each level of ripeness is 24 images for unripe, 21 images for ripe, and 20 images for fully ripe. We divide the data into two parts: training and testing sets. The data portions are as follows: 50:50, 60:40, 70:30, 80:20, and 90:10 to analyze respective testing accuracy. We use Python for feature extraction and classification.

Neural Network	Neural Network Training accuracy	
[Training%: Testing%]	[%]	[%]
50 : 50	93.75	81.82
60 : 40	97.44	88.46
70 : 30	91.11	80.00
80 : 20	96.15	92.31
90:10	94.83	85.71

Table 3 The Accuracy of Neural Network.

From Table 3, we observe that the best accuracy for testing is 92.31% according to the training accuracy around 96.15% and the portion of the training data and testing data 80:20. It means that the amount of the image for the training set is 52 images while the number of the data for the testing set is 13 images. To measure the performance of the method, we use the confusion matrix. The confusion matrix is a crucial tool for evaluating the prediction of models that we create in machine learning. It is a table that is often used to describe the performance of a classification model on the data set of tests for which the true values are known (Asnor and others, 2013). The results of the confusion matrix of the testing set total 13 images are shown in. Table 4.

In the confusion matrix table, the actual class is the pineapple images based on the classification of ripeness level consisting of unripe, ripe, and fully ripe, shown in Table II, while the predicted class is the ripeness level results obtained by using neural network. The precision of the unripe and ripe level is 100% whereas the precision of the fully ripe level is 80%. Moreover, the accuracy of the method is around 92.31%.



Table 4 The Confusion Matrix of Neural Network.

5. Conclusion

We propose a ripeness level classification of pineapple using image processing with Neural network. We use a dataset, containing 65 images of pineapple fruit and three different classes, which each class represents the ripeness level of pineapple, namely, unripe, ripe, and fully ripe. In the image preparation process, there are 2 parts for automated classification: pineapple ripeness fruit area and pineapple fruit area. In the pineapple ripeness fruit area part, we convert an image from RGB to HSV color space and use morphology image processing. For the pineapple fruit area part, we use a binary threshold to extract the fruit area. In the feature extraction process, this is the ratio of the pineapple ripeness area pixels per pineapple fruit area. After that in the classification process, the ripeness level classification with neural network divided the data into two parts: training and testing. The result obtained by using neural network achieves a high classification accuracy of around 92.31%.

6. Suggestion

Some suggestions, that may improve this work, are given as follows:

1. The image dataset must not be blurred or cracked pixels and increase the number of image datasets.

2. The level classification of the ripeness pineapple process, the method can be improved by modifying or changing the techniques such as random multimodal, Artificial Neural Network and Convolutional Neural network.

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Integrating xPore and m6Anet for m⁶A site discovery

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ABSTRACT

N⁶-methyladenosine (m⁶A) modification is the most common RNA modification that occurs in eukaryotic mRNAs and viruses. m⁶A modification has a pivotal role in gene regulation. Presently, nanopore emerges as a technique capable of identifying the m⁶A positions by observing the different ionic current between wild-type and METTL3-knockout samples. Nanopore sequences the native RNA strands directly and bypasses reverse transcription. xPore program compares the ionic current from both samples to determine the m⁶A positions and their modification rate. However, METTL3-knockout RNAs is not always obtainable. m6Anet predicts the positions and provides the probability of m⁶A sites using only wild-type RNA. Nevertheless, m6Anet's accuracy is compromised when the organism of samples is different from the one in the training dataset. In this study, synthetic RNAs were used to generate reference current profile for unmodified nucleotides. This approach combines predicted sites in DRACH motifs from xPore and m6Anet to obtain high accuracy m⁶A sites with the area under curve (AUC) of 0.84 for receiver Operating Characteristic (ROC) curves, 0.44 for precision-recall (PR). This approach could provide the m⁶A landscape, allowing deeper understanding of m⁶A biology.

Keywords: m⁶A modification, Nanopore, xPore, m6Anet

1. Introduction

 $m^{6}A$ modification is the most prevalent RNA modification found in eukaryotic RNAs, including rRNA, tRNA, and mRNA (Wu et al., 2019). This modification adheres to the consensus RNA DRACH (D = A/G/U, R = A/G, H = A/C/U) motif and is regulated by three groups of enzymes: methyltransferase (writer), Demethyltransferase (eraser), and m⁶A-binding protein (reader). m⁶A modification levels or positions play important roles in gene expression, mRNA stability, RNA splicing, as well as viral RNA replication. Dysregulation of this modification can also lead to cancer (Wang et al., 2022).

Currently m⁶A sites are identified by antibody-based approaches such as MeRIP-seq and m6ACE-seq. In these approaches, m⁶A modified RNAs are captured by m⁶A specific antibody. Then the enriched RNAs were fragmented and sequenced by next generation sequencing (Koh et al., 2019). Since the data are short reads, they cannot provide the information regarding RNA isoform and phrase of multiple m⁶A modification sites on the same RNA strand. In addition, the use of antibody contains antibody bias for selected RNA motifs. Also, library preparation requires reverse transcription, which could introduce artificial mutations (Zhu et al., 2019).

Nanopore sequencing is the third-generation sequencing that can identify RNA modification from native RNA sequence (Wang et al., 2021). Nanopore sequencing monitors the change of ionic current occurs from each characteristic of nucleotide passing through the protein pore. Computational tools such as Epinano (Liu et al., 2019), Nanocompore (Leger et al., 2021), xPore (Pratanwanich et al., 2021), m6Anet (Hendra et al., 2022) use statistics and machine learning to identify the m⁶A sites. xPore uses multi-gaussian mixer model to find the deviation of ionic current between unmodified RNA and m⁶A modified RNA. xPore result provides single-base resolution with modification rate. However, the m⁶A-unmodified RNA is difficult to obtain for many cases such as clinical samples. In contrast, m6Anet can predict m6A sites from wildtype RNA alone. It employs multiple instance learning (MIL) to identify m⁶A sites using training dataset. Still, m6Anet's accuracy depends on the training dataset.

In this study, *in vitro* transcribed RNAs were used to generate current profile for unmodified RNA as a reference for xPore program. Furthermore, the predicted m⁶A sites from xPore were combined with m6Anet to provide high confident m⁶A sites. The obtained m⁶A map would be a fundamental resource to explore m⁶A biology in the future.

2. Research Objective

To identify m⁶A sites in HEK293T cell by integrating outcome of xPore and m6Anet

3. Literature Review

3.1 Theory, Concept and Related Research

N⁶ – methyladenosine (m⁶A modification)

 N^6 -methyladenosine (m⁶A) modification is a process that adds a methyl group to the sixth position of adenosine within RNA molecules. This modification is found across RNA species including ribosomal RNA (rRNA), transfer RNA (tRNA), and messenger RNA (mRNA). This modification is notably enriched near stop codons and 3' untranslated regions (UTRs). It follows a consensus DRACH (D = A/G/U, R = A/G, H = A/C/U) motif. m⁶A modification is regulated by three enzyme groups: 1. methyltransferase (writer), including methyltransferase-like 3 (METTL3), methyltransferase-like 14 (METTL14), and methyltransferase-like 16

(METTL16), which add methyl groups at the N⁶ position of base adenine. 2. demethyltransferase (eraser), exemplified by fat mass and obesity-associated protein (FTO), which removes methyl groups. 3. m⁶A-binding protein (Reader), such as YTH-family proteins, which bind to m⁶A. This modification influences various aspects of RNA, including RNA splicing, stability, and nuclear transport. For example, METTL16 induces the splicing of intron in Methionine Adenosyltransferase 2A (MAT2A), resulting translation of MAT2A and later conversion of S-adenosyl homocysteine (SAH) to S-adenosylmethionine (SAM) (Pendleton et al., 2017). In another example, the protein YTHDF2, as an m⁶A reader, can direct the RNA degradation by at least two pathways. First, YTHDF2 can bind to the heat-responsive protein 12 (HRSP12) and RNase P/MRP for rapid RNA degradation, Second, YTHDF2 can recruit CCR4-NOT4 deadenylase complex to deadenylate the RNA, leading to RNA degradation (Du et al., 2016; Park et al., 2019).



Figure 1 m⁶A modification

Antibody-based methods

 m^6A -Crosslinking-Exonuclease-sequencing (m6ACE-seq) is an antibody-based method used to investigate and precisely map the positions of N⁶-methyladenosine (m⁶A) modifications within RNA molecules. This method utilizes m⁶A specific antibodies to capture m⁶A modified RNA and protect the enriched RNA fragments from exoribonuclease degradation (Koh et al., 2019). The remaining RNAs are then sequenced by next generation sequencing. The sites of modification will be the positions with high accumulation of reverse transcription stop. However, m6ACE-seq has some limitations. It requires a specific antibody binding to m⁶A, which could have motif bias. Also, the reverse transcription step during library preparation may have induced mutation. Lastly m6ACE-seq needs high sequencing depth to obtain m⁶A sites with high confidence (Capitanchik et al., 2020).

Nanopore Sequencing Technology

Nanopore sequencing provides long read sequencing data (over 10 kilobases) that overcomes the limitation of second-generation sequencing such as Illumina's Novaseq, Hiseq and Thermo Fisher's Ion torrent. Nanopore technology sequences DNA strand by passing it through the protein pore embedded in a membrane. The ionic current signal altered by the nucleotides can be measured by the software in the device and this raw

signal can later be interpreted for nucleotide sequences (Wang et al., 2021). In addition, nanopore technology can also sequence native RNA directly without reverse transcription to cDNA. This reduces amplification bias and shortens the protocol. Furthermore, the raw data from native RNA sequencing can be used to distinguish between canonical and non-canonical nucleotides.

xPore

xPore (Pratanwanich et al., 2021) is a computational tool for m⁶A modification detection. This method calculates the mean signal for each k-mer and applies a two Gaussian mixture model to discern signal distribution disparities between modified and unmodified samples. xPore provides m⁶A sites with their corresponding differential modification rate. xPore achieves a precision of 0.6 (AUC = 0.86) when compared to m⁶A sites obtained from m6ACE-seq.

m6Anet

m6Anet (Hendra et al., 2022) is a computational tool that uses the combination of signal intensity and sequence feature from nanopore to predict and give probability of modification for each m⁶A site using multiple instance learning (MIL)-based neural network model. m6Anet is beneficial compared to xPore in term of sample requirement. m6Anet only uses wild-type RNAs and does not need the unmodified RNA. The reference data comes from the training dataset. AUC of precision-recall (PR) curve by m6Anet is 0.35 when compared with m6ACE-seq and miCLIP data. However, accuracy of m6Anet could be comprised when the origin of the wild-type sample does not match the origin of the training dataset.



3.2 Research Framework

Figure 2 Research Framework

3.3 Research Hypotheses

Combined m⁶A positions from xPore and m6Anet could improve specificity of m⁶A positions.

4. Research Methodology

4.1. Data collection and processing

The FAST5 files from of direct RNA nanopore sequencing data from HEK293T-WT, HEK293T-METTL3-KO (PRJEB40872) were basecalled with Guppy (version 5.0.11) (Wang et al., 2021) and stored in FASTQ. The sequences were adaptor-trimmed via Porechop (version 0.2.4) (Wick et al., 2017) and filtered based on nucleotide quality using Nanoplot (version 1.36.2) and Nanofilt (version 2.8) (De Coster et al., 2018). The combined FASTQ file was aligned to the reference genome using Minimap2 2.2 (minimap2 -ax map-ont -uf – secondary=no) (Li, 2018) and converted to BAM format by Samtools (version 1.17) (Danecek et al., 2021). For m6ACE-seq, the data was obtained from zenodo database (https://zenodo.org/record/5707193).

4.2. Identification of m⁶A modification

4.2.1. Identification of m⁶A modification by m6Anet (Hendra et al., 2022)

Nanopolish (version 0.11.3) (Loman et al., 2015) was used to align the raw signal from the modified sample to the reference genome through the 'index' and 'eventalign' commands. The Nanopolish outputs were used to predict and derive probabilities for each m⁶A position through the 'm6anet dataprep' and 'm6anet inference' commands in m6Anet (version 2.1).

4.2.2. Identification of m⁶A modification by xPore (Pratanwanich et al., 2021)

Nanopolish (version 0.11.3) was used to align the raw signals from both the modified and unmodified samples to the reference genome using the 'index' and 'eventalign' commands. The current profiles were organized for xPore (version 2.1) using 'xpore dataprep' command. Next 'xpore diffmod' and 'xpore postprocessing' commands were used to derive the m⁶A sites and modification rates from the two input samples.

4.3. Development of pipeline for identification m⁶A sites

The synthetic *in vitro* transcribed (IVT) RNA sequences were downloaded from GSE124309 (Liu et al., 2019). The sequences are 2329, 2543, 2678 and 2795 bp, consisting of all 1,024 k-mers. These IVT RNAs contain no RNA modification and were sequenced by direct RNA sequencing (SQK-RNA001).

To create current profile of unmodified RNA from the synthetic sequences, a function for the collection and selection of ionic current data from the unmodified synthetic sequence were developed by python (version 3.8). This data was used for comparison with the modified sample in xPore.

4.4. Data post-processing

To ensure enough coverage, only positions with 30 - 1,000 aligned reads in the NNACN motif were used for subsequent analysis. The positions with a difference in modification rate of less than 0 and an adjusted P value (calculated using the Benjamini-Hochberg method) less than 0.001 were deemed highly reliable. Consequently, these m⁶A positions with high confidence were ranked with z-scores and combined with the result from m6Anet using Python.

4.5. Pipeline validation

To evaluate the sensitivity and accuracy of the m⁶A sites by xPore and m6Anet, the Receiver Operating Characteristic (ROC) curves and Precision-Recall (PR) curves for NNACN k-mers were calculated by using m6ACE-seq data as a ground truth.

To plot the ROC and PR curve, m⁶A sites found in xPore, m6Anet, and m6ACE-seq were used as true positive positions, while the sites found only in xPore and m6Anet served as false positive positions. These positions were used to calculate the true positive rate (Sensitivity), false positive rate (1-specificity).

5. Research Findings

The ionic current profile from *in vitro* transcribed RNA data was used to generate the unmodified current profile. The table shows examples of the ionic current for each k-mers (Table 1). To select current signals for each k-mer and reduce bias in choosing the current signal, two methods ('random' and 'np.random.normal') were used to randomly pick current signals from a sample dataset in three human genes (ENSG00000114125, ENSG00000095380, and ENSG00000159111) provided by xPore. For these three genes, xPore comparing WT vs METTL3-KO gave 4 positions, while xPore comparing WT vs synthetic RNAs provided 16 and 17 positions by 'random' and 'np.random.normal' methods, respectively.

Table 1 show the ionic current from unmodified synthetic

5-mers	Ionic current	
TCCGG	77.2,76.4,75.9,77.3,77.7,76.7,	
CCGGC	100.7,97.1,92.8,101.2,99.7,	
CGGCT	113.9,102.6,98.0,105.5,116.8,	
GGCTG	114.5,113.7,115.6,115.6,111.1,	

The synthetic sequence generated from 'random' function provides 3 overlapping positions with xPore (WT vs METTL3-KO) (Fig 3A), whereas the 'np.random.normal' function gives 2 overlapping sites (Fig 3B). Hence, the 'random' function was chosen for selecting unmodified current signal from the synthetic sequences.



Figure 3 Venn diagram showing m^6A sites (P < 0.001) from xPore (WT vs METTL3-KO) and xPore (WT vs Synthetic reference) using (A) Synthetic reference – random, (B) Synthetic reference – np.random.normal

5.1 Comparison between xPore with synthetic reference and m6Anet

The synthetic sequences were generated from the full-length transcriptome of HEK293T cells comprised of 13,136 genes. The m⁶A sites within NNACN k-mers were identified using xPore (HEK293T-WT vs METTL3-KO) and validated against m⁶A sites by m6ACE-seq. A total of 17,701 m⁶A sites were identified using xPore (HEK293T-WT vs synthetic reference), with 866 of these sites overlapping with m⁶A sites identified in m6ACE-seq. In contrast, xPore (HEK293T-WT vs HEK293T-METTL3-KO) only provides 1,036 sites with 509 overlapping sites with m6ACE-seq (Fig 4A).



Figure 4 venn diagram show (A) m⁶A sites from xPore (WT vs METTL3-KO), xPore (WT vs Synthetic reference) and m6ACE-seq, (B) m⁶A sites from xPore (WT vs Synthetic reference), m6Anet (P < 0.05, Probability ≥ 0.9) and m6ACE-seq.

Although m6Anet can identify 964 positions from m6ACE-seq, there are only 37% of the total sites by m6Anet. Similarly, only 5% of m⁶A sites by xPore with synthetic reference overlap with m6ACE-seq. Hence, this suggests that both methods have their own intrinsic errors.

5.2 Combining between xPore with synthetic reference and m6Anet

To reduce the error mentioned above, overlapping m6A sites between two approaches probably could reduce these errors. All of the dataset, without applying any filtering parameters, revealed the detection of 5,108 m6A sites by both xPore (WT vs. synthetic reference) and m6Anet. To evaluate the specificity and sensitivity of the combined data, ROC and PR curve analyses for m⁶A sites from m6Anet and the combined results from xPore (WT vs synthetic reference) were generated. The combined approach achieved an AUC of 0.84 and 0.44 for the ROC and PR curves, respectively (Fig 5A, B). These surpass the performance of m6Anet with AUC of 0.82 and 0.26 for ROC and PR curves, respectively.



Figure 5 (A) ROC curve, (B) PR curve for m⁶A sites identified by m6Anet (blue), combined m⁶A sites by m6Anet and xPore (WT vs Synthetic reference) using the set of m6ACE-seq sites as a ground truth.

6. Discussion

The limitation of xPore lies in the difficulty of obtaining unmodified samples. By using synthetic unmodified RNA data as the reference for detection of m⁶A sites by xPore could alleviate the need of unmodified samples. However, the detected modification sites may include other types of RNA modifications such as m⁵C (Pratanwanich., 2021). Conversely, m6Anet can predict m⁶A sites using modified samples, but its efficiency is constrained by the specificity of RNA training data, resulting in varying performance across different samples. As evidence, the accuracy of m6Anet is lower when m6Anet trained by HCT116 is used to predict m⁶A sites in HEK293T and Arabidopsis (Hendra et al., 2022). Therefore, our approach, which uses the combined m⁶A sites predicted by both methods increases the accuracy compared with single method alone, as evidenced by ROC and PR analyses (Fig 5A, B). We believe that this combined approach offers highly reliable m⁶A site predictions. The resulting m⁶A map could enhance our understanding of m⁶A modification and its biology in cancers and many diseases, paving the way for future development of diagnosis and treatment.

7. Suggestion

(1) The availability of reference data sequences obtained through direct RNA sequencing (SQK-RNA002) presents an opportunity for pipeline enhancement. Additionally, the inclusion of data from RNA-002 offers the potential to further improve our pipeline.

(2) By loosening the constraints within m6Anet, which are confined to NNACN k-mers, and extending them to include other types of k-mers, we can potentially identify positions that were previously missed by our pipeline.

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The propagator for projectile motion using the Feynman path integral

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ABSTRACT

In this paper, the propagator for a projectile motion with the Lagrangian at most quadratic in the velocity and position variables is derived by using Feynman path integral as well as Functional methods. We hope that this work should be accessible to advanced undergraduates.

Keywords: Feynman path integral, propagator, Lagrangian

1. Introduction

The Feynman path integral method, as introduced by Feynman in 1948, is a powerful and elegant approach employed for the computation of propagators. Such the path integral method has hitherto been extremely successful in tackling nonrelativistic quantum-mechanical problems, such as the calculation of eigenvalue of harmonic oscillator (Cohen, 1998; Holstein 1998), the evaluation of propagator for electron in a magnetic field and for spinless particle in a one-dimensional (Nevels, Wu & Huang, 1993) as well as infinite square well (Goodman, 1981), the application to spinless particle moving through potential barriers problem (Barut & Duru, 1988), and so on (Inomata, Kuratsuji & Gerry, 1992; Schulman, 1981; Khandekar, Lawande & Bhagwat, 1995; Grosche & Steiner, 1997; Kleinert, 1995; Amit, 1984; Fried, 1972; Rivers, 1987; Ashok, 1993).

Recently work done by Brown and Zhang (Brown & Zhang, 1994) calculated the quantum propagator for a particle moving under a constant force such as the gravitational force near the surface of the Earth using the Feynman path integral method. Their result showed that it is consistent with the well-known standard text book approach, which treats this problem as an energy eigenvalue problems (Landau & Lifshitz, 1977), whose solution involves a higher transcendental function, the Airy function, as well as famous textbook of Feynman and Hibbs (Feynman & Hibbs, 1965), which sketched in a problem. However, this problem is just one-dimensional propagator. The projectile motion, which is a particle moving along a curved path always directed towards the center of the Earth and under constant acceleration when thrown obliquely near the Earth's surface, is one of the simplest and most familiar undergraduate examples of two-dimensional motion in classical mechanics. The path of such a particle is called the projectile's trajectory. Introductory treatment of projectile motion normally ignores air resistance and treats the problem using either differential and integral calculus (Halliday, Resnick & Walker 2005; Serway & Jewett, 2014; Knight, 2008; Weidner, 1985; Tipler & Mosca, 2004; Fishbane, Gasiorowicz, & Thornton, 1993) or algebra and trigonometry (Giancoli, 1980; Giambattista, McCarthy-Richardson, & Richardson, 2017), or even without trigonometry (Mohazzabi, & Kohneh, 2005). It is quite interesting if seen from the path integral point of view. The purpose of present work is to apply the Feynman path integral method, which is the spirit of the work of Poon and Muñoz (Poon & Muñoz, 1999) of computation of the nonrelativistic propagator for a general quadratic Lagrangian—a natural point of departure if one intends to do perturbation theory in the path integral approach—in three dimensions, for obtaining a formal expression of the propagator for a projectile motion. The Lagrangian of two-dimensional motion of a particle under a gravitational force near the surface of the Earth can be written as

$$L = \frac{1}{2}m(\dot{x}^{2} + \dot{y}^{2}) - mgy$$
 (1)

where m is the mass of the particle, g is the gravitational force.

