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Editorial Note

RMUTT Global Business Accounting and Finance Review (GBAFR) is an academic journal prepared by Graduate Studies (Ph.D. Program), Faculty of Business Administration, Rajamangala University of Technology Thanyaburi (RMUTT). The GBAFR journal aims to disseminate good academic outputs related to business administration, accounting, and finance aspects of individuals from both within and outside the university. It is an intermediate for exchanging academic views as well as a source for promoting and developing research competency of faculty staffs, academicians, researchers, students, and any persons in terms of business administration, accounting, and finance fields.

This journal published seven research and academic papers, and one book review. In addition, each of the research and academic articles presented such interesting concepts, for employees' motivation, customer's satisfaction, financial planning for retirement, sustainability reporting and competitive advantage strategy, leading to creating new knowledge to the reader. Therefore, this journal is a channel disseminating the knowledge of business administration, accounting, and finance which related persons could apply it for further benefits.

Lastly, the editorial department and editorial board would like to considerably thank you for supporting and pushing forward this journal to occur and well accomplish. We are hopeful of your good cooperation and continuing support in the future.

Asst. Prof. Suraporn Onputtha, Ph.D.

Editor-in-Chief

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FACTORS AFFECTING INTENTION TO USE NATIONAL SINGLE WINDOW (NSW) THROUGH PERCEIVED EASE OF USE AND PERCEIVED USEFULNESS IN IMPORT, EXPORT AND LOGISTICS ENTERPRISES

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ABSTRACT

Purpose – The purposes of this research were to study factors affecting intention to use National Single Window (NSW) through perceived ease of use and perceived usefulness in import, export, and logistics enterprises.

Methodology – The research methodology was quantitative research with survey method by using questionnaires for data collection. The respondents were 400 participants, who are importers, exporters, and logistics service providers which are located in the Bangkok Metropolitan Region. Descriptive statistics used for data analysis included frequency, percentage, mean, and standard deviation. Due to hypothesis testing, inferential statistics were used, specifically Pearson's Product Moment Correlation Coefficient and Partial Least Squares-Structural Equation Modeling (PLS-SEM).

Results – The results of hypothesis testing revealed that acceptance and use of technology had a positive and significant effect on perceived ease of use and perceived usefulness whereas organizational support had a positive and significant effect on perceived ease of use, and technology experience had a positive and significant effect on perceived ease of use and perceived usefulness at a significance level of 0.001. In addition, perceived ease of use had a positive and significant effect on perceived usefulness and intention to use, and perceived usefulness had a positive and significant effect on intention to use at a significance level of 0.001. Nevertheless, the results showed that organizational support did not have a significant effect on perceived ease of use. Finally, there were significant indirect effects on the relationships among acceptance and use of technology, perceived ease of use, perceived usefulness, and intention to use.

Implications –The findings present several implications for both academia and management practitioners, providing insights into crafting effective strategies to enhance users' or employees' technology adoption once new technologies and/or systems are introduced in the workplace.

Originality/Value – This research sought to enhance comprehensive comprehension of the intricate interplay among the UTAUT Model, perceived ease of use, perceived usefulness, and intention to use, interpreting their collective influence on potential users' decisions toward the use of systems or IT. Also, the research can fill existing gaps in the literature and provide valuable insights for refining technological capability and competencies, particularly focusing on international entrepreneurship.

Keywords: UTAUT Model, Perceived ease of use, Perceived usefulness, Import, Export, Logistics, National single window

Paper Type: Research Article

INTRODUCTION

Currently, information technology plays a crucial role in the growth and development of countries, affecting various levels such as national, industrial, and individual. The integration of technology is rapidly transforming business operations and organizational management. The utilization of information technology aims to enhance management capabilities, improve operational efficiency, and elevate competitiveness for businesses, especially for micro, small, and medium enterprises (MSMEs) (Arjang et al., 2023; Nugroho, 2015).

The readiness of organizations to adopt information technology for supporting their operations is a critical factor in their overall performance (Nugroho, 2015; Sani et al., 2020). Technological advancements must be driven by national policies to reform the country's processes and ensure stability, prosperity, and sustainability. The shift towards a digital economy emphasizes the use of information and communication technology to connect all sectors, both public and private, fostering electronic transactions securely and paperlessly (Yau et al., 2020; Mohanarajan, 2016).

One key industry driving the Thai economy is the import, export, and logistics services sector, with continually increasing statistics in trade activities and significant importance placed on customs-related documentation. The Thailand National Single Window (NSW) system is a platform that links data between government agencies and businesses (G2G, G2B, and B2B) for imports, exports, and logistics, supporting data connections among ASEAN member countries and other regional nations. The NSW operates as an automated and semi-automated service, accompanying the reformation of service processes and reducing paperwork. It provides convenience for service users, such as importers, exporters, and logistics operators, allowing them to conduct secure electronic transactions with government agencies and e-commerce activities, facilitating the entire process from licensing to customs clearance automatically. The e-Tracking feature enables users to monitor the progress of their transactions online 24/7 (NSW Operator, 2021).

Past research has shown that user perception influences behavioral intentions. Regarding the NSW system, many businesses in the import, export, and logistics sectors have yet to use the system themselves. This research aims to investigate acceptance and use of technology, organizational support, and technology experience affecting intention to use NSW system. In addition, this research focuses on the mediating effects of perceived ease of use and perceived usefulness on intention to drive efficient industry operations. for import, export, and logistics businesses.

LITERATURE REVIEW
Acceptance and Use of Technology (UTAUT)

This research applies the Unified Theory of Acceptance and Use of Technology (UTAUT) developed by Venkatesh et al. (2003) to investigate the acceptance and use of the National Single Windows (NSW) within the context of Import-Export enterprises and logistics providers. The UTAUT model, consolidating fundamental relationships from various theories, serves as the theoretical framework, emphasizing four primary factors which consist of performance expectation, effort expectancy, social influence, and facilitating conditions, influencing the intention and behavior associated with information technology systems. The research extended the UTAUT model by introducing additional variables, including gender, age, experience, and voluntariness of use, to enhance the predictive accuracy of technology acceptance. The details of each variable are drawn from Venkatesh et al.'s (2003 cited in Chao, 2019) research.

Performance expectancy involves an individual's belief in the benefits of technology use, specifically the NSW, in enhancing operational efficiency. It encompasses perceived benefits, system capabilities, and the anticipated impact on work effectiveness, and it is a significant predictor of intentions, particularly within the UTAUT model. *Effort expectancy* assesses the ease of accessing the NSW, considering factors such as system complexity, ease of understanding, and the learning curve. This variable is particularly significant during the initial stages of system use but diminishes in importance as users become familiar with the technology. *Social influence*

explores the perception that social factors and norms, such as opinions from close connections, play a crucial role in encouraging the use of the NSW. Social Influence directly impacts intentions, operating through acceptance, understanding, and identification mechanisms. *Facilitating conditions* refer to the environmental factors supporting the use of the NSW, including readiness and consistency suitable for users. Consumer perception of resources and support in using the technology, as articulated by Venkatesh et al. (2003), is crucial in the adoption process. Past research has confirmed that the condition of facilities in use affects the adoption and utilization of the system, representing behavior occurring post-intention.

In this research, the UTAUT model is applied at the organizational level, specifically examining the acceptance and use of the NSW by Import-Export enterprises and logistics providers. Therefore, individual-level variables are not included in the research framework, aligning with the organizational perspective adopted for this study. This research contributes to the understanding of technology acceptance and utilization within the organizational context of National Single Windows (NSW). By applying the UTAUT model, the study provides insights into the factors influencing technology adoption at the entrepreneur level, shedding light on the unique dynamics of technology use within the Import-Export and logistics sectors.

Organizational Support (OS)

Organizational support pertains to the degree to which senior and middle management allocate sufficient resources to assist employees in accomplishing organizational objectives. This support may include provisions like computer system assistance, targeted coaching, and guidance for utilizing various computer applications (Grover, 1993). It is endorsement, encouragement and positive attitude of the organization in the provision of information, system development, operations and reward system to meet organizational goals (Anandarajan et al., 2002 cited in Zainab, 2016). The widely held belief is that organizational support is a crucial factor influencing the utilization of information technology (IT) in organizations. Research conducted by Kim et al. (2007) and McFarland and Hamilton (2006) discovered a connection between organizational support and factors including perceived ease of use (PEOU), perceived usefulness (PU), and subjective norm. Moreover, Lee et al. (2011) concluded that the effectiveness of organizational support systems significantly influences the adoption of computer technology and the intention to use it (Derouin et al., 2005). Previous studies also found that organizational support has a positive effect on PEOU (Anandarajan et al., 2002; Lee et al., 2013; Sawang et al., 2013; Kim et al., 2007). Meanwhile, Park and Jung (2021) investigated how perceived organizational support influences the relationship between the PU of artificial intelligence (AI) and trust. The research results revealed that perceived organizational support played a moderating role in the impact of AI's perceived usefulness on affective trust. Specifically, the positive effect was observed only among individuals with low perceived organizational support.

Technology Experience (EX)

Technology experience pertains to the skills an individual gains in dealing with technology over time. In examining this experience factor, Alharbi and Drew (2014) conducted a study and found that experience did not positively influence perceived ease of use (PEOU) and perceived usefulness (PU). Abdullah et al. (2016) emphasized that, in addition to computer self-efficacy and motivation, various external variables play a significant role in affecting the acceptance of e-learning systems. These variables include subjective norm (Farahat, 2012), perceived enjoyment (Wu, & Gao, 2011), computer anxiety (Alenezi et al., 2010), and experience (Martin, 2012). Experience stands out as a well-examined moderator variable within the Technology Acceptance Model (TAM). Previous research consistently indicates that technology-related experience positively influences individuals' behavioral intentions to use a system or technology. Studies on individual learning and e-learning adoption emphasize that experience affects both students' PEOU (De Smet et al., 2012; Lee et al., 2011, 2013; Purnomo, & Lee, 2013) and PU (Lee et al., 2013; Martin, 2012; Purnomo, & Lee, 2013; Rezaei et al., 2008) about the e-learning system as well.

Perceived Ease of Use (PEOU)

Perceived ease of use (PEOU) refers to "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989 cited in Kampa, 2023). In other words, it involves service users' attitudes toward using information technology services, recognizing the value and benefits which enhance their work efficiency. When individuals perceive that the advantages of technology align with their needs, it fosters greater acceptance of that technology. Due to Phillips and O'Flaherty (2019), the concept of PEOU reflects users' confidence that implementing flipped learning will not be challenging. The ease of flipping a skill serves as a notable example of PEOU. Previous research has highlighted the significant impact of structure on behavioral attitudes (Phillips, & O'Flaherty, 2019). It also influences the long-term success of a flipped classroom. When technology is perceived as user-friendly, users tend to have a more positive view of it. Consequently, users can assess its benefits more clearly (Al-Rahmi et al., 2015; Scherer et al., 2019). Besides, they are more willing to adopt technology when they recognize its benefits.

Perceived Usefulness (PU)

Perceived Usefulness (PU) refers to "the degree to which a person believes that using a particular system would enhance his or her job performance." (Davis, 1989 cited in Kampa, 2023). It indicates how much users believe that technology helps increase work efficiency (Davis et al., 1989). Awa et al. (2010) explained that entrepreneurs who see the usefulness of an application or innovation are likely to believe that the application or innovation contributes to increasing the productivity, efficiency, and potential of their company. Previous research of Mohamed and Lamia (2018) indicated that the perceived benefit of a flipped classroom is how much users believe it can be a driving force in achieving learning objectives; thus, it is the extent to which users perceive that using a flipped classroom may improve their learning system. According to Al-Rahmi et al. (2015) and Huang et al. (2019), PU is a concept that has been proven to affect attitude. Similarly, it may influence users' intentions to use the flipped classroom in the future. Therefore, users' perceptions of its usefulness are important. In addition, students are more enthusiastic about embracing technology when they find it useful (Al-Rahmi et al., 2015; Scherer et al., 2019). Meanwhile, the study by Park and Jung (2021) revealed that cognitive trust and affective trust fully mediated the effects of PU of AI on intention to use it.

Behavioral Intention to Use (INT)

Behavioral Intention an individual's preparedness to engage in a specific behavior. This factor is considered to occur before the actual behavior takes place (Ajzen, 2002). It serves a dual function as a predictor (Cigdem, & Topcu, 2015) and as an explanatory factor (Gaitán et al., 2015). Within the theoretical framework of the UTAUT (Unified Theory of Acceptance and Use of Technology) proposed by Venkatesh et al. (2003 cited in Chao, 2019), it has been identified that factors predicting behavioral intentions and behaviors include performance expectation, effort expectancy, social influence, and facilitating conditions.

National Single Window (NSW)

The National Single Window (NSW) is a system that connects government and business agencies (G2G, G2B, and B2B) for import, export, and logistics. It supports data exchange among ASEAN member countries and other regions. NSW offers automated and semi-automated services, streamlining processes, reducing paperwork, and providing convenience for users like importers, exporters, and logistics providers to conduct secure electronic transactions with both government and business entities. Users can track import, export, and approval processes online 24/7 via e-Tracking.

Key components of Thailand's NSW, led by Thai Customs, include (1) electronic data exchange centers for relevant government and business agencies involved in import, export, and logistics, (2) development of national data standards for electronic data exchange among government and business agencies, including international standards, (3) mechanisms for supervision, pricing, and quality assurance of the NSW services, (4) registration system for

issuing licenses and certificates within Thailand, involving approximately 35 government agencies, (5) user registration system for businesses within Thailand, with around 125,000 registered companies, (6) technical and legal infrastructure standards related to the NSW system, (7) secure electronic issuance of licenses and certificates for government agencies without their own systems, (8) data linkage between Thai government agencies and international agencies, and (9) data linkage between Thai and foreign business entities.

Expected outcomes of a fully developed NSW system include reducing the burden of redundant data entry by allowing submission of a single set of data electronically to relevant agencies, facilitating data sharing among both domestic and foreign organizations, decreasing the service delivery time of government agencies involved in import and export processes, and lowering the overall costs for businesses in import and export processes by approximately 82,000 - 100,000 million baht per year compared to paper-based systems. (NSW Operator, 2021).

Conceptual Framework and Hypothesis

Based on the review of the literatures on acceptance and use of technology, organizational support, and technology experience affecting intention to use NSW system, the conceptual research framework was drawn in Figure 1. In addition, the research hypotheses were drawn in the next part.
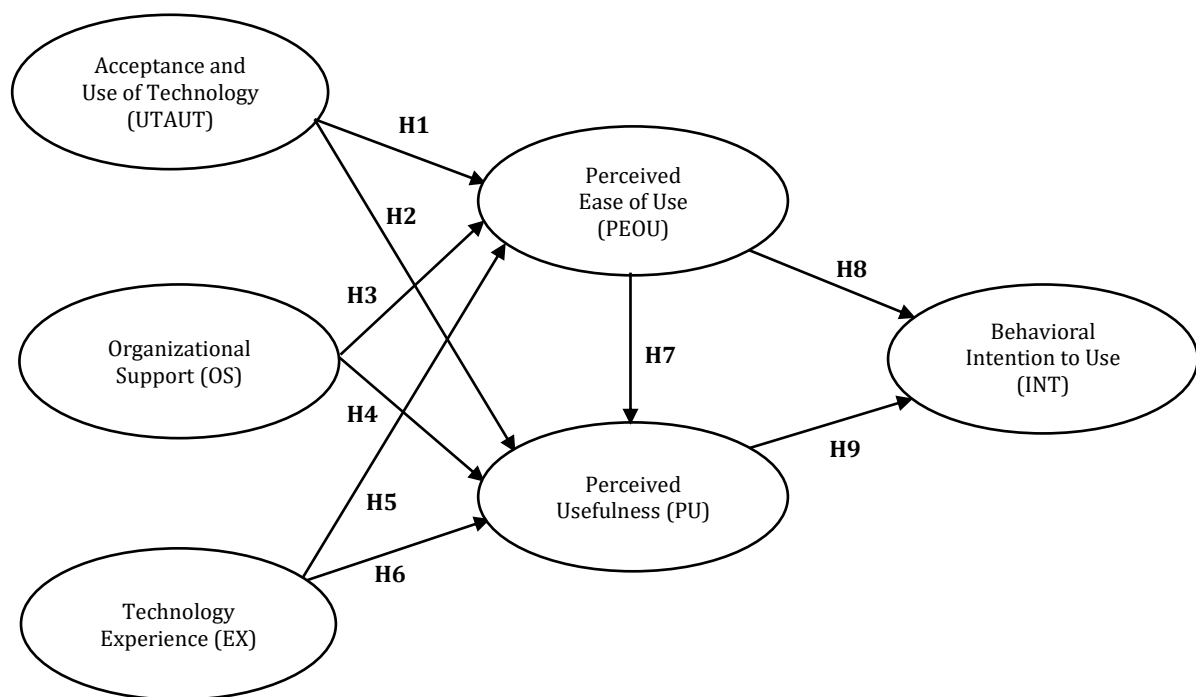
Figure 1. Conceptual Framework

The research hypotheses were drawn as follows:

H1: Acceptance and use of technology significantly affects perceived ease of use.
H2: Acceptance and use of technology significantly affects perceived usefulness.
H3: Organizational support significantly affects perceived ease of use.
H4: Organizational support significantly affects perceived usefulness.
H5: Technology experience significantly affects perceived ease of use.
H6: Technology experience significantly affects perceived usefulness.
H7: Perceived ease of use significantly affects perceived usefulness.
H8: Perceived ease of use significantly affects intention to use.

H9: Perceived usefulness significantly affects intention to use.

H10: Perceived ease of use plays a mediating role in the relationships between acceptance and use of technology and intention to use.

H11: Perceived ease of use plays a mediating role in the relationships between organizational support and intention to use.

H12: Perceived ease of use plays a mediating role in the relationships between technology experience and intention to use.

H13: Perceived usefulness plays a mediating role in the relationships between acceptance and use of technology and intention to use.

H14: Perceived usefulness plays a mediating role in the relationships between organizational support and intention to use.

H15: Perceived usefulness plays a mediating role in the relationships between technology experience and intention to use.

H16: Perceived ease of use and perceived usefulness play mediating roles in the relationships between acceptance and use of technology and intention to use.

H17: Perceived ease of use and perceived usefulness play mediating roles in the relationships between organizational support and intention to use.

H18: Perceived ease of use and perceived usefulness play mediating roles in the relationships between technology experience and intention to use.

METHODOLOGY

For Sample and Data Collection

Regarding sample and data collection, the research population consisted of importers, exporters, and logistics service providers located in the Bangkok Metropolitan Region. To estimate the total research population, the overall population for importers, exporters, and logistics service providers in the Bangkok Metropolitan Region was used to determine the population size. Employing the basis of sampling formula given by Cochran (1953) for infinite sample size determination with a confidence level of 95% and a margin of error of ±5% eventually yielded a total of 385 participants. Since this study employs structural equation modeling, it is essential that the sample size is at least 400, following the recommendations of Yuan and Bentler (2000) and Savalei and Bentler (2005). This research employed a non-probability sampling method with a purposive sampling technique to distribute the questionnaire to importers, exporters, and logistics service providers located in the Bangkok Metropolitan Region.

The research methodology employed in this research was quantitative research, utilizing the survey method. Data collection was conducted using questionnaires comprising 6 sections. Sections 1 to 5 consisted of 5-point Likert scale items, measuring variables such as acceptance and use of technology, organizational support, technology experience, perceived ease of use, perceived usefulness, and intention to use. The scale ranged from 1, indicating "strongly disagree," to 5, indicating "strongly agree." Section 6 of the questionnaire contained closed-ended questions focusing on capturing organizational background and business experience. These questions encompassed variables such as type of business, experience, and total employees.

Descriptive statistics used in quantitative data analysis included frequency, percentage, mean, and standard deviation. Due to hypothesis testing, inferential statistics were used, specifically Pearson's Product Moment Correlation Coefficient and Partial Least Squares-Structural Equation Modeling (PLS-SEM).

RESULTS

The research results indicated that the respondents had an overall agreement towards the acceptance and use of technology, organizational support, technology experience, perceived ease of use, perceived usefulness, and intention to use, at the agree level, with mean scores of 3.83, 3.93, 3.95, 4.04, 4.05, and 4.09, respectively, as depicted in Table 1.

Table 1. Mean and Standard Deviation for Variables

Latent Variable	Mean	Standard Deviation	Agreement Level
Acceptance and Use of Technology (UTAUT)	3.83	0.59	Agree
Organizational Support (OS)	3.93	0.62	Agree
Technology Experience (EX)	3.95	0.65	Agree
Perceived Ease of Use (PEOU)	4.04	0.66	Agree
Perceived Usefulness (PU)	4.05	0.64	Agree
Intention to Use (INT)	4.09	0.63	Agree

Validity and Reliability

Cronbach's alpha and composite reliability were investigated to measure construct reliability. In terms of composite reliability, all factor loading values ranged from 0.881 to 0.934, which is more than the recommended value of 0.70; hence, the constructs in the research model are acceptable (Hair et al., 2016). The measurement model in table 2 also showed that Cronbach's alpha coefficient of each construct ranged from 0.880 to 0.926, meaning that all constructs are acceptable according to the recommended threshold value of 0.70 (Fornell & Larcker, 1981). In terms of composite reliability, all values ranged from 0.881 to 0.934, which is more than the recommended value of 0.70; hence, the constructs in the research model are acceptable (Hair et al., 2016).

Table 2. Factor Loading, Cronbach's Alpha Coefficient (CA), Composite Reliability (CR) and Average variance extracted (AVE) for Measurement Model

Latent Variable	CA	CR	AVE	Indicators	Loads
Acceptance and Use of Technology (UTAUT)	0.926	0.934	0.947	PE	0.862
				EE	0.947
				SI	0.911
				FC	0.895
Organizational Support (OS)	0.882	0.888	0.914	OS1	0.816
				OS2	0.760
				OS3	0.830
				OS4	0.848
				OS5	0.864
Technology Experience (EX)	0.896	0.896	0.923	EX1	0.867
				EX2	0.812
				EX3	0.818
				EX4	0.843
				EX5	0.859
Perceived Ease of Use (PEOU)	0.880	0.881	0.918	PEOU1	0.862
				PEOU2	0.820
				PEOU3	0.869
				PEOU4	0.878
Perceived Usefulness (PU)	0.903	0.904	0.928	PU1	0.863
				PU2	0.818
				PU3	0.814
				PU4	0.867
				PU5	0.883
Intention to Use (INT)	0.904	0.907	0.929	INT1	0.859
				INT2	0.775
				INT3	0.855
				INT4	0.882
				INT5	0.879

In addition, AVE was in the range of 0.914 to 0.947, which exceeded the minimum threshold value of 0.50, confirming convergent validity. The discriminant validity was tested and the square roots of AVEs were more than the 0.40 minimum threshold, and all values were more than the correlations among the latent constructs (0.757 – 0.959); thus, it is valid (Henseler et al., 2015).

Analysis of Structural Model

From the structural model in this research, the direct effects indicated that R^2 of the dependent variable, or intention to use (INT) was 0.804 indicating that 80.4% of employee's intention variance was explained by the independent variable. For the indirect effects, R^2 of the mediating variables showed that R^2 of perceived ease of use (PEOU) was 0.776 and R^2 of perceived usefulness (PU) was 0.815.

Table 3. Structural Model

	β	T Statistics	P-value
H1: UTAUT → PEOU	0.092	2.756	0.006**
H2: UTAUT → PU	0.139	3.39	0.001***
H3: OS→ PEOU	0.177	3.297	0.001***
H4: OS→ PU	0.107	1.672	0.095
H5: EX → PEOU	0.657	12.419	0.000***
H6: EX → PU	0.319	5.064	0.000***
H7: PEOU → PU	0.407	7.759	0.000***
H8: PEOU → INT	0.266	3.93	0.000***
H9: PU → INT	0.656	10.357	0.000***
H10: UTAUT → PEOU → INT	0.024	2.228	0.026*
H11: OS→ PEOU → INT	0.047	2.392	0.017*
H12: EX → PEOU → INT	0.175	3.854	0.000***
H13: UTAUT → PU → INT	0.091	3.139	0.002**
H14: OS→ PU → INT	0.07	1.62	0.105
H15: EX → PU → INT	0.21	4.822	0.000***
H16: UTAUT → PEOU → PU → INT	0.025	2.401	0.016**
H17: OS→ PEOU → PU → INT	0.047	3.083	0.002**
H18: EX → PEOU → PU → INT	0.175	5.077	0.000***

Note: ***p <. 001, **p <. 01, *p <. 05 (two-tailed test)

Table 4. Total Effect

Item	PEOU	PU	INT
UTAUT	0.092	0.176	0.140
OS	0.177	0.179	0.164
EX	0.657	0.587	0.560
PEOU	-	0.407	0.533
PU	-	-	0.656

Table 5. Direct Effect

Item	PEOU	PU	INT
UTAUT	0.092	0.139	-
OS	0.177	0.107	-
EX	0.657	0.319	-
PEOU	-	0.407	0.266
PU	-	-	0.656

Table 6. Indirect Effect

Item	PEOU	PU	INT
UTAUT	-	0.037	0.140
OS	-	0.072	0.164
EX	-	0.267	0.560
PEOU	-	-	0.267
PU	-	-	-

The results in table 3, 4, 5, and 6 showed that acceptance and use of technology had a positive and significant effect on perceived ease of use (β = 0.092, $p < 0.01$) and perceived usefulness (β = 0.139, $p < 0.001$), while organizational support had a positive and significant effect on perceived ease of use (β = 0.177, $p < 0.001$), so hypothesis 1, 2, and 3 were supported. The results also revealed that technology experience had a positive and significant effect on perceived ease of use (β = 0.657, $p < 0.001$) and perceived usefulness (β = 0.319, $p < 0.001$), perceived ease of use had a positive and significant effect on perceived usefulness (β = 0.407, $p < 0.001$) and intention (β = 0.266, $p < 0.001$), and finally perceived usefulness had a positive and significant effect on intention (β = 00.656, $p < 0.001$), so hypothesis 5, 6, 7, 8 and 9 were supported. On the other hand, the results showed that organizational support (β = 0.107, $p > 0.05$) did not have significant effect on perceived ease of use, so hypothesis 4 was rejected.

The results also demonstrated that there was a significant indirect effect on the relationships among acceptance and use of technology, perceived ease of use, perceived usefulness, and intention. Perceived ease of use played a mediating role in the relationships among acceptance and use of technology and intention (β = 0.024, $p < 0.05$), organizational support and intention (β = 0.047, $p < 0.05$), and technology experience and intention (β = 0.175, $p < 0.001$), so hypothesis 10, 11, and 12 were supported. Second, perceived usefulness played a mediating role in the relationships among acceptance and use of technology and intention (β = 0.091, $p < 0.01$), and technology experience and intention (β = 0.21, $p < 0.001$), but did not have effect on the relationship between organizational support and intention. Thus, hypothesis 13 and 15 were supported while hypothesis 14 was rejected. Finally, perceived ease of use and perceived usefulness played mediating roles in the relationships among acceptance and use of technology and intention (β = 0.025, $p < 0.01$), organizational support and intention (β = 0.047, $p < 0.01$), and technology experience and intention (β = 0.175, $p < 0.001$), so hypothesis 16, 17, and 18 were supported.