In their well-known exposition of the path integral approach to the propagator, Feynman and Hibbs (Feynman & Hibbs, 1965) show that the propagator for a particle mass m can be written as

$$K(\vec{r},T;\vec{r}_0,0) = N \int D\vec{r} \, e^{iS/\hbar}$$
⁽²⁾

with $D\vec{r} \equiv \lim_{N \to \infty} \prod_{l=1}^{N-1} d^3 r_l$, a normalization factor given by $N \equiv \lim_{N \to \infty} \prod_{k=1}^{N-1} (m/2\pi i\hbar\varepsilon)$, and where the time interval T has been divided into N equal pieces of length ε . The action S is defined as the integral of the Lagrangian function over the period of time T:

$$S = \int_0^T L(\dot{\vec{r}}, \vec{r}) dt$$
(3)

The propagator in Eq. (2) arises as a sum over all paths beginning at the space-time coordinate $(\vec{r}_0, 0)$ and ending at the space-time coordinate (\vec{r}, T) , and conveys the particle from an initial state $\psi(\vec{r}, T)$, namely.

$$\psi(\vec{r},T) = \int d^{3}r_{0}K(\vec{r},T;\vec{r}_{0},0)\psi(\vec{r}_{0},0)$$
(4)

The organization of the rest of the paper is as follows: in Sec. II we will derive the propagator for a two-dimensional motion of a particle under a gravitational force near the surface of the Earth is derived by employing Functional methods. Finally, we conclude with a summary of our results in Sec. III.

2. Derivation of the propagator

Since Eq.(2) involves an integral over all possible paths $\vec{x}(t)$, may be written as a linear combination of the classical path $\vec{x}_{cl}(t)$, the solution of the Euler-Lagrange equations obtained from L, and the deviated path $\overline{x}_i(t)$, i = 1, 2, $\overline{x}_1(t) = \overline{x}(t)$ and $\overline{x}_2(t) = \overline{y}(t)$, the quantum fluctuation:

$$x_i(t) = x_{cl}^i(t) + \overline{x}_i(t)$$
(5)

with the boundary conditions,

$$x(T) = x_f, \ x(0) = x_0, \ \dot{x}(0) = v_{0x}$$
(6)

$$y(T) = y_f, \ y(0) = y_0 \quad \dot{y}(0) = v_{0y}$$
 (7)

$$\overline{x}_i(T) = \overline{x}_i(0) = 0 \tag{8}$$

Covering all paths is now accomplished by integrating over the fluctuation $\overline{x}_i(t)$. The classical solution $x_{cl}^i(t)$ can be found from the Euler–Lagrange equation,

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_k}\right) - \frac{\partial L}{\partial x_k} = 0 \quad (k = 1, 2, 3) \tag{9}$$

The equation of motion is

$$\ddot{x} = 0 \tag{10}$$

$$\ddot{y} = -g \tag{11}$$

The solution of the classical equation of motion Eq.(10) obeying the boundary conditions Eq.(7) is

given by

$$y_{cl}(t) = y_0 + \left[\frac{y_f - y_0}{T} + \frac{1}{2}gT\right]t - \frac{1}{2}gt^2$$
(12)

We now separate the classical contribution to the action, $S=S_c+\overline{S}\,$, with

$$S_{c} = \int_{0}^{T} \left(\frac{1}{2} m \left(\dot{x}_{c}^{2} + \dot{y}_{c}^{2} \right) - mgy_{c} \right) dt,$$

$$= \frac{m \left(x_{f} - x_{0} \right)^{2}}{2T} + \frac{m \left(y_{f} - y_{0} \right)^{2}}{2T} - \frac{1}{2} mg \left(y_{f} + y_{0} \right) T - \frac{1}{24} mg^{2} T^{3}$$
(13)

and

$$\overline{S} = \int_0^T \left[m \dot{x}_c \dot{\overline{x}} + \frac{1}{2} m \dot{\overline{x}}^2 + m \dot{y}_c \dot{\overline{y}} + \frac{1}{2} m \dot{\overline{y}}^2 - m g \dot{\overline{y}} \right] dt, \qquad (14)$$

Applying the condition Eq. (8) after integration by parts,

$$\overline{S} = \int_0^T \left[-m\ddot{x}_c \overline{x} - m\ddot{y}_c \overline{y} - mg\overline{y} + \frac{1}{2}m\dot{\overline{x}}^2 + \frac{1}{2}m\dot{\overline{y}}^2 \right] dt$$
(15)

The first three terms,

$$-m\ddot{x}_{c}\overline{x} - m\ddot{y}_{c}\overline{y} - mg\overline{y} = -m\ddot{x}_{c}\overline{x} - m(\ddot{y}_{c} + g)\overline{y}$$
(16)

vanish because of the equation of motion Eqs.(10) and (11). Now

$$\overline{S} = \int_0^T \left(\frac{1}{2}m\dot{\overline{x}}^2 + \frac{1}{2}m\dot{\overline{y}}^2\right) dt = \int_0^T \left(-\frac{1}{2}m\overline{\overline{x}}\,\dot{\overline{x}} - \frac{1}{2}m\overline{\overline{yy}}\right) dt$$

$$= \int_0^T \left(-\frac{1}{2}m\overline{\overline{x}}_i\,\dot{\overline{x}}_i\right) dt = \int_0^T \overline{\overline{x}}_i\Lambda\overline{\overline{x}}_j dt$$
(17)

where

$$\Lambda_{ij} = -\frac{1}{2}m\delta_{ij}\frac{d^2}{dt^2} \tag{18}$$

A convenient way to integrate over the quantum fluctuations $\overline{x}_i(t) = (\overline{x}(t), \overline{y}(t))$ is to first expand these in terms of the eigenfunctions of Λ . Since this is a 2×2 matrix differential operator, eigenfunctions satisfying the boundary conditions (7) should be associated with (a triple infinity of) discrete eigenvalues. We shall use $(n_1, n_2) \equiv n_{\alpha}$ to label these eigenvalues and eigenfunctions, i.e.,

$$\Lambda u_{n_{x}} = \lambda_{n_{x}} u_{n_{x}} \tag{19}$$

$$u_{n_{\alpha}}(0) = u_{n_{\alpha}}(T) = 0 \tag{20}$$

defines the eigenvalue–eigenfunction problem for $\,\Lambda$. With this notation, the expansion we seek reads

$$\overline{x} = \sum_{n_{\alpha}} c_{n_{\alpha}} u_{n_{\alpha}}$$
(21)

Then

$$\Lambda \overline{x} = \sum_{n_{\alpha}} c_{n_{\alpha}} \lambda_{n_{\alpha}} u_{n_{\alpha}}$$
(22)

and Eq. (19) becomes

$$\overline{S} = \int_0^T \sum_{m_\beta, n_\alpha} c_{m_\beta} c_{n_\alpha} u_{m_\beta}^T \lambda_{n_\alpha} u_{n_\alpha} dt$$
(23)

The orthornormality of the eigenfunctions, $\int_0^T u_{m_\beta}^T u_{n_\alpha}^T dt = \delta_{m_\beta n_\alpha}$ yields

$$\overline{S} = \sum_{n_{\alpha}} c_{n_{\alpha}}^2 \lambda_{n_{\alpha}}$$
⁽²⁴⁾

leads to the propagator

$$K(x, y, T; x_0, y_0, 0) = N \exp(iS_c / \hbar) \int \exp(i\overline{S} / \hbar) D\overline{x}$$
⁽²⁵⁾

where $\mathbf{x} \equiv \vec{x}$ and the remaining path integral has the explicit form

$$\int \exp\left(i\overline{S} / \hbar\right) D\overline{x} = \int \lim_{N \to \infty} \prod_{l=1}^{N-1} D\overline{x}_l \exp\left(i\sum_{n_\alpha} \lambda_{n_\alpha} c_{n_\alpha}^2 / \hbar\right)$$
(26)

Since the expression (21) for \overline{x} is linear in $c_{n_{\alpha}}$, the Jacobian J of the transformation from \overline{x} to $c_{n_{\alpha}}$,

$$\prod_{l} d\overline{\mathbf{x}} \to J \prod_{n_{\alpha}} c_{n_{\alpha}}$$
⁽²⁷⁾

does not depend on the $C_{n_{\alpha}}$, so that

$$\int e^{i\overline{S}/\hbar} D\overline{x} = J \prod_{n_{\alpha}} \int_{-\infty}^{\infty} e^{i\lambda_{n_{\alpha}}c_{n_{k}}^{2}} dc_{n_{\alpha}} = J \prod_{n_{\alpha}} \sqrt{\frac{i\pi\hbar}{\lambda_{n_{\alpha}}}}$$
(28)

or

$$\int e^{i\overline{S}/\hbar} D\overline{x} = J(\det \Lambda)^{-1/2} \prod_{n_{\alpha}} \sqrt{i\pi\hbar}$$
⁽²⁹⁾

where det $\Lambda \equiv \prod_{n_{\alpha}} \lambda_{n_{\alpha}}$. Hence $K(x_{f}, y_{f}, T; x_{0}, y_{0}, 0) = NJ e^{iS_{c}/\hbar} (\det \Lambda)^{-1/2} \prod_{n_{\alpha}} \sqrt{i\pi\hbar}$ (30)

We may avoid a direct calculation of N, J, and the infinite product in Eq.(30) by appealing to the freeparticle propagator $K^{(F)}$. Therefore,

$$K^{(F)}(x_f, y_f, T; x_0, y_0, 0) = NJ e^{iS_c^{(F)}/\hbar} (\det \Lambda^{(F)})^{-1/2} \prod_{n_a} \sqrt{i\pi\hbar}$$
(31)

We may then write Eq.(30) in the form

$$K(x_f, y_f, T; x_0, y_0, 0) = K^{(F)}(x_f, y_f, T; x_0, y_0, 0) \left(\frac{\det \Lambda^{(F)}}{\det \Lambda}\right)^{-1/2} e^{i(s_c - s_c^{(F)})/\hbar}$$
(32)

The free particle propagator may be found in numerous textbooks (Feynman & Hibbs, 1965; Schulman, 1981; Khandekar, Lawande & Bhangwat, 1995; Grosche & Steiner, 1997) and journal articles (Poon & Muñoz 1998; Cohen, 1998; Nevels, Wu & Huang, 1993) (where it is usually computed directly from the Schrödinger equation or by means of operator methods):

$$K^{(F)}(x_{f}, y_{f}, T; x_{0}, y_{0}, 0) = \left(\frac{m}{2\pi i\hbar T}\right) e^{iS_{c}^{(F)}/\hbar}$$
(33)

Thus our final result is

$$K(x_f, y_f, T; x_0, y_0, 0) = \left(\frac{m}{2\pi i\hbar T}\right) \left(\frac{\det \Lambda^{(F)}}{\det \Lambda}\right)^{1/2} e^{iS_c/\hbar}$$
(34)

For the applications that follow it will be convenient to have an explicit expression for det $\Lambda^{(F)}$. For the free particle, $\Lambda_{ij}^{(F)} = -(m/2)\delta_{ij}(d^2/dt^2)$. The eigenfunctions satisfying Eq. (20) are $u_{n_{\alpha}}(t) = \beta \times \cos\left(\sqrt{(2\lambda_{n_{\alpha}}^{(F)}/m)t}\right) + \gamma \sin\left(\sqrt{(2\lambda_{n_{\alpha}}^{(F)}/m)t}\right)$ with β and γ arbitrary column vectors. Imposing the boundary conditions (20), we find the three eigenvalues: $\lambda_{n_{\alpha}}^{(F)} = (m/2)(n_{\alpha}\pi/T)^2$ where $n_{\alpha} = 1, 2, 3, ...$ for each $\alpha = 1, 2, 3, ...$ Consequently,

$$\det \Lambda^{(F)} = \prod_{n_{\alpha}} \lambda_{n_{\alpha}}^{(F)}$$

$$= \prod_{n_{1}} \frac{m}{2} \left(\frac{n_{1}\pi}{T}\right)^{2} \prod_{n_{2}} \frac{m}{2} \left(\frac{n_{2}\pi}{T}\right)^{2}$$
(35)

or

$$\left(\det \Lambda^{(F)}\right)^{-1/2} = \prod_{n_1, n_2} \left(\frac{2T^2}{m\pi^2}\right) (n_1 n_2)^{-1}$$
(36)

In our problem, to find det Λ , we need to solve for the eigenvalues of Λ from Eqs.(19) and (20), with

$$\Lambda = -\frac{m}{2} \begin{pmatrix} \frac{d^2}{dt^2} & 0\\ 0 & \frac{d^2}{dt^2} \end{pmatrix}$$
(37)

which yields

$$\lambda_{n_1} = \frac{1}{2} m \left[\left(\frac{\pi}{T} \right)^2 n_1^2 \right]$$
(38)

$$\lambda_{n_2} = \frac{1}{2} m \left[\left(\frac{\pi}{T} \right)^2 n_2^2 \right]$$
(39)

with $n_1, n_2 = 1, 2, 3...$ Now

$$\left(\det\Lambda\right)^{-1/2} = \prod_{n_1,n_2} \left(\lambda_1 \lambda_2\right)^{-1/2} = \prod_{n_1,n_2} \left(\frac{2T^2}{m\pi^2}\right) \left(n_1 n_2\right)^{-1}$$
(40)

Using Eq.(36) and the product formula (see in Ref. (Arfken & Weber, 1995)), we find

$$\left(\frac{\det \Lambda^{(F)}}{\det \Lambda}\right)^{1/2} = 1 \tag{41}$$

Substituting Eq.(41) in Eq.(34) we obtain the propagator

$$K(x_f, y_f, T; x_0, y_0, 0) = \left(\frac{m}{2\pi i\hbar T}\right) e^{iS_c/\hbar}$$
(42)

with S_c given by Eq.(13).

3. Conclusion

We have presented a strictly analytical method by which the full propagator for the projectile motion be obtained using Feynman's path integral approach and the functional methods which was proposed in this paper has been generalized by Poon and Muñoz (Poon & Muñoz 1998) for the Lagrangian at most quadratic in the velocity and position variables. We hope that this work should be accessible to advanced undergraduates.

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5. References

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Rapid and Sensitive DLLME for the Quantitative of Atrazine in Human Urine Using Liquid Chromatography-Tandem Mass Spectrometry

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ABSTRACT

The herbicide atrazine (ATZ) has been extensively used in Thailand. Atrazine is classified as an endocrine-disrupting chemical. Exposure to ATZ may be associated with an increased risk of certain cancers, such as ovarian cancer, non-Hodgkin's lymphoma, and prostate cancer. The assessment of chronic ATZ exposure in farmers requires an accurate, rapid, and sensitive method. Liquid chromatography-tandem mass spectrometry (LC-MS/MS) in combination with dispersive liquid-liquid microextraction (DLLME), known for its efficiency in sample extraction. We aimed to develop and validate an accurate, rapid, and sensitive DLLME method for the extraction of ATZ in human urine, and quantification by LC-MS/MS following FDA guidelines of 2018. The conditions for DLLME, including extraction time and the ratio of urine, methanol, and dichloromethane, were determined. The results showed that the optimized extraction conditions included a 10-second extraction time and a urine: methanol: dichloromethane ratio of 5:4:1. The method exhibited a lower limit of quantitation of 0.5 ng/mL, with an accuracy of 101.7% and precision of 5.55% CV. The accuracy, precision, recoveries, and matrix effects of the method at low, medium, and high-level quality control (QC) samples ranged from 95.82-105.06%, 5.65-6.64%, 76.17-86.07%, and 100.73-103.94%, respectively. The stability of the extracted QC samples over 7 days at different temperatures and freeze-thaw stability demonstrated accuracy within the 87-115% range. In conclusion, an accurate, rapid, and sensitive DLLME method for ATZ extraction from human urine, followed by quantification using LC-MS/MS, was successfully developed, and validated according to FDA guidelines in this study. This method provides a valuable tool for assessing ATZ exposure in farmers.

Keywords: atrazine, endocrine disrupting chemical, human urine, DLLME, LC-MS/MS

1. Introduction

Atrazine (ATZ) is one of herbicides that is commonly used in crop fields such as corn, rice, and sugar cane to increase productivity and has been extensively used in Thailand and worldwide. Because of its selective control of grasses and broadleaf weeds. The World Health Organization (WHO) classifies ATZ as an endocrine-disrupting chemical (EDC) (1). *In vitro* studies showed that exposure to ATZ may be associated with an increased risk of certain cancers, such as ovarian cancer, prostate cancer (2-3). Many studies *in vivo* showed that ATZ was associated with the alteration of steroid hormones balance, especially the reproductive hormone system leading to reproductive dysfunction in adult and offspring animals (4-7). Epidemiologic studies in people who live in ATZ contaminant area in United State showed that ATZ exposure was associated with an increased risk of preterm delivery (8), increased menstrual cycle irregularity, longer follicular phases, and decreased levels of menstrual cycle endocrine biomarkers of infertile ovulatory cycles in women (9), and exposure to ATZ over the entire gestational period associated with reduced birth weight especially in early and mid-pregnancy may be most critical for its toxic effects on the fetus (10).

Thailand increases the import of pesticides annually; ATZ ranks in top five among high volumes of herbicides imported into Thailand (11). In Nan, a province in Northern part of Thailand, many studies showed that ATZ contamination has been found in agricultural areas and causes adverse effects to aquatic animals that live in herbicide contaminated soil and water paddy fields. Male crabs in the contaminated site had lower body weight than male crabs in the other site (12). ATZ also affects the immune system in frogs that live in contaminated areas as well (13). The ATZ accumulation is also found in mussel's tissue and showed negative correlation with potential health effects (14). However, few studies evaluate the adverse effect of ATZ on farmers in Thailand. To evaluate the adverse effect of ATZ, the sensitivity, accuracy and selectivity technique is needed to measure biomarkers of ATZ exposure.

Liquid chromatography-tandem mass spectrometry (LC-MS/MS) is known as a sensitivity, accuracy and selectivity technique, and can be used for measuring biomarkers of toxic substances in biological fluids such as blood, urine, saliva. LC-MS/MS is the effective technique used for assessment of ATZ exposure in humans or animals (15-17). However, the extraction process is needed before analysis of ATZ by LC-MS/MS. Solid phase extraction (SPE) is one of the effective extractions but needed to buy SPE cartridge, which is expensive, whereas liquid-liquid extraction (LLE) left a large volume of solvent waste. Dispersive liquid-liquid microextraction (DLLME) is a small scale of LLE, dispersive solvent is used to improve the extraction efficiency (18). DLLME is widely used for ATZ extraction before analysis by gas chromatography-mass spectrometry (GC-MS) (19-20). However, few studies have used DLLME for extraction ATZ from human urine and analysis by LC-MS/MS.

In this study we aimed to develop and validate an accurate, rapid, and sensitive DLLME method for the extraction of ATZ in human urine, and quantification by LC-MS/MS following FDA guidelines of 2018. Hopefully, the developed method could be used for determination of ATZ levels in urine for assessing ATZ exposure in Thai farmers.

2. Methods

2.1 Optimization of DLLME condition

To determine the optimal condition for enhancing DLLME efficiency, the ratio between volume of urine sample, extraction solvent (dichloromethane) and dispersive solvent (methanol) were studied as shown in Table 1, and every condition was tested for optimal extraction time at 10, 30, and 60 seconds. Four standard levels in the urine matrix were used for extraction at varied conditions as above and to construct calibration curves. The extracted condition that gives linearity of the curve with correlation coefficient (r) more than 0.995 will be selected for DLLME extraction in the next step.

Sample volume	Total volume of Solvent	Dispersive solvent volume	Extraction solvent volume
50 µL	50 µL	40 µL	10 µL
	25 μL	20 µL	5 µL
200 µL	200 µL	160 μL	40 µL
	100 µL	80 µL	20 µL
	50 µL	40 µL	10 µL
	25 µL	20 µL	5 µL

Table 1: Optimal ratio between volume of urine sample, extraction solvent and dispersive solvent.

2.2 Extraction of urinary atrazine with DLLME

The optimized conditions of DLLME were used for ATZ extraction. Human urine, methanol and dichloromethane were pipetted in appropriate volume into a 1.5 mL microtube. Mix with a vortex mixer and centrifuge. The sediment fraction was collected and adjusted solubility property for LC-MS/MS analysis.

2.3 Matrix-matched calibration and quality control preparation

To create a matrix-matched calibration, seven points of atrazine standards (0, 0.5, 1.0, 5.0, 10.0, 20.0, 40.0 ng/mL) were prepared in the blank human urine with internal standard (atrazine-d5) at final concentration of 5 ng/mL. Three levels of quality controls, i.e., 2.0, 7.5, 25 ng/mL with internal standards were prepared in the blank human urine same as standards.