DISCUSSION AND IMPLICATIONS
The findings of the research, indicating the significant effects of acceptance and use of technology, organizational support, and technology experience on employees' intention to use the system, with the mediating roles of perceived ease of use and perceived usefulness, revealed important insights into the dynamics of technology adoption in the workplace. The research results showed that employees had a strong acceptance and usage of technology, indicating openness to adopting and utilizing technological tools. They perceived significant organizational support, including policies and resources as well as facilitating technology integration. Respondents reported substantial experience with technology, suggesting familiarity and competence. They found the technology easy to use, indicating minimal challenges. Moreover, they believed that technology was valuable and beneficial to their tasks, influencing their decisions to adopt IT to their work. Finally, a high intention to continue using technology indicated a positive attitude and willingness to incorporate it into future activities. This was consistent with previous studies which revealed the effects of two constructs of acceptance and use of technology, social influence and facilitating conditions, on perceive usefulness, perceived ease of use, and behavioral intention to use. In other words, social influence has a significant direct effect on perceived usefulness (Räckers et al., 2013) and perceived ease of use (Abdullah & Ward, 2016; Chen & Aklikokou, 2020) while

facilitating conditions has a significant positive influence on perceived usefulness and perceived ease of use (Chen & Aklikokou, 2020).

Due to hypothesis testing on the effect of organizational support on perceived usefulness and perceived ease of use, the research results were supported. This implies that support from the organization contributes to employees perceiving the technology as easy to use. The research result was in accordance with previous studies by Lee et al. (2013) and Anandarajan et al. (2002) which revealed that organizational support has a positive effect on perceived ease of use and concluded that it is a motivating factor for users to accept new system and the same results were also found in some other studies (Kim et al., 2006; Sawang et al., 2013).

Regarding technological experience, the results indicated that individuals with more experience with technology find it easier to use and more useful. This suggests that when users find a technology easy to use, they are more likely to perceive it as useful and express an intention to use it. Users who perceive technology as highly useful are more inclined to express an intention to use it. The research results aligned with the previous studies which emphasized the importance of experience influencing perceived usefulness, perceived ease of use, and intention to use. Irani (2000) found the effect of prior experience and high level of experience on perceived usefulness and intent to use Internet communication tools whereas Rivera et al. (2015) indicated in their study that technological experience has a significant direct impact on perceived usefulness and attitude toward mobile apps. The result also aligned with the study by Saadé and Kira (2007) which revealed that computer experience and internet experience have a significant effect on perceived ease of use.

In addition, the results revealed a significant effect of perceived ease of use on perceived usefulness. This was consistent with some previous studies confirming the significant effect of perceived ease of use on perceived usefulness (Chen & Aklikokou, 2020; Abdullah & Ward, 2016; Alalwan et al., 2018; Baabdullah et al., 2016). This implies that the less complicated National Single Window (NSW) system is for using, the more users will find it useful. Moreover, perceived ease of use was also found to have a significant effect on behavioral intention to use suggesting the importance of NSW free of complication and easy to use. The easier employees perceived NSW is, the more they will make use of them. This result aligned with previous research (Chen & Aklikokou, 2020; Alalwan et al., 2018; Baabdullah et al., 2016; Martins et al., 2014; Mensah & Mi, 2018; Ruffin et al., 2014) Meanwhile, the results also indicated that perceived usefulness has a significant positive influence on employees' intention to use NSW. This is consistent with many previous studies (Chen & Aklikokou, 2020; Abdullah & Ward, 2016; Alalwan et al., 2018; Baabdullah et al., 2016; Baganzi & Lau, 2017; Martins et al., 2014; Mensah & Mi, 2018) indicating that the more useful NSW is perceived, the more users make use of them. The usefulness of NSW relates to the benefits it provides to users. The more apparent such usefulness is to a user, utilization or even re-utilization of NSW becomes evident.

The mediating roles of perceived ease of use and perceived usefulness in the relationships between acceptance and use of technology, organizational support, technology experience, and employees' intention highlight the cognitive processes involved in shaping employees' intentions (Davis et al., 1989; Venkatesh et al., 2003). Perceived ease of use acts as a mediator, suggesting that when employees find the technology easy to use, it positively influences their intention. This aligned with the foundational principles of Technology Acceptance Model (TAM), emphasizing that ease of use contributes to positive attitudes toward technology. Similarly, perceived usefulness serves as a mediator, indicating that employees are more likely to express positive intentions when they perceive the technology as valuable and beneficial. The research findings underscore the importance of considering both individual and organizational factors in promoting the successful adoption of technology in the workplace. Aligning with established theories in technology acceptance, the research highlights that ensuring ease of use, perceived usefulness, and organizational support are critical for fostering positive intentions toward technology adoption among employees. The result is consistent with previous studies conducted by using Acceptance and Use of Technology (UTAUT) factors and Technology Acceptance Model

(TAM) in terms of perceived ease of use and perceived usefulness (Alyoussef, 2022), effort expectation, perceived ease of use, and perceived usefulness (Rezvani et al., 2022), social influence, performance expectancy, and perceived ease of use (Guo et al., 2023), and UTAUT model and intention to use technology (Almaiah et al., 2019; Venkatesh et al., 2003; Kissi et al., 2018; Yang et al.,2019; Luo et al., 2021; Alwahaishi & Snásel, 2013; Rumangkit et al., 2023).

These insights have practical implications for organizations aiming to introduce new technologies in the workplace. Efforts to enhance employees' technology adoption should not only focus on the technical features but also consider the broader organizational support and employees' technology experiences. Creating a user-friendly and supportive technological environment can contribute to a positive user experience, ultimately enhancing employees' intentions to use the system.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

The researcher's focus in this research was factors affecting intention to use National Single Window (NSW) through perceived ease of use and perceived usefulness in import, export and logistics enterprises in Thailand ignoring other countries. Since the data were collected from 400 respondents toward Thailand only, the generalization of the results could be limited. Besides, other variables, such as, self-efficacy, perceived anxiety, relative advantage perceived enjoyment, attitude toward using NSW, and demographics were not included in this research. As this research was cross-sectional, data was collected at one specific time point. Furthermore, the hypotheses were tested using quantitative research approach, but the qualitative approach techniques such as in-depth interview or focus group were excluded from the research. Consequently, there are more opportunities for future research. First of all, further studies are advised to replicate the research in other industries, besides import-export and logistics industry, where the environments are different, and take these limitations into further consideration. It is also recommended that additional follow-up experimental and mixed-methods research be conducted in this area of study. There should also be a study related to any other aspects from organizational perspective, including employee commitment, employee performance, and employee citizenship behavior in the import-export and logistics industry. In addition, further studies could concentrate on cross-cultural comparisons regarding factors influencing intention to use a specific technology or system through perceived ease of use and perceived usefulness from other countries or regions.

CONCLUSION

The research results indicated a comprehensive understanding of the factors influencing technology acceptance. Users who are exposed to and have experience with technology tend to find it more usable and valuable. Organizational support also plays a crucial role, emphasizing the importance of a supportive organizational environment in enhancing the perceived ease of use. The positive relationships among perceived ease of use, perceived usefulness, and intention highlight the interconnected nature of these factors in shaping users' attitudes and behavioral intentions toward technology adoption.

These findings have practical implications for organizations aiming to promote technology acceptance among their users. Strategies focusing on enhancing technology experience, providing organizational support, and emphasizing perceived ease of use and usefulness could contribute to increased user acceptance and intention to use the technology.

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CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest found in this research.

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EXPLORING BRAND AWARENESS AND UTILIZATION PATTERNS OF POISON CONTROL CENTER SERVICES IN THAILAND: A COMPARATIVE STUDY AMONG HEALTHCARE PROFESSIONALS AND THE GENERAL PUBLIC

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ABSTRACT
Purpose – The purpose of this study is to compare the brand awareness and utilization patterns of Poison Control Center services in Thailand among healthcare professionals and the general public.
Methodology – This study employs quantitative methodology to compare the brand awareness and utilization patterns of Poison Control Center services among healthcare professionals and the general public in Thailand.
Results – The results of the study reveal that healthcare professionals in Thailand have significantly higher brand awareness of Poison Control Center services compared to the general public. The findings also indicate that healthcare professionals are more likely to utilize these services than the general public.
Implications – Implications of this study suggest the need for targeted educational campaigns to increase brand awareness and encourage more effective utilization of Poison Control Center services among the general public in Thailand.
Originality/Value – This study contributes to the existing literature by examining the brand awareness and utilization patterns of Poison Control Center services in Thailand, specifically comparing healthcare professionals and the general public. The findings highlight the need for targeted educational campaigns to increase brand awareness and promote the effective utilization of Poison Control Center services among the general public in Thailand. The findings of this study highlight the disparity in brand awareness and utilization of Poison Control Center services between healthcare professionals and the general public in Thailand.

Keywords: Thailand Poison Control Center (PCC), Brand awareness, Public awareness, Communication channel, Healthcare professionals, General public

Paper Type: Research Article

INTRODUCTION
Poison control centers are crucial in managing and preventing poisoning incidents, providing guideline and treatement planning for both the general public and healthcare professionals. The science of toxicology reveals an increase in poisoning cases in Thailand due to economic growth, technological advancements, and industrial expansion. The introduction of different chemical-related products has extended beyond industry to the households (Erkekoğlu & Sabuncuoğlu, 2021).

The causes of poison exposure are diverse, including work-related equipment, household products, medication issues, poisonous animals, and insecticides. Lack of knowledge in handling chemicals poses fatal risks that require prompt treatment. The establishment of toxicology center is vital for the to promote public awareness on poison control (Saoraya & Inboriboon, 2013). Moreover, understanding brand awareness and utilization patterns of Poison Control Center services is crucial for improving public health outcomes (Guo & Bai, 2019; Sabahi et al., 2022).

Most studies focused on technical aspects of poison control center, such as reported cases, case management procedures, and the effects of drugs/poisons. Little attention was presented on the awareness and utilization of poison control center. Additionally, there is a lack of comprehensive studies examining the utilization or adoption of poison information systems among healthcare professionals (Leong et al., 2018; Rhalem et al., 2013).

This study seeks to critically assess and improve the service quality of Poison Control Centers (PCCs) in Thailand by exploring the awareness and utilization levels across different demographics, focusing on healthcare professionals and the general public. This study investigates what drives individuals to use PCC services, discern any variations in these motivations across user groups, and examine if perceptions about communication channels differ between the general public and healthcare professionals. Additionally, the study will determine the most effective communication channels for engaging with PCCs and whether user preferences for these channels vary among different groups. The resaerch findings are scrutinized for the development of business strategy to promote the awareness and utlization of poison control in Thailand. The research also seeks to identify potential improvements in the area such as communicaton channel and service quality (e.g. ease of contact and information accuracy). Through a comprehensive review of the Thai poisoning literature, it becomes evident that there is a need for further support of the PCC in Thailand (Saoraya & Inboriboon, 2013).

This study provides significant public health advantages through the facilitation of targeted educational initiatives, the provision of insights for policy development, and the enhancement of healthcare provision. It advocates for efficient allocation of resources, fosters additional research endeavors, and fosters inter-sectoral cooperation to enhance emergency readiness and responsiveness.

LITERATURE REVIEW
Global Perspectives on Poison Control Center Effectiveness
Toxic exposure is a major global public health issue, therefore; PCCs have emerged globally to assist health professionals in understanding the toxicity of various substances, recognizing the impracticality of expecting them to possess comprehensive knowledge about every substance's toxicity (World Health Organization, 2016). Poison control centers play a crucial role in providing information, guidance, and treatment for poison-related incidents (Pourmand et al., 2012). They serve as a valuable resource for healthcare professionals, offering expertise in toxicology and aiding in the diagnosis and management of poison exposures (World Health Organization, 2021).

A Poison Control Center addresses inquiries regarding exposure to various chemical agents through phone communication, offering clinical guidance and tailored advice on treatment for poisoning incidents. These incidents occur in settings like homes, workplaces, or rural areas far from medical facilities. The center provides evidence-based advice as a hub of toxicological expertise and aids in diagnosing patients with acute symptoms of unknown origin (World Health Organization, 2021; World Health Organization, 2016).

Globally, services offering information, advice, and sometimes treatment and laboratory services for poisoning management are designated by various terms such as "poisons information centre," "poison control centre," "toxicology information service," among others. In this context, these terms could denote establishments solely providing information and advice or functioning as both a poisons information centre and possessing a clinical treatment unit and/or a toxicological laboratory (Ramathibodi Poison Center, 2015; Siriraj Poison Control Center, 2020; World Health Organization, 2016).

The Historical Evolution of Poison Control Centers in Thailand.

The increasing chemical usage in Thailand, driven by population growth, economic expansion, industrialization, agricultural practices, and household consumption has resulted in widespread environmental pollution and contamination of the food chain. This presents a significant public health risk from both acute and chronic toxicities due to the improper use or overuse of these substances (Ramathibodi Poison Center, 2015; Siriraj Poison Control Center, 2020). Healthcare professionals play a crucial role in diagnosing and treating toxicities but face challenges such as inadequate data on the toxic substance's patients are exposed to. Patients often arrive at hospitals too late for timely treatment because of factors like geographic distance or lack of awareness about the dangers of toxic substances. The poison control centers are dedicated institutions that research and manage toxins' impact on public health by providing comprehensive information about these substances, which empower medical practitioners with essential knowledge.

Background: Public Awareness of Poison Control Center in Thailand

In Thailand, the role of Poison Control Centers (PCCs), particularly the Siriraj Poison Control Center (SiPPC) and the Ramathibodi Poison Control Center (RPCC), is pivotal in the fight against the acute health effects of pesticide exposure, an issue that continues to challenge public health efforts (Ramathibodi Poison Center, 2015; Siriraj Poison Control Center, 2020). Studies indicate a notable gap in public awareness of these centers, with pesticide poisoning standing out as a pressing problem that underscores the urgent need for enhanced education and utilization of PCC services (Saoraya & Inboriboon, 2013). Although emergency healthcare professionals have some knowledge in this area, there is room for improvement. Research indicates that actively promoting poison prevention behaviors and increasing awareness of the services offered by poison centers can significantly reduce hospitalizations and emergency department visits related to poisoning incidents (Spiller & Griffith, 2009). Community characteristics such as population density and education levels also influence the utilization of poison center services (Churi et al., 2013; Nguyen et al., 2016). Addressing the current challenge of insufficient public awareness and education on poison control in Thailand can benefit from valuable recommendations derived from existing research and best practices Additionally, there is a lack of awareness regarding the critical importance of timely management in poisoning cases. Interventions aimed at improving public awareness and education about poison control centers in Thailand are crucial to ensure timely and appropriate management of poisoning incidents (Kanjanarach et al., 2014). Using the provided sources, it is evident that pesticide poisoning is a major problem in Thailand (Saoraya & Inboriboon, 2013). Recent research by Somboon et al. (2022) has highlighted the alarming prevalence of pesticide-related health issues among agricultural workers, while Laohaudomchok et al. (2020) emphasize the significant health and environmental risks posed by pesticides, further pinpointing critical research and policy gaps. Moreover, Sapbamrer et al. (2024) illustrate the acute health symptoms from pesticides that Thai farmers experience, spotlighting the importance of perceptions and practices in managing these risks. Collectively, this body of work advocates for a strengthened role of PCCs in promoting safe practices and improving public and medical practitioners' awareness to manage and mitigate the incidence of pesticide poisoning effectively. It is essential for the public and medical practitioners to be aware of and utilize the services offered by poison control centers in Thailand to effectively manage and reduce the incidence of pesticide poisoning cases.

Research Questions

To enhance the service quality of PCCs in Thailand through a quantitative methods approach, the study addresses the following consolidated main research questions: What is the level of awareness and utilization of PCC among different user groups, and what factors influence their choice to use its services? It also identifies four sub-questions as follows:

     1. What is the level of awareness and utilization of the PPC among the general public and healthcare professionals?

     2. What factors influence the choice of using the PPC's services, and are there differences in these factors among various user groups?

3. Is there any difference on the perceived communication channels between the general public and healthcare professionals?

4. Which communication channels are most suitable for contacting the PCC and is there any difference in the choice of channel among user groups?

This discusses key aspects such as public awareness, user demographics, service use, and communication preferences to understand poison control dynamics in Thailand. As a result, the study aims to investigate the awareness, usage, and factors that impact the utilization of PCC among different user groups in Thailand. The research questions are formulated to identify differences in levels of awareness, patterns of use, and factors influencing the selection of PCC services among both the general public and healthcare professionals. This leads to the following hypotheses:

Awareness and Utilization:
The variable under consideration in this research is the dependent variable, which is influenced by independent variables. Specifically, the focus lies on the degree of awareness, utilization, or intention to use PCC among healthcare professionals (Saoraya & Inboriboon, 2013). Given the current limited implementation of PCC among healthcare professionals, this study concentrates on evaluating awareness levels and intentions towards usage, aiming to predict motivating factors influencing PCC utilization. The situation in Myanmar serves as a pertinent parallel. There, increased Facebook usage without adequate digital literacy led to misinformation and social unrest (Whitten-Woodring et al., 2020). Similarly, in Thailand, insufficient PCC knowledge among healthcare professionals could impede the effective management of poisoning incidents. Therefore, this study formulated a hypothesis designed to examine various drivers behind healthcare professionals' knowledge and willingness regarding PCC usage. Additionally, recognizing its broader implications, our investigation extends beyond medical settings to consider societal impact. Educating the public about PCC plays a crucial role in preventing severe poisoning cases, empowering individuals to proactively contribute to the reduction of poisoning incidents and enhancing community well-being in Thailand (Pac-Kożuchowska et al., 2016). The hypothesis is defined as follows:

H0: There is no significant difference in the level of awareness and utilization of the PCC between the general public and healthcare professionals.

H1: The level of awareness and utilization of the PCC varies significantly between the general public and healthcare professionals.

Factors Influencing Service Utilization:
Factors Influencing Service Utilization: Various factors can impact the utilization of PCC services. These encompass the accuracy and precision of information, the timeliness or speed of advice, the ease of access, completeness of information and assistance in treatment planning. In essence, a multitude of factors contributes to the adoption of PCC services. Refer to Figure 2, the results of descriptive statistics on factors influencing the decision to use PCC by healthcare professionals. The hypotheses are stated as follows:

H2: The factors influencing the decision to use PCC services are consistent across different user groups.

H3: There are significant differences in the factors influencing the decision to use the PCC services among various user groups.

Communication Channels
The choice of communication methods and channels of communication perceived by the user are critical in influencing the use of PCC services (Ellington et al., 2011). Additionally, Kshatri et al. (2021) stated that the readily available and easily accessible effective communication channels are essential to enhance awareness and utilization of services. In term of the perceived communication channels, the provision of a telephone number for easy access to poison control centers can significantly influence the use of their services and result in quicker response times, ultimately leading to improved outcomes for those seeking help from these centers(Alexander et

al., 2007; Carr et al., 2010). Additionally, the impact of social media platforms can offer another avenue for people to obtain information and support from PCC services. By prioritizing user expectations and offering multiple communication channels such as a phone number and social media platforms, the accessibility and utilization of PCC services can be enhanced, ensuring that individuals receive prompt and accurate support in managing poisoning incidents (Churi et al., 2013), as hypothesized H4, H5,H6 and H7 in this study.

H4: There is no difference in the perceived communication channels of PCC across user groups.

H5: There is a difference in the perceived communication channels of PCC across user groups.

H6: The choice of communication channels for contacting the PCC is consistent across user groups.

H7: The choice of communication channels for contacting the PCC is different across user groups.

METHODOLOGY

Data Collection and Sample size:

Data was gathered through the distribution of questionnaires to a sample group including both the general public and healthcare professionals in Thailand. This study employs a quantitative approach to investigate public awareness and education on poison control in Thailand. The data collection process involves designing a questionnaire for healthcare professionals and the general public, conducting a pilot survey with 25 individuals, and then distributing the finalized questionnaire to 193 respondents using snowball sampling for large-scale statistical data collection. Data analysis includes eliminating missing responses and using statistical tests to explore relationships between variables.

The research covers surveying both the general public and healthcare professionals to gather data on their recognition and utilization of PCC by distributing questionnaires inclusive of healthcare providers, medical staff, as well as members of the public. The collected data is then analyzed accounting for incomplete responses; statistical analysis is subsequently conducted covering response frequencies, means calculation, along with exploring relationships between variables employing quantitative surveys coupled with statistical analysis aiming at achieving comprehensive understanding focusing specifically on recognition and utilization patterns concerning PCC dynamics through numerical research methods.

The conclusive step involves reporting and summarizing research findings in a comprehensive research report. Key insights, such as the frequency of PCC use, factors influencing service utilization, and recommendations for improving the PCC, are presented. This structured approach ensures a thorough investigation, utilizing quantitative methods for a holistic understanding of PCC. The quantitative approach used in this study facilitates a comprehensive examination of public awareness and education on PCC in Thailand.

RESULTS

Descriptive analysis aims to illustrate the basic characteristics of data by summarizing and examining it to understand its inherent patterns and nature. This approach presents data in a clear format, facilitating decision-making and planning efforts. It serves as a crucial initial step in data analysis, providing fundamental insights before further examination. The obtained data sheds light on the features of respondent groups within the project.

The study involved 193 participants who responded to the survey. Among them, 41.5% (N = 80) were from the professional healthcare sector, including physicians, nurses, pharmacists, paramedics, and medical volunteers. The rest of the respondents at 58.5% (N = 113) were from the general public. The demographic characters of the sample size, including both healthcare professionals (N = 80) and the general public (N = 113) are presented in Table 1. Among the respondents, 74.1% identified as female; age groups included Generation Z (> 26 years old), 3.1%,

Generation Y (27-42 years old), 60.l%, Generation X (43-58 years old), 35.2%, and Boomers (more than 59 years old), 1.6%. The majority have an average working experience of more than five years.

Table 1. Demographic characteristics

Individual-level variables	N	Percent
Age		
Less than 26 years old	6	3.1
27-42 years old	116	60.1
43-58 years old	68	35.2
More than 59 years old	3	1.6
Gender		
Male	48	24.9
Female	143	74.1
LGBTQ	1	0.5
Rather Not Say	1	0.5
Years of Experience		
Less than 1 year	8	4.1
1-3 years	8	4.1
3-5 years	11	5.7
More than 5 years	166	86
Income		
Less than 5000	3	1.6
5000-15000	13	6.7
15001-50000	61	31.6
More than 50000	116	60.1

To address hypotheses H0 and H1, the survey data, encompassing responses from 80 healthcare professionals and 113 members of the general public, provides insights into the awareness and utilization of PCC services. Among healthcare professionals, the findings indicate that 72.2% were not only familiar with PCC services but had also utilized them. Additionally, 22.8% were aware of the services but hadn't utilized them, and a smaller percentage, 5%, were neither aware of nor had used the services. In contrast, within the general public group, a minimal percentage of 0.8% had utilized PCC services while being acquainted with them. A larger proportion, 23.3%, were aware of the services but hadn't used them.

(1) Medical Professionals (N = 80)

72.2% — Know and have been used the service

22.8% — Know but never used the service

5% — Do not know and never used the service

(2) General Public (N = 113)

0.8% — Know and have been used the service

23.3% — Know but never used the service

46.6% — Do not know and never used the service
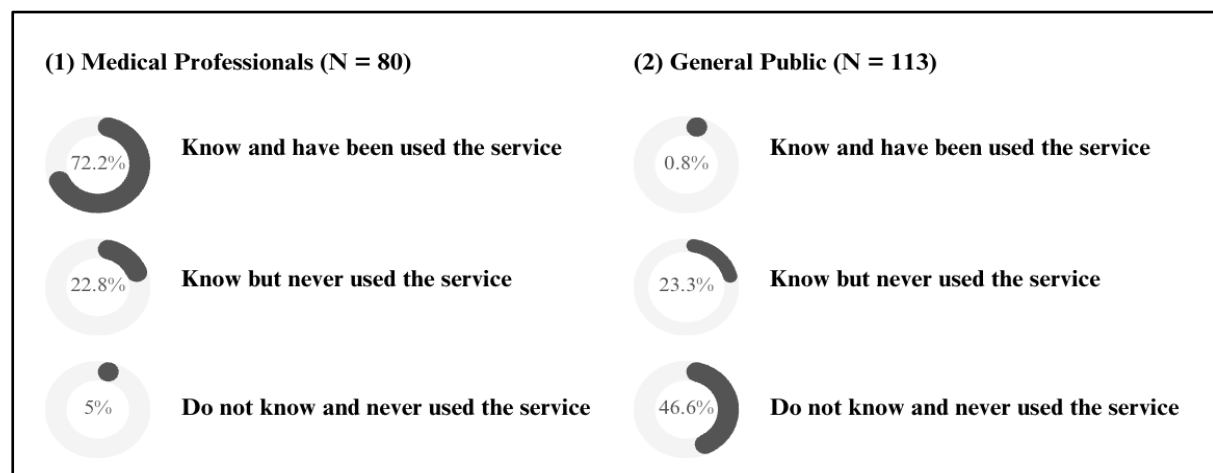
Figure 1. The results of descriptive statistics on awareness and utilization of the Poison Control Center (PCC) between the general public and healthcare professionals.

Significantly, a substantial portion, comprising 46.6%, indicated neither awareness nor utilization of PCC services. These findings offer valuable insights into the utilization patterns and awareness levels of PCC services among both healthcare professionals and the general public, laying the foundation for the assessment of hypotheses H0 and H1.

To further validate the descriptive analysis on the awareness and utilization of PCC. The independent samples t-test was performed to evaluate the significant level of differences between the target groups. Table 2. illustrates the results of t-test analysis.

Table 2. The result of independent samples t-test on awareness and utilization of the Poison Control Center (PCC) between the general public and healthcare professionals

Occupation	N	Mean	Std. Deviation	t	P
Healthcare professionals	80	1.34	0.57	19.126	.001*
General Public	113	2.75	0.45		

*Significant at the level p < 0.05

The results indicated a significant level of $p < 0.05$ of an awareness and utilization of PCC between healthcare professionals and the general public. The finding reveals the profession has an influence on the awareness and utilization of PCC and hence rejected H0.

The next hypothesis focuses on the factors influencing the decision to use PCC across user groups. These factors are (1) accuracy and precision of information, (2) completeness of information, (3) speed of information provision, (4) the ability to recommend antidotes and allocate resources, (5) assistance in treatment planning, (6) consultation from poisonology experts, and (7) case study development.