2.4 LC-MS/MS analysis of ATZ

Extracted samples were analyzed by HPLC (Agilent 1260 infinity) directly connected with Mass spectrometry (AB SCIEX QTRAP 6500) with positive ESI interface. Two microliters of sample was injected to Kinetex XB C18 column (2.6 μ m particle size, 100 × 1.00 mm, Phenomenex, Torrance, CA, USA) and eluted with an isocratic of 35% A (0.1% formic acid in 5% methanol) and 65% B (0.1% formic acid in 95% methanol)

Compound name	Precursor ion (<i>m/z</i>)	Product ion (<i>m/z</i>)	Collision Energy (V)
Atrazine	216	174	23
Atrazine-d5	221	104	29
		109	31.94

with 10 minutes run times at flow rate of $70 \ \mu$ L/min. Mass spectrometer was operated in multiple reaction monitoring (MRM) for quantification of the substances. Parameters for MRM-MS/MS as shown in table below.

2.5 Method Validation

The DLLME LC-MS/MS developed method for ATZ quantitation in human urine was performed in accordance with US Food and Drug Administration Center for Drug Evaluation and Research guidance for bioanalytical method validation. The accuracy, precision, linearity, sensitivity in terms of lower limits of quantification (LLOQ), recovery, matrix effect and stability were determined according to FDA guidelines of 2018 (21).

2.6 Participants and Statistical Analysis

Pool human urine, which was used to construct matrix-matched calibration curves and in-house quality control materials, was collected from healthy non-farmers participants who had no exposure to ATZ. All quality control materials including blank urine pools were placed in a freezer at -20 °C until use. This study protocol was approved by The Research Ethics Review Committee for Research Involving Human Research Participants, Group 1, Chulalongkorn University (reference number COA No. 146/66).

3. Results and Discussion

3.1 Optimization of DLLME condition

Eighteen calibration curves were generated from 18 conditions for optimization of DLLME extraction as shown in Table 1. Only the condition that provided a calibration curve with linearity, r > 0.995, was selected for ATZ extraction in this study. We found that the optimized extraction conditions were a 10-second extraction time and a urine: methanol: dichloromethane ratio of 5:4:1 that is 200 µL: 160 µL: 40 µL. The correlation coefficient (r) of the calibration curve from this extract condition was acceptable and passed the criteria above. Additional extraction time between 10, 30, and 60 seconds did not give different results, thus 10 seconds was selected. Compared to other studies using SPE or LLE for ATZ extraction, DLLME is fast, cheap, and ecofriendly. Our study showed that only 10 seconds per sample was enough for effective ATZ extraction. This helps reduce turnaround time, and is also suitable for identification and quantification of ATZ using LC-MS/MS.
3.2 LC-MS/MS Analysis of ATZ

ATZ samples were extracted using optimized DLLME conditions and then analyzed by LC-MS/MS. ATZ and ATZ-d5 were eluted at almost the same time, 2.73 min and 2.71 min, respectively (Figure 1 (A) and (B)). However, MRM-MS/MS has the powerful selectivity for discrimination of ATZ and ATZ-d5 thus ratios of the areas under the curve of ATZ and ATZ-d5 can be used for quantification. Only the calibration curve of seven standard concentrations i.e., 0, 0.5, 1.0, 5.0, 10.0, 20.0, 40.0 ng/mL with r > 0.995 was accepted for validation criteria of FDA. As shown in Figure 1 (C), the calibration curve of ATZ showed acceptable linearity with r = 0.9991.



Figure 1: HPLC-MS/MS chromatogram of ATZ (A) and internal standard, ATZ-d5 (B), Calibration curve of ATZ with r = 0.9991 (C), and the LLOQ concentration of ATZ at 0.5 ng/mL, defined by S/N ratio more than 10 (D).

3.3 Method Validation

The accuracy, precision, linearity, sensitivity in terms of lower limits of quantification (LLOQ), recovery, matrix effect and stability of our DLLME LC-MS/MS developed method were determined according to FDA guidelines of 2018, the results shown in Table 2 and Table 3. The signal to noise ratio or S/N more than 10 represents a lower limit of quantification (LLOQ) which can depict the sensitivity of this method. This study, the S/N of ATZ was evaluated using Analyst software (SCIEX) and shown in Figure 1 (D). We found that the sensitivity of this method or LLOQ was 0.5 ng/mL with S/N at 13.7. The accuracy and precision of our developed method was shown in Table 2. The LLOQ of this study was comparable with other studies that used on-line SPE LC-MS/MS for analysis of ATZ in urine (22), also DLLME-GC/MS for analysis of ATZ in water matrix samples

(23). The sensitivity of this study might be improved by reducing the volume of solvent that is used for adjusted solubility property of sample fraction before LC-MS/MS analysis. μ L

Quality Control Material (QC)	Accuracy (%) (Mean <u>+</u> SD)	Precision (%)	Recovery (%) (Mean <u>+</u> SD)	Matrix Effect (%) (Mean <u>+</u> SD)
Low (2 ng/mL)	95.82 ± 4.99	6.48	76.17 ± 2.73	102.80 ± 3.45
Medium (7.5 ng/mL)	102.18 <u>+</u> 5.78	5.65	85.52 <u>+</u> 2.54	100.73 <u>+</u> 8.13
High (25 ng/mL)	105.06 ± 7.03	6.64	86.07 ± 5.08	103.94 <u>+</u> 4.87

Table 2: Accuracy, precision, recovery, and matrix effect of the DLLME LC-MS/MS developed method.

The accuracy, precision, recovery, and matrix effect of our DLLME LC-MS/MS developed method were determined according to FDA guidelines of 2018 using in-house quality control (QC) samples with low (2 ng/mL), medium (7.5 ng/mL), and high (25 ng/mL) concentrations. According to FDA guidelines of 2018, the criterion of accuracy is $100\pm20\%$ for the LLOQ and at $100\pm15\%$ for the other concentrations, whereas the precision should be set at $\pm20\%$ CV for the LLOQ and at $\pm15\%$ CV for the other concentrations. The recovery should be done using low, medium, high concentrations QC samples, but the appropriate value is not recommended in the guideline. However, we set %recovery of our developed method to $100\pm30\%$ for the LLOQ and at $100\pm20\%$ CV for the other concentrations.

Accuracy was calculated as formula: [(measure concentration - true concentration)/true concentration] \times 100%). As a measure of precision, the %CV (standard deviation/mean of the measured concentration \times 100%) was evaluated. Both parameters were determined using five samples on three different days. The accuracy and precision of the developed method at low, medium, and high-level quality control (QC) samples ranged from 95.82-105.06% and 5.65-6.64%, respectively. These results were acceptable according to FDA guidelines of 2018.

To evaluate the effects of extraction process which can result in losing of analyte. The extractive recovery was determined by comparing the peak areas of the extracted samples with those of the corresponding extracts of blank samples spiked with the analyte after extraction [(pre-extraction QC peak area/post extraction QC peak area) \times 100%]. The result of the extractive recovery for low level QC or 2 ng/mL ATZ was 74.44% which was within the range of 100±30% whereas the extractive recoveries of other concentrations were within the range of 100±20%. This means the processing steps might result in the loss of the analyte by about 20% of the analyte's concentration.

To evaluate the impacts of matrix solvent that can cause the value of analyte to be at false levels by increase or decrease the ionization of analytical injection. The matrix effect was determined by analyzing five QC samples. For the determination, extracted matrix QC samples post-spiked with atrazine were compared with non-extracted standard solvent according to the following formula: [post extraction std peak area/standard solvent peak area] × 100%. The results of the matrix effect of this study range from 95.9-103.2%. This means our DLLME LC-MS/MS developed method didn't suppress or enhance ionization of target compound or ATZ.

Table 3: The different temperature stability of the extracted QC samples with low (2 ng/mL),

Quality Control Material (QC)	%Accuracy (Mean ± SD)					
	4°C stability 7 days	25°C stability 7 days	1 st Freeze- thaw stability	2 nd Freeze- thaw stability	3 rd Freeze- thaw stability	
Low (2 ng/mL)	94.33 <u>+</u> 4.77	88.53 <u>+</u> 3.07	101.00 ± 0.58	115.00 <u>+</u> 0.00	89.36 <u>+</u> 1.01	
High (25 ng/mL)	87.65 <u>+</u> 1.06	93.77 <u>+</u> 0.58	108.67 <u>+</u> 4.58	103.97 <u>+</u> 4.05	90.76 <u>+</u> 0.78	

medium (7.5 ng/mL), and high (25 ng/mL) concentrations over 7 days and freeze thaw stability.

The stability was investigated using 3 levels of QC samples. Short-term stability was assessed by storing the samples for 24 h at 4 °C and at 25 °C over 7 days. Three cycles of freeze-thaw stability were also determined. Samples were frozen for at least 12 hours between cycles. The peak area ratios of analyte and internal standard of the quantifiers of the stability experiments were compared with those of the freshly extracted samples on the day of measurement. The stability of the extracted QC samples over 7 days at different temperatures and freeze-thaw stability demonstrated accuracy within the 87.62 -115.00 % range as shown in Table 3. These results pass the FDA guideline which recommends 85 - 115% for stability testing.

4. Conclusion

Atrazine is an endocrine disrupting chemical that is shown to have adverse effects on the human body. Generally, the analytical process of atrazine in urine has been performed by using SPE as a pretreatment. DLLME has been a significantly cheaper technique and requires lower volumes of solvent when compared to SPE. This study, we successfully developed an accurate, rapid, and sensitive DLLME extraction followed by LC-MS/MS method for quantification of atrazine in human urine according to FDA guidelines of 2018. The optimization of DLLME extraction was conditions of extraction solvent 40 μ L, dispersion solvent 160 μ L and extraction time of 10 second. The requirement of sample volume was 200 μ L. The calibration was established in a seven-concentration range of 0 ng/mL to 40 ng/mL. The sensitivity or LLOQ was 0.5 ng/mL. The stability of samples can be stored for 7 days at 4°C and 25°C and can be freeze-thaw for at least 3 times without declining results. This developed method provides a valuable tool for assessing ATZ exposure in farmers.

5. Limitations

This study, in-house quality control materials were used because certified reference materials (CRMs) are not commercially available. Also, the higher limit of quantification of this method was not determined. This DLLME LC-MS/MS developed method might be effectively used for quantitation of ATZ metabolites as well, which needs to be evaluated in the future.

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Chemical Composition and Antioxidant Activity of Fermented Anthocyanin-Rich Glutinous Rice

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ABSTRACT

Khao-Mak is a Thai traditional dessert with a unique flavor profile from low-alcohol and lactic acid. Khao-Mak is made from cooked glutinous rice fermented with the starter culture (Look-Pang). Look-Pang including yeast, molds, lactic acid bacteria, and herbs. Khao-Mak was made from white glutinous and pigmented rice (Kam-Doi, Leum-Pua). This investigation focused on the physicochemical and antioxidant activity changes during fermentation. The total soluble solid (TSS) increased throughout the fermentation from 2.00 ± 0.00 to 35.50 ± 0.71 ^o Brix. Whereas, the pH of Khao-Mak has dropped from 6.34 ± 0.01 to 3.52 ± 0.00 during fermentation. Reducing sugar was increased on day 1 of fermentation and decreased until the end of fermentation. The %alcohol concentration varied between 0.31 ± 0.00 and $0.38 \pm 0.02\%$. In addition, phenolic content, anthocyanin content, %DPPH and ABTS were higher in anthocyanin-rich Khao-Mak and increased throughout the fermentation.

Keywords: Khao-Mak, Oryza sativa, fermentation, Kam Doi, Leum Pua

1. INTRODUCTION

Rice (*Oryza sativa*) is one of the most important dietary constituents worldwide, not only in India or East Asian countries (Naivikul, 2004). Rice can be transformed into various products, including rice starch, pasta, fermented food, beverages, puffed rice snacks, and noodles (Rosell *et al.*, 2008) because it will increase the rice's value and extend its shelf life. In Thailand, rice has many species, such as white rice (e.g. Hom Mali, Kor Khor, Khao Niew Khiaw Ngoo, etc.) and pigmented rice (e.g. Kam Doi, Leum Phua, Rice Berry, Sungyod, etc.) (Promsomboon *et al.*, 2016). Pigmented rice had greater antioxidant activity and lower digestibility than white rice. Furthermore, due to phenolics, flavonoids, tocopherols, tocotrienols, and χ -oryzanol were contained in the rice grain bran layer which affects positive health benefits (Pramai *et al.*, 2016).

Thailand has a popular traditional low-alcoholic fermented dessert from rice called "Khao-Mak" (Tochampa *et al.*, 2011). Khao-Mak is produced from cooked sticky rice and a fermentation starter called "Look-Pang" which semicircle starch balls include molds (Aspergillus sp., Rhizopus sp., and Mucor sp.), yeast (Saccharomyces cerevisiae and Candida sp.), and lactic acid bacteria in rice flour with pepper, garlic, and galangal

for antibacterial agents. In processing enzymes from the mold (Alpha-amylase, glucoamylase), starch in rice must be hydrolyzed into sugar, which is then partially fermented to alcohol by yeast. Lactic acid bacteria also generate organic acids such as lactic acid. The product is wrapped with banana leaves or a plastic cup and then left to fermentation at ambient temperature (\sim 30 ° C) for 2 to 3 days. Then, the texture of the cooked rice changed to agglutinated clumps and soft with a slight alcoholic flavor and lactic acid odor (Lotong, 1992).

However, there is still a lack of research information on physicochemical and antioxidant activity changes during fermentation.

Khao-Mak is produced from 3 different rice. White glutinous rice (Khiaw Ngoo) is suitable for making Khao-Mak because of its fragrance. Kam Doi is also flavorful locally sourced black sticky rice that highly contains flavonoids and anthocyanins. Furthermore, Leum Phua is another unique variety of aromatic, glutinous rice, and research suggests that it contains high antioxidant properties.

2. OBJECTIVES

1. To examine how fermentation affects Khao-Mak by evaluating changes in its physicochemical attributes. This evaluation encompassed Khao-Mak preparations derived from both white rice and anthocyanin rich rice.

2. To analyze shifts in total phenolic content, total anthocyanin content, and antioxidant activity, considering anthocyanin-rich rice varieties used in the process.

3. Literature Review

3.1 Anthocyanin-rich rice

Anthocyanin-rich rice has been a staple in the diets of China, Japan, and Korea for an extensive period. Traditionally, it has been harnessed within Chinese medicine to enhance kidney function, combat anemia, bolster blood circulation, alleviate blood stasis, address diabetes, and even improve vision. The extracts derived from pigmented rice serve multiple roles, acting as natural food colorants for products like bread, ice cream, and liquor, while also finding a place in the functional food sector.

Distinctly hued in shades like black, red, and dark purple, pigmented rice boasts a rich composition including flavones, tannins, phenolics, sterols, tocols, γ -oryzanols, amino acids, and essential oils. Notably, anthocyanins hold a pivotal role as the major functional components within pigmented rice. Within these anthocyanins, various compounds have been identified, such as cyanidin 3-glucoside, cyanidin 3-galactoside, cyanidin 3-fdiglucoside, malvidin 3-galactoside, peonidin 3-glucoside, and pelargonidin 3,5-diglucoside (Deng *et al.*, 2013).

3.2 Fermented rice (Khao-Mak)

Khao-Mak, a traditional fermented food, is presented as a low-alcohol sweetened rice product. It is crafted using glutinous rice in combination with a starter known as "Look-Pang" This traditional starter takes the

form of a semi-circular starch ball, composed of rice flour infused with yeast and mold inoculum, along with herbal elements like galangal, garlic, and pepper.

The creation of this delectable sweet and mildly alcoholic rice treat involves a series of steps. Initially, the rice is soaked and then steamed until uniformly cooked. Following this, the cooked rice is allowed to cool down to room temperature and subsequently rinsed with clean water until the water runs clear. After straining, the cooked rice is mixed with powdered Look-Pang Khao-Mak starter and left to ferment naturally at room temperature for a period spanning from 1 to 3 days.

The fermentation process of Khao-Mak primarily involves microorganisms such as yeasts and molds, which include species like Aspergillus, Rhizopus, Mucor, Saccharomyces cerevisiae, and Candida. Once the fermentation is complete, this sweetened fermented rice product becomes ready for consumption without any further cooking required (Tochampa *et al.*, 2011; Wongsa *et al.*, 2018).

3.3 Hypothesis

1. Substrate content in pigmented rice and germinated rice affects the fermentation time.

2. Antioxidant activity will be increased during fermentation.

4. Materials And Method

4.1 Materials and chemicals reagents

White glutinous rice 'Khao Niew Khiaw Ngoo' in Chiang Saen district, Chiang Rai province in northern Thailand. Anthocyanin-rich rice 'Kam-Doi' in Doi Saket district, Chiang Mai province in northern Thailand. And 'Leum-Pua' in Phop Phra district, Tak province in northern Thailand. All were purchased from a local farmer. They were all harvested in December 2020. Then vacuum-packed 1 kg/pack and transported by truck to the Kasetsart University, Bangkok, Thailand laboratory. Look-Pang (starter culture) was purchased from the local market in Lam Luk Ka district, Pathum Thani province in central Thailand. The chemicals and standards used in physico-chemicals, and analytical grade were all purchased from Sigma (Sigma-Aldrich, St. Louis, MO, USA).

4.2 Preparation of Khao-Mak

The traditional method from Wongsa *et al.* (2018) was used to make Khao-Mak. Briefly, rice samples were cooked in a rice cooker. Thereafter, the cooked rice was cooled down to room temperature by draining it with water for 15 min. The obtained rice (300 g) was mixed with Look-Pang starter powder (0.6 g) in a plastic cup. The plastic containers were closed tightly and kept at 30 °C for 3 days.

4.3 Physico-chemical analysis of Khao-Mak

The pH values and alcohol content of Khao-Mak samples from all treatments were examined by a pH meter (Oakton, IL, USA) and a vinometer, respectively. Khao-Mak samples were ground, and the TSS of the resulting liquid was evaluated by a refractometer (Krüss, Hamburg, Germany).

4.4 Reducing sugar content

The rice sample and fermentation broth of Khao-Mak 10 g were mixed and diluted by 10 times. the amount of the reducing sugar was measured by the 3,5-Dinitrosalicylic acid (DNS) assay (Garriga *et al.*, 2017)

by 1 mL of the extracted sample, adding 1 mL of DNS solution, boiled for 5 min, then cooling down in ice rapidly. Each sample was measured absorbance at a wavelength of 540 nm using a spectrophotometer (Thermo Fisher Scientific Inc., Waltham, MA, USA). For quantification, a glucose standard curve with a concentration between 0 and 1 mg/mL was used.

Reducing sugar (mg/mL) = (Absorbance × Dilution factor)/ Slope of standard/1/

4.5 Total anthocyanin content (TAC)

The rice sample and fermentation broth of Khao-Mak 10 g were mixed and diluted by 10 times. TAC was measured by the pH differenced method (AOAC, 2005). In the extracted sample 20 μ L was added 3 mL of pH 1.0 KCl buffer, and 20 μ L of the extracted sample was added 3 mL of sodium acetate pH 4.5 buffer. Two test tubes were measured for absorbance at 510 and 700 nm using a spectrophotometer. The total anthocyanin content of the sample was calculated from the following equation.

Total anthocyanin (mg/L) = $(A \times MW \times DF \times 103)/(e \times L)$ /2/

A = (A510 nm – A700 nm) pH 1.0 – (A510 nm – A700 nm) pH 4.5

MW = 449.2 g/mol/cm (Molecular weight of Cyanidin-3-glucoside)

e = 26,900 L/mol/cm (Molar absorptivity)

L = 1 cm (Length of cuvette)

DF = Dilution factor of sample solution

4.6 Total phenolic content (TPC)

The rice sample and fermentation broth of Khao-Mak 10 g were extracted with 70% acetone 90 mL and centrifuged for precipitation. TPC was measured by the Folin-Ciocalteu assay (Dela Rosa *et al.*, 2021). The extracted sample of 50 μ L was added to 125 μ L of 7.5% sodium carbonate solution, and then 25 μ L of 0.1 N Folin-Ciocalteu reagent was allowed to react for 30 min at ambient temperature. Measured absorbance at a wavelength of 755 nm by spectrophotometer. The results were expressed as mg gallic acid equivalent (GAE) /g of extract.

4.7 DPPH (2, 2-diphenyl-1-picrylhydrazyl) scavenging assay

The DPPH radical scavenging effect of the sample was determined according to the method of (Manosroi *et al.*, 2011) The spectrophotometer was used to measure the absorbance at wavelength 517 nm. The DPPH radical scavenging activity was measured by calculating using the following formula;

Scavenging activity (%) = $[(A \text{ control} - A \text{ sample})/A \text{ control}] \times 100$ /3/

A control = the absorbance of the control reaction

A sample = the absorbance of the sample

4.8 Statistical data analysis

The physicochemical and antioxidant activity data were analyzed at least twice, and the results were given as means of standard deviation (SD). The International Business Machines Statistical Package for the Social Sciences (SPSS) software version 22 was used to do a one-way analysis of variance (ANOVA) (SPSS Inc., Chicago, IL, USA). Duncan's multiple range test was used to assess significant differences between treatments at the 95% confidence level ($P \le 0.05$).

5. Result And Discussion

5.1 Physicochemical properties of Khao-Mak during fermentation

Khao-Mak was produced from three rice varieties, White glutinous rice (W), Kam-Doi (KD) and Leum-Pua (LP). The fermentation broth and rice were mixed to measure the physicochemical properties consisting of TSS, reducing sugar, pH, and %alcohol during the fermentation period. The results are shown in Fig. 1

The TSS of Khao-Mak from three rice varieties increased throughout the fermentation period. The TSS rapidly increased from day 0 and slightly increased after day 1 of fermentation. This was because mold saccharification due to total soluble solids indicates the content of various sugars such as sucrose, glucose, fructose, organic acids, and minerals dissolved in water (Samappito *et al.*, 2019; Wongsa *et al.*, 2018). The amount of TSS found was consistent with the amount of reducing sugar. The maximum reducing sugar content was detected on day 1 of fermentation in pigmented rice and white rice which was the highest reducing sugar on day 1 of fermentation (Oliveira *et al.*, 2010). Then reducing sugar content rapidly decreased, and the amount of alcohol increased. These results suggest that yeast consumed reducing sugar from saccharification and converted it to ethanol. During the fermenting process, the alcohol content increases. Khao-Mak produced from W showed a higher content of alcohol than other rice varieties. These results are in line with Wongsa *et al.* (2018). The pH value of Khao-Mak from three rice varieties decreased over the fermentation period. It rapidly decreased on day 1 of the fermentation and slightly decreased until the end because lactic acid bacteria convert sugar to acid (Taweekasemsombut *et al.*, 2021).



Fig 1. Physicochemical attribute (A) Reducing sugar, (B) Total soluble solid,(C) Alcohol content and (D) pH change during fermentation (0-3 days)

5.2 TAC, TPC, DPPH, and ABTS of Khao-Mak during fermentation

Anthocyanin and phenolic compounds are secondary metabolites produced in plants. The results of TAC, TPC and %DPPH radical scavenging were shown in Fig. 2. On day 0 of the fermentation, the highest of TAC and TPC was found in LP followed by KD, and W, respectively. TAC and TPC were increased throughout the fermentation period (*Zheng et al.*, 2022). The enzyme from microorganisms and alcohol during the fermentation process would break the bonds between anthocyanin and phenolic compounds with other substances, releasing anthocyanin and phenolic compound monomers or antioxidants. according to (Kong *et al.*, 2003), acid or weak acid can cause a partial or complete hydrolysis of anthocyanin molecules. Therefore, the total anthocyanin content could be decreased. The higher amount of TPC and TAC was found to have higher antioxidant activity. The DPPH radical model was a wide and quick tool for estimating free radical-scavenging activity (Dela Rosa and Medina, 2021). The ability of antioxidants to donate hydrogen was thought to respond to their effect on DPPH radical scavenging. This scavenging was observed as a change in color from purple to yellow. As a result, DPPH was commonly used as a substrate to assess antioxidant activity (Lee *et al.*, 2010). Khao-Mak produced from LP had the highest %DPPH radical scavenging contents (74.43%) at the end of the fermentation period. Followed by KD, and W, respectively.



Fig 2. (A) Total anthocyanin content, (B) Total phenolic content, (C) %DPPH radical scavenging and(D) %ABTS radical scavenging change during fermentation (0-3 days)

6. Conclusions

Khao-Mak from the rice varieties W, KD and LP was successfully prepared in the laboratory. The changes in physicochemical properties and antioxidant activity were investigated to determine the overall properties of the sweet fermented rice during fermentation. The physicochemical properties show that TSS increased throughout fermentation because mold saccharification due to total soluble solids indicates the content

of various such as sugars and minerals. The reducing sugar increased on day 1 and then decreased because yeast consumed reducing sugar from saccharification and converted it to ethanol. Resulting in alcohol content increased throughout fermentation. The pH of Khao-Mak decreased over the fermentation period because lactic acid bacteria convert sugar to acid. TPCs and antioxidant activity were higher in the fermentation period, especially anthocyanin-rich Khao-Mak. The enzyme from microorganisms, acid or weak acid and alcohol during the fermentation process would break the bonds between anthocyanin and phenolic compounds with other substances, releasing anthocyanin and phenolic compound monomers or antioxidants.

7. Recommendation and Future Study

Currently, the investigation of metabolite alterations holds a significant role in comprehending fermentation processes. In the future, this technique could potentially extend to the study of Khao-Mak fermentation. Sensory evaluation should be also conducted to achieve consumer acceptance.

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Impact of Fermentation Time on Physicochemical Properties and Phytochemicals in Nam Hom Coconut Cider

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ABSTRACT

"Nam Hom Coconut" the most renowned palm family plant in Thailand and across the globe, is cherished for its delectable, sweet meat and the uniquely fragrant water it holds, the coconut water inside these coconuts is vulnerable to microbial degradation and has a short shelf life. This research delves into the physicochemical characteristics of Nam Hom coconut cider, a product of fermentation with EC-1118 yeast. Parameters such as brix, pH, reducing sugar, alcohol, phenolic compounds, and antioxidant activity were examined. The fermentation resulted in a significant decrease in Brix and reducing sugar, reaching 9.33 Brix and 15.33 mg/L, respectively. In contrast, alcohol content surged to 7%. Moreover, phenolic content increased remarkably by 17-fold, reaching the highest content of $621.20 \pm 5.56 \text{ mg/L}$, along with a 1.7-fold increase in antioxidant activity, reaching the highest antioxidant activity at 55.64 ± 3.40 in the fermented cider. Regarding targeted metabolites, sugars continued to decrease during fermentation, while flavors experienced an increase in the fermented Nam Hom coconut cider.

Keywords: Cider, Yeast, Fermentation, Coconut

1. Introduction

Nam Hom coconut has been a well-known fruit among Thai people for an extensive period. Every part of the coconut, from its apex to its base, can be utilized. Both its water and meat offer a delightful combination of sweetness, aromatic allure, and deliciousness. Significantly, coconut water stands out for its exceptional health benefits, enriched with essential vitamins and minerals (Jirapong, Wongs-Aree, Noichinda, Uthairatanakij, & Kanlayanarat, 2016). Furthermore, it boasts another remarkable attribute its low caloric content. With a mere 18.9 kilocalories per 100 grams (FAO, 2000), coconut water emerges as a nourishing and guilt-free choice.

Coconut belongs to the palm family of plants. Among coconut varieties, Nam Hom coconuts are particularly favored for direct consumption due to their freshness (Luckanatinvong, Mahatheeranont, & Siriphanich, 2018). However, the coconut water within Nam Hom coconuts possesses a limited shelf life and is susceptible to degradation by microorganisms. An innovative approach to address this challenge involves transforming Nam Hom coconut water into cider, presenting the dual advantage of prolonging its preservation while simultaneously enhancing the overall value of the coconut.

Cider refers to the anaerobic fermentation of fruit juice, orchestrated by yeast, where the sugars present in the fruit undergo conversion into alcohol. While apples are the most common source, this term can encompass other fruits as well. The cider-making procedure mirrors that of brewing, involving yeast fermentation, although here the yeast is nourished by the natural sugars within the fruit (Coton, Coton, & Guichard, 2016). This transformative process continues until the majority, if not all, of the sugar content is metabolized into alcohol. Consequently, cider's alcohol content varies, ranging from 3% to 8% alcohol by volume (Joshi, Sharma, & Thakur, 2017). To enhance the cider fermentation process and achieve elevated quality, a comprehensive exploration of the transformations occurring throughout the course of cider fermentation becomes imperative.

Nonetheless, the quest to refine the quality of coconut cider beckons for rigorous scientific investigation. Exploring the nuanced shifts in Brix levels, pH values, alcohol content, reducing sugar concentrations, phenolic compounds, and antioxidant activity within coconut cider production opens the door to a profound understanding. Immersing in these transformations will yield a comprehensive comprehension of how cider evolves throughout the intricate voyage of fermentation.

2. Research Objectives

1. To explore the impact of fermentation on cider by assessing alterations in the physical-chemical characteristics of both coconut water and cider, employing the EC-1118 yeast strain.

2. To examine the influence of fermentation on cider, focusing on variations in total phenolic content and antioxidant activity with the application of the yeast strain EC-1118.

3. To delve into the consequences of fermentation on cider, particularly by scrutinizing shifts in targeted metabolites and aromas, utilizing the yeast strain EC-1118.

3. Literature Review

3.1 Nam Hom Coconut

Coconut varieties (*Cocos nucifera L.*) are commonly categorized into two primary types: tall and dwarf. Tall varieties are cultivated to gather fully matured fruits, with their seeds being processed to obtain coconut milk and oil. In contrast, dwarf varieties are favored for their immaturity, offering both revitalizing water and a tender texture. Within the realm of dwarf varieties, certain types have gained renown for their naturally sweet nectar. Notable examples include Thailand's Nan-Wan and Sri Lanka's King cultivars.

Additionally, Nam-Hom, another Thai variety, stands out for its captivating fragrance and delightful flavor, both in its coconut water and meat (Luckanatinvong *et al.*, 2018). Nonetheless, Nam-Hom coconuts exhibit a short shelf life and are susceptible to spoilage. Converting them into cider presents an alternative approach to food preservation.

3.2 Cider

Cider is categorized as a beverage derived from fruit juices. The term cider usually pertains to unprocessed apple juice or fruit juice. On the other hand, hard cider designates alcoholic products resulting from fermentation (Laaksonen, Kuldjarv, Paalme, Virkki, & Yang, 2017). The precise interpretation of the term cider can vary based on cultural and regional influences. For the purposes of this study, cider specifically refers to a fermented alcoholic beverage. These alcoholic ciders generally possess an alcohol content ranging from 3% to 8% (v/v) (Joshi *et al.*, 2017). To thoroughly investigate these changes, it is essential to delve into various physicochemical aspects. These include factors like Brix, pH, reducing sugar, and alcohol content, which play a crucial role in effectively monitoring the evolution of cider throughout the fermentation process. Furthermore, the augmentation of phenolic and antioxidant activity presents a compelling area of interest for examining the dynamics of antioxidant effects within cider.

3.3 Hypothesis

3.3.1. The fermentation time will lead to distinct physical-chemical characteristics in cider.

3.3.2. The targeted metabolite and flavor changes in coconut cider are attributed to the fermentation duration.

4. Materials and Methods

4.1 Chemicals

Gas hromatography Flame Ionization Detector (GC-FID), Gas Chromatography-Mass Spectrometry (GC-MS), and analytical-grade chemicals were procured from Sigma-Aldrich (St. Louis, MO, USA) and RCI Labscan (Pathumwan, Bangkok, Thailand). All standards used were of reagent grade and obtained from Sigma-Aldrich (St. Louis, MO, USA).

4.2 Choosing and Preparing Nam Hom Coconuts

Namhom coconut (*Cocos nucifera* L.), sourced from Aromatic farm in Damnoen Saduak district, Ratchaburi province, undergoes a fruiting cycle of approximately 6 months. Afterward, the coconut water is filtered and treated with 200 ppm of potassium metabisulfite before being stored at -20°C for further use. This process serves the dual purpose of disinfection and preservation to uphold the coconut water's quality.

4.3 Yeast

Activate the dry yeast by dissolving 5 g of Saccharomyces cerevisiae bayanus yeast (EC1118, Lalvin) in 20 ml of water. Maintain a temperature of 35 - 40°C for 15 minutes.

4.4 Production of Nam Hom Coconut Cider

Begin by adding sugar to the coconut water to attain an initial concentration of 18 Brix. Adjust the acidity using malic acid to achieve a pH of 4. Heat the mixture to approximately 55°C to facilitate dissolution. Subsequently, introduce 4 ml of activated yeast into each of the three fermentation tanks. Allow fermentation to take place at a controlled temperature of 20 ± 1 °C. The fermentation process continues until a stable Brix level is reached, signifying the completion of fermentation. Once the Brix level stabilizes, transfer the fermentation tanks

to a cool storage room set at 10°C for a duration of 2 weeks. Afterward, to precipitate the yeast, carefully extract the supernatant into a new container. Filter the resultant aromatic coconut cider using a Büchner filter. Finally, gather samples of the coconut cider, and store them in 200 ml bottles for further analysis.

4.5 Sampling Nam Hom Coconut Cider

Sampling involved collecting initial samples prior to fermentation commencement, followed by subsequent sampling every 2 days. The process encompassed measuring Brix and pH until a stabilized Brix level was achieved. All sampling procedures adhered to aseptic standards, with samples drawn using pipettes from a 45 mL fermentation tank into centrifuge tubes. The collected samples were then subjected to centrifugation at 4200 rpm and a temperature of 4°C for 10 minutes to facilitate separation. This procedure resulted in the sedimentation of yeast and the collection of the clear fraction. Subsequently, the samples were preserved at -18°C, preserving their integrity for subsequent analysis.

4.6 Analysis of Physicochemical Properties, Targeted Metabolites, and Flavor in Coconut Water and Cider

4.6.1 Brix level measured using a handheld refractometer.

4.6.2 pH value determined via a 2-star pH meter.

4.6.3 The alcohol content was assessed using a vinometer.

4.6.4 Reducing sugar content quantified using the Dinitrosalicylic (DNS) colorimetric method(Sudheer Kumar, Prakasam, & Reddy, 2009).

4.6.5 Total phenolic content was evaluated using the Folin-Ciocalteu method(Zhou & Yu, 2006).

4.6.7 Antioxidant activity is appraised through the DPPH method (Carmona-Jimenez, Garcia-Moreno, Igartuburu, & Garcia Barroso, 2014).

4.6.8 Targeted metabolite analysis using GC-FID

4.6.9 Targeted flavor analysis using GC-MS

4.7 Statistical Data Analysis

The physicochemical, metabolite, and flavor measurements were performed in triplicate and presented as mean \pm standard deviation (SD). Statistical analysis was executed through one-way analysis of variance (ANOVA) utilizing IBM's Statistical Package for the Social Sciences (SPSS) software version 21 (SPSS Inc., Chicago, IL, USA). Significant distinctions among treatments were identified at the 95% confidence level (p \leq 0.05) employing Duncan's multiple range test.

5. Results

In our investigation of the impact of fermentation on the physicochemical attributes of "Nam Hom" coconut cider, utilizing EC-1118 yeast, Figure 1 displays the alterations in Brix, pH, reducing sugars, and alcohol levels. As fermentation advanced, a noticeable decline in both Brix and reducing sugars was observed. By the final day of fermentation, Brix and reducing sugar had notably reduced to 9.33 Brix and 15.33 mg/mL, respectively. Meanwhile, the alcohol content experienced a substantial increase to 7% due to yeast fermentation. This process involves yeast breaking down sucrose into glucose and fructose (Yu, 2006), which then serve as

precursors for alcohol and carbon dioxide production. The results indicate that the typical alcohol content in cider falls within the range of 7-8%, aligning with the broader cider category's usual alcohol content of 2-8% (Joshi *et al.*, 2017).

Turning to the total phenolic compounds and antioxidant activity, depicted in Figure 2, coconut cider subjected to EC-1118 yeast fermentation exhibited a notable increment. This enhancement is attributed to the production of specific metabolites during fermentation, particularly polyphenolic compounds. As a consequence, the overall phenolic content of coconut water cider witnessed an increase. Specifically, coconut water's phenolic compounds registered at 36.09 ± 0.36 mg/L, while EC-1118 yeast-fermented coconut cider displayed a total of 621.20 ± 5.56 mg/L phenolic compounds.

Furthermore, the antioxidant activity of both coconut water and coconut cider was assessed through the DPPH method (Figure 2). The findings disclosed a statistically significant disparity in antioxidant activity between the two. Notably, yeast-fermented coconut cider EC-1118 exhibited the highest antioxidant activity at 55.64 ± 3.40 , while coconut water displayed a scavenging activity of 31.61 ± 0.09 . This divergence is attributed to the variance in phenolic compounds the natural antioxidants between the two. Coconut cider contains a higher concentration of phenolic compounds than coconut water, accounting for the observed variance in antioxidant activity.



Figure 1 Physicochemical properties of Nam Hom coconut cider produced by yeast EC-1118





Figure 2 Total phenolic content and antioxidant activity of Nam Hom coconut water and coconut cider fermented for 14 days at $20 \pm 1^{\circ}$ C with the yeast EC-1118.

In the investigation of targeted metabolites within fermented "Nam Hom" coconut cider using yeast EC-1118, the findings are illustrated in Figures 3, 4, and 5. Figure 3 delineates the fluctuations in sucrose and mannitol. Notably, the sucrose content consistently diminished over the fermentation period, attributed to the yeast's conversion of sugar into alcohol. Furthermore, a decline in mannitol content was observed, signifying the absence of lactic bacterial contamination. This phenomenon aligns with the understanding that lactic bacteria typically transform fructose into mannitol (Zuo *et al.*, 2019). Therefore, the reduction in mannitol served as an indicator of favorable cider quality.

Figure 4 illustrates the presence of fructose and glucose. Notably, the sugar content experiences a significant reduction as yeast utilizes carbohydrates to generate alcohol. Research indicates that yeast primarily utilizes glucose followed by fructose in this process. This phenomenon counterbalances the elevation of glycerol levels, as glycerol is a by-product of yeast metabolism (Kosseva & Kennedy, 2001). Glycerol contributes to the cider's aroma, and body texture, and imparts a gentle sweetness and viscosity, thereby augmenting the cider's overall softness and harmonious character. Beyond its sensory effects, glycerol also fulfills a role in cider stabilization, influencing its resilience against microbial spoilage and oxidation (Gawel, Sluyter, & Waters, 2007).

In Figure 5, the evolution of targeted flavor in cider is depicted across fermentation time, unveiling the presence of ethanol, 1-butanol-3-methyl acetate, and ethyl 9-decanoate.

Ethanol content exhibits a remarkable surge, which aligns with its role as a principal product of yeast fermentation. 1-butanol-3-methyl acetate emerges as the predominant acetate ester in this cider. This is attributed to acetate esters resulting from the reaction between alcohol and acetyl-CoA(Hazelwood, Daran, van Maris, Pronk, & Dickinson, 2008).

Furthermore, the content of ethyl 9-decanoate experiences a substantial increase. This is attributed to ethyl ester, a by-product of the hydrolysis of Acyl-CoA that produces medium and long fatty acids. Acetyl-CoA, synthesized from pyruvate during yeast metabolism, interacts with alcohol's hydroxyl groups, contributing to the synthesis of these ethyl esters (Lee, Rathbone, Asimont, Adden, & Ebeler, 2004). Importantly, the heightened presence of ethyl 9-decanoate might lead to an intensified fruity aroma within the cider (Zhang *et al.*, 2022).



Figure 3 Sucrose and mannitol in Nam Hom coconut cider fermented with EC-1118 yeast at different fermentation times.



Figure 4 Fructose, glucose, and glycerol in Nam Hom coconut cider fermented

with EC-1118 yeast at different fermentation times.



Figure 5 Ethanol,1-butanol-3-methyl acetate, and ethyl 9-decanoate in Nam Hom coconut cider fermented with EC-1118 yeast at different fermentation times.

6. Discussion

The physicochemical attributes of Nam Hom coconut cider, fermented with EC-1118 yeast, encompass Brix, pH, reducing sugar, and alcohol. During fermentation, Brix and reducing sugar decrease significantly, while alcohol content rises. This metabolic process of yeast. In oxygen-depleted conditions, yeast uses sugar as a precursor, resulting in ethanol as the final product of the glycolytic pathway (van Maris et al., 2006). Fermentation results in higher phenolic compounds, particularly polyphenols, causing phenolic content to increase from 36.09 \pm 0.36 mg/L in coconut water to 621.20 \pm 5.56 mg/L in fermented cider. Furthermore, the DPPH method reveals notable differences in antioxidant activity between yeast-fermented coconut cider and coconut water, with the coconut cider at a higher concentration than coconut water. The findings align with the research conducted by Karna L. Sacchi, Linda F. Bisson, and Adams (2005), regarding increased phenolic content in red wine. Sucrose, fructose, and glucose diminish as yeast transforms sugar into alcohol. Reduced mannitol suggests the lack of lactic bacterial contamination, implying favorable cider quality. This observation aligns with the findings of Zuo et al. (2019), who conducted a study on apple cider. Additionally, the investigation unveiled that yeast metabolizes a higher quantity of glucose in contrast to fructose, aligning with the findings of Tronchoni, Gamero, Arroyo-Lopez, Barrio, and Querol (2009) Regarding flavor evolution, there was a notable ethanol surge, a primary yeast fermentation product. The predominant acetate ester was 1-butanol-3-methyl acetate, and the heightened ethyl 9-decanoate. According to a study by Zhang et al. (2022), ethyl compounds like ethyl 9-decanoate exhibit a positive correlation with fruity aromas, contributing to a more pronounced fruit aroma in the cider.

7. Recommendation and Future Study

7.1 Recommendation

(1) Use tightly sealed, high-quality containers to prevent any loss of flavor in the product.

(2) When gathering samples for analysis, ensure they are stored at freezing temperatures using a container designed to withstand cryogenic conditions and pressure.

(3) For cider filtration, it is common to utilize a membrane filter with a pore size of 0.45μ m. However, for analytical purposes, a membrane with a resolution finer than 0.45μ m is necessary.

7.2 Future study

(1) Research should focus on understanding how various strains of yeast impact the fermentation of coconut cider.

(2) This study should encompass a comprehensive analysis of different coconut cultivars, considering factors such as planting location and the cider-making process.

(3) Given that cider production results in the generation of phenols and antioxidants, known for their potential health advantages, exploring the creation of alcohol-free cider products presents an intriguing avenue for further investigation.