The descriptive analysis presented in Figure 2 demonstrated the factors influencing the selection of PCC for healthcare professionals, including the accuracy and precision of information (average importance score of 9.55), the speed of information provision (average importance score of 9.19), and the ability to recommend antidotes and allocate resources (average importance score of 9.15). Similarly, the general public emphasized comparable factors as crucial in their choice of using PCC services. Figures 3 exhibited factors being prioritized by the general public, including accuracy and precision of information (average importance score of 9.06), completeness of information (average importance score of 8.86), and assistance in treatment planning (average importance score of 8.80).
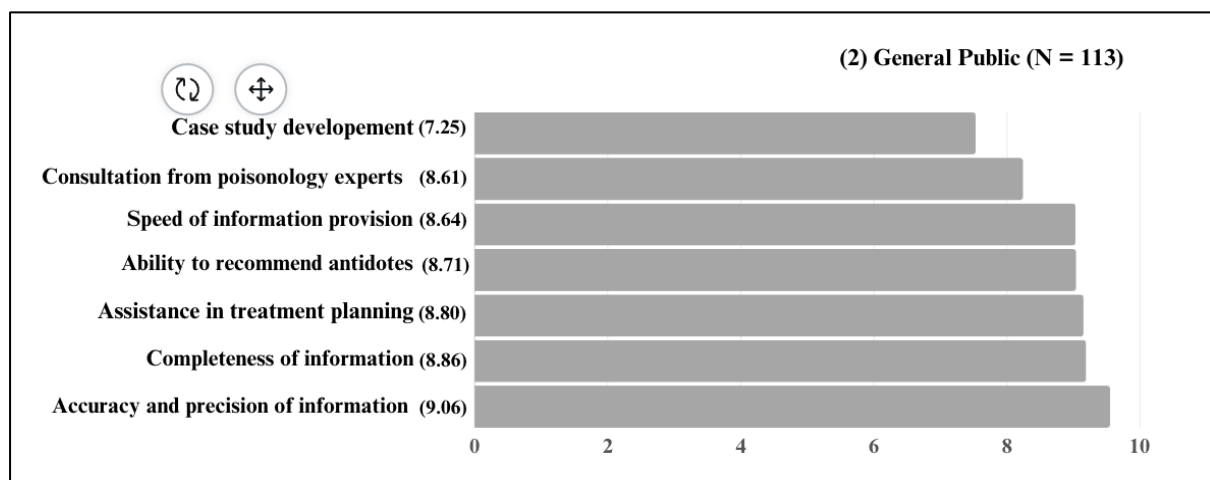
Figure 2. The results of descriptive statistics on factors influencing the decision to use PCC by healthcare professionals
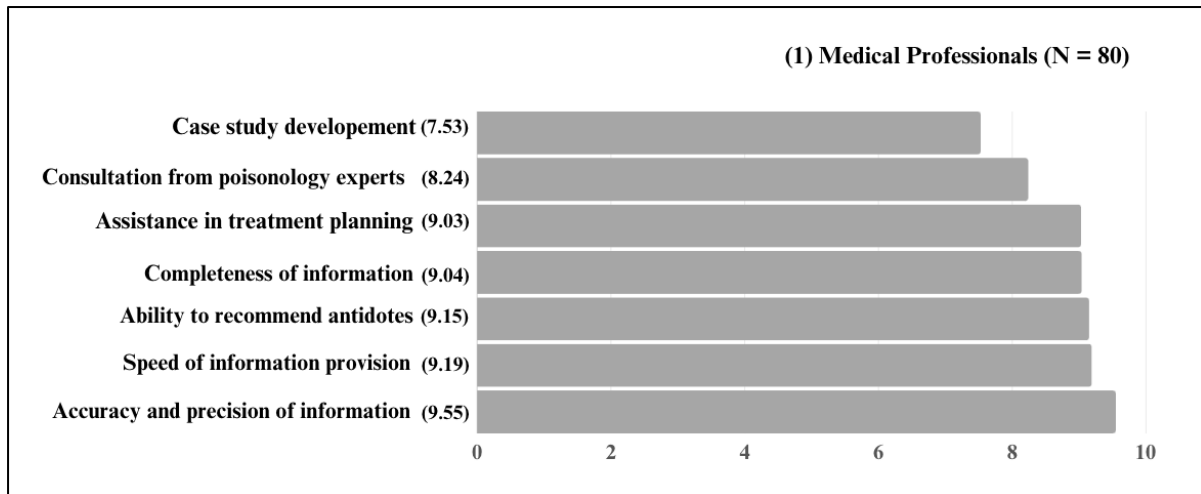
Figure 3. The results of descriptive statistics on factors influencing the decision to use PCC by the general public.

These findings align with H2, indicating consistency in factors influencing PCC service choice across user groups. Nuanced distinctions in importance scores support the exploration of H3.

The descriptive analysis was validated by the independent samples t-test. Table 3. illustrates the results of significant test analysis on the factors influencing the decision to use PCC.

Table 3. The result of independent samples t-test on the factors influencing the decision to use PCC across different user groups

Factors	Professions	N	Mean	Std. Deviation	t	P
Speed of information provision	Medical Professional	80	9.20	1.51	1.86	0.06
	General Public	113	8.64	2.37		
Accuracy and precision of information	Medical Professional	80	9.56	1.38	1.83	0.06
	General Public	113	9.05	2.19		
Completeness of information	Medical Professional	80	9.04	1.47	0.60	0.54
	General Public	113	8.87	2.19		
Consultation from poisonology experts	Medical Professional	80	8.29	1.94	1.00	0.31
	General Public	113	8.60	2.27		
Assistance in treatment planning	Medical Professional	80	9.05	1.66	0.87	0.38
	General Public	113	8.79	2.27		
Case study development	Medical Professional	80	7.59	2.56	0.91	0.36
	General Public	113	7.23	2.74		
Ability to recommend antidotes	Medical Professional	80	9.15	1.57	1.43	0.15
	General Public	113	8.72	2.34		

*Significant at the level $p < 0.05$

The results indicated an insignificant level of $p > 0.05$ for all the factors influencing the decision to use PCC. The t-test analysis corresponding to the descriptive analysis showed that the differences of factors used to select PCC by professions was naught, and hence rejected H3.

Hypotheses 4 & 5 investigate the differences on perceived communication channels between the general public and healthcare professionals. Figure 4 & 5 presented the descriptive analysis on perceived communication channel. The results suggested that (1) word-of-mouth, (2) website, and (3) social media are the most well-perceived channels for all user groups.

Figure 4. The results of descriptive statistics on perceived communication channel of PCC by healthcare professionals

Figure 5. The results of descriptive statistics on perceived communication channel of PCC by the general public

Table 4. presented the result of independent samples t-test on perceived communication channel of PCC across user groups. The analysis indicated an insignificant level of $p > 0.05$ for all the perceived communication channels. The t-test result suggested that there is indifference on how the users perceived the service of PCC and therefore rejected H5.

Table 4. The result of independent samples t-test on perceived communication channel of PCC across different user groups

Factors	Professions	N	Mean	Std. Deviation	t	P
Website	Medical Professional	67	0.52	0.50	0.95	0.34
	General Public	20	0.40	0.50		
Social Media	Medical Professional	63	0.48	0.50	1.00	0.31
	General Public	18	0.61	0.50		
QR Code	Medical Professional	57	0.02	0.13	0.96	0.33
	General Public	16	0.06	0.25		
Sticker	Medical Professional	58	0.16	0.36	0.95	0.34
	General Public	16	0.06	0.25		
Exhibition	Medical Professional	57	0.02	0.13	0.96	0.33
	General Public	16	0.06	0.25		

Table 4. (Cont.)

Factors	Professions	N	Mean	Std. Deviation	t	P
Poster	Medical Professional	58	0.09	0.28	0.38	0.70
	General Public	17	0.12	0.33		
Word-of-mouth	Medical Professional	69	0.70	0.46	0.51	0.60
	General Public	22	0.64	0.49		
Other	Medical Professional	58	0.09	0.28	0.36	0.71
	General Public	17	0.06	0.24		

*Significant at the level $p < 0.05$

Hypothesis 6 & 7 addresses the choices of communication channels for contacting the PCC between user groups. Figure 6 and 7 revealed the results of descriptive analysis on communication channel to promote PCC by healthcare professionals and the general public. The findings showed consistent results on the promotional communication channel, including (1) social media, (2) website, and (3) doctor reference as the most preferred communication channels across user groups.
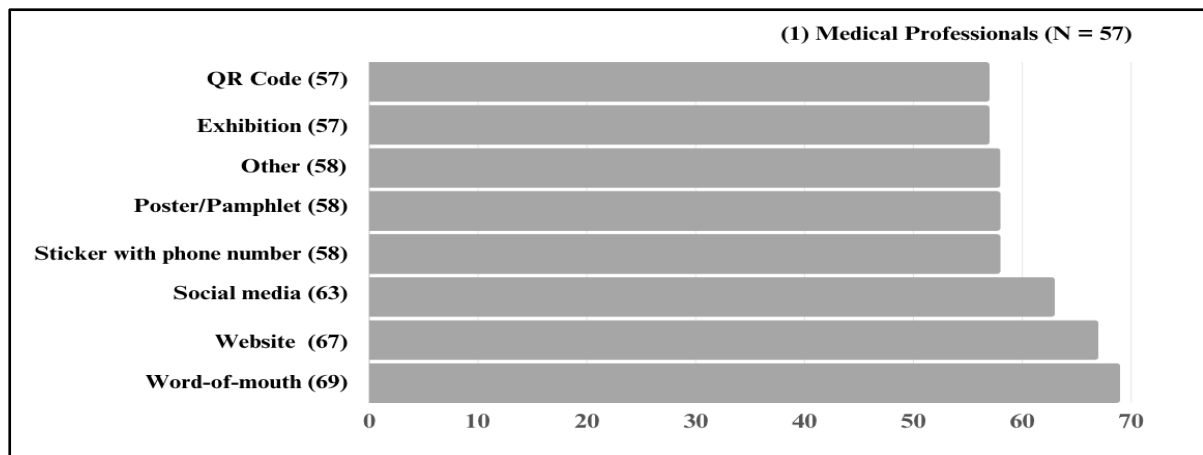

Figure 6. The results of descriptive statistics on communication channel to promote PCC by healthcare professionals
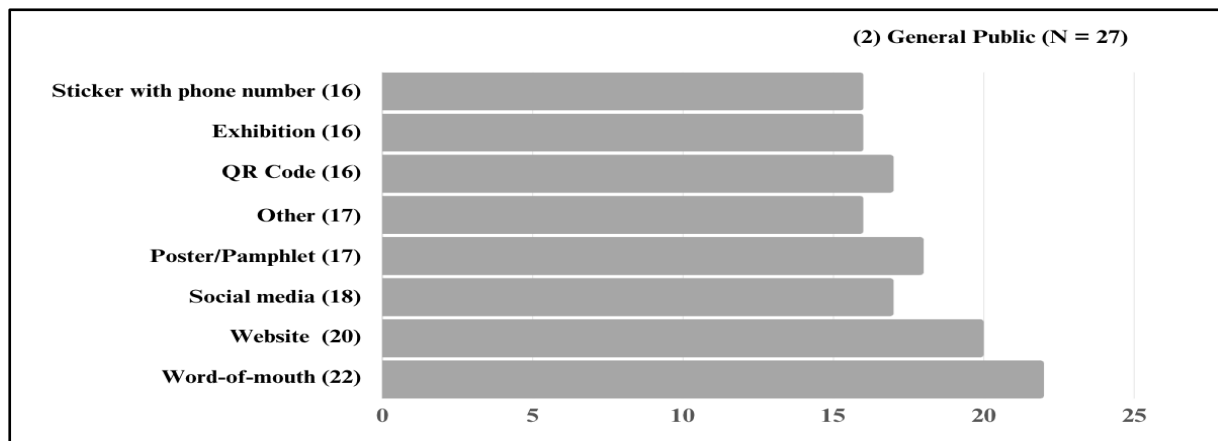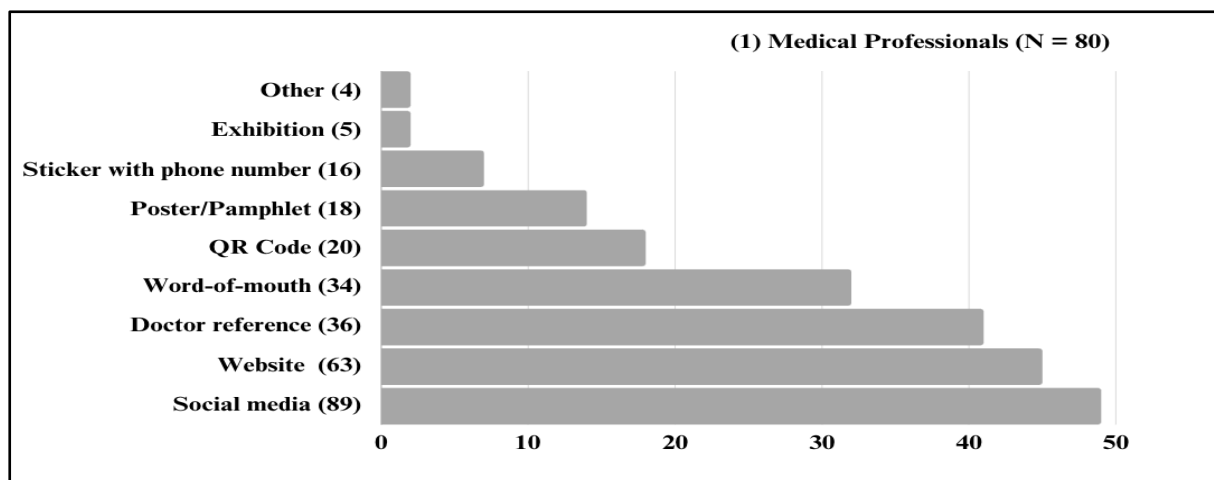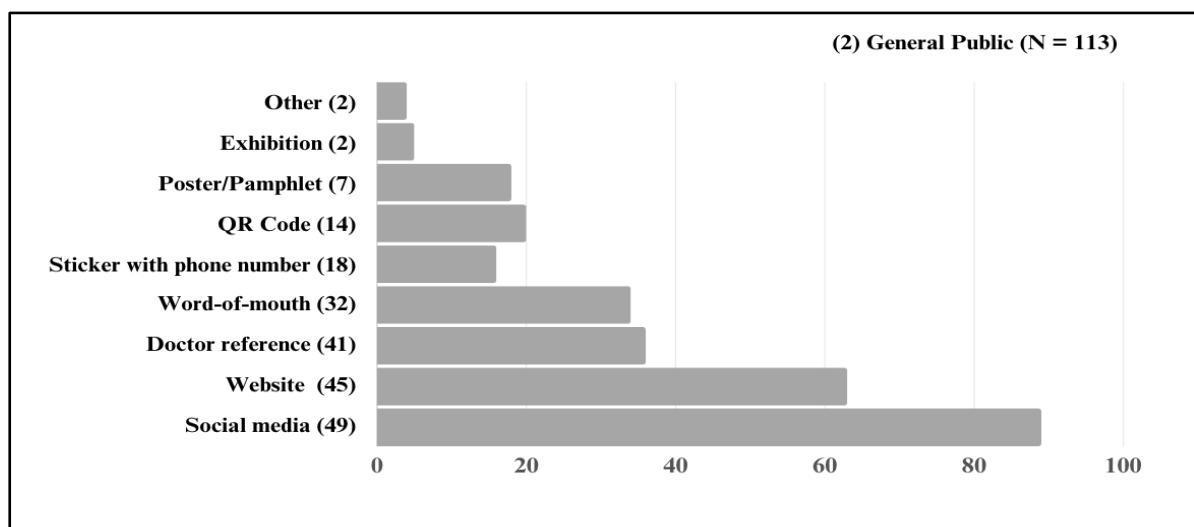

Figure 7. The results of descriptive statistics on communication channel to promote PCC by the general public

Table 5. showed the result of independent samples t-test on communication channel to promote PCC. The results revealed a p-value > 0.05 for all the communication channels. This indicated no significant difference on the choices of communication channels of PCC between healthcare professionals and the general public and hence rejected H7.

Table 5. The result of independent samples t-test on communication channel to promote PCC by healthcare professionals and the general public

Factors	Professions	N	Mean	Std. Deviation	t	P
Website	Medical Professional	80	0.57	0.49	0.24	0.81
	General Public	113	0.56	0.49		
Doctors	Medical Professional	80	0.55	0.50	3.14	0.00
	General Public	113	0.33	0.47		
Social Media	Medical Professional	80	0.59	0.49	2.30	0.02
	General Public	113	0.74	0.43		
QR Code	Medical Professional	80	0.15	0.35	0.49	0.62
	General Public	113	0.18	0.38		
Sticker	Medical Professional	80	0.23	0.42	1.49	0.13
	General Public	113	0.14	0.35		
Exhibition	Medical Professional	80	0.04	0.19	0.07	0.93
	General Public	113	0.04	0.18		
Poster/Pamphlet	Medical Professional	80	0.09	0.28	1.30	0.19
	General Public	113	0.15	0.35		
Word-of-mouth	Medical Professional	80	0.40	0.49	1.98	0.04
	General Public	113	0.27	0.44		
Other	Medical Professional	80	0.03	0.15	1.19	0.23
	General Public	113	0.06	0.24		

*Significant at the level $p < 0.05$

DISCUSSION AND IMPLICATIONS

This study underscores a notable disparity in the utilization of PCC resources between healthcare professionals and the public. The results reveal that healthcare practitioners exhibit significantly greater familiarity with, and active utilization of these facilities compared to other groups. The study's findings highlight a consistent discrepancy in the levels of engagement with PCC services, with healthcare professionals consistently demonstrating a higher level of involvement than the public. However, it is important to acknowledge the limitations inherent to the scope of our sample. The diversity within the healthcare professional community and the general public, as well as regional variations across Thailand, may not be fully represented in our study. This limitation could potentially restrict the direct applicability of our findings to all segments of the Thai population. While our results offer valuable insights, they should be interpreted with caution when considering their extension to the broader populace.

When studying the factors influencing the use of poison control services, this study indicates that accuracy and speed were significant influences. Additionally, treatment planning assistance and poison antidote recommendations emerged as important factors. These findings may present opportunities for expanding or developing new services at PCC (Alexander et al., 2007; Churi et al., 2013). Furthermore, our study revealed that healthcare professionals predominantly rely on word-of-mouth referrals and online channels such as websites and social media to gather information about poison control services. To more fully understand the disparities observed in our study, it is crucial to consider the underlying factors that contribute to these differences. The roots of disparity in healthcare service utilization are complex and multifaceted. It is possible that healthcare professionals' greater familiarity with PCC services is a result of their professional education and networks, which emphasize the importance of poison control in clinical practice. In contrast, the general public's awareness and utilization may be influenced by a variety of factors, including but not limited to socioeconomic status, accessibility

of resources, and educational outreach. Additional research exploring these factors could shed light on the mechanisms driving these disparities and help inform targeted interventions.

Healthcare professionals primarily learn about facilities through word-of-mouth referrals and online channels such as websites and social media. Using social media can be more effective than just relying on websites for raising awareness about PCCs. This highlights the importance of fast service delivery in influencing decision-making for recommending personnel and potential users. It suggests a need to concentrate on minimizing perceived information gaps to improve service performance, as suggested by Saud et al. (2020)

Moreover, our findings prompt a discussion about the barriers to service utilization, which may range from socio-economic and educational limitations to cultural and linguistic barriers. For instance, individuals from lower socio-economic backgrounds may lack the means to access poison information centers, while differences in educational levels may influence an individual's understanding and perception of poison control services. Furthermore, cultural beliefs and practices might shape attitudes towards seeking assistance from such centers. To address these barriers, targeted educational programs and culturally sensitive communication strategies must be developed. This would ensure that PCC services are not only available but also accessible to all segments of society, regardless of socio-economic status or cultural background.

Placing a greater emphasis on communication strategies through word of mouth, healthcare alumni, and social media is recommended. Poison information centers play a crucial role in providing timely services to reduce poisoning incidents, improve patient care, and prevent future accidental poisonings. Their utilization can help decrease morbidity and mortality caused by poisoning. Additionally, these centers have a critical role in acquiring and disseminating vital information during crises such as bioterrorism or chemical terrorism, as well as in responding to public health emergencies. By effectively utilizing social media platforms, poison centers can enhance their communication strategies and reach a wider audience to increase awareness and utilization of their services for improved public health outcomes (Kirk & Iddins, 2015; Vo & Smollin, 2015). Therefore, in today's rapidly changing world, the significance of accurate communication and fast service delivery, through channels such as websites and social media, cannot be overstated. The ability to adapt and respond quickly is crucial in order to meet the evolving needs of individuals and communities.

Theoretical Contributions

This research provides new insights into the awareness and utilization of Poison Control Centers among healthcare professionals and the general public in Thailand. It highlights disparities in knowledge and usage, emphasizing the need for targeted interventions. The study also enriches understanding of factors influencing PCC services' utilization, such as accuracy, speed, education, and communication strategies. Additionally, it emphasizes strategies like community workshops, public service announcements, collaborations with healthcare providers, and effective use of social media to increase PCC services' usage. Overall, this study contributes to developing a theoretical framework for improving poisoning management strategies and enhancing public health safety. Overall, this research emphasizes the importance of effective communication and fast service delivery in the context of poison information management. Public education plays a crucial role in promoting poison prevention behaviors and raising awareness of poison center services. It has been shown to significantly reduce hospitalizations and emergency department visits for poisonings (Lambdin et al., 2022).

Managerial Contribution:

The study's quantitative method explanatory approach yields implications for healthcare organizations and policymakers, emphasizing the need for tailored interventions to strengthen public awareness and education on poison control. Delineating distinct communication channels specifically tailored for healthcare practitioners and the general public is also emphasized. The research recommends strategic utilization of social media platforms as a powerful tool to broaden informational reach, engaging a diverse audience. It advocates integrating targeted interventions and deploying social media strategically to enhance public comprehension, increase use of poison

center resources, and reduce hospitalizations linked to poisoning cases. Overall, it offers actionable recommendations that can be embraced by healthcare organizations and policymakers alike toward fostering heightened awareness on poison control.

The study provides guidance for healthcare organizations and policymakers to prioritize efforts in promoting poison prevention behaviors and raising awareness of poison center services. By focusing on enhancing public understanding of the role of poison control services, stakeholders can contribute proactively to improvements in public health outcomes. The comprehensive findings recommend strategically tailored interventions and leveraging social media platforms to effectively disseminate crucial knowledge, engage diverse audiences, and enhance public awareness and education on poison control. These measures are poised to catalyze transformative improvements in public health outcomes by reducing hospitalizations and emergency department visits linked to poisoning cases.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

Certain limitations warrant acknowledgment; sample size may not fully capture population diversity. Besides these limitations our study establishes foundation for future targeted interventions initiatives aimed at enhancing public awareness of education on poision control.To address these, future research could involve larger diverse samples & employ more objective measures.Also exploring comparative effectiveness traditional advertising versus digital marketing strategies promoting brand awareness for Poision Control Services.Thus,this study influences use opportunities meaningful improvements.

CONCLUSION

In summary, our research has provided insights into the current landscape of poison control awareness and utilization in Thailand. Employing quantitative methods, this study delved into the factors shaping the decision to engage with poison control services. The research identified challenges faced by the center and presented strategies for enhancement. Extensive public awareness campaigns on online platforms have been underscored, catering to both the general public and healthcare professionals. Additionally, addressing sustainability concerns related to budgeting and income generation for information services is imperative. The intricacies of communication channels and the impact of phone numbers on service usage were scrutinized, emphasizing comprehensive education and awareness programs in fostering PCCs' utilization.

PCCs play a crucial role in providing timely assistance,reducing morbidity and mortality caused by poisoning, as well as assisting in preparedness response to public health emergencies. To ensure high-quality services at new Poison Information Center thorough assessment of nature quality through an evaluation plan examining areas such as timely response treatment planning gathering feedback from both populations is recommended. Furthermore, collaboration between PCC & other relevant stakeholder, such hospitals, universities, public health serves crucial in developing countries like Thailand.

In conclusion, our research has provided insights into poison control awareness and utilization in Thailand through a comprehensive quantitative approach. This study has identified factors influencing service usage, pinpointed challenges faced by the center, and proposed targeted improvement strategies. Emphasizing the importance of extensive online awareness campaigns for both the general public and healthcare professionals, our study underscores the need to address sustainability issues in budgeting and income generation for information services. This study has also scrutinized communication channels and phone number impact on service usage, focusing on enhancing direct services by poison specialists' recall. Acknowledging limitations such as potential bias and sample size constraints, the research lays a solid foundation for future endeavors to enhance public awareness and education on poison control in Thailand. Overall, this study contributes to the understanding of poison control services and suggests ways to improve public awareness and utilization in Thailand, emphasizing the need for targeted interventions and collaboration among various stakeholders to ensure effective poison control measures are implemented and sustained.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest found in this research.

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ASSESSING THE ROLE OF AI-POWERED CHATBOTS IN IMPROVING CUSTOMER EXPERIENCE IN PHARMACEUTICAL E-COMMERCE BUSINESSES IN BEIJING

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ABSTRACT

Purpose – The advent of new technologies like artificial intelligence in service industries has become a vital factor in creating a positive customer experience. The primary objective of organizations nowadays is developing excellent customer service that makes their customers satisfied, enhances their purchasing experience, and fosters engagement and loyalty. To achieve this, AI-enabled chatbots are widely used by businesses as they are more reliable, convenient, and accessible, provide quick resolutions as well as provide tailored recommendations for customers. This study examines the role of AI-powered chatbots in improving the customer experience in e-commerce pharmaceutical platforms in Beijing.

Methodology – This study will employ a qualitative secondary research method by examining existing information on online pharmacies using AI chatbots in Beijing.

Results – The findings reveal that there is huge potential for AI chatbots in online pharmacies because they can personalize customer interactions, streamline the healthcare journey of an individual, and cater to the growing demand for convenient and accessible healthcare services in an aging society like Beijing. In simple terms, healthcare treatment and diagnosis are time-consuming processes, however, with the incorporation of AI chatbots, customers gain access and convenience with personalized healthcare management, empowered self-service, 24*7 support, cost saving, eliminated hospital visits, retrieval of drug information and making them aware with proper education on medication and related services. The study indicates significant advancement in customer support and service quality within e-commerce pharmacies in Beijing. Integration of AI chat bots have shown capacities in providing personalized healthcare solutions, Real time information and also the emotional support to customers. These results together with the research objectives of assessing the impact of AI on customer satisfaction and service efficiency, as written in hypothesis 1 and hypothesis 2.

Implications – The study has identified both opportunities and Threats associated with AI chatbots. Hence, the successful integration of AI chatbots in online pharmacies to improve customer experience requires proper integration between regulatory compliance, ethics, and innovation.

Originality/Value – This research contributes to existing research by shredding valuable insights on the transformative potential of using AI chatbots in online business models.

Keywords: AI-powered chatbots, Healthcare, E-commerce, Customer engagement, AI application

Paper Type: Research Article

INTRODUCTION

Digitalization in the healthcare sector provides the potential to revolutionize patient healthcare globally. Trenfield et al. (2022) stated that the advent of technologies like artificial intelligence, blockchain, augmented reality, and so forth are providing significant benefits in patient care and satisfaction in the pharmaceutical industry. Pharmaceutical inventions, design, and distribution are expanding into the digital sphere. Each stage in the lifecycle of medicine from hit detection to marketing and patient outcomes is seeing the adoption of next-generation digital technologies. The pharmaceutical industry has incorporated such technologies due to the widespread adoption rate in other industries and its substantial benefits in various facets of client satisfaction and engagement. For example, many pharmaceutical companies are implementing AI-guided drug discovery due to its speed, capability for resource-saving, and constant operations. Likewise, AI-powered chatbots are becoming gradually popular in the pharmaceutical industry as they can offer customers easy access to information and support them in making better decisions. They can deliver personalized instruction and recommendations on medications and treatments, as well as respond to commonly inquired inquiries.

The population of China is increasing at a faster rate. Chen et al. (2010) mentioned that the city of Beijing has become an aging society with a population of about 12.3 million, which has resulted in noteworthy social significance in Beijing. Aged patients account for more than 60% of emergency cases, 85% of long-term care, and 49% of hospital days. Amongst those aged over 75 years, two-thirds suffer from three or more chronic illnesses, approximately half have one or more functional disability, and 15% have drug-related opposing actions due to polypharmacy. There is no proper specialized healthcare system for such situations in Beijing and people have to visit hospitals even for mild diseases and infections. There is often delay in diagnosis and treatments due to complicated processes and repeated higher medical costs which increase patient's medical expenses. There is a lack of effective connections and improper information-sharing systems across various medical facilities. As a result, there is an evitable enormous waste of public health resources negatively impacting patient care.