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Effect of Electrospinning Parameters on the Bismuth Nanofiber Size

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ABSTRACT

In this work, we investigated the effect of electrospinning parameters on the size of a bismuth oxide (Bi_2O_3) -based nanofiber. A combination of sol-gel process and electrospinning method was employed to synthesize Bi_2O_3 nanofiber using the polyacrylonitrile (PAN) and N,N-dimethylformamide (DMF) solution containing 0.2 g bismuth (III) nitrate pentahydrate $(Bi(NO_3)_2 \cdot 5H_2O)$. The studied electrospinning parameters included a solution flowrate of 0.5, 0.8 and 1 ml·h⁻¹, the needle tip-to-collector distance of 8, 10, and 12 cm, the voltage between nozzle-to-collector of 0 -20 kV, and collector rotation speed of 100, 200 and 300 rpm. FE-SEM was used to characterize the size of the bismuth nanofiber. The results showed that 10% of PAN was sufficient to form a nanofibers film on the collector. The appropriate condition for fiber formation was found to be at the spinning solution flow rate of 0.5 ml·h⁻¹, the nozzle-to-collector distance of 10 cm, the voltage of 10 kV, and the collector rotation speed of 300 rpm. Subsequently, upon subjecting the nanofibers to calcination at 400°C for 2 hours, Bi_2O_3 nanofibers were successfully achieved with an average diameter of 538 nm which can be further utilized as an anode material for desalination and battery applications.

Keywords: Desalination; Electrospinning; Bismuth Oxide; Nanofiber

1. Introduction

Water scarcity is a global problem that is becoming increasingly concerning due to the growing population and climate change. Desalination is the process of removing salt and other minerals from seawater, which is one way to address this issue. This technology can provide a reliable source of clean freshwater, especially in regions where water is scarce. Several desalination technologies are available today, including thermal distillation, reverse osmosis (RO), and electrodialysis (EDL) (Elimelech & Phillip, 2011; Islam et al., 2018). One promising technology is capacitive deionization (CDI), which uses electric fields to remove salt ions from seawater, resulting in clean and fresh water. CDI is an energy-efficient and cost-effective method that can be used in both small and large-scale applications. By utilizing desalination technologies like CDI, we can overcome the challenges of water scarcity and ensure a sustainable water supply for future generations.

Interestingly, CDI technology has found another application in desalination batteries. These batteries utilize a CDI electrode and a battery electrode to both generate electricity and desalinate seawater, creating an intriguing combination (Pasta et al., 2012; Pezeshki & Kettab, 2021). During charging, the electrodes adsorb ions from the water using electrostatic forces, resulting in purified water. When discharging, the ions are released back into the solution, restoring it to its original ion concentration. However, while this technology has a wide range of applications, it also has limitations. Conventional carbon-based CDI is inadequate for removing high seawater concentrations (Jiang et al., 2020). Therefore, significant modifications have been made to the CDI structure to enhance its practicality and effectiveness. These modifications include flow-through, spiral-wound, stacked, capacitive mixing, and three-dimensional structures (Gupta et al., 2019). These structures can be customized to address specific water treatment challenges, making CDI a versatile and efficient technology.

Another formidable challenge involves enhancing capacitive deionization (CDI), which can be accomplished by carefully selecting suitable electrode materials. These materials must possess exceptional ion adsorption efficiency and capacity, establish chemical bonds with ions, and remain insoluble in electrolytes to ensure their long-term durability (Nam & Choi, 2017). Currently, scientists are actively exploring a variety of materials for CDI electrodes, including transition metals, conducting polymers, metal carbides, nitrides, sulfides, carbon-based materials, and metal-organic frameworks (MOFs). When it comes to sodium storage, there's a wide array of successful materials, given their prior use in batteries (Abbas et al., 2022; Slater et al., 2013). However, for chloride storage, further development is necessary to achieve practical results. Among the available options, bismuth emerges as a promising alternative material due to its low toxicity and remarkable chemical stability, making it an attractive substitute for other toxic substances used in chloride storage electrodes removal (Chang et al., 2020; Nam & Choi, 2017). To meet the requirements of an efficient electrode, a bismuth-based electrode must exhibit a high surface area to facilitate rapid reactions and exceptional electrical conductivity. This objective can be accomplished by employing various nano-synthesis techniques, including sol-gel synthesis, chemical vapor deposition, electrospinning, atomic layer deposition, hydrothermal synthesis, solvothermal synthesis, template-assisted synthesis, and others. These advanced methods enable the production of nanoscale materials with precisely tailored properties, resulting in the creation of efficient and effective electrodes.

The primary focus of this study is to investigate the impact of various electrospinning parameters including the solution flowrate, the distance and voltage between the nozzle and collector, the bismuth content, and the collector rotation speed on the formation of nanofibers. Initially, the material will be prepared through the sol-gel method, utilizing a polymer as the primary structural component. Subsequently, a calcination process will be employed to produce bismuth oxide fibers. The fibers size will be analyzed using Field Emission Scanning Electron Microscopy (FE-SEM).

2. Research Objectives

- 1) To study the effect of various electrospinning parameters on the size of bismuth fibers.
- 2) To synthesize bismuth oxide nanofibers by calcination.

3. Literature Review

Nam D. H. et al. (Nam & Choi, 2017) proposed that Bi can be used as a chloride-storage electrode. They demonstrated that Bi electrode could not just store salt ions in the double layer, but it could also store the ions in the bulk of the electrode through the formation of chemical bonding which created practical possibilities. The Bi electrode was used to construct a desalination cell, known as Capacitive Deionization (CDI). Through the charging and discharging process, the desalination cell can repeatedly store and release salt ions. The discharging process can recover some of the energy, therefore the cell has the potential to achieve desalination while using the least amount of overall energy input. In Nam et al.'s work, a nanocrystalline Bi foam electrode was used as an efficient and high-capacity Cl-storage electrode. It stored Cl ions in the form of BiOCl and was coupled with NaTi,PO4. They showed that the Bi/ NaTi,PO4 cell could perform a desalination/salination cycle with a net input of 0.2 V when the process was performed constantly at ± 1 mA cm⁻². Moreover, the acidic solution significantly improved the rate of Cl release from BiOCl. In another study, Liao et al. (Liao et al., 2016) proposed that metal oxide nanofibers from the electrospinning technique possess unique optical and electrical characteristics. This type of nanofiber has been used in various energy devices such as solar cells and battery technologies. In Liao et al. work, the electrospinning technique, and its process parameters, which affect the diameter and morphology of metal oxide nanofibers, have been discussed briefly by exemplified zinc oxide (ZnO) nanofibers. ZnO nanofibers were produced by the sol-gel method with a mixture of polyvinylpyrrolidone (PVP). From the experiments by examining from SEM samples, it is clear that the diameter of ZnO-PVP nanofibers could be escalated by increasing the concentration of either PVP or zinc acetate in the precursor solution because it increased the viscosity of the solution. In the same way, increased applied voltage and molar mass of PVP also resulted in thicker electrospun nanofibers. In addition, the results from XRD showed that the longer the calcination time, the more crystalline ZnO was obtained. It can be said that the calcination condition plays an important role in crystallizing the as-spun ZnO-PVP nanofibers and removing residual PVP components from the nanofibers for practical applications. However, the operating conditions to produce metal oxide nanofibers can be adjusted, depending on the polymer and metal oxide used. Recently, Matysiak (Matysiak, 2022) has adopted a technique

to prepare a Bi₂O₃ solution for electrospinning, called the sol-gel method. In Matysiak's work, a mixture of PAN in DMF with 13 wt% polymer concentration was used as a solvent. After that, to obtain PAN/Bi(NO₃)₃ hybrid nanofibers, 1.5 g of Bi(NO₃)₃·5H₂O was added to 20 ml of PAN/DMF base solution a stirred homogeneously for 24 hours. After electrospinning with fixed parameters, which included a distance between the nozzle and collector of 13.5 cm and the voltage between the electrode equal to 17 kV while the rate of the spinning solution that was fed was 1.5 ml/h. The obtained fibrous composite mats were dried at room temperature for another 24 hours followed by the calcination process at two different temperatures of 400 and 600°C for 3 hours with a heating rate of 10° C ·min⁻¹. The analysis of the structure, chemical composition, and morphology of the produced nanowires after calcination showed that the average diameter was 277 nm and 247 nm, respectively. Matysiak W. concluded that with an increase in the temperature used during the calcination process, the complex refractive index decreased (from 2.62 to 2.53), the dielectric constant decreased (from 6.87 to 6.42) and the value of the energy band gap decreased from 3.19 eV to 2.97 eV. To conclude, Nam et al. found bismuth effectively absorbs chloride ions from seawater and can serve as electrodes for CDI. Liao et al. proposed a method for producing metal oxide fibers via electrospinning, highlighting the impact of polymer concentration on fiber size. This suggests the potential for bismuth oxide fiber synthesis. Matysiak's research successfully synthesized bismuth oxide fibers, confirming their feasibility and providing a guideline for synthesizing bismuth oxide fibers.

4. Research Methodology

4.1 Preparation of Solutions for Electrospinning

For this experiment, Polyacrylonitrile (PAN) (C_3H_3N), Scientific Polymer Products, Inc. (USA), was chosen as the base polymer, and DMF (Dimethylformamide), Tedia Company, Inc. (USA), served as the solvent. To create the solution, a 10% PAN solution was prepared in DMF. This was achieved by thoroughly mixing 0.524 g of PAN with 5 ml of DMF using a magnetic stirrer for 2 hours at a temperature of 35°C. Following the stirring process, 0.2 g of bismuth(III) nitrate pentahydrate (Bi(NO₃)₃·5H₂O), Alfa Aesar (Germany), Thermo Fisher Scientific was added into the 10% PAN/DMF solution, and the mixture was further stirred for an additional 24 hours at 35°C. In this step, we achieved a PAN/DMF/ Bi(NO₃)₃·5H₂O solution for electrospinning.

4.2 Synthesis of Bismuth Nanofibers Using Electrospinning Method

To produce bismuth nanofibers, the PAN/DMF/Bi(NO₃)₃·5H₂O solution was loaded into the pump of the electrospinning device and subjected to the electrospinning procedure. An FES-COE electrospinning machine (Falco Tech Enterprise, Taiwan) was employed to create a PAN/Bi₂O₃ solution. Various electrospinning parameters were adjusted during the process, including the nozzle- to- collector distance, electrode voltage, spinning solution flow rate, and roller collector speed set at 300 rpm. To prevent gravitational interference, the needle was horizontally oriented, as illustrated in Figure 4.1. Following the electrospinning process, the nanofibers were air-dried at room temperature for 24 hours before undergoing calcination process to eliminate the PAN component. This calcination occurred in an ambient air environment. The temperatures were 400°C for

2 hours with a heating rate of 10° C per minute. As a result, we obtained B_2O_3 nanofibers. Then, the fibers size was analyzed using Field Emission Scanning Electron Microscopy (FE-SEM), Regulus 8100, Hitachi.



Figure. 4.1 Experimental procedure scheme for fabrication of B₂O₃ nanofibers

5. Results

5.1.1 Blank test

In order to determine the suitable electrospinning parameters, we conducted experiments using a 10% w PAN/DMF solution without bismuth content to observe the behavior at the needle tip during the electrospinning process. The studied electrospinning parameters included a solution flowrate of 0.5, 0.8 and 1 ml·h⁻¹, the needle tip-to-collector distance of 8, 10, and 12 cm, the voltage between nozzle-to-collector of 0 -20 kV, and collector rotation speed of 100, 200 and 300 rpm. Various phenomena were observed during the formation of fibers under different electrospinning conditions. It is evident that the behavior undergoes changes corresponding to alterations in potential difference. The results are presented in Table 5.1. Based on our observations, we can categorize the phenomena into four distinct stages. In the first stage (red region), minimal electric field influence results in solution accumulation at the needle's tip, leading to rapid droplet formation, with increased potential difference accelerating droplet fall. Flow rate has little effect, but altering the needle-collector distance impacts this stage. In the second stage (yellow region), the electric field initiates fiber formation, reducing droplet production with higher voltage and a wider stage influenced by PAN concentration and flow rate. The third stage (green region) shows equilibrium with a Taylor's cone and visible fibers, its potential influenced by various factors. The final stage (blue region) exhibits mass flow rate imbalance, causing fiber whipping, resembling electrospraying but still yielding fibers.

5.1.2 Effect of the Parameters on Average Fiber Diameter

I. Effect of Flow Rate and Voltage on PAN Fiber Diameter

In Figure 5.1, SEM images of fibers are shown under different conditions (green section in Table 5.1). When the effect of flow rate on average fiber size was observed, it was noted that there wasn't much of a difference. Even when the distance was kept the same, the size varied by just 100 nanometers. To make the PAN fibers larger, the voltage had to be increased, which prevented bead formation. This caused the fibers to appear stretched, akin to a rubber band being pulled. As a result of the flow rate and voltage being adjusted accordingly,

the fiber size didn't change much. Across all experimental conditions, fiber sizes were found to be maintained between 500 and 700 nanometers.

II. Effect of Distance and Voltage on PAN Fibers Diameter

In general, with increasing the distance between a needle tip and a collector, the size of the fiber must be smaller due to more time for the solvents in the fiber to evaporate. But in the case of our study, the fibers diameter increased with the distance. The voltage had been increased to make it more suitable for fiber production. We can use the electric field equation to help determine this situation, as shown in eq. 5.1.

$$\mathbf{V} = \mathbf{E} \cdot \mathbf{d} \tag{5.1}$$

As distance (d) in the electric field increases, the electric field weakens (E). To keep a constant electric field, raise the electric potential (V) (Table 5.2). Similar electric field values suggest an optimal field for a given flow rate. PAN fiber size trend slightly increased.

III. Effect of Concentration or Viscosity on Fibers Diameter

The addition of bismuth nitrate to the sol-gel solution significantly increased its viscosity. Viscosity required an increase in voltage. The fiber size increase is evident, with a significant jump from \sim 500 nm to \sim 1500 nm. The data is shown in Table. 5.1.

IV. Effect of Roller Collector Speed on Fibers Alignment

The main effects of the roller collector speed are on the alignment and orientation of the fibers, as shown in Figure 5.2. When the collector speed is high, the fibers are deposited in a more linear and parallel arrangement, resulting in a higher degree of alignment. This is because a higher collector speed tends to stretch and align the fibers along the direction of rotation, resulting in fibers that are more oriented in the direction of the roller surface (Alfaro De Prá et al., 2017). In contrast, when the collector speed is low, the fibers are deposited in a more random and disordered arrangement, resulting in a lower degree of alignment. This is because a lower collector speed allows the fibers to fall more randomly onto the surface of the collector, resulting in fibers that are less oriented in any particular direction.

V. Effect of Voltage on PAN + Bi(NO₃)₃ Fibers Diameter

To determine the voltage effect, we performed a PAN + $Bi(NO_3)_3$ solution with a flow rate of 1 ml·h⁻¹. The voltage was adjusted to 12, 14, and 16 kV for observation. According to Figure 5.3, the fiber size follows a theoretical trend: as the voltage increases, the fiber size decreases. As the voltage increases while the distance remains constant, the electric field increases, thus increasing the pulling force.

5.1.3 PAN + Bi(NO₃)₃ Fibers After Calcination

The resulting fibers were then subjected to calcination at temperatures of 400°C for 2 hours. The SEM images obtained before and after the process were shown in Figure. 5.4. It can be seen that after the calcination process, the fiber has a rougher surface. Gaussian distribution was used to determine the average fiber size. The distributions of the fibers before and after calcination that were measured randomly from 50 samples were shown. The average diameter before and after calcined was 1589 nm and 538 nm. The calcination led to polymer degradation and a reduction in the average diameter of the fibers.



Table 5.1 Phenomena during fiber formation under different electrospinning conditions.

Figure 5.1 The SEM images of PAN fibers at the optimum electrospinning conditions (green region)

Table 5.2 The electric field values at optimum conditions (green region) for PAN fibers production at a flow rate

of 0.5 ml·h⁻¹.

Voltage (kV)	7	8	10
Distance (cm)	8	10	12
Electric field (kV·cm ⁻¹)	0.875	0.8	0.83



Figure 5.2 SEM of PAN + Bi(NO₃)₃ fibers were collected at different rotational speeds (100, 200, and 300 rpm) with parameters of 0.5 ml·h⁻¹ 10 kV, and 10 cm



Figure 5.3 SEM images of PAN + Bi(NO3)3 fibers were taken at different voltages (12, 14, and 16 kV) with parameters of 0.5 ml·h⁻¹, 10 kV, and 10 cm.



Figure 5.4 SEM images of the bismuth fibers before and after calcination at 400°C, and its Gaussian distribution.

6. Discussion

Table 5.1 shows various fiber formation phenomena that are observed under different electrospinning conditions. It is concluded that the production of droplet-free fibers requires appropriate electric fields influenced by distance and potential difference. Increasing the bismuth precursor concentration significantly affects solution viscosity and fiber diameter. For 10% PAN with 0.2 g of Bi(NO₃)₃, the suitable conditions for electrospinning are a flow rate of 0.5 ml/h and a distance of 10 cm with 10 kV. Furthermore, during calcination at 400°C, PAN fibers decompose completely, leaving behind bismuth oxide fibers with an average diameter of 538 nm, which is smaller than their size before calcination. One should be aware that fiber formation at the tip did not confirm fiber formation at the collector. Our results are consistent with the work of Zargham et al. (Zargham et al., 2012). In their work, Nylon 6 in formic acid was electrospun to form nanofibers. A suitable flowrate could maintain the fiber stability without dropping. This flow rate was also found to influence the shape of the initiating droplet, the jet trajectory, and the Taylor cone formation. In another study, Mazoochi et al. (Mazoochi et al., 2012) studied the effect of different parameters on polysulfone fiber formation. They found that increasing the applied voltage reduced the fiber diameter and bead frequency, while increasing the tip-to-collector distance resulted in more uniform fibers and less bead formation.

7. Suggestions

To create nanofibers through electrospinning, it is crucial to fine- tune key parameters like voltage, needle- to- collector distance, and spinning solution flow rate. Experiments with different settings to achieve the desired fiber characteristics and stability will need to be further studies in order to optimize the electrospinning parameters. In addition, the choice of polymer and its concentration, as well as the solvent, can significantly impact the quality of your nanofibers, thus the step of sol-gel preparation of the spinning solution, particularly the PAN/DMF/Bi(NO₃)₃·5H₂O solution has to be extremely careful. Furthermore, during the electrospinning process, the mass equilibrium must be well monitored and controlled by adjusting the potential difference and solution flow rate to maintain equilibrium, as this can influence the formation of continuous nanofibers.

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Simulation of pressure generated by fresh concrete in a very long column formwork by using finite element analysis.

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ABSTRACT

The purpose of this research is to analyze the pressure (P) or stress on concrete according to the railway platform construction standard KKU S-T-003-256x. The railway platform formwork was made of SS400 steel. Four different thicknesses (t) of formwork were examined: 0.3, 0.4, 0.5, and 0.6 cm, respectively. The vertical steel batten (P_L) is 15 cm, and the horizontal steel batten (P_H) is 15 cm. A finite element method (FEM) was used to solve the problem. The initial pressure of liquid concrete (P) at the top of the long column was six different (h), i. e., 500, 600, 700, 800, and 900 cm. In the analysis, it was found that P was increased as increasing h the maximum stress or P was increased as the thickness (t) reduced. Then, the maximum stress of t = 0.3, 0.4, 0.5, and 0.6 cm becomes 424, 371, 273, and 244 MPa. Respectively. If h is higher than 600 cm, thicknesses (t) are between 0.3 and 0.4 cm. The formwork was not resistant to deformation owing to the maximum strength of SS400 being 245 MPa, leading to the analyzed result of the present study being higher than the strength of SS400.

Keywords: Long column, Railway platform formwork, Finite Element Method

1. Introduction

Infrastructure development is an important part of laying the foundation for economic development. To increase competitiveness and attract investment according to the 20-year national strategy, 2018-2580 [1] contains the topic of the plan for building competitiveness. Which part of the content will focus on the infrastructure in the field of transportation to connect travel transportation with neighboring countries and to improve the linkage network to support the entry into the ASEAN Community through various channels in the

strategy of developing Thailand's transportation infrastructure from 2015 - 2022. [2] This is to improve the rail transport infrastructure system. A double-track railway system is ready to operate the first six lines. This project expedites the push to be able to carry out the construction of a standard gauge double track linking with neighboring countries and the People's Republic. In South China, by constructing one more railway parallel to the original line from the existing track, it is also connected to the former railway network of the State Railway of Thailand (SRT). In the route section Map Krabao-Khlong Khanan Chit, CSP Technology Co., Ltd. was a subcontractor for the construction of a new Muak Lek Railway Station. It consisted of station buildings and platforms. Muak Lek station must be moved to a new place. The State Railway of Thailand (SRT) selected the most suitable area, but it was found that the construction area needed to be upgraded to the platform. To raise the original ground up to meet the design standard, KKU S-T-003-256x [3], according to the rail construction standard, the slope (gradients) normal limit was not more than 2%, as shown in Fig. 1.



Figure 1 The design of the track railway according to the KKU standard S-T-003-256x.

The design of the platform columns of Muak Lek (New) station was a long column with a pair of platforms on a length of 400 meters. The height of the platforms was in the range of 400 cm to 900 cm, supporting a total of 242 platforms. The conditions for casting columns without joints arise when the liquid concrete must be poured on time. Standard formwork is usually used when the concrete has been poured to a height of 5 m [4], as shown in Fig. 2.



Figure 2 Deformation at the edge of the column formwork.

Standard column formwork cannot withstand the pressure of liquid concrete. This caused damage to the column formwork, resulting in column formwork failure. From the existing knowledge studies [5], no reference data has yet been found to solve the problem in practice. To solve column casting problems, the finite element analysis method [6] was explored, which is the most used method to solve problems in continuum mechanics. The general principle was to divide a continuous object into smaller parts called elements. These elements were separated by an imaginary line or other imaginary surface and connected by a node at the boundary of the element, as shown in Fig. 3.