Similarly, a news channel has reported a large jump in the number of hospitalizations due to COVID-19 in Beijing. According to Farge (2023), the number of hospitalizations has risen by 70% to 63,307 compared to the previous week in January 2023 and this is the highest figure China has reported since the pandemic emerged 3 years before. Similarly, hospitals in China are faced with a lack of proper supply of medicines, ventilators, and other equipment. Chinese healthcare professionals are urging people through the media to avoid overcrowding hospitals and seek alternative solutions (Singh, 2022). Compared to the growing demand, pharmacy reserves and stocks are running out at a faster rate where essential medicines have become scarce commodities and people are finding it difficult to acquire medicines due to the complicated registration process for offline pharmacies. In the middle of such intricacies, the attention turns to digitalization and innovation. E-commerce pharmacies along with artificial intelligence could assist customers in navigating shortages along with fulfilling other healthcare requirements. Hence, this report aims to examine the potential of AI chatbots within pharmaceutical e-commerce businesses to improve customer experience in Beijing.

Research Objectives

1. To study various types of AI chatbots used in the e-healthcare industry, examining their role, functionalities, and effectiveness in healthcare services.

2. To examine the role of AI-driven chatbots in enhancing customer experience within e-commerce pharmaceutical companies in Beijing.

Benefits

The researcher aims to identify the power of technology like artificial intelligence in enhancing the customer base by providing them with convenient and easy-to-access health services, thereby reducing the complexities of accessing medical support and facilities.

LITERATURE REVIEW
Overview of the pharmaceutical e-commerce landscape in Beijing

There is a rise in consumer demand for convenience and accessibility in healthcare services due to which online pharmacy is expanding at a faster rate. The e-commerce pharmacy has been experiencing significant growth all over China (Statista, 2023). Figure 1 demonstrates current future revenue projections in this sector. It is observed that revenue in e-commerce pharmacy is $7.44 billion in 2023, which is anticipated to grow at the rate of $21.42 billion by 2028. Likewise, user penetration in this area is 40.85% in 2023 which is expected to hit 64.84% by 2028 (Figure 2). Customers are turning to e-commerce platforms for healthcare services because they save time and effort by enabling them to obtain prescribed drugs and medications from the comfort of their homes. Likewise, before making a purchase, they have the option to compare costs and read reviews online as well as speak to medical experts online, which provides them easy access to prescription drugs, guidance, and faster service. The expansion of services beyond pharmaceutical sales is one significant trend in the online pharmacy industry. An extensive variety of healthcare services counter drugs, vitamins, supplements, as well as personalized healthcare services are available from numerous internet pharmacies. This assists online pharmacies to draw a huge number of customers and boost sales. One prominent example of an e-commerce pharmacy in Beijing, China is JD Health, which is the largest online healthcare platform in China. The business was incorporated in 2018 and is headquartered in Beijing (Yahoo Finance, 2023). It offers pharmaceutical products like OTC drugs, health supplements, medical devices, and other medical supplies through direct selling and an online retail pharmacy network. It further offers online medical consultation, healthcare management services, referrals to doctors and hospitals, genetic testing, consumer healthcare, beauty care services, advertising, and intelligent healthcare services. In addition, it is involved in order management, customer management, and other traders' operational and maintenance support activities.

The growth of e-commerce pharmacies is prevalent in countries like China with high smartphone penetration rates. The number of mobile phone users across China as of 2023 is 1.68 billion and it is predicted that the mobile internet market will increase in big cities like Beijing (Seo China agency, 2023). Similarly, about 14% of the population of China is over 65 years and in the next 2 decades, it will add more over 65s population (Hawkins, 2023), which will increase the demand for faster healthcare services. The increase in internet penetration rates, increasing healthcare costs, and aging population add to the growing demand for online pharmacy services. As more persons gain admittance to the internet and search for cost-effective healthcare resolutions, the online pharmacy marketplace is predicted to continue growing. According to the report on China Pharmaceutical E-Commerce Industry Research 2021, as stated by Yang (2021), there are two major benefits of e-commerce pharmaceuticals in Beijing have been highlighted. Firstly, quick delivery and secondly, faster customer service have prompted Chinese citizens to buy medicines online. As per the online survey media and research platform VCBeat Research in association with JD Health, it was found that about 46.6% of people in Beijing would purchase medication and healthcare services online if they fell ill. Simultaneously, common family medications and prescription drugs account for 25.4% and 25.9% of users' online medication procurements, correspondingly. In compliance with the relaxation of regulations on online sales of prescription drugs by the Chinese government, pharmaceutical e-commerce has a significant potential to grow its market share and also offer a wide range of personalized services to its customers. similarly, about 40% of people in a survey agreed that they would be willing to pay more to access personalized services through experienced healthcare providers online. The main reason behind this upsurge in demand of e-commerce in healthcare services can be attributed to COVID-19 which has revealed unstructured healthcare services in China and led to the growth of online pharmacies from RMB 100 billion yuan to 200 billion yuan over the past year. This offers huge prospects for pharmaceutical corporations to incorporate these online platforms along with their digital marketing resolutions and technological advancements as a significant network to reach end-users.
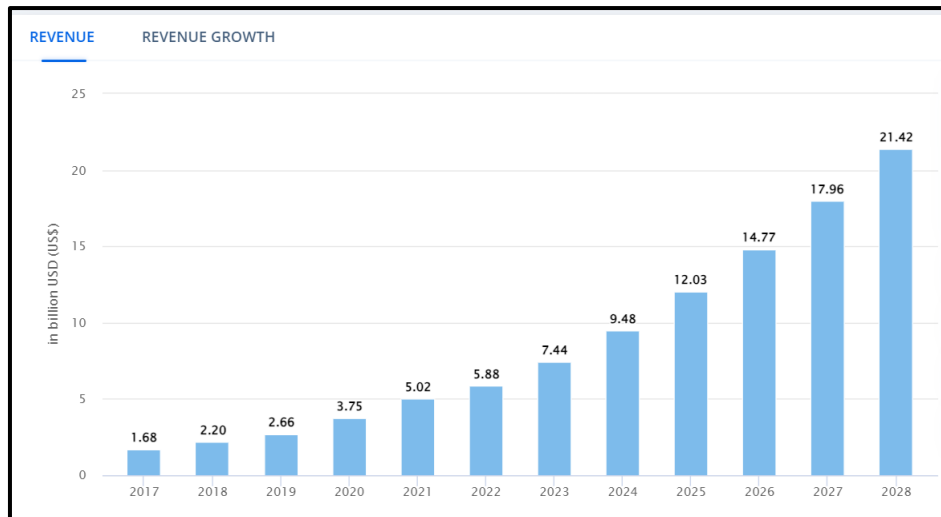
Figure 1. Revenue growth in e-commerce pharmacy
Source: Statista (2023)
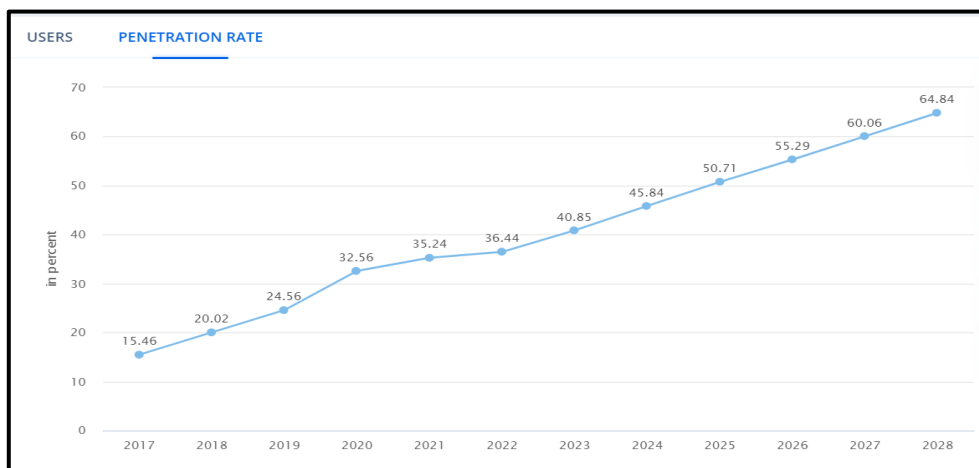
Figure 2. User penetration rate in e-commerce pharmacy
Source: Statista (2023)

Electronic business model and digital transformation in pharmaceutical e-commerce in Beijing

The fast-paced growth of pharmaceutical e-commerce is evidence of how digital models in the business landscape are evolving and changing the healthcare industry. Panchal et al. (2023) stated that online retail pharmacies can disrupt the outdated brick-and-mortar pharmacy industry, as they offer better convenience and lower prices. The growth of the internet has revolutionized our lives in every aspect including communication, procurement, and so forth. As access to internet services has increased globally, people are making wider use of it to seek healthcare information and services. This has led to the emergence of new business models in pharmacy. E-commerce permits customers to retrieve every minute detail of their health and shop from home saving their amount of time energy and money. After this, there is a noteworthy enhanced growth in the e-commerce of pharmaceutical industries enabling progress in online pharmacies. This enormous upsurge of convenience and accessibility by the customer is filling the information gap between the customer and the supplier. There is no doubt that businesses are consuming the internet in a diversity of manners to advance commercial performance by offering appropriate information on products and services to the purchaser. This kind of retailing and exchanging goods and services on the internet is termed e-commerce.

In China, the first online pharmacy opened in 2005 and ever since then, its expansion has been significantly increasing at a faster pace. Chen (2018) pointed out that, according to the official website data of the China Food and Drug Administration (CFDA), there are an overall of 693 online pharmacies in China, among which 52% of China's total number of online pharmacies are confined within five jurisdictions and cities including Zhejiang, Shandong, Guangdong, Jiangsu, and Beijing. In this context, due to the high potential of this business model, traditional brick-and-mortar pharmacies have experienced digital change giving way to innovative digital platforms that completely transform the way medicines are accessed and purchased. For example, leading online retailers including Tmall and JD Health are leading this transformation in the industry by offering extensive choices of prescription drugs, medical supplies, and related services through their online storefronts. These businesses have embraced digital adoption in their business models to meet the changing needs of customers and fulfill the gap in the traditional healthcare sector as exposed by the pandemic in 2019.

Various key forces have shaped the digital ecosystem in the pharmaceutical industry. Bu et al. (2021) argued that health tech is among the major forces in Overall China including major cities like Beijing to transform from cutting-edge contact tracing and immunization arrangement systems to the explosion of online clinician consultations and service bookings, to ground-breaking associations among digital pharma businesses and doctors, China's HealthTech sector is exploding, with far-reaching influences. COVID-19 also accelerated the implementation of AI applications and robotics systems to assist healthcare staff, comprising cleaning robots, food delivery chatbots, temperature-screening systems, and health AI chatbots. AI-equipped diagnostic assistants have drastically enhanced the effectiveness of healthcare services. In contrast, Navarro (2021) argued that the presence of computer-generated assistants or chatbots, nanotechnology, and the practice of 5G infrastructure in remote surgical operations with AI applications and, predominantly, machine learning, in the healthcare field, could serve, as a tool that advises/counsels, examine descriptions, allocates resources, or acts as a second judgement for diagnosis and treatment of illnesses, however, the control remains with the health professional. Hence, proper coordination of humans and AI is necessary for the successful integration of AI-enabled tools like chatbots to assist customers online.

In July 2023, the Chinese Government issued its new and finalized guidelines for generative artificial intelligence. As mentioned by Ferguson et al. (2023), the Interim Measures for the management of Generative AI services (Interim GAI Measures) were accepted by seven foremost Chinese government agencies. The main objective of the Interim GAI Measures is to regulate content generated by AI and involves several local and application-based laws. The AI regulations of Beijing may have a big impact on the adoption of AI in several sectors. For example, Beijing's 13th five-year plan (2016-2020) specified that AI has the potential to enhance economic growth, and its current 14th Five-year plan (2021-2025) signaled constant state investment in AI. However, Broersma (2023) reported that the Beijing Municipal Health Commission has banned medical prescriptions that are generated by AI chatbots. This presents difficulties and growing concerns related to the incorporation of artificial intelligence in the healthcare industry. This is mainly to regulate potential threats related to internet-based medications, thereby, mandating strict regulations like having three experiences by doctors by businesses who offer AI-based treatments. Henceforth, striking a balance between regulations and the commercial landscape is vital to survive in the digital era.

Role of AI-powered Chatbots in Improving Customer Experience and Business Value in e-commerce pharmaceutical platform
History of chatbots
Artificial intelligence (AI) is at the frontage of changing several facets of our lives by changing the way we explore information and refining decision-making through problem-solving, intellectual, and knowledge. Xu et al. (2021) asserted that Machine learning (ML) is a subgroup of AI that enhances its performance based on the data offered to a general algorithm from experience rather than outlining instructions in outdated methods. The handling of complex data, accuracy, speed, cost-effectiveness, and decision-making have benefited from advancements in machine learning.

A prime instance of an AI system that has evolved from machine learning is a chatbot, often discussed as a smart bot, chatter robot, digital assistant, conversational agent, and intellectual agent. A chatbot is well-defined as a computer program that can hold a discussion with an individual mainly through the Internet. The concept of chatbots was first familiarised in 1950 by Alan Turing when he put forward the question "Can machines think?". The initial versions of chatbots were developed to test the Turing test and mimic human language as closely as possible. The very first known chatbot that was designed to mimic humans and perform as a psychotherapist in the healthcare field was "ELIZA" in 1966. It utilized pattern matching and template-based answers for engaging users in question-based communication online in the healthcare field. Similarly, later various improvements were made to develop chatbots with more human-like appearance and PARRY was evolved which was developed by Kenneth Colby and stimulated paranoid patients. Among the most well-known chatbots that was developed by Richard Wallace in 1995 was ALICE which made use of a pattern-matching technique for retrieving sample sentences from outcome patterns to avoid unsuitable answers. Later major advancements in chatbots were made and the emergence of Alexa, Google Assistant, and Microsoft Cortana took place. Figure 3 indicates the most popular development of chatbots for healthcare resolutions including diagnosis, patient support, counseling, and healthcare promotion.
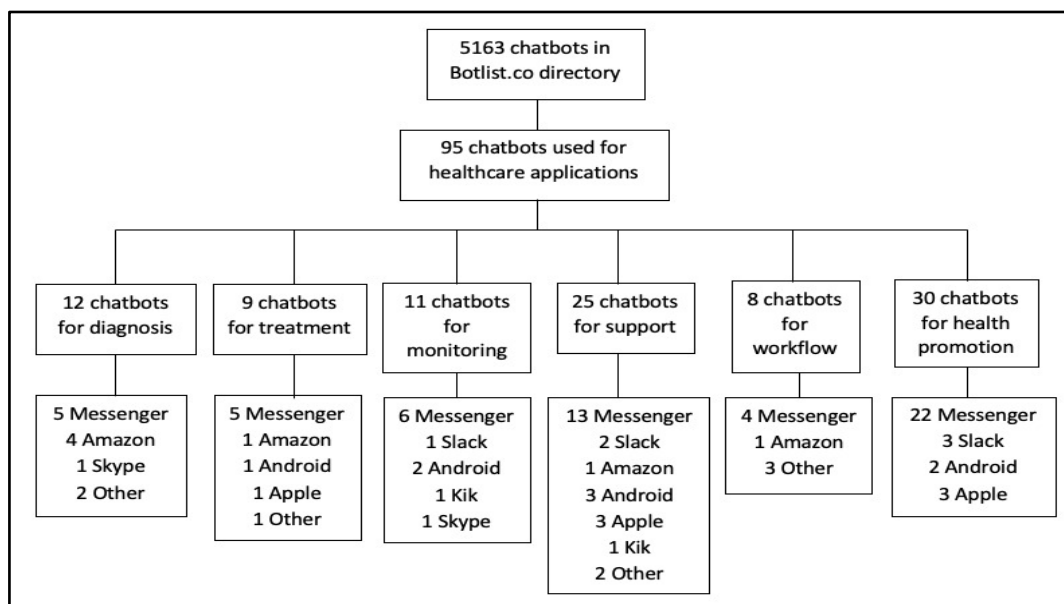
Figure 3. Healthcare AI chatbots
Source: Xu et al. (2021)

Chatbot offers programmed replies that are then produced by examining user input, on the transcript or verbal ground, and retrieving appropriate information. Difficulties arise while dealing with more multifaceted circumstances in dynamic environments and handling social conversational practices according to particular settings and exclusive communication approaches (Dahiya, 2017). Chatbots have evolved for two eras and combined themselves into several fields including education, entertainment, travel, security, and others. Chatbots have proven to be mainly pertinent in various healthcare components that frequently include face-to-face connections. With their capability for compound discussion management and communication flexibility, the incorporation of chatbot expertise into medical practice might decrease costs, improve workflow competencies, and expand patient outcomes. Healthcare chatbots are beneficial for the self-management of personal health better psychological and physical and behavioral outcomes.

Types of AI-powered Chatbots in e-Healthcare
Various types of AI-enabled chatbots are widely used in e-commerce pharmaceutical platforms. Some of them include:

Knowledge domain chatbots: This includes open and closed domain chatbots. In the open domain, chatbots respond to broader and general topics and concerns which can be easily searched within the databases, and specialize in repetitive symptom screening, connecting customers to service providers, and involving health promotion applications (Xu et al., 2021). In the closed domain, the chatbots involve more complex and specific healthcare concerns raised by users which necessitates in-depth research. Such chatbot is mainly preferred for treatment planning and suggestions.

Service provider: Service provider chatbots are categorized into three different types. Firstly, interpersonal chatbots are mainly used to transmit information without any intimate connections with users, mainly preferred for imaging diagnosis or heredity assessments wherein the main responsibility is to transmit factual information to users (Xu et al., 2021). Secondly, intrapersonal is tailored for support and offers services like counseling, health promotion, and emotional support which necessitate a human touch. One such example of a chatbot in Beijing, China is "The Xiaotian app", which is an AI chatbot that provides mental health support to users (Huaxia, 2022). It can stimulate the human brain and has combined skills applied by professional counselors who deal with realistic cases. Lastly, the interagent model is used to communicate with other computer systems of chatbots specifically to transfer information about patients between locations.

Rule-based chatbots: The chatbot is intended to respond to regularly queried medication-related interrogations like drug communications and their side effects. The chatbot follows predefined instructions and decision trees to control its relations with users, offering them precise and reliable medication-related information (Ramadhani, 2023). However, the chatbot is imperfect in its capability to comprehend and retort to compound inquiries, as it is constructed on a fixed set of guidelines and cannot acquire and adapt over time.

Machine learning-based chatbots: These chatbots use complex algorithms and voice-text-voice features to solve user queries related to medications, side effects, dosages, and interactions with other medicines. This further assists with information about healthcare providers and scheduling appointments (Ramadhani, 2023). One such example of this type of chatbot is the "Ada Health chatbot". This makes it a influential tool for patients who seek customized healthcare services and advice.

Architecture of AI-chatbots

Chatbots can be developed using a multitude of methods, however, the overall structure is quite simple. As stated by Ketakee and Champaneria (2017) the main idea is similar for every type of computer application that uses machine learning to stimulate human actions and includes four stages, namely, input process, input understanding, response generation, and response selection. A simple AI chatbot is illustrated by Xu et al. (2021) in Figure 4 which receives queries from users either in speech or text form and interprets them, processing them to provide meaningful information to the customer or user.
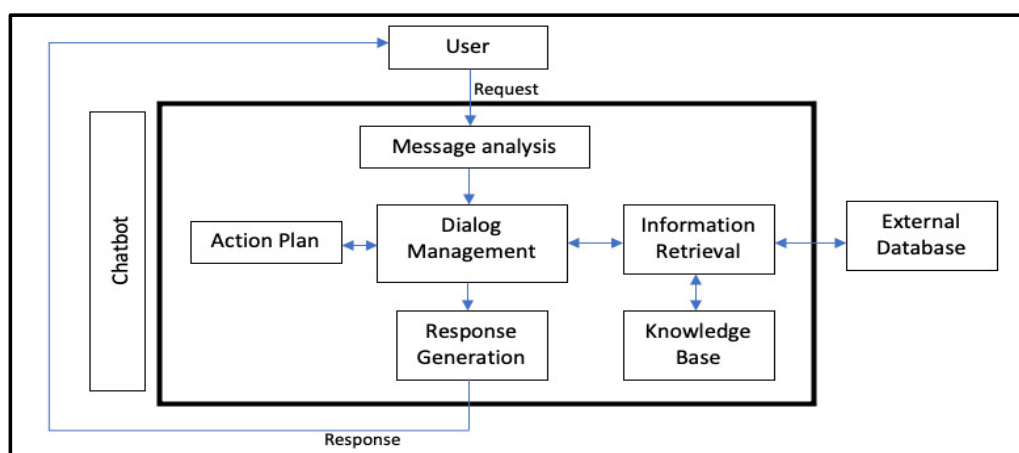

Figure 4. Chatbot Design/ architecture
Source: Xu et al. (2021)

AI-chatbots in improving customer experience in e-commerce pharmaceutical platform

Artificial intelligence is drastically altering marketing strategies particularly in the field of enhancing customer experience because contemporary marketing has turned out to be more data-driven, and automated. El Bakkouri et al. (2022) stated that the advent of intelligent technological agents has enabled smooth interaction between humans and machines. For example, AI-enabled chatbots can capture customer input and offer customized solutions instantly. Currently, companies in almost every sector are progressively developing chatbots in their direct communications with customers to offer a customized service despite one-sided buying. Jenneboer et al. (2022) opined that in the era of technological advancements, where customers spend more time online, companies are seeking innovative ways to keep in touch with them. To improve customer experience, service quality is critical for every organization. An excellent customer experience is likely to increase trust, satisfaction, and commitment among customers which results in loyalty and increased intention to purchase among the customers. Response duration, accessibility, readiness, dependability, and flexibility are the five factors that together make up the system quality dimension, that is used to evaluate the chatbot's technological performance. The length of time chatbots take to receive a response is termed as Response duration, the simplicity in usage is readiness, to be able to use it from anywhere is accessibility, and at any time is dependability. Similarly, the capability to adjust to the changing needs of customers is flexibility. With chatbots in pharmacies, customers' questions and complaints could be responded in real-time making businesses less expected to lose sight of their customers. AI-enabled chatbots offer a new level of assistance comprising resolving complaints for the aspect of service quality and as a result of digitalization, personalized services are available to customers anywhere and anytime. However, customers are concerned about their data getting revealed on an online platform. Meanwhile, when e-commerce businesses offer specialized discounts or packages to customers, their concerns fade away. The quality of quick service, data availability, and user-friendly and factual information that customers can receive on their health and well-being, assist the companies in pharmaceutical platforms gain customer satisfaction which in turn gets concerted into customer loyalty.

In the realm of customer experience inside the pharmaceutical e-commerce landscape, the effective handling of customer complaints is pivotal. In this context, Guillot et al. (2023) argued that chatbots provide easy access to medical information for which a patient has to follow a tedious process offline from making appointments with doctors to seeking their advice after the receival of medical check-up reports. This generally takes 1-2 days. However, the virtual agents incorporated in e-commerce pharmaceutical platforms assist customers by not only advising them about medications but also educating users about their use, benefits, limitations, and well as side-effects of using different medications and equipment. This also lessens manual tasks and workloads for customer support agents in pharmaceutical companies as technologies like chatbots can help complete these tasks with ease. Moreover, the most vital part of using chatbots in pharmacy and for effective customer service and experience is maintaining contact touch with the patients to track their progress and assist them 24*7 whenever in need. For example, chatbots are effective tools that provide constant reminders, notifications, and alerts to customers instructing them about their treatments, the schedule of their ongoing medications, and additional questions that a patient always has related to their progress in treatments, any substitutes, prescription, and disease.

Placing orders for medicine had been easier than before. According to Rane et al. (2019), online pharmacies make use of mobile applications to facilitate the online purchase of medicines through verification of the prescription uploaded by the user and confirming the order. This system comprises mobile application interfaces, a pharmacologist interface, a database, and a web service provider for intermediary procedures to offer service through Android mobile phones with chatbots to assist them. Whenever a customer wants to purchase or raise any healthcare query with the help of a mobile application, he is asked to upload the details of the prescription by the doctor or specific details related to the personal health of the customer. The data is then stored in the database where the user precedes the process by providing details of medications in the mobile application chatbot interface. When the medicine or queried services

are available at the pharmacy, the customer is permissible to add the service to the cart, and if the medication is not accessible, the chatbot will offer suggestions by offering an equivalent brand of medicine and hold the process to assist the customer in the best possible manner. Later the service added in the cart list is compared with the prescription or details uploaded by the customer and will be approved by the pharmacist before the order is placed. The technique that is used in the entire process to speed up the searching procedure by the customer is the "n-gram technique". Divya et al. (2018) argued that leading a good and healthy life is very significant, however, it is sometimes very difficult to obtain a consultation with a doctor in case of health problems. Hence, the other alternate form of this is medical chatbot using artificial intelligence which is capable of diagnosing disease as well as offering basic details about the best possible medications and suggestions available before consulting a doctor and simplifying the search process of the customers to ease their treatment journey. similarly, it has the capability of reducing medical costs and expanding accessibility to medical knowledge. For instance, several chatbots act as medical reference books for customers, which assist the customers/patients in accessing more information about their disease and health conditions and help to recover their health. However, the user can attain the actual benefit of a chatbot only when it can detect all categories of sickness and deliver compulsory information. In this situation, a text-to-text chatbot is likely to engage customers in communication regarding their medical concerns and offer them personalized resolutions based on their symptoms. Henceforth, when people have the right idea about their health and can access the right information at the accurate time, their overall experience is enhanced which further positively impacts their satisfaction and trust level with the business.

Chatbots have been increasingly used in the e-commerce pharmacy field for assisting patients and healthcare professionals in disease education, medication management, and retrieval of medication information. Ramadhani (2023) mentioned that with the emergence of the COVID-19 pandemic, AI-enabled chatbots have been increasingly adopted by online pharmacies for teleconsultation services, health information, and education and assessment of symptoms. Researchers conducted an analysis on patients who had type 2 diabetes and learnt that AI-enabled chatbots were used by such patients regularly as a source of medication reminders which increased adherence among patients by 80%. Similarly, Chen and Liu (2023) reported that the healthcare system in China is faced with unprecedented challenges due to the re-occurrence of COVID-19, most of the top 100 hospitals in northern China are located in Beijing, where few hospitals help patients in applying for fake hospitalization procedures to deceive medical insurance funds. Similarly, some doctors produce fake medical records, charge excess fees, and falsify healthcare services to obtain benefits from medical insurance funds. This erodes the trust of customers in healthcare services and medical professionals. However, Ramadhani (2023) noted that in such situations, the adoption of AI chatbots by online pharmacies in Beijing stands as a pivotal tool to restore confidence and trust among customers by providing them with transparent and accurate information, answering common queries of customers, availability of medicines, and so forth. By empowering customers with real-time data, facilitating reporting mechanisms has enabled chatbots to increase customer satisfaction and engagement by improving their medical knowledge, and providing them accessibility and convenience from their homes, 24*7, where chatbots provide personalized information in the face of adverse calamity, that made the customers feel valued and involved in their care.

Theoretical Underpinnings

The "Technology Acceptance Model (TAM)" is the foundational theory that explains the acceptance and adoption of technology by users. Opoku and Francis (2019) stated that technology use behaviour, denoted as the behaviour tendency towards tolerant technology, can be measured through a user's outlook towards using technology. There are two main behavioral or outlooks towards technology usage that have been proposed. Firstly, perceived usefulness fosters a belief in an individual that the use of technology can promote the performance of their tasks. Secondly, perceived ease of use gives the perception to an individual that technology use is free from any kind of effort. In the context of AI-enabled chatbots in e-commerce pharmaceutical businesses, TAM sheds light on how chatbots are perceived by customers. For example, perceived usefulness

makes customers believe that AI chatbots in pharmacies would assist them in finding the right information about medications, receiving real-time health advice based on their medical condition, easing customer decision-making, and simplifying the purchasing journey. If customers find that the chatbots used by online pharmacies are beneficial in terms of tailored suggestions, and answering questions about medications, they are likely to adopt and use them at a faster rate, thereby increasing customer engagement and satisfaction. Similarly, perceived ease of use is vital if the chatbots are user-friendly and provide easy navigation to other healthcare websites for effective healthcare management, and makes the customers inclined to engage with the technology in their daily lives.

In literature review, the Technology Acceptance Model (TAM), discusses the theory relevant in the research. TAM explains how users accept and adopt technology, focusing on the usefulness and perceived ease of use. The theory is relevant to the research because it sheds light on how consumer perceives a chatbot in commerce pharmacies, impacting their adaptation and the behavior in the usage system. The usefulness and the ease use influence customers' acceptance and engagement with AI chatbots which affecting the overall experience.

Hypothesis Development
The literature review discusses studies by Ramadhani (2023), Fan et al. (2021), and Guillot et al. (2023), which highlight the role of AI-enabled chatbots in improving customer service, providing real-time information, and offering personalized services to customers. Therefore, this research considered set hypothesis 1 as below.

H1: The integration of AI chatbots in online pharmacies has the potential to enhance customer satisfaction and experience.

The literature review discusses studies by Ramadhani (2023) and Chen and Liu (2023), which emphasize the use of AI-enabled chatbots in teleconsultation services, health information dissemination, and medication management, particularly in the context of challenges like the COVID-19 pandemic. Therefore, this research considered set hypothesis 2 as below.

H2: The application of AI chatbots has the potential to increase efficiency of healthcare services and boost patient safety.
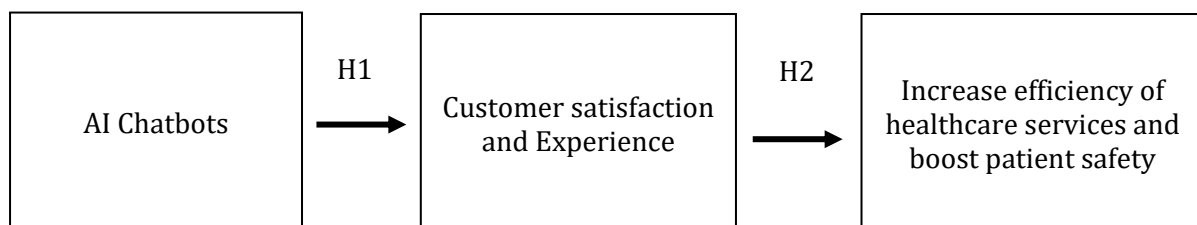
Figure 5. Theoretical Framework

METHODOLOGY
Research Design
This study will employ a qualitative secondary research method by examining existing information on online pharmacies using AI chatbots in Beijing.

Population and Sample size
The sample size of the reports will be between 35-40, and the keywords used in the research process include AI-powered chatbots, healthcare, e-commerce, customer engagement, customer service, and AI application.

Sampling Methods
Purposive sampling will be used to select information and sources based on specific purpose and criteria.

Research Tools
The research tools include Market research reports, Google Scholar, websites, government publications, case studies and other reliable sources.

Data collection Method
The data will be collected from peer-reviewed articles, journals, books, government publications, public records, newspapers, industrial reports, and company websites. Case studies will be used to examine the implementation of AI chatbots in e-commerce pharmacies in Beijing.

Data Analysis Techniques
Thematic Analysis will be used to justify, analysis and report patterns in the data collected.

Data collection: the data for the analysis was collected from various sources like peer reviewed articles, journals, government publications, books, public records, newspapers, industrial reports, and the website of the company.

Data preparation: once the data was collected, it was organized and the analysis was done. This process has involved transcribing interviews, extracting relevant excerpts from documents and ensuring that the data was in the format so as to make it easy for analysis. To transcribe interviews will include listening to it multiple times and drafting the transcript by adding time stamps and speaker labels. Proof-read it and then format the final transcript.

Coding the search began with reading the data to be familiar with its content and validity. The codes were assigned to segments of the data that represent the features, ideas or patterns.

Identifying Themes: once the coding of the data was done, the work was to identify broader patterns or themes that emerged from the data segment. Themes are recurring patterns of meaning or topic that capture something important about the data patterns.

Defining Themes: After refining the themes they were defined and the names were given to them which are descriptive in nature.

Analysis: The findings of the thematic analysis into a coherent narrative that addressed the questions are the objectives of the study.

RESULTS
Within the e-commerce pharmaceutical platform, various companies are embracing artificial intelligence in the form of chatbots to enhance the customer experience in several manners. One such example is JD Health. It is the digital healthcare subsidiary of JD.com and is headquartered in Beijing (Yahoo Finance, 2023). It is an e-commerce platform for retaining pharmaceutical products. JD.com has introduced an AI-enabled chatbot named "Chat Rhino" to assist industries like retail, healthcare, finance, and municipal services (Wang, 2023). This chatbot makes use of 79% generalized data in combination with 30% native intelligent supply chain data to provide personalized solutions to resolve issues and concerns. For instance, JD's smart customer service chatbot has made a paradigm shift in enhancing customer experience. Combined with AI, it can detect subtle human emotions which modernizes interactions and ensures proactive and sensitive support to the users (Cao, 2021). Emotion is a vital part of providing excellent customer service and the implementation of human robots has helped in interacting with customers more naturally while maintaining patient and caring mood 24*7. For example, in 2020, a customer asked JD's robotic customer service chatbot "How many sleeping pills a human consumer to take one's life". The chatbot with its unique AI feature of detecting human emotions and sensitivity, understood the abnormality of the inquiry and immediately redirected it to the suicide hotline team called "Life Channel" of JD Health. Later the customer was served by the trained front-line staff of the Life Channel by providing psychological counseling to calm the customer during communication and take suitable measures to ensure the customer's safety. Such proactive intervention in the form of AI chatbots which detect human emotions used by JD Health not only showcases technological advancement and commitment to the well-being of its customers but exemplifies how technology can be significant for the overall societal good. Similarly, by making this chatbot feature available to several other cities in China through the resident service hotline (12345 in China), it has improved and resolved about 97.9% of cases (Cao, 2021). Hence, this signifies a pioneering step towards using AI chatbots to enhance customer satisfaction and experience.

Similarly, Yaofang.com is an e-commerce pharmacy in Beijing that sells pharmaceutical products (Yaofang, 2023). It operates Renhe Pharmacy Network in Beijing which is an online pharmacy service and assists customers 24*7 by providing smooth healthcare services (Yaofang, n.d) (Figure 6). It assists customers in major areas like assisting in chronic diseases, family medications, traditional Chinese herbal treatments, nutrition and weight management, new and specific drugs, health services like doctors' appointments, and so forth. Similarly, this lets the customers get personalized and one-on-one assistance by adding their "WeChat" account by scanning it through a QR code where a highly skilled customer representative will be available to address the inquiries of the customer. This not only enhances customer service but also signifies a proactive approach towards providing elevating customer satisfaction and experience in gaining access to effective healthcare services. Hence, the utilization of QR codes for personalized services and AI Chatbots reflects the commitment of the e-commerce pharmacy in embracing digital means for streamlining customer service and interaction.
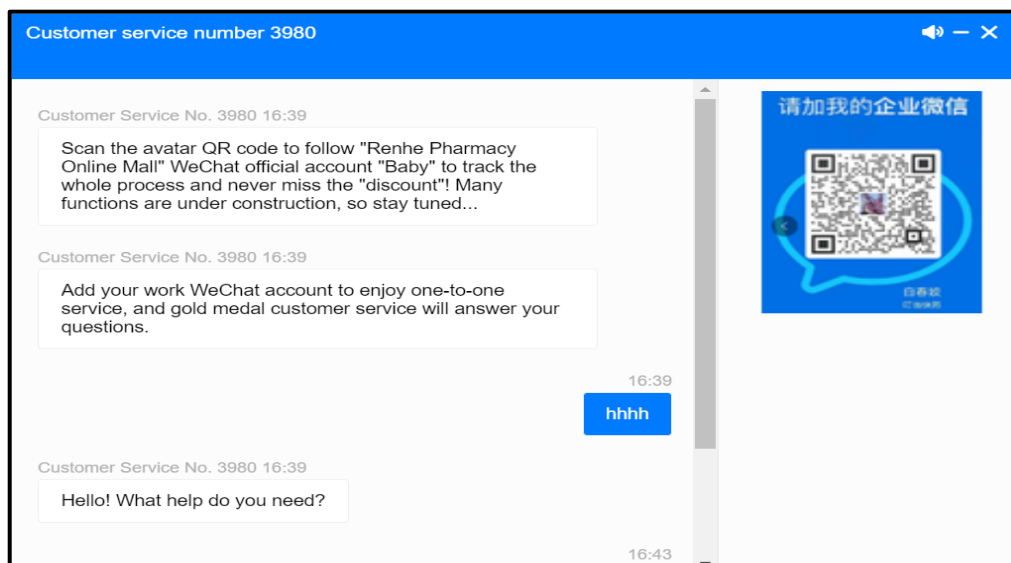
Figure 6. AI-chatbots at Yaofang.com
Source: Yaofang (n.d.)

Hypothesis 1: The finding demonstrated that the integration of AI chat bots in online pharmacies added to customer satisfaction and experiences. This was evidence by the improved customer service, recommendations and real time assistance.

Hypothesis 2: The study of hypothesis to reveal that the application of AI chat bots increase the efficiency of the healthcare services and contributes to the patient safety.

Doctor Bot is an AI-driven chatbot in Beijing that represents a groundbreaking use of technology in the e-commerce pharmaceutical landscape of China. Fan et al. (2021) opined that it leverages extensive medical datasets as well as cutting-edge AI techniques like deep learning for delivering tailored services to customers seeking medical advice. E-commerce pharmacies incorporate this chatbot to empower users with a huge range of services like self-diagnosis, dietary recommendations, drug usage, and so forth. Figure 7 illustrates an overview of the chatbot which uses both English and Chinese language for the ease of users and starts by prompting for the user to describe their main complaint or symptoms. After being prompted, like "Why I am coughing?", triggers the chatbot to ask a series of queries related to the symptoms of the user. The user is then asked to provide a medical history of hospital visits, any ongoing or past medication or allergies, and so forth. Lastly, based on the symptoms and medical data provided by the customer, the chatbot provides details treatment suggestions whether to see a doctor or medication recommendations. Hence, this empowers users to get a detailed overview of their health conditions with real and factual data that deliberately enhances their overall experience as a patient or consumer.
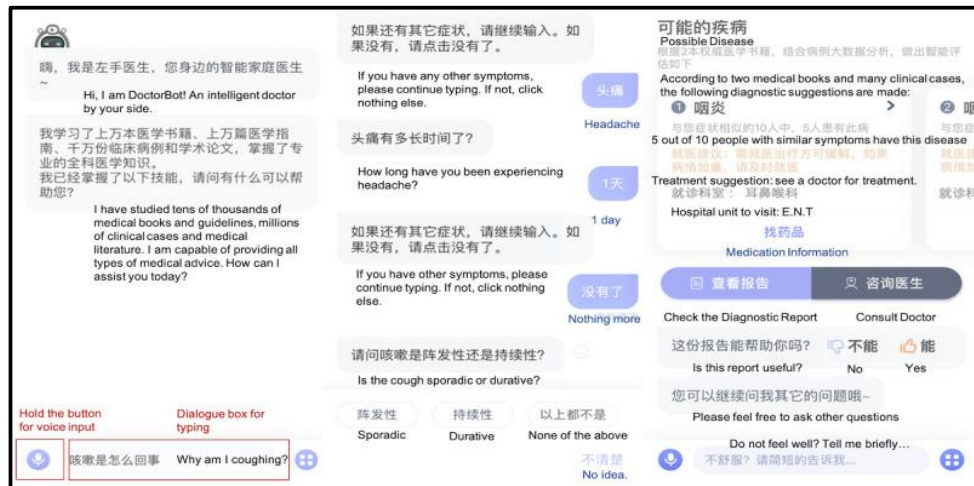
Figure 7. Overview of Doctor Bot
Source: Fan et al. (2021)

Online pharmacies work in collaboration with doctors and physicians before recommending medications to the customers. Waszyk-Nowaczyk et al. (2021) stated that for patients, effective collaboration among healthcare teams and pharmacies can lead to better coordination and more effective treatment, by improving patient outcomes, thereby enhancing customer trust in online pharmacies. In this context, Baidu is a Chinese multinational technology company that has launched an artificial intelligence-powered chatbot named "Melody" to link patients and doctors for effective treatment and improve the overall healthcare scenario of China (Taylor, 2016) (Figure 8). Baidu has used advanced deep learning and natural language processing technologies to influence Melody. It is specifically designed to be able to assist a person feeling sick at home, where a customer can pose a query in the chatbot and get real-time input. As per the data of WHO, it is predicted that there will be a worldwide deficit of almost 13 million health-care professionals in 2 decades. In this scenario, this chatbot can assist online pharmacies in taking the leverage of assisting customers by getting a quick grasp of their medical condition and assisting them as early as possible. Melody has been designed to use health data from several sources, textbooks, and websites that assist the chatbot in handling medical queries and asking the right questions from the customers/users, and collecting the right information that doctors can use to treat their condition. Hence, this presents scope for wider acceptance of this AI-chatbot by both offline and online pharmacies in improving customer experience at large.
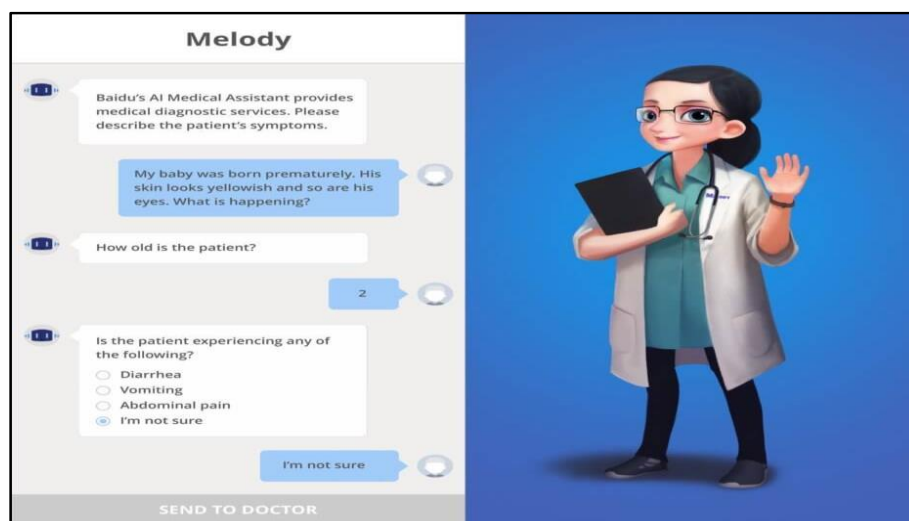
Figure 8. Overview of AI-chatbot "Melody"
Source: Robles (2016)

Summary of Research Result

| E-healthcare industry	Type of AI Chatbot used	Role	Functionalities	Effectiveness	customer satisfaction
Online Pharmacy	Chat Rino	Provide personalized solutions to resolve issues and concerns	Maintaining a patient and caring mood 24*7, detecting human emotions and sensitivity, psychological counseling, calm the customer during communication	Improved and resolved about 97.9% of healthcare cases	Enhanced customer satisfaction and experience
Online Pharmacy	QR code-based chatbots	Customers get personalized and one-on-one assistance by adding their "WeChat" account	Assists customers 24*7, assisting in chronic diseases, family medications, traditional Chinese herbal treatments, nutrition, and weight management.	Helped in gaining easy access to effective healthcare services	Streamlining customer service and interaction
Online Pharmacy	Doctor Bot	Leverages extensive medical datasets as well as cutting-edge AI techniques like deep learning for delivering tailored services	empower users with a huge range of services like self-diagnosis, dietary recommendations, drug usage, and so forth.	Assists in reducing hospital visits, and empowers patients to get a detailed overview of their health.	Real and factual data that deliberately enhances customers' overall experience as a patient or consumer.
Online Pharmacy	Melody	Link patients and doctors for effective treatment and improve the overall healthcare scenario of China	Specifically designed to be able to assist a person feeling sick at home, where a customer can pose a query in the chatbot and get real-time input	Assist online pharmacies get a quick grasp of customer's medical conditions and assisting them as early as possible	Improved customer experience and satisfaction.

DISCUSSION AND IMPLICATIONS

Objective 1: Assessing AI chatbots in e-commerce pharmacy

An analysis of AI chatbots in the pharmaceutical e-commerce industry demonstrated notable improvements in support for customers. Platforms such as JD Health and Yaofang.com have demonstrated their capacity to customize consumer interactions through the use of AI-driven chatbots, which offer prompt and all-inclusive healthcare solutions. With their cutting-edge features, these chatbots effectively attended to the requirements of their users by providing emotional support, medical guidance, and individualized healthcare services. This aligns with the findings of Panchal et al. (2023) who demonstrated that e-commerce pharmacies have disrupted traditional brick-and-mortar business models with the acceptance internet and revolutionary technologies in their business models. For example, Wang (2023) came to similar conclusions by stating that online pharmacies use 70% of generalized data in combination with 30% intelligent supply data with the power of AI chatbots to provide tailored solutions to customers. Hence, Customers' access to healthcare services has been revolutionized by the deployment of cutting-edge chatbot technology, which has improved customer satisfaction and loyalty. If the intention restore confirm that the hypothesis through research, the focus should be on designing the study to test the specific hypothesis. This involves defining the variables, selecting research methods, and collecting data that directly addresses the hypothesis.

Objective 2: Evaluating the role of AI chatbots by online pharmacies in improving customer experience.

AI-enabled chatbots discussed above including "Chat Rhino", "Melody", and "Doctor Bot" proved to be pivotal in enhancing customer service. They were capable of providing real-time information and personalized services to the customers. This finding aligns with the view of El Bakkouri et al. (2022) who revealed that AI-enabled chatbots can capture customer input and offer customized solutions instantly. Similarly, Guillot et al. (2023) argued that in effective customer service, it is very vital to effectively handle the complaints of their customers to gain their loyalty and trust. However, with the effective implementation of artificial intelligence by online pharmacies, customers are getting easy access to every sort of medical information for which a patient has to follow a tedious procedure from making appointments with doctors to seeking their advice after the receipt of medical check-up reports. For example, as discussed in the results section, the chatbot used by JD Health improved and resolved about 97.9% of cases. This signifies technological advancement and commitment to the well-being of its customers. Hence, the literature review and analysis indicate that there is a growing trend of AI-chatbots in online pharmacies, as they are capable of enhancing customer experience by offering real-time and instant resolution of their queries. The findings revealed that all of the chatbot's reliability, service quality, interactivity, and usability have a significant positive impact on the customer experience.

Practical or theoretical implications of the research

The growth of AI-enabled chatbots in online pharmacies has several potentials to improve customer/patient care and engagement in Beijing's e-commerce pharmaceutical platforms. It was found that the integration of artificial intelligence in the form of chatbots has the potential to provide customized and real-time medications and recommendations. Additionally, many online pharmacies discussed above have expanded language capabilities by accommodating English as well as a non-English language like Chinese to increase accessibility and engage a maximum number of customers. Furthermore, chatbots can not only utilized for providing suggestions on medications, but, it is impactful in knowledge transfer by making customers aware of their health conditions, and adhering to monitoring and patient education, which has the potential to reduce hospital hospitalizations and improve the overall healthcare sector in Beijing. Likewise, the voice-text-voice feature presents a significant opportunity for the future growth of online pharmacies. As discussed, the population of Beijing is aging at a faster pace and as time passes, AI will continue to improve. This advancement will enable the elderly to seek quick resolutions regarding their health conditions, get more personalized options, and allow customers to get tailored recommendations on treatments and medications. Similarly, these chatbots would also prove effective marketing tactics in the future for online pharmaceutical companies, as they are capable of collecting huge amounts of customer data, feedback, and insights, which could be further used by the companies to improve their products and services. Hence, proper adherence to regulations by e-commerce pharmacies and the adaptive nature of businesses to accept technological change in the online pharmaceutical industry look promising in terms of engaging more customers and improving their experience, as AI will continue to improve and evolve at a faster rate..

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

The major limitations of this study are limited time and use of secondary methods because many sources do not have open access and restricted the use of data and information. The future study should focus on exploring the use of artificial intelligence on diverse customer segments like people with disabilities and the elderly, mainly disadvantaged or marginalized groups who do have a helping hand to assist them in their treatment process. Research of this nature can assist in identifying any potential biases or restrictions in the application of AI and in formulating solutions. Similarly, future research can look into the long-term consequences of AI on consumer engagement, including how it affects customer retention and loyalty.

CONCLUSION

To conclude, the research examined the role of AI chatbots in enhancing customer experience in e-commerce pharmacies in Beijing. The findings reveal that due to technological advancement there is significant potential growth and potential of using AI in business models as it can positively influence customer journeys. However, challenges like legal compliances, data security, and privacy should be adhered to and will result in successful implementation of AI in enhancing customer service and satisfaction. Despite the challenges, there is growing interest in chatbots can be observed in healthcare mainly because of the accessibility, affordance, and portability. In this world of technological advancements, where every industry is leveraging digitalization to enhance their business process and improve customer satisfaction. Thereby, there is no doubt that there is lot of room for improvement as early medical detection will be possible, attract more customers to access online service which in turn boost revenue. Similarly, the analysis revealed that the population of Beijing is increasing at a faster pace which will further give rise to healthcare concerns mainly among the aged population. In this context, chatbots are a boon for online healthcare because this has the potential to not just increase customer satisfaction with enhanced patient safety and easy accessibility of medications and other healthcare services, but also, further improve the overall economy by saving on medical costs.

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CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest found in this research.

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INTERNATIONAL MARKET SELECTION FOR FROZEN SHRIMP EXPORTS FROM THAILAND: AN INTEGRATION OF CAGE DISTANCE FRAMEWORK AND DATA ENVELOPMENT ANALYSIS

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ABSTRACT

Purpose – This research aims to assess and rank the efficiency of countries where Thailand exported frozen shrimp to, and to provide actionable insights for policymakers and stakeholders in the frozen shrimp export industry based on the efficiency scores.

Methodology – This study employed the integration of the CAGE Distance Framework and Data Envelopment Analysis (DEA) to investigate the dynamics of international market selection for frozen shrimp exports from Thailand. The study evaluated and ranked the effectiveness of 20 nations that were chosen based on 2022 export values exceeding 1,000,000 US Dollars. The DEA BCC model, utilizing linear programming techniques, categorized these countries as Decision Making Units (DMUs), assessing their efficiency to determine how efficiently a DMU produced outputs given a set level of inputs.

Results – Results from the DEA analysis highlighted efficiency leaders with an efficiency score of 1, such as China, the United States, Japan, Taiwan, Hong Kong SAR, Australia, Myanmar, Vietnam, Singapore, Cambodia, and Laos. Additionally, it identified intermediate performers with room for improvement and countries with opportunities for optimization.

Implications – This integrated methodology served as a valuable guide for future students and professionals navigating the complexities of the global frozen shrimp trade.

Originality/Value – The integration of the CAGE framework with DEA offered a unique approach that had not been explored in previous applications. It established a pioneering approach for policymakers, practitioners, and entrepreneurs.

Keywords: International market selection, Frozen shrimp exports, CAGE Distance framework, Data envelopment analysis, DEA

Paper Type: Research Article

INTRODUCTION

Frozen shrimp trade expanded significantly worldwide, establishing Thailand as a major exporter in this market. In the process of international expansion, businesses were required to meticulously evaluate a range of factors encompassing market attractiveness, political stability, economic conditions, cultural disparities, and the long-term potential of the target market (Sakarya et al., 2007). However, the decline in Thai shrimp exports to significant markets like the United States and Japan was attributed to heightened competition from major rivals, particularly India and Ecuador. These competitors provided greater volumes at more competitive prices than Thai shrimp (Thai Frozen Foods Association, 2023). As a result, finding efficient importers

became essential for making strategic decisions. This raised the question of how efficiently countries that Thailand exported frozen shrimp to were performing. Therefore, this research aimed to 1) assess and rank the efficiency of countries that Thailand exported frozen shrimp to and 2) provide actionable insights for policymakers and stakeholders in the frozen shrimp export industry based on the efficiency scores. The utilization of Data Envelopment Analysis (DEA) in international market selection, as demonstrated by Cano et al. (2017), Elkefi and Layeb (2022), and Wang and Le (2018), facilitated the ranking of the efficiency of exported countries across various goods, providing a comprehensive and nuanced approach to decision-making.

To ensure a more systematic approach in this research, the study incorporated the CAGE distance framework introduced by Ghemawat (2001). This framework encompassed key dimensions such as Cultural, Administrative, Geographic, and Economic distances, playing a pivotal role in international market selection. This framework had been extensively applied in various studies. These applications had highlighted its significance in understanding complexities, guiding strategic decisions, and offering valuable insights into multinational enterprises' decision-making processes (Doanh et al., 2020; Ferreira & Falcão, 2019; Long et al., 2023; Tokas & Deb, 2020; Maciel et al., 2020; Wohlgemuth et al., 2020; Malhotra et al., 2009; Dow, 2000; Miloloža, 2015). Using the attributes of the CAGE distance framework, this research employed the Data Envelopment Analysis (DEA) model in recognition of the complex decision-making process involved in choosing an international market. CAGE distance framework integration with DEA offered a unique approach that had not been explored in previous applications.

LITERATURE REVIEW
International Market Selection
To select an international market for expansion, companies have considered various factors such as market attractiveness, political stability, economic conditions, cultural distance, and long-term market potential. Sakarya et al., (2007) also emphasized the importance of market selection for international expansion, highlighting the need to consider internationalization, dynamism, and emerging markets. Additionally, Douglas and Craig (2011) stressed the significance of contextual factors in assessing international marketing opportunities, suggesting that these factors provided crucial insights for market assessment. Furthermore, Zhang and Li (2022) discussed the importance of market competition intensity in accurately selecting overseas target markets, especially in the increasingly active and complex international market. Moreover, the choice of entry strategy was crucial for internationalization, as it significantly impacted export performance (Sadaghiani et al., 2011). Sadaghiani et al. (2011) also highlighted the critical role of entry strategy in the internationalization process and its influence on export performance. Similarly, Hasani-Nasab and Shirazian (2019) emphasized the importance of the selection of the entry method as a critical strategic decision for companies seeking global expansion and market selection. Furthermore, the institutional environment and market characteristics of emerging economies played a significant role in market selection. Hitt et al. (2004) found that China's stable and supportive institutional environment influenced alliance partner selection, indicating the importance of considering institutional effects in market selection, particularly in emerging markets. Additionally, Guesmi and Nguyen (2011) demonstrated the varying correlations of international stock markets over time, highlighting the need to assess the global integration of emerging market regions for market selection. Therefore, when selecting an international market for expansion, companies should carefully consider market attractiveness, political stability, economic conditions, cultural distance, as well as contextual factors in long-term market potential.