Figure 3 Divide the workpiece into smaller elements to analyze the problem.

In this study, we would like to present the development of a very long column formwork using mathematical modeling. The formwork for the long column with a height of 900 cm was studied. The horizontal steel battens (P_H) were 15 cm. The vertical steel battens (P_L) were 15 cm long. The finite element method (FEM) was applied to analyze the concrete stress acting on the formwork of the long column.
2. Research Objective

Study the influence of formwork thicknesses (t) made of SS400 steel. Four, consisting of 0.3, 0.4, 0.5, and 0.6 cm, affect stress from the pressure of liquid concrete (P) at a 5-difference level (h) of 500, 600, 700, 800, and 900 cm.

3. Literature Review

3.1 Weight and pressure of concrete [7]

The pressure of concrete in the early stages was calculated with the same properties as water. The pressure of concrete varies according to the depth and density of the liquid shown in Fig. 4.



Figure 4 Divide the workpiece into smaller elements to analyze the problem.

Refer to Fig. 4 to compare the pressure of the concrete acting as a fluid (liquid) with the concrete in the form of a non-fluid. The pressure of the concrete with a low height gave a value close to the pressure of the liquid calculated according to CEB (Comite Euro-International du Beton). So, we got Eq. (1). $P_h = \gamma H.$ (1)

3.2 Theories used in stress analysis.

In this research, maximum distortion energy theory [8] or von Mises theory and a theory of failure derived from the Strain energy principle are used to calculate the maximum value that the formwork can accept before failure. For the result in the case of 3D stress, von Mises can be obtained as shown in Eq. (2).

$$\sigma_{v} = \sqrt{\frac{1}{2}(\sigma_{1} - \sigma_{2})^{2} + (\sigma_{2} - \sigma_{3})^{2} + (\sigma_{3} - \sigma_{1})^{2}}$$
(2)

where σ_v represent the von Mises stress and σ_1 , σ_2 , and σ_3 represent the primary stress.

3.3 Clinical Trial Registration

The development of this finite element caused the development of computational tools that can calculate and store more data as well. The finite element method (FEM) is a numerical process to obtain an approximate solution by dividing the domain into smaller, aligned elements. The entire domain without overlapping is called "Mesh" and then constructs each element of the equation. on the principle that the equations created must be consistent with the control equations of the problem being considered. Problems in engineering, science, and others are covered by these three elements. The finite element method of analysis is therefore applied to solve a wide variety of problems.

3.4 Solid works

Solid Works [9] is software to use as an engineering design tool and to create a mock product example before creating a real prototype product. The software is in the Computer Aided Design (CAD) family, which creates 3D model parts. Solid Work is a program that is very flexible and able to work in many forms. Whether it is a workpiece that needs to be solid or a surface, there is a machine that supports it very well. When the workpiece is finished, it can be assembled in the mode of the assembly instruction set. For those who want the drawing of the workpiece just drag the workpiece and place it in the worksheet.

4. Research Methodology

4.1 Formwork structure design

Solid Works was used to design the formwork. The actual size was width x length, equal to 60 cm \times 60 cm. The material used for building the concrete formwork was carbon steel, type SS400. The properties of steels were based on the Thailand Industrial Standard reference, TIS 1227-2538 [10], as shown in Table 1. Four formwork thicknesses (t), consisting of 0.3, 0.4, 0.5, and 0.6 cm, were examined. The horizontal steel batten (P_H) was 15 cm. The vertical steel batten (P_I) was 15 cm. The model of this work is presented in Fig. 5.



Figure 4 Model.

No.	Property details	Volume	Unit
1	Tensile strength at the lowest yield point	245	MPa
2	Tensile strength	400-510	MPa
3	Shear modulus	800	MPa
4	Density	7,860	kg/m ³

 Table 1 SS400 Carbon Steel Properties

4.2 Assumptions and analysis condition

The assumptions and the analysis conditions used in analyzing the force (pressure) acting on the concrete formwork are presented in Tables 2 and 3. The properties of concrete were based on the standards of the State Railway of Thailand (SRT).

Table 2 The assumptions used in the equation.

No.	Assumptions
1	The pressure of the concrete acts is directed from the top.
2	The pressure acting on the concrete formwork is constant.
3	There is no lateral force on the outer formwork.
4	The physical properties of steel are constant.

Table 3 Analysis conditions

No.	Parameters	Factor	Unit
1	Concrete density	2,400	Kg. $/m^3$
2	Height levels (h) of initial pressure	500, 600, 700, 800 and 900	cm
3	The thickness of steel (t)	0.3, 0.4, 0.5 and 0.6	cm
4	Vertical Steel battens (P_{I}) and Steel battens Horizontal (P_{H})	15	cm

5. Analyzed Results

5.1 Elements independence test results

The design of the platform columns of Muak Lek (New) station was a long column with a pair of platforms on a length of 400 meters. The height of the platforms ranged from 400 cm to 900 cm and included a total of 242 platform columns. The conditions for casting columns without joints arise when the liquid concrete must be poured on time. Normally, standard formwork is used when the concrete has been poured to a height of 500 cm [4], as shown in Fig. 2.



No of Element

Figure 6 Elements independence test results.

5.2 The Stress Result of formwork

Figure 7 presents the stress experienced by the very long column formwork in the simulation, analyzed with a thickness (t) of 0.3 cm. Similarly, Figure 8 shows the stress distribution for a thickness (t) of 0.4 cm, while Figure 9 displays the stress for a thickness (t) of 0.5 cm. Additionally, Figure 10 illustrates the stress patterns for a thickness (t) of 0.6 cm. Furthermore, the results for the heights (h) of 500 cm, 600 cm, 700 cm, 800 cm, and 900 cm are depicted, respectively, in Figures a, b, c, d, and e.



Figure 7 The stress of t = 0.3 cm



Figure 8 The stress of t = 0.4 cm



Figure 9 The stress of t = 0.5 cm



Figure 10 The stress of t = 0.6 cm

6. The discussion on the effect of analyzed parameters.

The results of the analysis indicated that the stress experienced by the formwork can be summarized in Table 4. The calculated stress values ranged from 129 MPa to 453 MPa. However, it was observed that the formwork did not withstand deformation due to the maximum stress capacity of SS400 being 245 MPa. Only in one case, where the thickness (t) was 0.6 cm, did the calculated stress fall below the strength of SS400. Furthermore, to better understand the impact of thickness (t) on the formwork stress caused by the concrete pressure, Figure 11 is provided. It illustrates that the stress acting on the formwork increases with higher concrete levels, while thicker formwork results in decreased stress levels.

level of Initial	Stress at Thickness, (N/m. ²)						
pressure (h) (cm.)	t.= 0.3 cm	t.= 0.4 cm	t.= 0.5 cm	t.= 0.6 cm			
500	239,855,000	197,221,000	142,300,000	129,620,000			
600	275,314,000	240,967,000	173,900,000	158,543,000			
700	325,519,000	284,720,000	205,400,000	187,267,000			
800	375,575,000	328,466,000	242,948,000	216,091,000			
900	453,381,000	371,860,000	273,775,000	244,709,000			

Table 4 Stress at Horizontal steel battens difference level



Figure 11 Stress acting on the formwork.

7. Summary of the Calculation

The pressure analysis using the finite element method (FEM) of liquid concrete or pressure (P) applied to the railway platform column formwork was constructed from SS400 steel by AASHTO M85 Railway Station Construction Standards. In the present study, it was found that the stress tended to increase with the decrease in thickness of the formwork (t) and the initial pressure of liquid concrete (P) at the top of the long column. It was found that P increased as increased (h). Then, the maximum stress of t = 0.3, 0.4, 0.5, and 0.6 cm becomes 424, 371, 273, and 244 MPa. Respectively. If h gave higher than 600 cm, thicknesses (t) at 0.3 and 0.4 cm The formwork was not resistant to deformation owing to the maximum strength of SS400 being 245 MPa, leading to the analyzed result of the present study being higher than the strength of SS400. Therefore, this preliminary information can lead to improving the formwork structure.

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Effect of Packaging on The Quality of Lychee During Transportation

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ABSTRACT

Effect of Packaging on The Quality of Lychee During Transportation, is an experiment of the efficiency of lychee packaging. Lychee delivery Packaging is important in distribution process because it helps to keep the quality close to freshly harvested lychee. The process of this experiment is a part of the study of packaging process efficiency to keep and extend quality of lychee. The sample of this study is freshly harvested in the Samut Songkhram province, average diameter of approximately 33.12 millimeters. and the average force of puncture force testing is 31.32 Newton-meter. Collected data are temperature and humidity data from samples for a duration of 72 hours. (which represents the maximum allowable delay for lychee shipments) and measure the hardness by puncture force testing. The result shown that the packaging that sealed humidity is the most efficiency for keep and extend lychee quality, the average diameter of the lychee decreasing by only 2.58%, and the puncture force reducing by 1.76% The reduced puncture force is attributed to the dry and crisp nature of the peel, indicating a significant quality measure for lychees.

Keywords: Effect, Packaging, Quality, lychee, Transportation

1. Introduction

Lychee is the important economic crops in Thailand. It is a seasonal fruit. Because of the appropriate weather and terrain of lychee growth, there is limited cultivation area. The proper temperature is about 20 - 30 degrees Celsius, but before flowering period it needs 10 - 20 degrees Celsius continuously for 4 weeks; depending on the type and growing area. After fruiting, temperature can be higher, but should not be over 40 degrees Celsius, because it may explode.

Nowadays, logistics business in Thailand is more competitive. This is an opportunity to distribute products to consumers. Due to more supportive transport sector, the distribution of agricultural products no need to rely on middlemen, which changing to a way that farmers can sell their produce and send it directly to consumers through couriers immediately.

However, there are some problems that occur to the lychee by sending it in the form of parcels, such as moldy, and dry peel caused by improper packaging. Some packaging cannot keep the quality of lychee after harvested and while transport. As a result, the product may be damaged and affect consumer satisfaction.

Minimizing physical harm to fresh produce is crucial for maximizing its shelf life, and the utilization of appropriate packaging plays a pivotal role in achieving this objective (Thompson A.K., 1996).

From the above problem, it is an idea of a research project of the study of packaging process to keep and extend quality of lychee and guide the packaging of lychee product for make an opportunity, revenue, and expand the market of lychee.



Figure 1 Example of Lychee

2. Research Objective

- (1) To study the packaging process to keep and extend quality of lychee
- (2) To serve as packaging guidelines for lychee products

3. Literature Review

3.1 Role of Packaging in Logistics

For the role of packaging in logistics, when designing packaging and transportation equipment, the focus is on convenience and cost. This can involve modifying materials, reducing or increasing the size of cargo boxes, and using cushioning materials such as corrugated paper or paper pallets to suit the products. The roles and responsibilities of logistics packaging can be divided into three main categories (Hongthai, n.d.):

 Storage Support: In the logistics system, packaging serves as a storage support. It protects the products from damage and facilitates organized storage and placement during transportation. It allows for easy inspection and counting of goods.

2) Transport Support: Packaging plays a role in transportation by ensuring convenience and safety during movement.

3) Cost Reduction: Packaging helps reduce costs by optimizing space, both for storage and transportation. Packaging can be stacked efficiently, allowing for the transportation of a large quantity of goods at once.

3.2 Important of Packaging in Business

Packaging is a critical element that can significantly enhance the value of a product and its marketability.

The decision to purchase a product is often influenced by the allure of its packaging. In this discussion, we delve into the multifaceted role of packaging, exploring its impact on business success, advertising, environmental considerations, cost-effectiveness, and customer satisfaction. Understanding the importance of packaging is pivotal in today's competitive market, where the visual and functional aspects of a product's presentation can make all the difference. Let's explore the various facets of packaging and its profound influence on both products and businesses.

1) Enhancing Perceived Value: Packaging serves as the initial point of contact between a consumer and a product. A well-designed package can convey a sense of quality and value, making a product more appealing. This perceived value can influence a consumer's decision to buy, even before examining the actual product.

2) Effective Advertising: Beyond its functional role, packaging acts as a powerful advertising tool. It communicates crucial information about the product, including its brand, features, benefits, and usage instructions. Clever packaging design can capture a consumer's attention and leave a lasting impression.

3) Environmental Responsibility: In an era of increasing environmental awareness, sustainable packaging choices are gaining importance. Packaging made from eco-friendly materials or designed for easy recycling not only reduces the ecological footprint but also appeals to environmentally conscious consumers.

4) Cost Efficiency: Efficient packaging practices can lead to cost savings for businesses. Optimizing packaging materials and design can reduce material expenses and transportation costs. This efficiency contributes to a company's bottom line.

5) Damage Mitigation: Packaging is not just about aesthetics; it's also about protecting the product during transit and storage. Robust packaging helps prevent damage from factors like leakage, breakage, and wear and tear. Customers trust products that arrive in pristine condition.

3.3 Keep and Extend Quality of Lychee by Packaging

There are many research that shows the result of keeping quality of fruit and vegetables by controlling atmosphere of storage and packaging. Modified atmosphere packaging and controlled atmosphere storage are employed to extend the freshness duration of fruits and vegetables (Das E., Gurakan G. C. and Bayindirli A., 2006). Moreover, Proper packaging empowers processors to package both fresh and fresh- cut fruits and

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vegetables, ultimately extending their shelf life. Critical factors in achieving this shelf-life extension include controlling temperature, managing moisture levels, and implementing a modified atmosphere (M. Scetar et al., 2010). According to the research objective, study to the packaging process to keep and extend quality of lychee, researchers aim to collect the data from different lychee packaging pattern experiment to evaluate and conclude the result that reflects what should be considered in keep the quality of lychee.

3.4 Research Hypotheses

The hypothesis of this research is controlling moisture within the packaging can affect the alteration of diameter and peel hardness, consequently impacting the quality of lychee.

4. Research Methodology

4.1 Population and Sample

This study involves simulating the parcel packaging of lychee delivered process by using different packaging materials to evaluate the quality of lychee that closely resembles the quality of fresh fruits. The study includes details of the materials and research steps as follows:

4.1.1 Lychee

Samples of lychee used by researchers for study involve collecting data on lychee production are Freshly harvested maturity lychee in the Samut Songkhram province. These lychees are seasonal fruits, with an average diameter of approximately 32.18 millimeters.



Figure 2 Lychee Sample Diameter

4.1.2 Packaging

The researchers observed changes in lychee fruits when they were stored on an open area after harvesting. The peel of the lychee would dry up and change to a brown color. This drying and browning process would continue until the fruit became crispy and ultimately lost its quality. Based on these observations, the researchers hypothesized that humidity/moisture played a crucial role in preserving the quality of lychee. Therefore, researchers used plastic bags as the primary packaging material for data collection because it effectively maintained the moisture content of the lychee and Plastic bags were widely used in the cultivation area.

4.3 Research Instrument

The tools used for data collection in this study are as follows:

4.3.1 Data Logger: This device is employed to collect temperature and humidity data within various patterns of packaging. It helps in comparing and evaluating the effects of different packaging patterns on lychee. The data logger records temperature and humidity levels at regular intervals, allowing researchers to monitor the storage conditions throughout the study.

4.3.2 Digital Force Gauge: This tool is utilized to gather data on the hardness of the lychee peel puncture force testing. By using the digital force gauge, researchers can measure and compare the hardness of freshly harvested lychee fruits with those stored in different packaging patterns. This data is crucial for evaluating the quality of the lychee fruits, as changes in peel hardness can indicate degradation or loss of freshness.

By combining data from the data logger and digital force gauge, the study aims to provide insights into how different packaging methods affect the temperature, humidity, and hardness of lychee. This information will help in assessing the overall quality of lychee fruits stored in various packaging patterns and their resemblance to freshly harvested produce.

4.4 Data Collection

4.4.1 Measuring the diameter of lychee and collecting data on the hardness of their peels is standard for assessing their quality.

4.4.2 Pack lychee into four different types of packaging as follows:

1) Packaging#1, sample packed into plastic bag, tie the bags tightly with a string, and place them inside non-perforated cardboard boxes, data logger placed in the plastic bag.



Figure 3 Packaging#1

2) Packaging#2, sample packed into perforated plastic bag, tie the bags with a string, and

place them inside non-perforated cardboard boxes, data logger placed in plastic bag.



Figure 4 Packaging#2

3) Packaging#3, sample packed into fruit-type shipping boxes with air vent and use banana leaf support at the bottom inside, data logger placed with the sample.



Figure 5 Packaging#3

4) Packaging#4, sample packed into fruit-type shipping boxes with air vent



Figure 6 Packaging#4

4.4.3 Collect temperature and humidity data from samples for a duration of 72 hours (which represents the maximum allowable delay for lychee shipments)

4.4.4 Record the results of temperature and humidity data collected from the data logger and use a digital force gauge to measure the hardness of lychee peels from various packaging patterns studied in this research.

4.4.5 Evaluate the data collection results and summarize the research.

4.5 Data Analysis

Analyze the variance of humidity data from different packages, and comparing the results of humidity preservation in different packaging patterns and the measurements of lychee peel hardness to assess their ability to keep quality similar to fresh harvested lychee.

5. Research Findings

From the observation, lychee peel after stored on open area is dry up and change to a brown color which makes the condition of the lychee appear unappetizing and directly affects the quality of the lychee. Based on the researcher's hypothesis, drying the peel would change its hardness, experiments were conducted, and data on the hardness of the lychee peel were collected by the measurement of the force applied to the lychee peel until it punctures is known as puncture force testing. are shown in Figure 7.



Figure 7 Lychee's Peel Puncture Force Testing

As the result, the fact that lychees peel change to brown color affects the hardness of the peel, and the longer they are stored in an open area, the drier the peel becomes. Furthermore, it can be observed that the diameter of the lychee also decreases accordingly. The temperature and humidity data during transportation are collected using a data logger, which is shipped as a package through the courier or parcel delivery service provider. This data is collected to analyze the climate conditions during transportation, especially during the season when lychees are sent to the consumer are shown in Figure 8.



Figure 8 Transport Climate Data

Sample of lychees would be lychees that are harvested simultaneously, the researchers selecting lychees of similar diameter and packing them in different pattern, including both the fruit and leaves, with a total weight of 500 grams, average diameter of the sample is 33.12 millimetres and average force of puncture force testing is 31.32 Newton-metre. The reason for packing both the fruit and leaves in the packaging is because in retail, lychees are often packaged this way for aesthetic purposes, and it also provides additional cushioning to prevent damage during transportation.



The results of temperature and humidity data collection for 72 hours from each type of packaging, as shown in the following figure.

Figure 9 Results of Temperature from Each Packaging

From Figure 9 shown that the packaging pattern designed for this experiment exhibit minor temperature variations, but they remain consistent with each other. It can be observed that as temperature increases or decreases, the temperature inside the packaging changes in a correlated manner. The temperature factors may have only a minor impact on the deterioration of the lychee. The important data in this experiment is the humidity inside each packaging format, as shown in Figure 10.



Figure 10 Results of Humidity from Each Packaging

The collection data of different packaging were analyzed by Analysis of Variance (ANOVA) as following table **Table 1** Analysis of Variance of Research Hypothesis about Packaging Patterns Effect on Humidity within Packaking

ANOVA							
Source of Variation	SS	df	MS	F	P-value	F crit	
Between Groups	1114627.844	3	371542.6146	11947.57816	0.00	2.605409803	
Within Groups	551549.4206	17736	31.09773459				
Total	1666177.264	17739					

Research hypothesis about packaging patterns. There are four different packaging patterns with an effect on the humidity within the packaging (H0). The significance level is set at Alpha = 0.05. When tested using ANOVA: Single Factor, it was found that H0, which suggests that the packaging patterns have a significant effect on the humidity at the 0.05 level, is rejected (P-Value = 0.00).

From figure 10 the results of Humidity data collection in each package differ significantly.

Packaging #1, humidity is preserved best, with only minor temperature effects on the internal moisture. This is because the first type of packaging does not allow air exchange, which impacts humidity inside the packaging bag and prevents moisture loss during the experiment.

Packaging #2 will experience some humidity loss due to the presence of holes in the plastic bag, which are designed to prevent excessive humidity. However, it still maintains humidity reasonably well. It can be observed that the humidity level decreases significantly compared to packaging #1 and decreases in line with packaging #2 and packaging #3

Packaging #3 will have lower humidity levels than the first two packages. This is because it is not sealed inside. a plastic bag but instead has absorbent with banana leaf placed at the bottom of the box to increase humidity from the banana leaf. The humidity level fluctuates with external weather conditions, as it is packaged inside a fruit box with air vents.

Packaging #4 is consistent with packaging #3, as it is the packaging format that retains the least humidity, and its humidity levels vary significantly with external weather conditions.

From the above results, it is evident that there are differences in humidity preservation among the various packaging patterns. The researchers have designed a method to evaluate the quality of lychee by comparing the diameter of the lychee and using puncture force testing to measure the hardness of the lychee peel. The experimental results are as follows.



Figure 11 Result of Diameter and Puncture Force Testing from Different Packaging

As a result, the diameter of sample that packed in Package#1 has few decreases and use the force for puncture force testing similar the fresh harvest. Others are decreasing respectively followed in the ability to

preserve humidity. In conclusion of the experiment, Packaging#1 is the most efficient packaging that can keep the quality of lychee while shipped in transportation process.

6. Discussion

From the experiment, the results show that packaging that is most efficient to keep and extend quality of lychee is packaging #1 which retains humidity the best, resulting in lychees that maintain their quality close to freshly harvested ones. This is measured by the average diameter of the lychee decreasing by only 2.58%, and the puncture force reducing by 1.76% when compared to packaging #4, which does not retain moisture at all. In contrast, packaging #4 sees a significant decrease in lychee diameter by 9.10% and a 37.40% reduction in puncture force. The reduced puncture force is attributed to the dry and crisp nature of the peel, indicating a significant quality measure for lychees. The most important thing that needs to be concerned about keeping fresh of lychee is humidity preservation, because the reduction of moisture in the lychee directly affects the size.

7. Suggestion

In future research, it would be beneficial to study the effects of quality changes in flavor or the texture of lychee flesh. This would support the findings of the current research and further advance the development of suitable packaging formats for fruits with similar characteristics.

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Energy and environmental assessment of a waste-solar trigeneration system

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ABSTRACT

In this work, a waste– solar trigeneration system is presented. A case study of Mae Moh district, Lampang province, Thailand is considered. The energy and environmental simulations are developed by using a mathematical model. A life cycle assessment (LCA) method is conducted based on the ISO 14040 and ISO 14044 standards. The ReCiPe technique is used to analyze 18 midpoint-level impacts. The hybrid system consists of an incineration rate of 3.83 Ton/d, a double-stage organic Rankine cycle (ORC) of 137 kW_{e} , an absorption chiller of 41.32 kW, a drying room of 171.17 kW, and a solar-rooftop photovoltaic (PV) system of 847 kW_{p} . The thermal simulation results imply an ORC efficiency of 7.02%, an absorption coefficient of performance (COP) of 0.81, and a drying efficiency of 56.38%. The overall efficiency is approximately 9.99%. The LCA impacts are driven from 3 materials of concrete, steel, and clay in the parts of a construction phase of 64.42%, an operation phase of 31.88%, and a decommissioning of 3.70%, respectively. The main LCA impacts are found from a climate change of $1.63E-01 \text{ kg CO}_2$ eq, a human toxicity of 6.79E-02 kg 1,4-DB eq, a fossil depletion of 4.73E-02 kg oil eq, a metal depletion of 1.89E-02 kg Fe eq, and a freshwater ecotoxicity of 1.08E-02 kg 1,4-DB eq, respectively.

Keywords: Life cycle assessment; Organic Rankine cycle; Absorption chiller; Drying room; Solar photovoltaic system.

1. Introduction

The solid waste issue revealed a municipal solid waste (MSW) of 24.98 million Ton/y (PCD, 2021) in 2021, Thailand. In addition, Mae Moh district, Lampang province was found 6,516.96 Ton/y or 17.85 Ton/d. The Mae Moh Power Plant plans to manage the MSW in Mae Moh area. Energy planning goal under the Thailand's Alternative Energy Development Plan between 2018-2037 (Ministry of energy, 2022) is focused for a waste-to-energy (WtE) concept as a case study of Mae Moh district.

From the WtE study, Adeboye et al. (2022) investigated the physical characteristics of MSW in Osun, Nigeria. The proportion was organic of 35.71%, plastics of 21.6%, paper of 12.03%, respectively. The low heating value (LHV) of combustible MSW was approximately 21.58 MJ/kg. Markphan et al. (2021) reported the waste situation in Phrom Lok Municipality, Nakhon Si Thammarat province, Thailand. The daily MSW generation was approximately 3.47 Ton. The mass ratio of waste comprised as the combustible waste of 43.33%,

non- combustible of 48.33% waste, and other waste of 8.33%. This finding was supported by Yatsunthea and Chaiyat (2020), who utilized the infectious medical waste and MSW with a LHV of 26.92 MJ/kg to produce a power of 23.65 kW_e. Organic Rankine cycle (ORC) showed a system efficiency of 8.91%. Sorgulu et al. (2021) focused on utilizing a food industry of 400 Ton/d. Drying process was used to reduce the moisture content of waste at a LHV 13.91 of MJ/kg for an ORC power of 2.92 MW_e. Zhang et al. (2023) enhanced thermal performance of a two-stage ORC system with R-141b as working fluid. This improvement showed an increase rate efficiency of 5.89% compared with the conventional ORC system. In addition, overall energy losses in the modified system decreased 19.58 kW.

Environmental impact on the renewable energy systems reported by Chaiyat et al. (2021), life cycle assessment of a combined cooling, heating, and power (CCHP) system from geothermal energy was performed by using the ReCiPe method. The analysis yield as a single-score value of 0.0631 Pt was indicated. The construction activity was a high contribution of 62.17% of the CCHP system. Single environmental indicator was supported by Kythavone and Chaiyat (2020) at a 0.000348-Pt small-scale power generation system integrated with an infectious medical waste incinerator. Hosseini et al. (2022) presented the natural gas to power system in Iran. A climate change impact of 511 g CO_2 eq was found from a fossil fuel energy of 9.52 MJ. Dong et al. (2020) studied the community-scale incinerator, which revealed a carbon dioxide equivalent emission of 102 kg CO_2 eq/Ton_{MSW}.

As mentioned above, the waste management in terms of the energy and environmental issues in Mae Moh district, Lampang province, Thailand is not considered. Thus, the objectives of this study are as follows:

- To investigate the energy and environmental assessments of the waste-solar trigeneration system,
- To develop the mathematical model under the energy and LCA perspectives.

2. The concepts of system description

A principle operating diagram of the waste–solar trigeneration system is illustrated in Figure 1. The MSW of Mae Moh area is separated to be the combustible and non-combustible wastes at point 1 m. Organic waste at point 2 m is used for fertilizer process. Combustible waste at point 3 in form of municipal solid waste type 1 (RDF-1) is fed into an incinerator. Hot fluid loop at points 1w-8w as clean water is used in heat transfer process between the incineration and hot fluid medium. The hot fluid tank and pumps are the main components for extracting heat from combustion heat into hot fluid. The ORC unit as power process is the first system in the waste-CCHP system. A novel double-stage ORC cycle is presented in this work. R-245fa is selected as working fluid of both cycles. A high-temperature above 115 °C transfers heat for a high-stage ORC cycle at points 1-7. A fluid temperature less than 95 °C applies for a low-stage ORC cycle of points 1h-7h. After that, a hot fluid temperature of approximately 85 °C supplies heat to a water-lithium bromide absorption chiller at points 1a-10a. Next, a low-water temperature of approximately 80 °C is used to extract moisture in a drying room at points 1d-3d. Cooling unit at points 1c-9c is selected for extracting heat from the ORC and absorption systems, respectively. The dropdown water temperature is sent back through the storage tank and incineration, respectively. The waste-

CCHP system is parallel connection by a solar-rooftop PV system at point 1s-2s. Two power systems from the double-stage ORC and solar PV are combined in this work. A trigeneration system of the combined double-stage and solar PV system as power process, the absorption chiller as cooling process, and the drying room as drying process is a novel renewable energy system of this work.



Figure 1 A schematic diagram for a trigeneration system from waste-solar energy.

3. Methodology

The thermal and environmental assessment of the trigeneration system from the waste-solar hybrid energy are the method and apparatus as follows:

3.1 Exploration

The physical property of MSW in Mae Moh district such as the amount, proportion of combustible and non-combustible, and type of waste are collected as the initial condition of simulation processes.

3.2 Energy impact

The first law thermodynamic is used to develop the thermal mathematical model. Energy, mass, and concentration balances are considered in each part of the waste-CCHP system. Standard equations based on the solar-radiation and solar-power are referred to design the solar-rooftop PV system. In addition, the standard testing conditions (STC), ambient temperature, and Mae Moh location parameters are considered in terms of the cell temperature, power, current, and voltage. The initial conditions of thermal simulation are specified in Table 1. A correlation of mathematical equation of the waste–solar trigeneration system is shown in Figure 2.

Table 1 The operating conditions for thermal simulation.

Description	Quantity	Reference	
Drying room			
Different temperature of hot water at drying coil ($\Delta T_{HW,DC}$, °C)	9	(Chaongew and Chaiyat, 2019)	
Effectiveness of drying coil (e _{HX,DC} , %)	80	(Chaongew and Chaiyat, 2019)	
Air temperature of Lampang province $(T_{amb}, ^{\circ}C)$	28.40	(Meteorological department, 2023)	
Relative humidity of Lampang province $(RH_{amb}, \%)$	55	(Meteorological department, 2023)	
Dry bulb temperature $(T_{2d}, °C)$	78	-	
Relative humidity (RH _{2d} , %)	55	-	
Dry bulb temperature $(T_{3d}, °C)$	68	-	
Relative humidity (RH _{3d} , %)	81.96	-	
Wet basis after drying (WB _{F} , %)	35.25	-	
Incinerator			
Efficiency incinerator (η_{IC} , %)	31.66	(Yatsunthea and Chaiyat, 2020)	
Bottom ash (Ash, %wt)	6.45	(Yatsunthea and Chaiyat, 2020)	
Hot water temperature $(T_{2w}, °C)$	94	-	
Ash mixture ratio in the concrete block ($M_{i,concrete}, kg_{Ash}/piece$)	0.50	(Wongthong et al., 2021)	
Efficiency incinerator (η_{IC} , %)	31.66	(Yatsunthea and Chaiyat, 2020)	
ORC			
Superheating of ORC (SH _{ORC} , °C)	9.20	(Chaiyat, 2023)	
Subcooling of ORC (SC _{ORC} , °C)	1.50	(Chaiyat, 2023)	
Temperature difference of the hot water pinch point ($\Delta T_{PT,B}$, °C)	10	(Chaiyat, 2023)	
Temperature difference of the cold water pinch point ($\Delta T_{_{PT,C}},$ °C)	5	(Chaiyat, 2023)	
Different temperature of hot water (ΔT_{HW} , °C)	5	(Chaiyat, 2023)	
Different temperature of cooling water (ΔT_{CW} , °C)	5	(Chaiyat, 2023)	
Efficiency isentropic pump ($\eta_{s,P}$, %)	90.44	(Chaiyat, 2023)	
Efficiency isentropic expander ($\eta_{s,Exp}$, %)	69.20	(Chaiyat, 2023)	
Efficiency generator ($\eta_{\rm G}$, %)	85	(Chaiyat, 2023)	
Pump mechanical efficiency ($\eta_{_{MC,P}}$, %)	65	(Chaiyat, 2023)	
Effectiveness of boiler (e _B , %)	95.00	(Chaiyat, 2023)	

Description	Quantity	Reference
Absorption chiller		
Concentration of LiBr (X _{min} , % LiBr)	60	(Inthavideth and Chaiyat, 2017)
Superheating of Absorption chiller (SH _{AB} , °C)	5	(Inthavideth and Chaiyat, 2017)
Subcooling of Absorption chiller (SC _{AB} , °C)	5	(Inthavideth and Chaiyat, 2017)
Effectiveness of heat exchanger (e _{HX} , %)	85	(Inthavideth and Chaiyat, 2017)
Different temperature of solution (ΔT_s , °C)	3	(Inthavideth and Chaiyat, 2017)
Isentropic efficiency of solution pump ($\eta_{s,sP}$, %)	80	(Inthavideth and Chaiyat, 2017)
Solar rooftop		
Latitude angle (ϕ, \circ)	18.277	(Google, 2023)
Longitude angle (l_{Loc}, \circ)	99.735	(Google, 2023)
Metres above sea level (H _{sea} , m)	323	(Google, 2023)
Maximum power (W _{mpp} , W _p)	550	(Sun power, 2023)
Maximum power point voltage (V _{mpp} , V)	39.50	(Sun power, 2023)
Maximum power point current (I _{mpp} , A)	13.92	(Sun power, 2023)
Temperature coefficient of short circuit current ($_{a_p}$ %/°C)	0.05	(Sun power, 2023)
Temperature coefficient of open circuit voltage (b_V , %/°C)	0.26	(Sun power, 2023)
Nominal operating cell temperature $(T_{NOCT}, ^{\circ}C)$	45	(Sun power, 2023)
Module efficiency (η_{STC} %)	21.10	(Sun power, 2023)
Dimension of module (A_{PV}, m^2)	2.20	(Sun power, 2023)
Inverter maximum power point tracking losses (η_{inv} , %)	99	(Smets et al., 2016)
Inverter conversion losses (η_{dist} , %)	95	(Smets et al., 2016)
Ohmic losses (η_{abs} , %)	99	(Smets et al., 2016)

3.3 Goal and scope definition of the LCA

The scope of environmental impact is a cradle-to-grave perspective. Up steam process is considered in terms of the raw materials, resource, energy, and transportation activities for a lifespan of 20 y. Functional unit is an energy production of 1 kWh from the waste–solar hybrid system.

3.4 Inventory analysis of the LCA

Three parts of the construction, operation, and decommissioning phases are collected. The acquired data will be utilized to assess environmental impacts in the next part.

3.5 Impact assessment of the LCA

The environmental impact assessment employs the ReCiPe methodology (NIPHE, 2016). The midpoint-level impact across 18 impact categories is investigated by using the SimaPro database.

3.6 Interpretation of the LCA

The LCA results are analyzed from the interpretation process. The advantages and disadvantages are considered based on the LCA impacts. This procedure is used to modify the high-impacts from the raw materials and energy in the construction, operation, and decommissioning processes of the waste–solar trigeneration system.



Figure 2 A correlation of mathematical model of the waste-solar trigeneration system.

4. Results and discussion

4.1 Physical property of MSW

The MSW data of Mae Moh district in 2021 establishes a total amount of 6,516.96 Ton/y or 17.85 Ton/d. Mass proportion of MSW is a combustible of 33.13%, a non-combustible of 35.24%, and an organic of

31.63% from a random exploration of 10 garbage bags. Combustible waste in form of RDF-1 shows a density of 101.06 kg/m^3 and an LHV of 23.01 MJ/kg, which is nearly with Adeboye et al. (2022) of 21.58 MJ/kg.

4.2 Energy performance

Figure 3 depicts the energy simulation results. RDF-1 at an average mass of 3.83 Ton/d is used as solid fuel in the batch type incinerator at a combustion chamber of 38 m³ to generate hot fluid at a temperature above 105 °C. A hot fluid tank of 10 m³, a hot fluid pump of 5.95 kW_e, and a hot water pump of 5.95 kW_e design for storage heat and supply to the waste- CCHP system. At steady state condition, hot water supplies heat into the double-stage ORC system at a gross power of 137 kW_e. The cooling process, a hot water temperature of 85 °C transfers heat to the absorption chiller at a cooling capacity of 41.32 kW. The heating process, a hot water temperature of 80 °C extracts moisture at a rate of approximately 35.24% in the drying room through a drying coil of 171.17 kW. The waste-CCHP system generates a total energy of 274.78 kW at an energy efficiency of approximately 8.98%, which is corresponded with Yatsunthea and Chaiyat (2020) of 8.91%. At the same time, a 3D model of building for installation the waste–solar trigeneration system is developed, as also presented in Figure 3. The rooftop at an area of 4,008 m² is designed to handle a power generation system of 847 kW_p at a PV number of 1,540 panels and each panel capacity of 550 W_p. An average hourly solar radiation of 451.51 W/m² leads to a daily solar power of 5.83 kWh/(m²·d) and a net daily power output of 2,745.49 kWh/d under a solar PV efficiency of 9.23%. The waste–solar trigeneration system shows a total energy output of approximately 4,973.71 kWh/d and an overall efficiency of 9.99%.



Figure 3 Raw material and energy flow for a waste-solar trigeneration system.

4.3 Life cycle inventory

Life cycle inventory is the raw materials and energy under the construction, operation, and decommissioning phases. Construction process reveals three materials of 13,991-Ton concrete, 523-Ton steel, and 357-Ton clay, respectively. A novel concept for waste management is used to reduce materials for landfill. Bottom ash from combustion process is mixed with cement and husk for producing concrete block.

4.4 Life cycle impact assessment

Table 2 provides the 18-midpoint environmental impacts. Raw materials affect a construction impact of 64.42%. Air pollution from combustion process conducts an operation impact of 31.88%. Waste deposal of landfill process leads the LCA results at a decommissioning of 3.70%.

. .	Unit	Construction	Operation	Decommissioning		Total emission	
Impact				Recycle	Landfill	Lifetime	1 kWh
CC	kg $\rm CO_2$ eq	4.02E+06	3.46E+06	-1.90E+06	2.92E+05	5.87E+06	1.63E-01
OD	kg CFC-11 eq	2.20E-01	3.55E-03	-5.26E-02	4.12E-02	2.12E-01	5.87E-09
TA	kg SO_2 eq	1.73E+04	4.55E+04	-5.69E+03	2.21E+03	5.94E+04	1.64E-03
FE	kg P eq	1.10E+03	1.46E+00	-4.61E+02	1.35E+01	6.56E+02	1.82E-05
ME	kg N eq	7.78E+02	3.20E+04	-2.62E+02	3.03E+02	3.28E+04	9.09E-04
HT	kg 1,4-DB eq	2.45E+06	2.97E+05	-3.98E+05	9.85E+04	2.45E+06	6.79E-02
POF	kg NMVOC	1.45E+04	5.49E+04	-6.03E+03	2.98E+03	6.63E+04	1.84E-03
PMF	kg PM ₁₀ eq	7.75E+03	1.21E+04	-4.78E+03	2.14E+03	1.72E+04	4.78E-04
TET	kg 1,4-DB eq	5.99E+02	3.14E+01	-4.96E+01	3.35E+01	6.15E+02	1.70E-05
FET	kg 1,4-DB eq	3.99E+05	2.35E+03	-1.53E+04	3.44E+03	3.90E+05	1.08E-02
MET	kg 1,4-DB eq	3.56E+05	2.33E+03	-1.46E+04	3.11E+03	3.46E+05	9.60E-03
IR	kBq U ₂₃₅ eq	2.69E+05	1.22E+03	-2.36E+04	1.64E+04	2.63E+05	7.29E-03
ALO	m ² a	1.31E+05	4.01E+01	-1.79E+04	4.57E+03	1.18E+05	3.27E-03
ULO	m ² a	1.02E+05	4.26E+01	-1.61E+04	1.83E+04	1.04E+05	2.88E-03
NLT	m^2	7.54E+02	8.00E+00	-1.13E+02	-5.46E+02	1.03E+02	2.87E-06
WD	m ³	4.68E+04	-6.54E+01	-2.55E+03	2.43E+03	4.66E+04	1.29E-03
MD	kg Fe eq	1.43E+06	4.99E+03	-7.62E+05	8.26E+03	6.83E+05	1.89E-02
FD	kg oil eq	8.25E+05	1.08E+06	-3.19E+05	1.24E+05	1.71E+06	4.73E-02

Table 2 The LCA impacts of the waste-solar trigeneration system.

Four environmental impacts are directly driven from concert. An urban land occupation of 2.88E-03 m²a, a natural land transformation of 2.87E-06 m², an ozone layer of 5.87E-09 kg CFC-11 eq, and a climate change of 1.63E-01 kg CO₂ eq.

The environmental impacts associated with the use of gypsum board, which is commonly used for lightweight walls and ceilings in office buildings. These impacts include an emission of ionizing radiation 7.29E- $03 \text{ kBq } \text{U}_{235}$ eq and an agricultural land use 3.27E-03 m²a.

Air pollution is found from carbon monoxide, carbon dioxide, nitrogen dioxide, and volatile organic compounds. These include a marine eutrophication of 9.09E-04 kg N eq, a terrestrial acidification of 1.64E-03 kg SO_2 eq, a photochemical oxidant formation of 1.84E-03 kg NMVOC, and a particulate matter formation of 4.78E-04 kg PM_{10} eq.

The toxicity impacts of copper materials effects to a freshwater ecotoxicity of 1.08E-02 kg 1,4-DB eq, a marine ecotoxicity of 9.60E-03 kg 1,4-DB eq, a freshwater eutrophication of 1.82E-05 kg P eq, a human toxicity of 6.79E-02 kg 1,4-DB eq, and a terrestrial ecotoxicity of 1.70E-05 kg 1,4-DB eq.

The environmental impacts for using steel materials in the building, pipeline, machinery, and equipment installations leads to a reduction in mineral resources 1.89E-02 kg Fe eq, a water resources 1.29E-03 m³, and a fossil fuel 4.73E-02 kg oil eq.

4.5 Interpretation

The analysis results in this work are compared with the waste-to-power (WtP) system by Kythavone and Chaiyat (2020) and Chaiyat et al. (2021) to validate impact values and confirm reliability. The 18-midpoint LCA impacts of the WtP system are directly driven from concert, steel, and copper. On the other hand, the waste– solar trigeneration system is conducted by concrete, steel, and clay. The functional unit of 1 kW of this work is lower than that of the WtP system at approximately 46.44%. In the next work, the concrete for each floor layer should be considered based on force per each area such parking, office, operation, store, etc.

5. Conclusions

The study results can be concluded as follows:

- The incineration rate of 3.83 Ton/d, double-stage organic Rankine cycle (ORC) of 137 kW_e, absorption chiller of 41.32 kW, drying room of 171.17 kW, and solar-rooftop photovoltaic system of 847 kW_p are the optimal design for the Mae Moh trigeneration system.

- The total energy output is approximately 4,973.71 kWh/d under the overall efficiency of 9.99%.

- The LCA impacts are driven from 3 materials of concrete, steel, and clay in the parts of construction phase of 64.42%, operation phase of 31.88%, and decommissioning of 3.70%, respectively.

- The main LCA impacts are found from a climate change of $1.63E-01 \text{ kg CO}_2$ eq, a human toxicity of 6.79E-02 kg 1,4-DB eq, a fossil depletion of 4.73E-02 kg oil eq, a metal depletion of 1.89E-02 kg Fe eq, and a freshwater ecotoxicity of 1.08E-02 kg 1,4-DB eq, respectively.