Global Shrimp Export Dynamics
The global shrimp export market has been influenced by various factors such as trade policies, sanitary and phytosanitary (SPS) measures, and technical barriers to trade (TBT) (Debaere, 2010; Khaliqi et al., 2018). The export of Thai shrimp in major markets such as the United States and Japan has trended downward due to increased imports from key competitors, particularly India and Ecuador, which have offered larger volumes at lower prices than Thai shrimp. As a result, there has been a shift in shrimp exports towards China and the ASEAN region as an alternative to

the declining primary markets (Thai Frozen Foods Association, 2023). The loss of Thailand's preferential trade status in Europe and differences in food-safety standards during the antibiotics crisis shifted Thai shrimp exports away from Europe towards the United States (Debaere, 2010). Additionally, the impact of SPS and TBT policies on Indonesian shrimp exports has been found to be inconclusive, indicating the complexity of trade regulations affecting shrimp exports (Khaliqi et al., 2018). The determinants of shrimp importation into the USA have been studied, with findings indicating substantial damage or threat to the US shrimp industry from exports of shrimp from Thailand, China, Vietnam, India, Ecuador, and Brazil (He et al., 2013). This highlights the competitive dynamics and trade disputes within the global shrimp market, particularly concerning the USA as a major importing country. Moreover, the competitiveness of shrimp exports from Indonesia and Vietnam has been a focus of research, with studies analyzing the level of competitiveness and export dynamics position among competing countries in the international market (Yolandika et al., 2022; Mashari et al., 2019). These studies provide insights into the competitive landscape and export performance of these key shrimp-exporting countries. In addition to trade dynamics, the sustainability and ecological challenges of market-oriented shrimp farming have been examined, particularly in Vietnam, one of the largest shrimp exporters in the world (Lan, 2013; Nguyen et al., 2019). These studies shed light on the social, ecological, and economic dimensions of shrimp farming, emphasizing the need for sustainable practices in the industry. The economic factors affecting Thailand's frozen shrimp export volume to the United States and Japan have also been investigated, with findings indicating that wholesale prices in Thailand play a key role in determining export demand (Shuquan & Bu-iad, 2020). This underscores the significance of pricing strategies and economic factors in shaping export volumes to key markets. The literature has provided a comprehensive understanding of the complexities and challenges within the global shrimp export market, encompassing trade policies, competitiveness, sustainability, and economic factors influencing key exporting countries such as Thailand, Indonesia, and Vietnam.

International Market Selection Using DEA
To select international markets using Data Envelopment Analysis (DEA), companies can leverage DEA as a strategic tool to identify their competitive capabilities and recognize market export opportunities Wang and Le (2018). DEA has proven instrumental in international market selection, offering a robust approach to rank the efficiency of exported countries. Cano et al. (2017) and Elkefi and Layeb (2022) applied BCC models of Banker, Charnes, and Cooper in diverse contexts, including the selection of foreign markets for frozen bovine and pharmaceutical products. In addition, DEA was employed as a strategy for stock selection and portfolio construction, utilizing both CCR and BCC models to identify firms with high efficiency. Furthermore, Wang and Le (2018) showcased the application of DEA in international market selection for the export of goods, presenting a case study in Vietnam. Their study aimed to develop an integrated DEA model, combining the Super Slack-Based Measure (Super SBM) and Malmquist Productivity Index (MPI) analysis, to explore the most productive manner in which Vietnam exports goods.

DEA has been widely applied in various fields for different purposes, such as supplier selection and evaluation of the influence of e-marketing on performance (Liu et al., 2020). Besides, in the context of stock selection, DEA models have been widely utilized to construct portfolios and evaluate stock market efficiency (Chen, 2008). Furthermore, DEA models are becoming popular in stock portfolio selection due to their flexibility in selecting inputs and outputs as criteria for portfolio selection (Kedžo & Škrinjarić, 2015). The application of DEA in international market selection aligns with the need for efficient decision-making processes. DEA can be used to assess the efficiency and performance of various entities, providing valuable insights for market selection and entry mode choice processes, particularly for small and medium-sized enterprises (SMEs) (Musso & Francioni, 2014). Additionally, DEA can aid in the evaluation of the efficiency of general insurance companies, contributing to informed decision-making in the insurance sector (Mahyideen et al., 2021). Moreover, DEA has been utilized in the context of portfolio optimization, providing a valuable methodology for investors and researchers

(Huang et al., 2014). The integrated DEA-MODM approach has been proposed as a useful tool for portfolio optimization, offering practical benefits to investors and researchers (Huang et al., 2014). The literature demonstrated the diverse applications of DEA in market selection, portfolio optimization, efficiency assessment, and decision-making processes, highlighting its relevance and effectiveness in supporting strategic choices in international markets.

CAGE Distance Framework

The literature also addressed the influence of variables such as expropriation risk, psychic distance, and internalization theory on market entry decisions, underscoring the multifaceted nature of the variables influencing international market selection (Hearn et al., 2017; Elia et al., 2019; Sinha et al., 2015). Beugelsdijk et al. (2017) provided a comprehensive review and meta-analysis of literature about cultural distance and firm internationalization. Rothaermel et al. (2006) conducted their empirical analysis focusing on country risk, national culture, and market size concerning international market entry. Malhotra et al. (2009) explored the role of distance factors and target market selection, considering the moderating effect of market potential. Furthermore, Tokas and Deb (2020) applied the CAGE distance framework in their study titled "CAGE distance framework and bilateral trade flows: case of India," The authors utilized the framework to study the role of "distance" in cross-border acquisitions, providing insightful perspectives on its application in international business interactions. Interestingly, the variables used in various studies were relevant to the CAGE distance framework in international market selection.

The CAGE distance framework (Ghemawat, 2001), developed by Ghemawat, encompasses four dimensions: Cultural, Administrative, Geographic, and Economic distances, which are crucial in international market selection and expansion. This framework has been widely utilized in various studies to analyze its impact on different aspects of international business (Yang et al., 2022; Xi & Katsumata, 2019). They highlighted the application of the CAGE distance framework in the context of inbound tourism, emphasizing its role in understanding the comprehensive distance and its impact on tourist satisfaction and consumption of specialty products by inbound tourists. These studies demonstrated the framework's relevance in the tourism industry and its influence on consumer behavior and satisfaction. Furthermore, the CAGE distance framework has been applied in the context of trade efficiency, foreign direct investment outflows, and international trade. Studies by Doanh et al. (2020), Ferreira and Falcão (2019), and Long et al. (2023) explored the impact of institutional and cultural distances on trade efficiency, foreign direct investment decisions, and international trade, highlighting the framework's significance in understanding the complexities of international business interactions. In addition, the CAGE distance framework has been utilized to analyze the challenges of international market selection, subsidiary strategy, and expatriate destination matching. Studies by Tokas and Deb (2020); Maciel et al. (2020); and Wohlgemuth et al. (2020) demonstrated the framework's application in understanding market selection, subsidiary strategy, and expatriate destination matching, providing valuable insights into the decision-making processes of multinational enterprises. Moreover, the framework has been employed in the context of target market selection, psychological distance, and export market obstacles. In addition, Malhotra et al. (2009); Dow (2000); and Miloloža (2015) focused on the role of the CAGE distance framework in target market selection, psychological distance impact on export market selection, and identifying export obstacles, shedding light on its relevance in strategic decision-making. The CAGE distance framework has been widely applied across various domains, including tourism, trade, foreign direct investment, market selection, and strategic decision-making, highlighting its significance in understanding the complexities of international business interactions and expansion.

Cultural Distance

Cultural differences must be observed on national level. The reason for that is the fact that culture leaves the formative impression on international collaboration (Malhotra et al., 2009). The Hofstede cultural dimensions theory has been widely used in international marketing research to understand cultural values and their impact on market selection (Furrer et al., 2000; Lam et al., 2009; Soares et al., 2007). It provides a framework for comparing cross-cultural

receptivity and understanding the impact of cultural values on marketing ethical norms (Paul et al., 2006). The cultural gap, as measured by Hofstede's dimensions, influences word-of-mouth communication, service quality perceptions, and the development of suitable commercials for culturally different target groups (Lam et al., 2009; Calabrese et al., 2015; Rinuastuti et al., 2014). Cultural distance, as measured by Hofstede's dimensions, influences market entry decisions, with higher cultural distance reducing the likelihood of international market entry (Rothaermel et al., 2006). It also affects the choice of entry modes in emerging markets and influences the success of market entry in small emerging markets (Ha et al., 2020; Gollnhofer & Turkina, 2015; Alexander et al., 2007). Additionally, cultural congruence can strengthen the internal marketing and employee satisfaction relationship, impacting market selection decisions (Huang & Rundle-Thiele, 2014). The cultural gap can also influence the timing of foreign market entry, with near-market knowledge impacting entry timing decisions (Mitra & Golder, 2002). Furthermore, cultural distance significantly affects the entry mode selection of multinational enterprises, particularly in emerging markets (Lv et al., 2021). In conclusion, the cultural gap plays a crucial role in international market selection, influencing market entry decisions, consumer behavior, marketing strategies, and the success of market entry in culturally diverse environments which can be measured by Hofstede's dimensions.

Administrative Distance

Countries also created administrative and political distance through unilateral measures. These measures can include trade policies, regulatory changes, and sanctions. Therefore administrative distance can be measured through import tariffs and index of Economic Freedom. Import tariffs affect market access and trade efficiency, influencing the volume of imports and welfare (Soderbery, 2021; Anderson & Neary, 2007; Hwang et al., 2011). They can act as a barrier to market entry and impact the welfare of a country, affecting the level of foreign direct investments and trade flows (Soderbery, 2021; Burnie, 2019; Taran et al., 2016). Meanwhile, the Index of Economic Freedom is a significant determinant of economic performance, market integration, and foreign direct investments. It influences the integration of developing countries into global value chains and has a positive impact on employment growth and economic resilience (Burnie, 2019; Siregar et al., 2020).

In the study by Soon et al. (2019), the researchers investigated how adjusting quotas or reducing over-quota tariffs could increase Korean rice imports, revealing important insights into how import tariffs influence decisions related to market selection. Hwang et al. (2011) explored the equivalence of tariffs and quotas within a tariff-rate quota system, offering valuable perspectives on how import tariffs impact market access and trade. Hossain et al. (2018) took a broader approach, examining how globalization, including trade policies like import tariffs, affects economic growth and shapes market selection. In the work by Hranaiova and Gorter (2006), simulations demonstrated that increasing imports is achievable through a moderate expansion of quotas or a reduction in out-of-quota tariffs, providing valuable insights into the influence of import tariffs on market access. Additionally, Chen et al. (2011) examined the equivalence of domestic prices when considering tariff reduction and quota expansion, contributing important insights into how import tariffs shape decisions regarding market selection.

Sambharya and Rasheed (2015) explored how economic freedom affects foreign direct investment and its role in market selection decisions. Apergis and Cooray (2015) analyzed panel data from 138 countries to understand the relationship between economic freedom and income inequality, offering insights into its impact on market selection. Stocker (2016) examined the effects of crises on policy change and liberalization, revealing the dynamic nature of economic freedom and its influence on market selection. These studies collectively highlight the significance of economic freedom in the complex landscape of international business, shaping not only investment decisions but also broader economic indicators.

Geographic Distance

Geographic distance can affect the cost of transportation. Costs are significantly reduced between companies that are geographically close to each other (Sousa & Bradly, 2006). To assess the impact of geographical factors, transportation and communication infrastructure indices can be considered.

The distance between countries, the physical size of the country, the lack of common border and sea access, and differences in climate, transportation and communication due to time difference can increase costs. Therefore, geographic distance can be measured by distance between countries, temperature difference, time difference and logistics performance index ranking. The logistics performance index ranking influences market access, trade efficiency, and the integration of countries into global value chains (Kawahara, 2013).

The impact of distance on international market selection has been a subject of extensive research in the field of international business. Various dimensions of distance, including psychological, cultural, and geographic distance, have been studied to understand their influence on market selection decisions. The literature provides valuable insights into the complexities of international market selection and the role of distance in shaping firms' strategies and performance. Psychological distance has been identified as a significant predictor of market selection, with its impact decreasing after the first market entry decision but remaining a relevant factor in subsequent decisions Dow (2000). Similarly, the role of psychic distance, or its constituent elements, in determining foreign market selection has been a topic of debate, with no clear consensus in the current literature (Evans et al., 2008). However, it is evident that psychic distance is considered to be a significant predictor of international market selection (Sousa & Lages, 2011). Cultural and geographic distance have also been studied extensively in the context of market selection. The findings suggest that entry priority of small and medium-sized enterprises (SMEs) shifts from countries within a short geographical distance to countries with high purchasing power and within a greater geographical distance (Ojala & Tyrväinen, 2007). Additionally, as geographical distance decreases, export markets are more likely to be chosen, as companies tend to perform best in the foreign markets nearest their respective domestic markets (Lii et al., 2011). The impact of distance factors on firms' internationalization processes has been highlighted, emphasizing several boundary conditions of the impact of distance factors on market selection decisions (Malhotra et al., 2009). Furthermore, it appears that distance remains an important factor in explaining trade flows in commodity markets, including maize (Szerb et al., 2022). Additionally, during the process of market expansion, firms encounter the psychic distance paradox, which poses challenges in market selection and entry strategies (Sinha et al., 2015). The literature also suggests that distance from the home market has a negative impact on international trade levels, highlighting the significance of distance in market selection decisions (Alexander et al., 2007).

The Logistics Performance Index (LPI) has been a subject of extensive research in the field of international trade and logistics. The LPI is a composite index developed by the World Bank to assess the efficiency of logistics and trade facilitation processes in different countries. The literature provides valuable insights into the impact of LPI on international market selection and trade performance. Several studies have investigated the relationship between LPI and international trade, highlighting its significant impact on trade volume, trade probability, and trade efficiency. For example, Wang et al. (2018) found that the LPI of exporting and importing countries is positively correlated with trade volume, indicating that higher logistics performance is associated with increased trade activity. Similarly, Martí et al. (2014) used the LPI as an explanatory variable of trade and confirmed the marked impact that logistics performance has on trade, particularly in terms of infrastructure improvements.

Economic Distance

Economic distance pertains to factors such as income, wealth distribution, and the comparative purchasing power within a given context. Consumer income, in particular, emerges as a key economic attribute capable of distinguishing between countries. Furthermore, it plays a crucial role in influencing the feasibility of establishing business collaborations and the extent of trade engagement. Therefore GDP per Capita can be used to measure the economic distance. GDP per capita is a significant macroeconomic factor that influences foreign direct investments and economic performance (Taran et al., 2016). The Gross Domestic Product (GDP) per capita has been the subject of extensive research in the field of economics and international business. The GDP per capita is a key indicator of a country's economic performance and standard of living, and it plays a significant role in shaping international market selection decisions. Several studies have

investigated the relationship between GDP per capita and international market selection, highlighting its significant impact on trade, investment, and market attractiveness. For example, Wang and Le (2018) found that GDP per capita is positively correlated with trade volume, indicating that higher GDP per capita is associated with increased trade activity. The impact of GDP per capita on market selection has also been studied in the context of business cycles and economic growth. Osei et al. (2016) found that higher GDP per capita is associated with increased profit and market share for small and medium-sized enterprises (SMEs), influencing their marketing strategies and growth prospects. Additionally, the level of GDP per capita is an important factor in identifying international market competition intensity, reflecting its influence on market dynamics and competitive landscapes (Zhang & Li, 2022). Moreover, the literature suggests that GDP per capita impacts food consumption patterns, housing rent prices, and export performance, indicating its broad influence on market selection decisions (Chen & Chai, 2022; Laurinavičius & Laurinavičius, 2021; Trintini et al., 2021). Furthermore, the GDP per capita of source and destination countries has been found to be significant in shaping coal exports, highlighting its role in international trade and market selection (Az-zakiyah, 2023). In conclusion, the literature provides valuable insights into the significant impact of GDP per capita on international market selection, trade activity, investment decisions, and market dynamics.

Apart from the GDP per capita, inflation rate can also be used to measure purchasing power. The inflation rate affects economic performance and the attractiveness of markets for investment and trade (Hassan & Othman, 2015). The impact of inflation rate on market selection has also been studied in the context of trade and economic performance. For instance, Iqbal et al. (2020) found that high rates of inflation in trading partners have a positive and significant impact on the demand for Pakistani basmati rice, indicating its influence on market selection decisions (Iqbal et al., 2020). Additionally, Singh and Saxena (2022) observed that low inflation rates are associated with increased production efficiency, better allocation of resources, and increased foreign investments, influencing market selection decisions. Moreover, the literature suggests that the inflation rate impacts stock market returns, securities market behavior, and business cycle dynamics, indicating its broad influence on market selection decisions. Shubiri (2010) noted that inflation is inversely correlated to stock market price behavior. Additionally, Kapchanga et al. (2018) found that the inflation rate had a negative effect on securities market returns. In conclusion, the literature provides valuable insights into the significant impact of inflation rate on international market selection, trade activity, investment decisions, and market dynamics.

METHODOLOGY

The DEA (Data Envelopment Analysis) BCC (Banker, Charnes, Cooper) model (Banker et al., 1984) model is typically solved using linear programming techniques. To establish a methodology for international market selection using Data Envelopment Analysis (DEA), countries with the potential to import shrimp from Thailand are represented as Decision Making Units (DMUs). DEA is employed to categorize these countries, aiding the decision-making process for International Market Selection (IMS). The DEA model adopts the notation outlined in Table 1, where N DMU which will be evaluated consumes M inputs to generate S outputs.

Table 1. Index and parameter for DEA Model

Index and Parameter	
$j = 1...N$	DMU index
$i = 1...M$	Inputs index
$r = 1...S$	Outputs index
$X(i,j)$	Amount of input i required by DMU j
$Y(r,j)$	Amount of output r used by DMU j
$\lambda (j)$	Weighing of DMU j to build a virtual DMU
Φ	Efficiency of performance of the evaluated DMU

Source: Cano et al. (2017)

In the context of Data Envelopment Analysis (DEA) for international market selection, an output-oriented model is employed to assess the efficiency of decision-making units (DMUs), such as countries. an output-oriented model allows for the DMU to become an efficient entity by increasing outputs while outputs remain unchanged (Cooper et al., 2007). In this framework, the outputs represent the desirable outcomes or benefits that a destination country offers to a business engaging in international trade. These outputs, when assigned higher values, indicate more favorable conditions for business performance within the selected country. The choice of an output-oriented model is driven by the decision-maker's interest in finding a country where the benefits of exporting specific goods or services are maximized relative to the associated costs and efforts. Thus, the mathematical approach of the BCC output-oriented model is described in eq. (1)-(5).

$$\text{Max } \Phi \tag{1}$$

Subject to:

$$\sum_{j=1}^{N} \lambda_{(j)} \, y_{(r,j)} \geq \Phi y_{(r,j)} \quad \text{for } r = 1,....,S \tag{2}$$

$$\sum_{j=1}^{N} \lambda_{(j)} \, x_{(i,j)} \leq x_{(i,o)} \quad \text{for } i = 1,....,M \tag{3}$$

$$\sum_{j=1}^{N} \lambda_{(j)} = 1 \tag{4}$$

$$\lambda_{(j)} \geq 0, \text{ for } j = 1,...,N \tag{5}$$

The DEA BCC model (Banker et al., 1984) is a variant of the DEA approach, a non-parametric method used to measure the relative efficiency of decision-making units (DMUs), such as countries, companies, organizations, or other entities. The primary goal of the DEA BCC model is to evaluate the efficiency of each DMU relative to others. Efficiency is assessed by comparing the output produced to the inputs used, and the model identifies the best-performing DMUs. Efficiency scores obtained from the DEA BCC model range from 0 to 1. A score of 1 indicates a fully efficient DMU, while scores below 1 indicate varying degrees of inefficiency.

The selected countries (DMUs) include China (CHN), the United States (USA), Japan (JPN), Taiwan (TWN), Canada (CAN), Hong Kong (HKG), South Korea (KOR), Australia (AUS), Malaysia (MYS), Myanmar (MMR), Vietnam (VNM), Singapore (SGP), the United Kingdom (GBR), Germany (DEU), New Zealand (NZL), Cambodia (KHM), Russia (RUS), Laos (LAO), France (FRA), and Israel (ISR). These 20 countries were chosen based on the exported value exceeding 1,000,000 US Dollars in the year 2022.

This research collected secondary data from online sources available for download on the internet. The Harmonized System code (HS code) 0306, employed to identify frozen shrimp exports from Thailand to various countries, was used to search for import tariffs on the World Trade Organization website, exported amounts on the Ministry of Commerce website, and market share on the Trade Map website. Subsequently, inputs and outputs in the DEA model were calculated using MAXDEA Lite Software. The sources for each input and output are presented in Tables 2 and 3.

Table 2. Inputs collected according to CAGE distance framework during August to December 2023

CAGE Distance Framework	Input	Description	Measurement	Online Source
Cultural Distance	Cultural distance (CD)	Measures differences in cultural values between countries across six dimensions: power distance, individualism vs. collectivism, masculinity vs. femininity (Currently changed to Motivation towards Achievement and Success), uncertainty avoidance, long-term orientation vs. short-term orientation, and indulgence vs. restraint. Higher scores indicate greater cultural differences. Represents how disparate one nation is from another, as can be calculated using this formula (Babin & Harris, 2016, pp. 180-201): $$CD = \sqrt{\sum_{i=1}^{6}(TCSV_i - BCSV_i)^2}$$ Where: CD = Cultural Distance TCSV = Target Country Value Score on Dimension i BCSV = Baseline Country Value Score on Dimension i	1-100	Hofstede Insights (Data as of Aug 2023)
Administrative Distance	Import tariff (IT)	A tax imposed on imported goods, affecting the cost of doing business across borders. Higher tariffs can make it more expensive to export to a particular country.	%	World Trade Organization (HS Code: 0306; Data as of Aug 2023)
	Index of Economic Freedom ranking (IEFR)	Measures the degree of economic freedom in a country based on 12 quantitative and qualitative factors, grouped into four broad categories: Rule of Law (property rights, government integrity, judicial effectiveness) Government Size (government spending, tax burden, fiscal health) Regulatory Efficiency (business freedom, labor freedom, monetary freedom) Open Markets (trade freedom, investment freedom, financial freedom)	1-184	The Heritage Foundation (Data as of Aug 2023)
	Logistics Performance index ranking (LPIR)	A measure of a country's logistics infrastructure, including factors like customs efficiency, infrastructure quality, and timeliness of shipments. Higher rankings indicate better logistical capabilities and potentially smoother trade processes.	1-139	World Bank (Data as of Aug 2023)

Table 2. (Cont.)

CAGE Distance Framework	Input	Description	Measurement	Online Source
Geographic Distance	Distance between Thailand and exported country (DIST)	The physical distance between two countries' capital, measured in kilometers. Greater distances can increase transportation costs and time, as well as logistical challenges.	Kilometer	Google map (Data as of Dec 2023)
	Temperature Difference (TempDiff)	Measures the average temperature disparity between Thailand and the exported country. Higher differences may impact exported countries by influencing product suitability, storage requirements, and overall market adaptability, thereby affecting trade efficiency	Degree Celcius	Trading economics (Data as of Dec 2023)
	Time Difference (TimeDiff)	Measures the time disparity between Thailand and the exported country's capital. Higher differences affect exported countries by influencing communication and coordination challenges, potentially impacting the efficiency of trade processes	Hour	Countries-ofthe-word.com (Data as of Dec 2023)
Economic Distance	GDP per capita difference (GDPCap Diff)	The average income per person in a country, serving as an indicator of overall economic development. Significant differences in GDP per capita between Thailand and exported country can signal differences in consumer preferences and purchasing power.	US Dollar per capita	International Monetary Fund – IMF (Data as of Aug 2023)
	Inflation rate (IR)	The rate at which prices increase over time, affecting the cost of goods and services. High inflation rates can make it more challenging to predict costs and manage business operations.	%	International Monetary Fund – IMF (Data as of Aug 2023)

Table 3. Outputs collected based on HS Code 0306

Exported Amount (EA)	The exported amount of frozen shrimp to the destination country.		USD	Thailand's Ministry of Commerce (Data as of Aug 2023)
Average exported amt over the past 5 years (AvgEA5Y	The average exported amount of frozen shrimp to the destination country over the past 5 years		USD	Thailand's Ministry of Commerce (Data as of Aug 2023)
Market Share (MS)	a proportion of the total market for frozen shrimp in that destination.		%	Trade Map (Data as of Aug 2023)

RESULTS

When collecting data, the cultural scores for Cambodia, Myanmar, and Laos from Hofstede Insights were not available. Therefore, we decided to use the same score difference as Vietnam to be able to continue running the analysis since they belonged to the CLMV group, and their cultural characteristics were assumed to be more or less similar.

Regarding the Index of Economic Freedom ranking, data for Myanmar was not available. In this case, it was recommended to use the data for Laos, as the GDP per capita of Laos and Myanmar was closer compared to Vietnam.

Similarly, for the LPI (Logistics Performance Index) ranking of Myanmar, no data was available. Therefore, the rankings of Cambodia and Laos, both at 115, were used. It's worth noting that Vietnam had a better logistics infrastructure, as reflected in its higher ranking.

Table 4 shows the secondary data collected from online sources based on the Harmonized System code (HS code) 0306, gathered during August to December 2023, as presented below.

Table 4. DMUs (Country), Input, and Output Data Collected from Websites during August to October 2023.

DMU	Input									Output		
	CD	IT	IE FR	DIST	LP IR	Temp Diff	Time Diff	GDPCap Diff	IR	EA	AvgEA5Y	MS
CHN	76.8	6.11	154	4,248	19	18.7	1	5,243.4	0.7	285,275,498	266,215,495.2	3
USA	85.4	0.87	25	14,145	17	16.9	12	73,114.4	4.1	160,819,577	206,625,447.0	1.7
JPN	91.8	0.98	31	4,596	13	14.6	2	26,651.7	3.2	129,595,050	132,386,244.2	4.1
TWN	62.7	18.39	4	2,533	13	5.9	1	25,041.7	2.1	63,494,524	54,406,417.6	10.6
CAN	73.1	2.96	16	13,415	7	30.6	12	45,949.0	3.6	34,426,297	34,390,986.0	4.1
HKG	58.5	0	154	1,728	7	2.7	1	43,870.1	2.2	29,783,417	39,428,914.2	4.7
KOR	73.3	20.26	15	3,666	17	13.9	2	25,849.2	3.4	28,223,440	30,519,360.0	2.1
AUS	85.3	0	13	7,473	19	4.9	3	56,189.1	5.8	24,585,090	35,642,637.2	7.9
MYS	51	0.68	42	1,472.4	26	0.4	1	5,736.1	2.9	15,515,435	20,811,152.8	7.6
MMR	44.2	0	147	611	115	2.8	0.5	5,916.9	14.2	11,862,028	16,587,978.4	96.2
VNM	44.2	0	72	1,003.4	43	1.9	0	2,981.6	3.4	10,882,852	24,908,272.4	1.9
SGP	70.9	0	1	1,829.7	1	0.8	1	80,586.2	5.5	10,145,571	9,600,277.8	4.5
GBR	91.7	11.22	28	9,526	19	17.5	7	41,614.8	7.7	9,942,266	17,652,875.0	1.9
DEU	81.9	10.66	14	8,598	3	17.4	6	45,525.6	6.3	3,139,361	5,434,247.4	0.6
NZL	83.3	0	5	9,734	26	15.7	5	40,773.8	4.9	2,369,411	2,364,505.8	4.7
KHM	44.2	16.06	110	651.6	115	0.5	0	5,382.4	2	2,188,126	4,567,162.4	96
RUS	72.1	4.5	125	7,060	88	30.6	4	5,707.7	5.3	1,671,778	2,208,357.0	0.4
LAO	44.2	0	147	644.3	115	2.6	0	5,419.3	28.1	1,392,802	902,210.0	96.1
FRA	64.4	10.66	57	9,437	13	15.3	6	39,017.2	5.6	1,234,584	1,900,030.6	0.1
ISR	79.8	10.14	34	6,883	26	6	5	45,897.9	4.3	1,231,620	1,049,040.8	5.4

Before running the input and output data, correlations were tested. Table 5 shows Correlation analysis of inputs and Table 6 Correlation analysis of outputs. Correlation values closer to 1 or -1 indicate stronger relationships between variables, while values closer to 0 suggest weaker or no correlation. Highly correlated variables, with correlation coefficients between 0.7 and 1.0 (positive) or -0.7 and -1.0 (negative) (Ratner, 2009), may be removed from the model to avoid redundancy and prevent the inclusion of duplicate or highly similar information. In input model, since "Temperature Difference" and "Time Difference" are highly correlated with distance, it is advisable to consider excluding them. Additionally, since distance is highly correlated with cultural distance, it can be inferred that the further apart countries are, the greater the difference in culture. Therefore, distance can be omitted from the analysis. In output model, "Export Amount" and "Average Export Amount over the Past 5 Years" are highly correlated; therefore, choose to keep "Average Export Amount over the Past 5 Years" as it provides a more stable representation of the country's export performance over time.

Table 5. Correlation Analysis of Inputs

Input	CD	IT	IEF	DIST	LPIR	TempDiff	TimeDiff	GDP/Cap	IR
CD	1	0.061	-.568**	.712**	-.635**	.575**	.579**	.607**	-0.334
IT		1	-0.214	-0.008	-0.065	0.105	-0.012	-0.118	-0.271
IEF			1	-.480*	.652**	-0.141	-.448*	-.620**	0.344
DIST				1	-.445*	.747**	.958**	.568**	-0.204
LPIR					1	-0.231	-0.393	-.646**	.583**
TempDiff						1	.693**	0.108	-0.197
TimeDiff							1	.570**	-0.155
GDP/Cap								1	-0.195
IR									1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 6. Correlation Analysis of Outputs

Output	EA	AvgEA5Y	MS
EA	1	.986**	-0.217
AvgEA(5Y)	.986**	1	-0.229
MS	-0.217	-0.229	1

** Correlation is significant at the 0.01 level (2-tailed).

Twenty DMUs were selected. After removing highly correlated coefficients, the existing number of DMUs is deemed sufficient, in accordance with the guidelines proposed by Golany and Roll (1989), which suggest that the number of units should be at least double the number of inputs and outputs considered, resulting in a total of 14 units (5 inputs + 2 outputs = 7; 7 x 2 = 14). Boussofiane et al. (1991) emphasized the importance of achieving good discriminatory power in BCC models by setting a lower bound on the number of Decision Making Units (DMUs) as the multiple of the number of inputs and outputs, recommending a minimum of 20 DMUs (5 inputs x 2 outputs = 10; 10 x 2 = 20).

Table 7. DEA Results

DMU	Score	Rank
CHN	1	1
USA	1	1
JPN	1	1
TWN	1	1
CAN	0.72	13
HKG	1	1
KOR	0.35	15
AUS	1	1
MYS	0.45	14
MMR	1	1
VNM	1	1
SGP	1	1
GBR	0.16	18
DEU	0.18	17
NZL	0.9	12
KHM	1	1
RUS	0.01	20
LAO	1	1
FRA	0.02	19
ISR	0.23	16

In Table 7, the DEA analysis of frozen shrimp exports from Thailand to 20 selected countries revealed valuable insights into the relative efficiency of these markets. Notably, several key observations emerged from the data. The DEA analysis sheds light on the relative efficiency of 20 countries importing frozen shrimp from Thailand. It revealed insights into resource utilization and potential for optimization within this dynamic trade sector, which can be concluded below:

Top Performers: Utilizing Resources Optimally

China, the United States, Japan, Taiwan, Hong Kong SAR, Australia, Myanmar, Vietnam, Singapore, Cambodia, and Laos stand out with perfect DEA scores of 1 and rank first. These "efficiency leaders" efficiently convert their inputs – likely resources, capital, and infrastructure – into maximum frozen shrimp import volumes. Their adept resource allocation positions them as model importers within the Thai frozen shrimp market.

Intermediate Performers: Room for Improvement

Canada, Malaysia, and New Zealand occupy the middle tier with scores between 0.45 and 0.90. While performing well, they possess potential for efficiency gains. Benchmarking against the leaders and identifying areas for streamlining processes could propel them closer to the efficiency frontier.

Opportunities for Optimization: Addressing Inefficiencies

The United Kingdom, Germany, Korea Rep., and Israel exhibit scores below 1, indicating opportunities for substantial improvement. The UK, with a score of 0.16, presents the most pressing case for efficiency enhancement. Analyzing underlying constraints and implementing targeted interventions in these countries could unlock significant increases in their frozen shrimp import performance.

France and Russia: Potential for Transformation

France and Russia Federation bring up the rear with scores of 0.02 and 0.01, respectively. Their efficiency lags significantly behind the pack. Comprehensive restructuring, strategic investments in infrastructure or trade agreements, and a focus on streamlining import processes could be crucial for them to tap into the full potential of Thai frozen shrimp imports.

DISCUSSION AND IMPLICATIONS

This study explores the effectiveness of Data Envelopment Analysis (DEA) as a strategic tool for Thai businesses to identify promising international export markets. DEA allows entrepreneurs to assess the efficiency of potential target countries, highlighting competitive advantages and export opportunities. Research by Cano et al. (2017), Wang and Le (2018), and Elkefi and Layeb (2022) reinforces the value of DEA in selecting markets for various products. Our contribution lies in combining DEA analysis with the CAGE distance framework (Ghemawat, 2001). This comprehensive approach acknowledges the significance of external environmental factors captured by the CAGE framework (Cultural, Administrative, Geographic, and Economic distances). This aligns with previous studies emphasizing the multifaceted nature of market selection (Sakarya et al., 2007; Douglas & Craig, 2011). Our findings echo prior research (Sadaghiani et al., 2011; Hasani-Nasab & Shirazian, 2019) by demonstrating the crucial role of strategic market selection in achieving international expansion goals and maximizing export performance. We expand on existing literature by applying the CAGE framework (Ghemawat, 2001) to the specific context of shrimp exports. We recognize cultural, administrative, geographic, and economic distances as key determinants of market selection. Integrating insights from the CAGE framework allows for a holistic perspective on the complexities of international trade. This, in turn, provides practical guidance for Thai businesses navigating diverse market environments, aligning with recent studies in related fields that exhibit varied influence, illustrating the dynamic nature of distance in international business dynamics. (Tokas & Deb, 2020; Yang et al., 2022).

For countries operating at peak efficiency, such as China, the United States, Japan, Taiwan, Hong Kong SAR, Australia, Myanmar, Vietnam, Singapore, Cambodia, and Laos, leveraging the insights from the CAGE framework can aid in maintaining their competitive edge. Understanding the specific dimensions where they excel or face challenges allows for targeted strategies in adapting to evolving market dynamics. Countries in the middle tier, such as Canada, Malaysia, and

New Zealand, can capitalize on the CAGE-informed findings to streamline their processes and potentially move closer to the efficiency frontier.

United Kingdom, Germany, Korea Rep., Israel, France, and Russia, exhibiting lower efficiency scores, necessitate a strategic overhaul informed by the CAGE framework. Addressing cultural, administrative, geographic, and economic distances can unlock untapped potential and facilitate a more efficient integration into the frozen shrimp market.

In essence, the CAGE distance framework, when applied in conjunction with the DEA analysis, not only refines the understanding of efficiency but also guides targeted interventions and strategic decisions in the intricate landscape of international trade. This integrated approach offers a potent tool for policymakers and stakeholders in navigating the challenges and opportunities within the global frozen shrimp trade.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES
Limitation of the study
There are two primary limitations to the study that should be taken into account. First of all, one of the challenges is the lack of complete data from some countries, most notably Laos and Myanmar. As a result, the study chooses a practical strategy by using data from comparable nations. The economic environments of the replacement countries may differ, which creates a possible source of bias even though this substitution permits ongoing investigation. Second, the inherent dynamic of market conditions, a common challenge in international trade studies, adds another degree of complexity. The study may not fully capture the temporal aspect introduced by the dynamic nature of markets, which could hinder the findings' long-term application.

Future recommendation
Future research in the domain of international market selection and trade efficiency could benefit from targeted improvements in data accessibility, methodological refinement, and the incorporation of qualitative factors. Firstly, efforts should be directed towards enhancing data accessibility and completeness, particularly for countries with limited available data. Collaborations with international organizations and initiatives promoting data transparency could contribute to a more comprehensive analysis. Secondly, the exploration of alternative or complementary methodologies, such as the Slack-Based Measure (SBM) in conjunction with Data Envelopment Analysis (DEA), would offer a more detailed perspective on efficiency assessments. Comparative analyses between different models could uncover additional insights and enhance the robustness of efficiency evaluations. Lastly, future research could enrich the analysis by incorporating qualitative factors through methods like interviews, surveys, or case studies. This qualitative dimension would provide a deeper understanding of the contextual factors influencing market selection and trade efficiency, complementing the quantitative findings and offering a more holistic view for policymakers and practitioners.

CONCLUSION
The DEA analysis of frozen shrimp exports, augmented by the incorporation of the CAGE distance framework, revealed an efficiency landscape among the 20 selected importing countries. China, the United States, Japan, Taiwan, Hong Kong SAR, Australia, Myanmar, Vietnam, Singapore, Cambodia, and Laos emerged as high-efficiency markets with DEA scores of 1, operating at the highest level of effectiveness. Conversely, a middle tier, including Canada, Malaysia and New Zealand, exhibited moderate efficiency, signaling potential areas for improvement. While the United Kingdom, Germany, Korea Rep., and Israel exhibit scores below 1, indicating opportunities for substantial improvement. Notably, France and Russia lagged behind, showcasing substantial inefficiencies in their frozen shrimp import processes.

The DEA research provides insight into the efficiency landscape of Thailand's frozen shrimp exports, especially when combined with the inclusion of the CAGE distance framework. Thai

entrepreneurs may use the findings to boost sales and expand market share in their pursuit of improved market performance.

The CAGE-informed DEA study provides crucial information for Thai firms looking to maximize their efficiency in the global frozen shrimp industry. The differences in efficiency rankings among importing countries highlight the need for strategic steps to acquire a more significant market presence. When designing strategies for certain markets, it is essential to understand the effects of cultural, administrative, geographic, and economic distances.

CONFLICTS OF INTEREST
The author declares that there are no conflicts of interest found in this research.

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ASSESSING THE IMPACT OF RUBBER DEVELOPMENT POLICIES ON THE NATIONAL ECONOMY, INTRA-SECTOR DYNAMICS, AND EMPLOYMENT: UTILIZING A COMPUTABLE GENERAL EQUILIBRIUM MODEL APPROACH

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ABSTRACT

Purpose – This research explores the effects of three rubber development policies on Thailand's economy and employment: increasing import taxes on rubber products, raising the rubber export tariff (CESS), and boosting domestic rubber consumption. The goal is to strengthen the rubber industry's foundation by promoting policies that enhance domestic rubber utilization, expand the rubber processing industry, and support farmer institutions.

Methodology – Using a Computable General Equilibrium (CGE) model, the study analyzes the impact of these policies. Expert brainstorming sessions and in-depth interviews provided additional insights, guiding recommendations for government strategies to streamline rubber supply management and support the entire rubber production chain.

Results – Key findings include: 1) Raising the rubber export tariff has minimal impact on the overall economy. 2) Mandating 30% domestic rubber utilization leads to modest economic growth and employment increases, despite Thailand's limited production structure. And 3) Increasing tariffs on imported rubber products has significant macroeconomic effects: a 10% tax increase results in 3.63% economic growth (612,707.70 million THB) and a 2.93% price rise. Employment increases by 6.69%, rubber product prices surge by 23.287% to 26.094%, and primary rubber prices rise by 41.091%.

Implications – Policy recommendations include: Streamlining national rubber supply management, supporting upstream rubber production and creating value-added products, aligning rubber research with synthetic rubber needs, - enhancing domestic rubber usage and procurement regulations, developing new strategies for rubber growth, promoting the rubber glove industry, and achieving a 40:60 ratio of natural to synthetic rubber within five years, Establishing rubber special economic zones and strengthening farmer institutions and the Rubber Authority of Thailand (RAOT), and addressing low productivity per acre, establishing a central market, and creating an online platform for future rubber trading to boost producers' earnings and global competitiveness.

Originality/Value – Implementing a 10% tariff increase on imported rubber products, comprehensive rubber system management, and maintaining a 30% domestic rubber usage rate are crucial. These measures are expected to invigorate the rubber market and enhance producers' earnings, securing a sustainable competitive advantage globally.

Keywords: Rubber development policies, Economic impact, Rubber industry, Computable general equilibrium

Paper Type: Research Article

INTRODUCTION

Thailand, as the world's leading natural rubber producer, holds the top position with approximately 86% of its rubber production, as primary products, directed towards exports. The remaining 14% of rubber is domestically utilized for the production of various rubber products. Notably, the majority of Thailand's natural rubber is exported to international markets.

Based on Thailand's rubber statistics (Rubber Division Department of Agriculture, 2022), it is observed that over the past decade (2013-2022), the proportion of exported processed natural rubber products (such as smoked rubber sheets, rubber blocks, latex, etc.) to rubber products (rubber for vehicles, elastic rubber, rubber gloves, etc.) has increased. In 2013, the total value of exported processed natural rubber was 249.29 billion THB, from a volume of 3.66 million metric tons of natural rubber, compared to exported rubber products with a total value of 0.79 million metric tons, accounting for 4.61 times per unit. Moving forward to 2022, the total value of exported processed natural rubber is 178.06 billion THB, from a volume of 4.40 million metric tons of natural rubber. In contrast, the total value of exported rubber products is 373.80 billion THB, from a volume of 0.45 million metric tons of natural rubber, indicating that the volume of exported rubber products is higher than the exported processed natural rubber, at a ratio of 9.77 to 1.

The predominant focus on exporting processed natural rubber products has led to an imbalance between production and continuous consumption of natural rubber in Thailand over an extended period. Thailand, emphasizing the expansion of production for more processed natural rubber, faces low bargaining power, making it challenging to set appropriate selling prices. This is due to the market for processed rubber being dominated by powerful buyers who dictate prices, leaving sellers unable to negotiate effectively and susceptible to risks through forward contracts. Depending heavily on international markets and a lot of substitutes products, it has allowed the global market to exert pressure on the purchase prices of natural rubber domestically. This situation results in market fluctuations and consistent depression of rubber prices in the global market, beyond the country's control, directly impacting the livelihoods of local farmers. Therefore, the current production structure, emphasizing only the quantity of exported processed rubber, poses significant risks to the country. The higher the proportion, the greater the risk of increased dependence on international agricultural product markets.

In this scenario, the situation is not conducive to the long-term development of the Thai economy and industry. It is crucial to continuously develop the industrial structure to create added value for natural rubber. This involves transitioning from raw materials at the upstream level to an industry that produces innovative rubber products. There is a need to foster a sufficient number of rubber processing industries to create economic stability and self-reliance for the Thai rubber industry. This includes diversifying risks and promoting economic resilience. Therefore, it is necessary to establish a system that adds value to natural rubber within the country, transforming it into high-value rubber products. This transformation will contribute to building a robust industry with the potential to absorb a significant quantity of rubber production from the agricultural sector. This, in turn, will lead to a sustainable rubber system and related industries that can thrive both at the midstream and downstream levels. The goal is to create a sustainable and resilient rubber industry that can absorb a substantial portion of rubber production from the agricultural sector and develop into a high-value, diversified industry.

The industrial development experiences of countries in the past indicate that the development of the rubber industry leads to significant economic expansion, positively influencing continuous industrial development and domestic employment. This is particularly significant as natural rubber is a key economic crop closely tied to households across all regions in Thailand. It serves as a backbone industry, representing a crucial part of the value chain, including the automotive industry (with 58.6% reliance on natural rubber), rubber glove industry (10.2%), elastic and band industry (10.7%), and other industries (20.5%) (Sowcharoensuk, 2023).

However, the current government has a policy to promote the domestic use of natural rubber, aiming to achieve a domestic consumption target of 30% within five years. Despite these efforts, the measures have yet to yield clear results, evident in the reduction of domestic natural rubber consumption from 13.60% in 2019 to 12.73% in 2020. This is attributed to the short-term

nature of the policy and the lack of a comprehensive analysis of the entire natural rubber supply chain. Additionally, the measures to encourage and support investment in the rubber industry are not specifically tailored to promote the natural rubber sector.

This implies that the current policies and measures are not sufficiently effective in bringing about the necessary structural changes in the natural rubber industry. It is crucial to implement both short-term and long-term measures to develop a continuous natural rubber industry. These measures should be based on a comprehensive analysis and management of the entire natural rubber supply chain system. There is a need to analyze the problems and obstacles of the existing policies and measures, including policies promoting investment in the initial processing industry in all regions. Additionally, there should be encouragement for industries producing rubber-related products linked to community-level rubber industries. This would enhance the quality of production in alignment with the needs of farmers and address various regulations and challenges.

Supporting research and development, skills enhancement, and incentives for entrepreneurs to invest in establishing rubber processing industries in Thailand are also necessary. The policy and measures, both short-term and long-term, should be detailed and structured to enhance the value of rubber products, increase competitiveness in raw material procurement, and ensure a fair price transfer to farmers/agricultural institutions. These actions should be accompanied by analytical measures in the regional economy to assess the impact on economic expansion and employment. This evaluation is crucial to determine the effectiveness of policies and measures. Overall, it is essential for the government and related agencies to recognize the importance of developing industries that create value and coordinate efforts to promote sustainable industrial development (e.g., Ministry of Agriculture, Ministry of Industry, Ministry of Science, etc.).

LITERATURE REVIEW

Natural rubber is a crucial economic crop for Thailand, where the country has been a major producer and exporter on a global scale since the year 1991 and continues to hold a significant position in the market. The production of natural rubber has consistently increased over the years, underscoring its importance to the Thai economy. Recognizing the fluctuations and occasional downturns in natural rubber prices, the Thai government has deemed it essential to implement policies addressing the rubber sector. These policies take into account various factors, including anticipated yields, supply and demand dynamics, seasonal variations, market forecasts, and challenges posed by middlemen. This strategic approach is aimed at mitigating the challenges faced by rubber farmers and fostering a favorable social and economic environment within the rubber cultivation sector.

Analyzing the policy development information on rubber in the study by Pinitjitsamut et al. (2012), it was found that in the year 2001, there was a strategic response to the challenges faced by the Thai natural rubber industry. The primary issue was the high production costs compared to competitive countries like Indonesia and Vietnam, resulting in limited rubber exports and a narrow market. Additionally, the inability to set rubber prices in the global market posed a significant constraint. In light of these challenges, a comprehensive strategy was formulated, encompassing six key areas. First, there was a focus on increasing rubber production yields to meet the demands of processors while maintaining low production costs. Second, efforts were directed towards strengthening the agricultural institutions by developing the basic infrastructure for rubber farmers. Third, initiatives were undertaken to organize business ventures at the grassroots level. Furthermore, there was an emphasis on enhancing the quality and standards of raw rubber processing industries to align with consumer needs. This multi-faceted approach aimed to address the complex issues in the rubber industry and position Thailand as a competitive force in the global market.

This involves developing the rubber product industry to meet international standards and creating value added for natural rubber. In a study by Satsue and Phitthayaphinant (2016), it was suggested that the government should promote increasing the value of rubber products in both midstream and downstream industries. Supports should be provided to cultivate rubber varieties

that yield higher production than current ones. Another study by Pongchomphoo (2013) pointed out that Thailand's natural rubber production per hectare is relatively low, contributing to the instability of prices, especially those received by farmers. This aligns with statistical data indicating that farmers still face low production levels per hectare and higher costs compared to competing countries. The study also highlighted ongoing issues related to the inadequate management of price volatility, indicating that the implementation of the outlined plans has not yielded the expected success.

In recent times, most government measures have been short-term interventions to address the fluctuation of natural rubber prices, typically occurring during periods of low prices. These interventions aim to alleviate the financial strain on rubber plantation owners, allowing them to sell rubber at higher prices, making it more cost-effective in response to production costs. This approach servPes as a tool to address specific challenges during certain periods. For instance, in 2009, the government, under the leadership of the Prime Minister Abhisit Vejjajiva, implemented a policy supporting rubber processing institutions to increase the targeted stockpile value, tackling the issue of plummeting rubber prices. An investment of 8 billion THB was allocated for this purpose. Subsequently, the Yingluck Shinawatra's Government carried out initiatives to enhance the capabilities of agricultural institutions to stabilize rubber prices. These involved institutions purchasing rubber from members, using the rubber as collateral, and utilizing revolving funds for the processing and distribution of rubber products, all aimed at maintaining a reasonable purchase price of 120 THB per kilogram with a budget of 15 billion THB. Despite these efforts, rubber prices continued to decline consistently. This approach achieved only limited success and proved insufficient to establish price stability. Moreover, the project accounted for a mere 5.83% of the total rubber production, indicating a relatively small proportion that had minimal influence on rubber prices. Additionally, domestic rubber traders, having already entered forward contracts, found it challenging to elevate prices. As a result, the task of increasing rubber prices remains a formidable challenge.

Short-term measures were implemented as part of the comprehensive plan to address the issues within the natural rubber system, introduced as a policy in 2014. Under this policy, financial support was provided to farmers as a production factor, amounting to 2,520 THB per Rai. The aim was to potentially increase rubber prices for farmers by approximately 12 THB per kilogram from market prices. However, there was a restriction on the allocated area, limiting it to no more than 25 Rai per individual. It's worth noting that there was no simultaneous development of a network market to purchase the produce in remote areas, which could have reduced transportation costs. Consequently, these urgent measures did not have a long-term impact on the overall capacity development of the Thai natural rubber system.

A notable policy involved establishing a joint venture rubber company among Thailand, Malaysia, and Indonesia. This initiative included forming a joint management committee with representatives from all three countries. Additionally, an office was set up in Thailand to manage a jointly registered fund, based on each country's share of natural rubber production. This office was responsible for facilitating the buying and selling of rubber from all three countries. To achieve specific goals, such as reducing overall rubber production by 4%, a Supply Management Scheme (SMS) was introduced. Simultaneously, the Agreed Export Tonnage Scheme (AETS) aimed to decrease export quantities by 10%. Unfortunately, both measures ultimately failed.

The export restrictions contradicted the principles of promoting exports to bring foreign currency into the country. Consequently, this policy contradicted itself when the government-imposed export quotas, leaving approximately 85% of rubber unaccounted for, requiring business operators to continue operations under normal conditions.

Moreover, with a limited monthly budget of 5 billion THB, the government's intervention led to a potential drop in rubber prices, further exacerbated by the fact that there was insufficient funding to support the program. The most affected were rubber plantation farmers, losing access to international markets due to their inability to compete with the government-set prices.

The short-term measure of suspending the collection of rubber welfare for a period of four months aimed to uplift the rubber prices for farmers, anticipating an increase within the country or a delay in the downward adjustment. However, statistical data on domestic rubber prices

indicated that this measure had limited effectiveness. While there was a short-term adjustment in rubber prices after the initiation of the project, influenced by psychological factors, there was a consistent trend of subsequent downward adjustments. Upon evaluating the period from September to December 2013, it was evident that this measure did not justify the incurred loss of 2 billion THB.

Furthermore, the Rubber Industry Development Plan (2013-2016) outlined strategies to increase the domestic consumption of natural rubber, boost rubber product exports, and develop rubber research organizations. This plan comprised three key programs: improving the quality of raw rubber, researching and developing of rubber technology, and developing market system with a focus on reducing production costs. However, Phaoprasert (2016) found a decline in support for rubber research funding, both in terms of project numbers and budget allocation. While research on traditional and new products received the highest research funding, the implementation of these studies did not translate into serious practical applications.

Furthermore, it was observed that various measures took a relatively long time to implement, such as the tax structure overhaul. Upon reviewing the execution of these measures, it was found that the focus was on developing the rubber industry and rubber products, particularly in addressing the issue of reducing production costs (raw materials/labor), reducing import tariff on raw materials and machinery, and tackling technology and management deficiencies. Additionally, efforts were directed towards training and courses in the rubber industry, marketing, and promoting investments in industries using natural rubber. However, the study highlighted the limited use of natural rubber in rubber product industries, leading to increased investments and support for greater benefits. Unfortunately, after the development plan ended, it couldn't fully achieve its objectives due to a lack of evaluation and the absence of additional supporting development plans.

The Ministry of Agriculture and Cooperatives' Rubber Development Plan for 2002-2006 established production targets for natural rubber. The primary aim was to maintain stable prices and prevent any decline. It introduced the first-ever goal to reduce rubber production, aiming to decrease it from 2.52 to 2.40 million tons per year. The plan also specified adjustments to the production ratios of smoked rubber sheets, rubber sheets, latex, and other types from 50:28:18:4 to 35:40:20:5. This was intended to reduce smoked rubber sheet while increasing rubber sheet, latex and other types of rubber production. Additionally, the plan aimed to limit the export of raw rubber materials to not exceed 2 million THB per year and maintain rubber cultivation areas at the level of 12 million Rais.

Moreover, the focus in previous studies should emphasize the development of agricultural institutions. This involves enhancing the capabilities of agricultural cooperatives and utilizing business plans (Pisanwanich et al., 2012). The entrepreneurial approach involving cooperative members from universities, community enterprise universities (industrial sector), and government agencies was recommended (Wanichcharoenteeratham et al., 2014). Risk management through rubber price insurance and price risk insurance purchases was suggested as well (Thiraphat & Tanthanongsakkun 2017). Additionally, fostering collaboration with farmers and communication with agricultural communities, community leaders, and stakeholders was highlighted.

Subsequently, a comprehensive strategy for the development of the rubber industry was implemented during the Rubber Master Plan (2002-2006) focusing on five key areas: rubber production, rubber industry, para rubber wood industry, market, and rubber sector management. This initiative involved both short-term and long-term measures with main operational frameworks, such as adjusting and reducing customs duties on chemicals and other raw materials, supporting the use of rubber products domestically, enhancing the efficiency of processing, and developing technology in rubber product manufacturing. There was an emphasis on increasing the use of natural rubber, developing high-quality products, and aligning national rubber product standards with international ones. Collaboration with synthetic rubber due to mutual and interconnected impacts was also considered (Rungreunganan et al., 2012).

The Ministry of Agriculture and Cooperatives played a central role in coordinating and executing the plan. However, due to the absence of allocated funds, specifically for the plans and projects, operational activities did not achieve significant success. This situation mirrored the

Rubber Development Strategic Plan for the fiscal years 2009-2013, initiated by the Natural Rubber Policy Committee, Ministry of Agriculture and Cooperatives, as a framework for operations. Unfortunately, the lack of additional budgetary provisions for various plans and projects meant that the agencies had to operate within the normal budget. Consequently, the implementation of the plan did not meet with considerable success. This was similar to the situation with the Para Rubber Development Plan of the Ministry of Agriculture and Cooperatives for the years 2002-2006. The plan aimed to develop the entire rubber production cycle and comprised eight strategies: enhancing production efficiency and the quality of rubber as a raw material, developing the domestic and international rubber market system, improving the rubber processing and product industry, reforming the state management system, promoting international cooperation to support the ASEAN Economic Community (AEC), supporting research, boosting income, and raising the quality of life for rubber farmers, and developing human resources (Rungreunganan et al., 2012).

Nevertheless, this plan is still lacking in crucial aspects, such as establishing a balance in the para rubber supply chain and developing infrastructure, particularly transportation routes and ports (Satsu, & Phitthayaphinant, 2016). The development of market networks for para rubber to facilitate purchasing in remote areas also needs attention (Pongchompoo, 2012). Additionally, logistical and supply chain management, as well as processing facilities (Nimsai, 2014), risk management, and enhancing production efficiency for environmental friendliness, disaster preparedness, promoting proactive use of natural rubber within the country, strengthening the competitiveness of natural rubber, and elevating the competitiveness of para rubber at the regional and global levels should be included (Suksaroj et al., 2012).