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Comparing Two Feature Reduction Techniques: Principal Component Analysis and Analysis of Variance for Classification Enhancement in Machine Learning

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ABSTRACT

Machine learning classification serves as a vital tool for addressing a diverse array of real-world challenges, automating decision-making, improving efficiency, and providing insights from data. Within this tapestry of machine learning, feature reduction constitutes an important tool, wielding the potential to profoundly shape the performance, resilience, and interpretability of classification models. This research embarks on an exploration of Analysis of Variance (ANOVA) and Principal Component Analysis (PCA) in the realm of feature selection and synthesis. The investigation is focused on a dataset drawn from Köklü, comprising a wide range of 106 distinctive features representing the shapes and colors of five rice varieties. Subsets of various sizes of this dataset are used to comparatively evaluate the performance of dimensionality reduction by ANOVA feature selection and PCA feature generation, using five distinct machine learning techniques: K-Nearest Neighbors, Decision Tree, Random Forest, Multilayer Perceptron, and Support Vector Machine. The results show that six features created by PCA suffice to obtain good classification accuracies for all models except the decision tree. Feature reduction by Principal Component Analysis shows noticeably better classification accuracies as compared to ANOVA feature selection, particularly for small-sized datasets.

Keywords: feature synthesis, ANOVA, PCA, classification

1. Introduction

Classification through machine learning has wide- ranging applications that significantly impact efficiency, accuracy, decision- making, and innovation across industries, making it a fundamental and indispensable aspect of the modern world. However, it is important to be aware of the potential weak points and challenges associated with this approach. Machine learning models heavily depend on the quality and quantity of

data and computational resources, which can make them impractical for deployment in data- constrained environments. Feature synthesis techniques aim to enhance the quality of input features used in machine learning models by creating new features that capture meaningful information or relationships within the data. These techniques can potentially improve the performance of classification models (Patel, 2021). Here are the steps to apply feature synthesis techniques for improving classification in machine learning:

1. Understand the relationships between features and the target variable.

2. Process the data by performing tasks such as data cleaning, handling missing values, and scaling features.

3. Perform feature selection.

4. Conduct exploratory data analysis (EDA) to identify potential feature relationships and patterns in the data.

5. Identify relationships and interactions between features.

6. Engage in feature engineering by creating new features or transforming existing ones to capture relevant information.

7. Perform feature selection again.

8. Train models, evaluate them, tune model parameters, and repeat the process to fine- tune their performance.

In this research, two feature reduction techniques, namely Analysis of Variance (ANOVA) and Principal Component Analysis (PCA), are investigated and compared. In order to assess their performances on large as well as small data sets, the rice data set freely available at https://www.muratkoklu.com/datasets/ (Köklü *et al.*, 2021) is chosen, as it is large-scale and feature-rich. It contains 75,000 data samples and comprises 106 distinct features representing the shapes and colors of rice from five different rice varieties: Arborio, Basmati, Ipsala, Jasmine, and Karacadag. The reduced feature sets obtained from ANOVA and PCA techniques are employed in training five different machine learning techniques: K-Nearest Neighbors (KNN), Decision Tree (Dtree), Random Forest (Rforest), Multilayer Perceptron (MLP), and Support Vector Machine (SVM). The accuracies of all these models are then compared and analyzed.

2. Research Objective

To assess and compare the effectiveness of two feature reduction methods, ANOVA and PCA, in lowering the dimensionality of a feature-rich dataset.

3. Literature Review

3.1 Machine Learning Algorithms

3.1.1 K-Nearest Neighbors (KNN)

The *K*-nearest neighbors (KNN) algorithm is a non-parametric supervised learning algorithm that works by finding the *K* most similar points to a new data point, and then assigning the new data point to the same

class as the majority of its K nearest neighbors. The choice of the hyperparameter K is crucial. A higher K reduces sensitivity to noise but may decrease accuracy, while a lower K increases sensitivity to noise but may enhance accuracy (Sun, Du, & Shi, 2018).

3.1.2 Decision Trees (Dtree)

The decision tree algorithm is a versatile supervised learning method for classification and regression tasks. It constructs a tree structure with nodes testing data features and leaf nodes representing class labels or predicted values. Notably, it's a non-parametric algorithm, making it applicable to diverse data types without assuming any specific data distribution (Patel & Prajapati, 2018).

3.1.3 Random Forest (Rforest)

A random forest algorithm is used for classification and regression tasks. The process involves building multiple decision trees during training. For classification, it selects the most commonly chosen class among the trees, while for regression, it takes the mean of individual tree predictions. The random forest algorithm is a supervised learning algorithm, which means it is trained on a dataset of labeled data. The algorithm works by creating a large number of decision trees, each of which is trained on a different bootstrap sample of the training data. At each node of a decision tree, a random subset of features is considered for splitting the data. This helps reduce correlation and overfitting risks (Schonlau & Zou, 2020).

3.1.4 Multilayer Perceptron (MLP)

A multilayer perceptron is a type of artificial neural network that is composed of multiple layers of interconnected neurons. Each neuron in a layer is connected to all of the neurons in the next layer The MLP is a feedforward network, meaning that the information flows in one direction, from the input layer to the output layer. MLP excels in classification, regression, and clustering tasks. It is trained with backpropagation, iteratively adjusting neuron connection weights to minimize errors. Its simplicity and efficiency make it a popular choice for machine learning, even with large datasets (Taud & Mas, 2018).

3.1.5 Support Vector Machine (SVM)

A support vector machine is a supervised machine learning technique applicable to both classification and regression tasks. Its core principle involves identifying the optimal hyperplane that effectively segregates data points belonging to two distinct classes. In this context, by hyperplane one means a shifted subspace of codimension one in high-dimensional space, a concept that generalizes the notion of plane in three-dimensional space. The SVM algorithm endeavors to locate the hyperplane with the maximum margin, which refers to the distance between the hyperplane and the nearest data points from each class. These nearest data points are commonly referred to as support vectors. When data consists of more than two classes, in a one-versus-all setting, a collection of individual SVMs is built, each separating one class from the union of the remaining classes (Namgyal, 2021).

3.2 Application of ANOVA in Feature Selection

3.2.1 Analysis of Variance (ANOVA)

Analysis of Variance (ANOVA) is a statistical technique used to analyze and compare the means of two or more groups or treatments to determine if there are statistically significant differences among them. Instead of comparing groups one pair at a time (which can lead to increased chances of Type I errors), it allows for a more comprehensive analysis. ANOVA assumes that the data within each group or treatment are normally distributed and have equal variances. It also assumes that observations are independent. ANOVA decomposes the total variability in the data into two components: variation between groups (explained variance) and variation within groups (unexplained or residual variance). It then assesses whether the explained variance is significantly larger than the residual variance. If ANOVA indicates that there are significant differences among groups, posthoc tests can be conducted to identify which specific group(s) differ from each other. ANOVA is a widely used method in various fields, including experimental research, social sciences, and manufacturing (Paolella, 2018).

3.2.2 Application of ANOVA in Feature Selection

Feature selection plays a crucial role in the realms of machine learning and data analysis, with its primary objective being the identification and retention of the most pertinent and informative features, while simultaneously reducing or eliminating the influence of irrelevant or redundant ones. ANOVA serves as a valuable statistical technique for feature selection, enabling the assessment of the individual features or variables' significance in predicting a given outcome or dependent variable. It is worth noting that ANOVA-based feature selection is most applicable when dealing with scenarios involving continuous target variables and either categorical or numerical features. However, it can also be used given discrete target variables given numerical or continuous data. ANOVA is versatile and finds utility in various facets of feature selection, including filter-based feature selection, multivariate analysis, feature ranking, feature subset selection, enhancement of model performance, and the facilitation of a clear understanding of how features contribute significantly to the final outcome (Tripathy & Sharaff, 2023).

3.3 Application of PCA in Feature Selection

3.3.1 Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is a dimensionality reduction technique used in data analysis and machine learning. It aims to transform a high-dimensional dataset into a lower-dimensional one while retaining the most important information. PCA accomplishes this by identifying the principal components (PCs), linear combinations of the original variables, in such a way that the first PC accounts for the highest variance in the data, the second PC for the second-highest, and so forth. Importantly, these PCs are orthogonal to each other, indicating that they are uncorrelated. This orthogonality property ensures that each PC captures unique information, effectively reducing redundancy in the data. PCA relies on the calculation of eigenvalues and eigenvectors derived from the covariance matrix of the original data. Eigenvalues quantify the variance explained by each PC, while eigenvectors determine the direction of each PC within the original feature space (Gray, 2017).

3.3.2 Application of PCA in Feature Synthesis

PCA can be employed in feature synthesis in multiple ways to decrease data dimensionality and elevate the quality of features utilized for modeling and analysis. It assists in the ranking of features according to their contributions to the primary principal components. PCA can also be harnessed to construct fresh features that encapsulate a blend of information from the original features. These novel features represent linear combinations of the initial variables and may occasionally offer superior informativeness or lower noise levels compared to individual features. This proves particularly advantageous when confronted with high-dimensional datasets, as it can enhance computational efficiency and mitigate the risk of overfitting in machine learning models (Mohammed et al., 2016). Furthermore, PCA does not require knowledge of the target variable, and may thus be considered an unsupervised technique.

4. Research Methodology

4.1 Research Hypotheses

PCA is more effective than ANOVA in performing feature reduction for classification by machine learning with datasets of various sizes.





Figure 1 Research Framework

4.3 Research Design

In this research, ANOVA and PCA are utilized for selecting and synthesizing features from 106 distinct attributes that represent various aspects of shape and color of rice from five different rice varieties: Arborio, Basmati, Ipsala, Jasmine, and Karacadag, as shown in Figure 2. In order to evaluate the performance on smaller sized datasets, sub-datasets of 1,500, 5,000 and 20,000 samples each were extracted from the original 75,000-sample dataset by random, in a manner to still represent each variety equally to obtain balanced data. The feature-reduced datasets obtained by ANOVA and PCA were then employed with five different machine learning techniques: K-Nearest Neighbors (KNN), Decision Tree (Dtree), Random Forest (Rforest), Multilayer Perceptron

(MLP), and Multiclass Support Vector Machine (SVM). The accuracies of these models were compared and analyzed using 10-fold cross validation.

4.4 The Data and Tools Used in the Research

The rice dataset is sourced from https://www.muratkoklu.com/datasets/, provided by Köklü (2021). There are 75,000 data samples of 106 distinct features of rice grains. Feature synthesis and the classification by



Figure 2 Images of rice grains (a) Arborio (b) Basmati (c) Ipsala (d) Jasmine (e) Karacadag

the five machine learning algorithms were done in the Python programming language, using the Scikit-learn version 1.2.1 Python Libraries together with the Intel(R) Extension for Scikit-learn. The most important parameters used in each machine learning model are listed in Table 1, all other parameters remain at their default values. The various programs were running under the Linux operating system on an AMD Ryzen 4500U CPU and 40GB of RAM.

Table 1 Parameters used in each machine learning model

KNN	Dtree	Rforest	MLP	SVM
K=5 Criterion="gini"		n_estimators=100	hidden_layer_sizes=(50,1)	Linear Kernel
Euclidean distance		Criterion="gini"	maxiter=200	Penalty C=1

5. Research Findings

Figure 3 shows the accuracy results from 10-fold cross validation as a function of the number of features used. Results are displayed for each of the four dataset sizes. The graphs in the left column reflect the results of ANOVA feature selection, choosing from one up to 40 of the top-ranked features. The graphs in the right column show the results from PCA feature synthesis, selecting from 1 up to 20 of the highest-ranked features.

Figure 4 shows performance comparisons of ANOVA versus PCA feature selection for each of the machine learning models individually. The dataset consisting of 1500 samples was chosen here, as its small size serves to highlight the phenomena to be observed.

Finally, Table 2 lists the results for the smallest (1,500 samples) and the largest (75,000 samples) data set numerically, to allow for a more detailed analysis.

6. Discussion

The results show that except for the decision tree model, using only the first six PCA-generated features already yields accuracies close to the highest accuracies achievable. When using ANOVA feature selection, on the other hand, accuracies are initially noticeably lower as compared to PCA selection. As the number of ANOVA features increases, the accuracies increase only slowly, to eventually surpass the accuracies of PCA selection.

The decision tree model is an exception to this. Figure 4(b) shows that an increase of the number of PCA components beyond ten leads to a noticeable drop in accuracy for the 1500-sample dataset. Such a drop can also be observed with the larger datasets, albeit to a lesser degree. It should be noted that the training of a decision tree already involves the ranking of the features, and PCA synthesis may interfere with this ranking process.



Figure 3 Performance evaluation of the various classification models.

(a) ANOVA, 1-40 top-ranked features, 1,500 samples (b) PCA, first 1-20 generated features, 1,500 samples (c) ANOVA,1-40 top-ranked features, 5,000 samples (d) PCA, first 1-20 generated features, 5,000 samples (e) ANOVA, 1-40 top-ranked features, 20,000 samples (f) PCA first 1-20 generated features, 20,000 samples

(g) ANOVA, 1-40 top-ranked features, 75,000 samples (h) PCA, first 1-20 generated features, 75,000 samples





Mazlan *et al.* (2020) have performed feature reduction on geomagnetic data and found by ANOVA that choosing two of nine features was sufficient. On the other hand, in case of PCA, four of the nine generated features should be used. However, the authors used statistical techniques for feature selection and did not evaluate their selection results through training of a machine learning model.

In Figure 4, a slight drop in accuracy for the 1500-sample dataset can be observed with the KNN model when the number of PCA components moves beyond 9. In fact, inspection of Table 2 shows that at only 8 or 9 PCA components, accuracy is indeed higher than when all 106 features are used. This means that PCA feature synthesis may at times help increase accuracies, a phenomenon which has also been observed in (Reddy *et. al.*, 2020) with different datasets.
Table 2 Accuracies by 10-fold cross validation.

1,500 samples						75,000 samples					
No of features	KNN	DT	RF	MLP	SVM	No of features	KNN	DT	RF	MLP	SVM
ANOVA1	86.00±2.6	83.20±3.11	86.33±2.46	87.27±2.39	86.47±2.94	ANOVA1	86.69±0.35	87.51±0.32	88.20±0.3	88.14±0.33	88.11±0.46
PCA1	51.73±4.26	45.67±4.79	50.87±4.08	54.07±4.38	53.60±3.95	PCA1	49.90±0.38	46.90±0.35	55.26±0.54	55.39±0.35	55.18±0.73
ANOVA2	87.47±2.56	82.67±2.92	87.13±3.14	89.20±2.1	88.47±2.17	ANOVA2	87.72±0.27	83.61±0.32	88.03±0.29	88.91±0.26	88.82±0.33
PCA2	78.87±2.09	72.67±2.55	78.13±3.17	79.87±2.79	79.2±2.45	PCA2	79.31±0.51	73.95±0.55	78.21±0.57	81.86±0.51	81.20±0.56
ANOVA3	87.20±2.84	82.33±3.3	86.60±2.56	89.33±2.75	88.87±2.89	ANOVA3	87.61±0.25	83.68±0.23	87.81±0.2	88.92±0.2	88.89±0.33
PCA3	86.40±2.86	81.8±2.97	86.40±2.95	86.40±2.31	86.07±1.92	PCA3	89.45±0.23	86.28±0.34	89.95±0.21	90.56±0.29	89.59±0.33
ANOVA4	87.33±2.86	82.80±4.09	87.13±2.63	89.00±2.72	88.93±2.55	ANOVA4	87.94±0.25	84.16±0.37	87.86±0.35	89.05±0.27	88.86±0.29
PCA4	96.73±1.75	94.93±2.19	96.60±1.35	96.80±0.78	96.40±1.24	PCA4	97.75±0.17	96.75±0.14	97.86±0.18	97.99±0.15	97.43±0.16
ANOVA5	87.60±2.31	82.73±3.46	87.13±2.37	88.4±2.53	87.60±2.59	ANOVA5	88.07±0.28	84.17±0.36	87.98±0.4	89.17±0.3	88.83±0.39
PCA5	98.73±0.81	95.40±1.62	97.27±1.38	98.20±1.16	96.60±1.28	PCA5	99.02±0.1	98.21±0.2	98.94±0.12	99.1±0.12	97.23±0.41
ANOVA6	96.67±1.23	94.27±1.77	95.93±1.41	96.73±1.53	96.40±1.31	ANOVA6	97.75±0.12	96.83±0.15	97.75±0.16	97.87±0.15	96.89±0.15
PCA6	99.53±0.6	97.60±1.0	98.73±1.28	99.53±0.67	99.20±0.58	PCA6	99.61±0.06	99.06±0.13	99.57±0.04	99.71±0.06	99.39±0.12
ANOVA7	97.33±1.55	95.0±1.53	96.67±1.12	97.33±1.37	96.60±1.35	ANOVA7	98.85±0.11	98.29±0.16	98.77±0.15	99.07±0.14	98.10±0.25
PCA7	99.47±0.58	96.87±1.74	98.87±1.12	99.47±0.5	99.27±0.63	PCA7	99.71±0.07	99.11±0.11	99.65±0.07	99.77±0.07	99.39±0.13
ANOVA8	97.87±1.29	94.87±1.49	96.87±1.52	96.93±1.64	97.00±1.44	ANOVA8	98.99±0.09	98.47±0.16	98.90±0.12	99.30±0.11	98.37±0.18
PCA8	99.60±0.61	96.73±1.59	98.80±1.39	99.60±0.33	99.47±0.58	PCA8	99.75±0.06	99.19±0.08	99.68±0.08	99.83±0.05	99.49±0.34
ANOVA9	97.73±1.24	96.20±1.27	97.53±1.16	97.60±1.2	97.13±1.03	ANOVA9	99.17±0.12	98.78±0.12	99.23±0.1	99.43±0.1	98.85±0.13
PCA9	99.60±0.61	96.93±1.67	98.93±1.08	99.53±0.43	99.60±0.53	PCA9	99.77±0.06	99.22±0.07	99.7±0.07	99.82±0.05	99.65±0.08
ANOVA10	97.93±1.09	96.87±1.46	97.27±1.25	98.20±0.95	97.33±1.12	ANOVA10	99.21±0.11	98.85±0.14	99.25±0.11	99.47±0.06	98.94±0.13
PCA10	99.40±0.63	96.60±1.72	99.07±1.4	99.47±0.5	99.60±0.53	PCA10	99.77±0.06	99.23±0.07	99.70±0.06	99.86±0.07	99.7±0.07
ANOVA15	97.80±1.19	96.73±1.62	97.33±1.15	98.47±1.19	97.13±1.37	ANOVA15	99.19±0.14	99.07±0.09	99.35±0.1	99.66±0.1	98.8±0.47
PCA15	99.53±0.6	96.13±1.76	99.20±1.02	99.60±0.33	99.47±0.4	PCA15	99.77±0.06	99.19±0.1	99.69±0.06	99.86±0.05	99.66±0.31
ANOVA20	97.60±1.31	96.53±2.04	97.33±1.26	98.53±0.83	97.40±1.09	ANOVA20	99.15±0.12	99.07±0.09	99.39±0.12	99.66±0.13	99.09±0.11
PCA20	99.40±0.63	96.27±2.09	99.13±0.95	99.53±0.79	99.60±0.44	PCA20	99.78±0.07	99.16±0.11	99.69±0.07	99.88±0.03	99.79±0.05
ANOVA30	98.87±0.85	97.07±0.8	98.13±0.78	99.20±0.93	98.07±0.96	ANOVA30	99.53±0.08	99.24±0.11	99.57±0.11	99.77±0.08	99.35±0.12
PCA30	99.33±0.67	96.33±1.61	99.13±0.9	99.67±0.45	99.60±0.44	PCA30	99.78±0.08	99.13±0.06	99.70±0.07	99.90±0.03	99.82±0.06
ANOVA40	99.13±0.73	97.20±1.26	98.47±0.67	99.40±0.47	98.60±0.76	ANOVA40	99.81±0.06	99.56±0.11	99.81±0.07	99.89±0.05	99.75±0.08
PCA40	99.40±0.63	96.13±1.76	99.33±0.79	99.67±0.45	99.60±0.44	PCA40	99.79±0.07	99.11±0.06	99.74±0.06	99.91±0.04	99.83±0.06
All 106	99.33±0.67	97.73±0.95	99.73±0.61	99.67±0.33	99.60±0.44	All 106	99.79±0.07	99.61±0.1	99.87±0.04	99.90±0.05	99.83±0.06

1,500-sample dataset (left) and 75,000-sample dataset (right)

Overall, listed in order of increasing accuracies, the K-nearest neighbour, the support vector machine and the multilayer perceptron models show best performance when employing PCA feature reduction. In case of the K-NN and SVM methods and the 1500-sample dataset, highest accuracy is achieved with only 9 PCA components. This points to the feasibility of PCA dimensionality reduction for smaller-sized datasets.

7. Suggestions

This study has shown that PCA feature synthesis can be successfully employed for feature reduction given a dataset with about one hundred features. However, many applications of machine learning to biology and

medicine deal with huge datasets containing thousands of features, and it would thus be informative to evaluate how ANOVA and PCA methods can deal with such types of datasets.

The graphs in figures 4 (a), (c) and (e) show that in the range of 9-21 ANOVA components, accuracies are essentially unchanged. While ANOVA ranks features in terms of their significance for classification, it does not exhibit relationships among the features themselves. Thus, it may be worthwhile to study correlation among the various features to allow for additional feature reduction.

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