Therefore, past studies have found that there has not been a truly successful strategic plan for the development of para rubber. Operations have fallen short of their objectives, and there needs to be an integrated plan within the supply chain and regulatory adjustments to strengthen the para rubber industry (Pisanwanich et al., 2012). The policies on para rubber in Thailand in the past have mainly been ad-hoc solutions and temporary measures to address urgent situations, such as low rubber prices. While a strategic plan for para rubber was formulated in 2006, the operational outcomes have not been evident. Furthermore, the predominantly reactive nature of the guidelines without proactive development policies and a clear industry leadership direction have resulted in minimal impact. The para rubber policy has been minimally implemented, and overall, policy responses lack a comprehensive and long-term approach. In summary, policy issues related to para rubber are both directional and practical, hindering successful implementation. There is a lack of appropriate reviews that persist to the present day. The Thai government continues to focus on short-term and populist policies instead of addressing long-term issues, aiming to improve the living standards of rubber farmers and the overall potential of the para rubber system.

METHODOLOGY

The research aims to explore viable policy models and strategies, assessing their applicability and direction—examining options like bolstering the supply chain (e.g., tax incentives, financial support) or stimulating demand (encouraging domestic rubber product purchases, public sector rubber use). This analysis covers short and long-term perspectives, with a focus on fostering growth in the rubber processing sector to add value along the natural rubber supply chain. It entails forging connections between agricultural entities and the rubber industry nationwide and setting up oversight mechanisms for policy adherence. Furthermore, the study seeks to evaluate the economic and employment impacts of policies supporting the expansion of rubber processing and product manufacturing, thoroughly assessing both cost-effectiveness and societal advantages. The research methodologies are as follows.

1) Document research: The research is conducted by reviewing the information related to the rubber industry including research reports and statistical data on natural rubber, such as cultivation areas, production quantities, policies promoting rubber processing, support for agricultural institutions, and analyses of suitable policies and practical measures for promoting the rubber processing industry. Additionally, it encompasses measures to promote rubber

processing at the agricultural institution level, data on the rubber supply chain in Thailand, and information on rubber policy/strategies. This also involves addressing issues and limitations in developing the rubber industry in various dimensions, including regulations and laws, agricultural institutions, and private sector entities such as the Department of Agriculture, the Rubber Authority of Thailand, National Natural Rubber Commission, and other relevant organizations.

2) Group Discussion: The goal of these meetings is to gather opinions and insights on the development of value-added and rubber processing industries, including tax incentives and other conditions. Participants in these discussions include experts, business professionals, farmers, and individuals involved in the rubber sector. The meetings will involve presenting questions to stimulate discussions and knowledge sharing, promoting the sustainable and efficient development of the rubber processing industry, including testing opinions on the three groups of natural rubber policies.

3) In-Depth Interviews: Conducting in-depth interviews with relevant stakeholders, including industry professionals, policy-level officials, practitioners, and experts, to gain a profound understanding of the development of measures promoting the rubber processing industry. The insights from these interviews contribute to a comprehensive understanding of the sustainable and effective development of the rubber processing industry.

4) Impact Analysis Using CGE Model: This involves analyzing the impact of policies promoting the development of the natural rubber and rubber product industries. The process includes developing an Input-Output Table, Social Accounting Matrix (SAM) and a set of CGE equations for the Thai economic system. Subsequently, the analysis is carried out using a CGE model. Detailed information on the economic impact of policies promoting the expansion of the rubber processing industry and rubber product manufacturing, affecting the country's economy and employment, is presented. This includes the analysis of social impacts, groupings in the SAM matrix, and trade data related to natural rubber between Thailand and other countries.

5) Research findings and Public Consultation: This phase includes presenting the study findings and gathering feedback from relevant organizations, academic experts, private sector professionals, and individuals associated with the rubber sector. It encompasses industrial agencies and other relevant organizations.

RESULTS

The study employs the Thailand Standard Industrial Classification (TSIC) structure for the year 2015, covering major categories from A to U, with a detailed analysis under category C (manufacturing). The focus is on the potential of the natural rubber industry to determine which rubber policies have the potential to generate positive economic impacts and drive economic growth. The analysis also investigates the impact on the development of related industries, both directly and indirectly, providing insights into suitable measures to promote production in the Thai natural rubber industry. The CGE model, known for its computable general equilibrium analysis, is utilized to demonstrate the multi-dimensional impacts of policy measures. This model excels in presenting simultaneous and detailed insights into the policy impacts that may occur in the future. The parameters of the CGE model are determined based on the data from the Social Accounting Matrix (SAM) and external sources, such as pre-existing research studies, time-series economic dimension estimates, and adjustments based on factor and production data from 2015, with assumption of economic structure remains consistent with the present structure in 2021.

1) Modifying the Up-to-date Input-Output Table and developing the SAM Matrix

To analyze the impact of promoting the natural rubber industry, especially the transformation into rubber products, the researchers have constructed the Input-Output Table for the year 2015 and 2021, by utilizing the primary data of Thailand's national income and categorizing into three main parts: 1) Production, 2) Expenditure, and 3) Income. Then, grouping activities in the Input-Output Table from the original 180 activities to 15 activities based on the national income data of Thailand. This adjustment covered aspects of production, expenditure, and income. The national income data related to production were compiled by the National Economic and Social Development Council (NESDC), encompassing production, expenditure, and

income aspects. Expenditure data were measured based on final expenditure on goods and services produced within the specified timeframe, including contributions from the private sector, government, and overall investments (capital accumulation and changes in inventories). Subsequently, adjusting the value-added figures with Thailand's national income data and separating activities related to the natural rubber industry, resulting in an Input-Output Table of 26 activities. Finally, adjusting the intermediate demand values using the production structure ratios and updating the current-year data.

A new Social Accounting Matrix (SAM) has been created by the researchers for studying and analyzing purposes. The matrix involves adjusting the data from the Input-Output Table, covering 180 activities. This dataset is the most recent publicly available information from the Office of the National Economic and Social Development Council (NESDC). The matrix is presented as the current-year Input-Output Table, and the economic and social data are adjusted for the ultimate goal, imports and exports, and trade margins and transportation to provide up-to-date data. Additionally, export data, import data, production and import tariff, and finally, balancing adjustments to the Social Accounting Matrix (SAM) were incorporated.
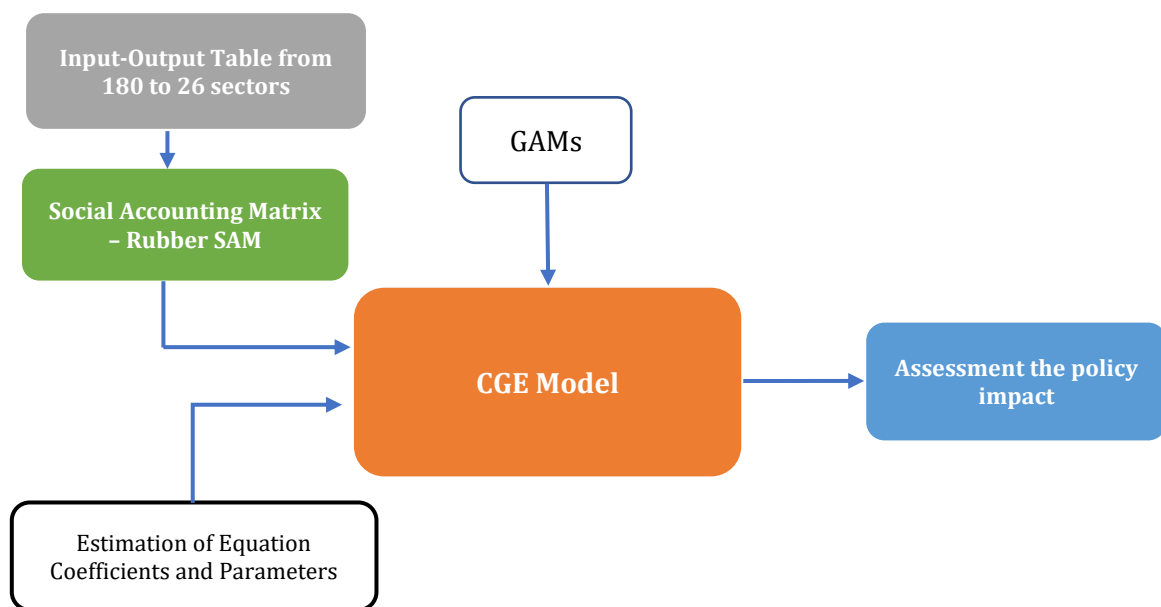
Figure 1. The Linkage of Social Accounting Matrix (SAM) and CGE Model

Table 1. Proportion of Intermediate and Final Value Added

No.	Code	Activities	Value at Intermediate	Final Value Added
1	1-29	Agriculture	0.37	0.63
2	30-41	Mining and Quarrying	0.37	0.63
3	042-123,125-126,128-134	Manufacturing	0.76	0.24
4	106	Secondary Steel Products	0.77	0.23
5	124	Railway Equipment	0.74	0.26
6	127	Repairing of Motor Vehicle	0.68	0.32
7	135-144	Public Utilities and Construction	0.65	0.35
8	145-146	Trade	0.79	0.21
9	147-148	Restaurants and Hotels	0.73	0.27
10	149	Railways	0.23	0.77
11	150,152-153,155,157-159	Transportation and Communication	0.16p	0.84

Table 1. (Cont.)

No.	Code	Activities	Value at Intermediate	Final Value Added
12	151	Road Freight Transport	0.67	0.33
13	154, 156	Ocean Transport	0.55	0.45
14	160-162	Bank and Insurance Services	0.53	0.47
15	163-178, 180	Other Services	0.74	0.26

Table 2: List of 26 Activities in the Social Accounting Matrix (SAM)

Code	Sector
016	Rubber (Agriculture sector)
001-015, 017-029	Other Agriculture Cereals
085	Synthetic Resins and Plastics
086	Fertilizer and Pesticides
087	Paints Varnishes and Lacquers
095	Rubber Sheets and Block Rubber
096	Tyres and Tubes
097	Other Rubber Products
098	Plastic Wares
125	Motor Vehicle
126	Motorcycle, Bicycle & Other Carriages
030-084,088-094,99-124, 127-137	Other Manufacturing
138-144	Construction
145	Wholesale Trade
146	Retail Trade
151	Road Freight Transport
152	Land Transport Supporting Services
153	Ocean Transport
147-150, 154-180	Other Service
190	**Total Intermediate Transaction**
201	Wages and Salaries
202	Operating Surplus
203	Depreciation
204	Indirect Taxes less Subsidies
209	**Total Value Added**
210	Control Total

    2) Impact Analysis of Rubber Development Policies

The CGE Equations were developed as a diagram in Figure 2 and the number of equations shown in Table 3. The base simulations are conducted to ensure that the model system balance, and are used to predict the impact. The analysis of the policy impact on the overall economy and employment from the promotion of the rubber processing industry and rubber product manufacturing is categorized into three policy groups:

    2.1) Policy to Increase Domestic Rubber Utilization: Simulating scenarios with a +10%, +20%, and +30% increase in domestic rubber utilization.

    2.2) Policy to Increase Export Tariff on Natural Rubber: Simulating scenarios with a +5%, +10%, and +15% increase in export tariff to incentivize the export of rubber products and stimulate domestic processing, considering the exemption from export duties on rubber products.

    2.3) Policy to Increase Import Tariff on Rubber Products: Simulating scenarios with a +5%, +10%, and +15% increase in import tariff on rubber products to protect the domestic market and encourage domestic processing.
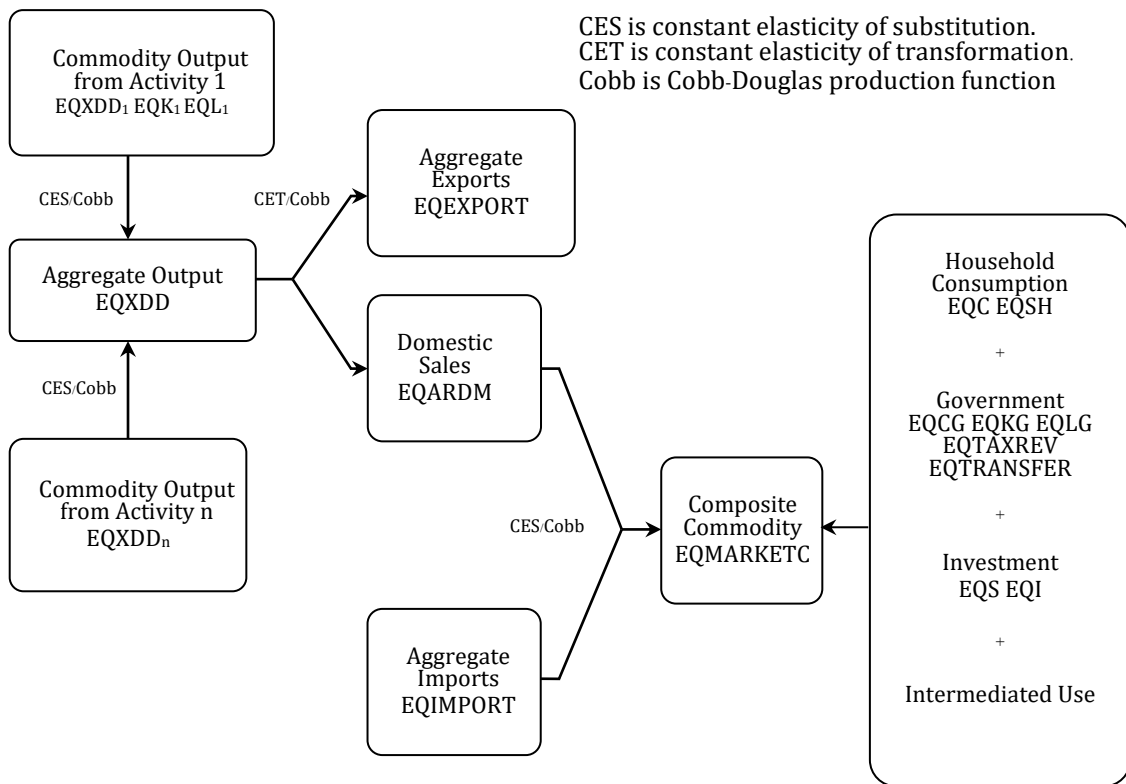
Figure 2. Structure of the General Equilibrium Model

Table 3. System of Equations for the Computable General Equilibrium Model (CGE equations)

Category	Equation	Description
* Households	EQC (sec)	consumer demand for commodity(sec)
	EQSH	household savings
* Firms	EQK (sec)	capital demand function firm(sec)
	EQL (sec)	labor demand function firm(sec)
	EQPROFIT (sec)	zero profit condition for the firms
* Investment	EQS	total savings
	EQI (sec)	the investment demand function for commodities
* Government	EQCG (sec)	government demand for commodities
	EQKG	government capital demand function
	EQLG	government labor demand function
	EQTAXREV	total tax revenues
	EQTRANSFER	total transfers
* Imports and exports	EQEXPORT (sec)	export supply
	EQXDD (sec)	domestic supply of domestic goods
	EQPROFITT (sec)	CET zero profit condition
	EQIMPORT (sec)	import demand
	EQARMD (sec)	demand for domestic goods
	EQPROFITA (sec)	armington's zero profit condition
* Market clearing	EQMARKETL	market-clearing for labor
	EQMARKETK	market-clearing for capital
	EQMARKETC (sec)	market-clearing for commodities
	EQTRADEBAL	balance of payments

Table 3. (Cont.)

Category	Equation	Description
* Definitions	EQEXPRICE (sec)	export price equation
	EQIMPRICE (sec)	import price equation
	EQPCINDEX	laspeyres consumer index
	EQINCOME	household income
	EQCBUD	household expenditure on commodities
	EQPHILLIPS	wage curve
* Objective function	OBJECTIVE	objective function

The analysis results from the model demonstrate the limitations of policies on the overall regional economy. Increasing export tariff on natural rubber producr does not significantly impact the overall economy. Conversely, the policy to increase domestic rubber utilization has the potential to generate modest economic growth. With a 30% increase in domestic rubber utilization, the overall economy could grow by 0.01%, equivalent to a value of 1,687.90 million THB. This policy also affects the domestic rubber price and the overall price level by 0.005%, leading to a 0.031% increase in employment.

However, the policy to increase domestic rubber utilization still has limited economic growth potential due to the constrained production structure of the continuous rubber industry within the country. With only a 14% share of domestic rubber utilization, the domestic rubber product manufacturing sector remains insufficiently linked to raw natural rubber. On the other hand, the policy to increase import tariff on rubber products significantly impacts the overall regional economy. A 10% increase in import tariff on three groups of rubber products generates substantial economic expansion—3.63%, equivalent to 612,707.70 million THB. This increase in import tariff leads to a 2.93% rise in the price of natural rubber and the overall price level within the country, contributing to a 6.69% increase in employment.

2.4) Policy to Increase Domestic Rubber Utilization by +10%, +20%, and +30%

The analysis of the simulated scenarios reveals that this policy yields short-term results and is unable to sustainably expand the volume of processed natural rubber. The production quantity responds minimally to the increased demand for rubber products within the country. Specifically, for three groups of rubber products: Rubber Sheet and Block Rubber Industry, (28), Vehicle Tire and Rubber Tube Industry (29), and Other Rubber Product Industry (30), these industries experience marginal growth (0.001%). Meanwhile, the prices of rubber products decrease by 0.011%-0.013%. Even with a +30% increase in domestic rubber utilization, the impact on employment so small as 0.014% in the Rubber Sheet and Rubber Block Industry, 0.019% in the Vehicle Tire and Rubber Tube Industry, and 0.003% in Other Rubber Product Industry. Overall, the employment impact remains modest.

This indicates that despite a 30% increase in domestic rubber utilization, the continuous impact on fostering the rubber product industry's growth is limited. The current structure of the rubber industry predominantly focuses on long-term raw material exports, and the continuous impact of increasing domestic rubber utilization on the rubber product manufacturing industry within the economy is restricted. An interesting consequence of the +10% domestic rubber utilization policy is the 27.98% increase in the export-adjusted price of natural rubber. This results from utilizing domestic rubber to produce additional rubber products.

Table 4. The Impact of Increase Domestic Rubber Utilization (27)

Sector	Increasing rate		
	10%	20%	30%
Rubber Sheets and Block Rubber (28)			
- Marginal growth (%)	0.001%	0.001%	0.001%
- Price (%)	-0.013%	-0.012%	-0.011%
- Employment (%)	n.a.	n.a.	0.014%

Table 4. (Cont.)

Sector	Increasing rate		
	10%	**20%**	**30%**
Tyres and Tubes (29)			
- Marginal growth (%)	0.001%	0.001%	0.001%
- Price (%)	-0.013%	-0.012%	-0.011%
- Employment (%)	n.a.	n.a.	0.019%
Other Rubber Products (30)			
- Marginal growth (%)	0.001%	0.001%	0.001%
- Price (%)	-0.013%	-0.012%	-0.011%
- Employment (%)	n.a.	n.a.	0.003%

2.5) Policy to Increase Export Tariff on Natural Rubber

This policy aligns with the idea of boosting incentives for higher rubber product exports, expecting to stimulate domestic processing due to the absence of tariff on domestically used rubber. Simulating scenarios with +5%, +10%, and +15% tariff increases, the study indicates a minimal expansion of the rubber product manufacturing industry, similar to the policy of increasing domestic rubber utilization. The impact is marginal (0.001%) across the three industries (28, 29, and 30), and there is no effect on rubber and rubber product prices.

Table 5. The Impact of Rubber Product Export Tariff to the Overall Rubber Production Quantity

Sector	Increasing rate		
	5%	**10%**	**15%**
Rubber Sheets and Block Rubber (28)	0.001%	0.001%	0.001%
Tyres and Tubes (29)	0.001%	0.001%	0.001%
Other Rubber Products (30)	0.001%	0.001%	0.001%

2.6) Policy to Increase Import Tariff on Rubber Products

The analysis of this policy shows a noteworthy economic expansion of the rubber industry. With import tariff increase of +5%, +10%, and +15% across the three industry groups, there is a significant rise in the price index of rubber products, particularly when import tariff on all three groups are increased by 10%. This results in a price increase of 23.287% to 26.094%. Simultaneously, the price of raw natural rubber adjusts upward by 41.091%, and the production quantity of the rubber product industries, including both manufacturing and agricultural rubber, also increases. The product group with the most substantial expansion is the Tyres and Tubes industry, experiencing a growth of 13.27%.

Table 6. The Impact of Rubber Product Import Tariff to the Rubber Price Index

Sector	Increasing rate		
	5%	**10%**	**15%**
Rubber (Agriculture sector) (27)	0.004%	41.091%	0.013%
Rubber Sheets and Block Rubber (28)	0.086%	24.113%	0.235%
Tyres and Tubes (29)	0.087%	26.094%	0.237%
Other Rubber Products (30)	0.032%	23.287%	0.086%

Table 7. The Impact of Rubber Product Import Tariff to the Overall Rubber Production Quantity

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.012%	3.379%	0.033%
Rubber Sheets and Block Rubber (28)	0.021%	0.553%	0.060%
Tyres and Tubes (29)	0.030%	13.271%	0.082%
Other Rubber Products (30)	0.004%	3.043%	0.011%

Table 8. The Impact of Rubber Product Import Tariff to the Domestic Rubber Production Quantity

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.014%	4.925%	0.036%
Rubber Sheets and Block Rubber (28)	0.037%	3.640%	0.099%
Tyres and Tubes (29)	0.040%	22.357%	0.111%
Other Rubber Products (30)	0.006%	6.217%	0.015%

Table 9. The Impact of Rubber Product Import Tariff to the Rubber Import Quantity

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.002%	-1.586%	0.006%
Rubber Sheets and Block Rubber (28)	-0.089%	-0.872%	-0.232%
Tyres and Tubes (29)	-0.158%	-1.484%	-0.415%
Other Rubber Products (30)	-0.079%	-0.743%	-0.205%

Table 10. The Impact of Rubber Product Import Tariff to the Employment in Rubber Sectors

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.003%	6.888%	0.009%
Rubber Sheets and Block Rubber (28)	0.005%	2.796%	0.014%
Tyres and Tubes (29)	0.007%	9.848%	0.019%
Other Rubber Products (30)	0.001%	3.682%	0.003%

The policy of increasing import tariff on rubber products can significantly stimulate the expansion of the domestic rubber product market, particularly in the Tyres and Tubes industry, with a tariff rate of 22.357%. The import quantities of rubber products in industrial groups 28, 29, and 30 have decreased when import tariff is increased. The impact of increased import Tariff has led to the reductions of 0.872%, 1.484%, and 0.743% in the import quantities respectively. This reduction is less than the increased tariff rates, reflecting the policy's effectiveness.

Furthermore, employment rates have increased, especially with a 10% increase in import tariff. The Tyres and Tubes sector experienced 9.848% increasing in employment, while there are contrasting trends in the Rubber Sheet and Block Rubber, and Other Rubber Product industries (Groups 28 and 30). This demonstrates a positive impact on job creation in the agricultural natural rubber sector as well. Therefore, an appropriate and beneficial level for expansion is achieved by implementing a 10% import tariff increase on rubber products.

2.7) Other Policies

Other policies and measures analyzed to study the expansion impact on the natural rubber and rubber product industries (Sections 27 to 30) include the analysis of the effects of changes in situations and policies. These factors include oil prices, labor shortages in rubber tapping, reduced yield per hectare, and reduced rubber planting areas. The analysis, based on the

comparison of the initial production output of the rubber sector (Section 27), indicates that a 10% and 15% increase in oil prices does not affect the rubber and rubber product production quantities. It also doesn't influence the stimulation of adjusting rubber prices in the global market. Additionally, an increase in oil prices has indirect effects on exchange rates, reducing them by 4.28%, with a consequential impact on the international rubber sales volume.

Concerning the factors of labor shortages in rubber tapping, reduced yield per hectare, and reduced rubber planting areas due to government policies, the analysis suggests that these factors could lead to a reduction in rubber production by 10% and 15%. This reduction would impact rubber prices in the domestic market, potentially allowing local farmers to sell their product at slightly higher prices. However, such policies or changes are deemed not cost-effective since they reduce the production potential by 10%, while the returns are minimal, with an increase in rubber prices by only 0.439%. Further detailed analysis is recommended.

3) Key Issues from Stakeholder Meetings on Thai Rubber Development

From the four stakeholder meetings, several key issues for the development of the natural rubber industry in Thailand have emerged:

3.1) Management of the Rubber Supply Chain by the Government

Effective management of the country's rubber system by the government should consider the entire system throughout the supply chain. The upstream, midstream, and downstream industries have different needs and knowledge levels. The upstream industry is concerned with pricing, while the midstream and downstream industries, being private sectors, require stability in prices for cost control in production. The government should support the rubber product industry (end of the chain) by setting conditions or quantities for using raw rubber in production and creating a linkage from upstream rubber tapping to downstream rubber product industries with value added.

3.2) Value Addition to Natural Rubber

The government should focus on adding value to the natural rubber industry throughout the upstream, midstream, and downstream levels through research and development. This can be achieved by improving the quality of products and creating high-value rubber products. Emphasis should be placed on producing rubber products with high value added, such as medical rubber products, engineering and safety rubber products (e.g., earthquake-resistant rubber sheets, shock-absorbing rubber, and road underlayment rubber sheets), and rubber products in rail transportation systems. This policy aims to replace the import of rubber products and promote the increased domestic production of high-value rubber products.

3.3) Promotion of Domestic Use of Natural Rubber

The government should take the lead in promoting the use of natural rubber domestically by increasing the usage in public sector organizations. This can be achieved by enhancing the use of rubber products in government agencies and creating sustainability by improving procurement regulations, tendering processes, and/or providing extra points for products produced domestically. As the budget allocated from the rubber fund is insufficient, a regular budget should be used to support the promotion of domestic rubber usage.

3.4) Rubber Strategy Direction

Given the changing economic landscape, evolving competition dynamics, and the impact of COVID-19, the government should clearly redefine its rubber strategy. Urgent measures are needed to advance the natural rubber glove industry. This can be accomplished by creating leading rubber products for the international market, with strong government support. The management of the natural rubber supply chain should be systematic, focusing on increasing the domestic use of natural rubber instead of addressing low rubber prices by reducing planting areas. This is crucial for Thailand to maintain its market share globally. Additionally, the establishment of Special Economic Zones (SEZ) or global rubber centers can better respond to the competitive rubber market than industrial estates, contributing to the country's economic development.

3.5) Strengthening Agricultural Institutions and Communities

Policies should be in place to promote the collaboration in the natural rubber sector between private sector, agricultural institutions, and educational institutions. This collaboration

should encourage joint research and development initiatives, linking with the creation of innovations or knowledge-based products and compounded formulations at the university level. Students should be engaged as research scholars, working on experiments in university's laboratories to disseminate knowledge or research findings. Farmers should be empowered to produce compounded rubber in households and communities, promoting the production of higher-quality natural rubber.

3.6) Role of the Rubber Authority of Thailand (RAOT)

RAOT should address the declining trend in rubber yield per hectare, a common issue among rubber farmers. This involves enhancing the quality of planting soils and water sources for rubber cultivation. Additionally, RAOT should improve the efficiency of the central market, controlling and certifying the quality of rubber that passes through the market. This should be done systematically and with standardized procedures. RAOT should establish rubber storage warehouses to negotiate and support credit sales of rubber to farmers. Furthermore, developing a forward contracts market linked to spot and future rubber markets can help stabilize the rubber market.

CONCLUSIONS

The aim of this research is to fostering a robust natural rubber industry and sustainably elevating the sector's competitiveness. This is achieved through policy mechanisms to increase the domestic consumption of natural rubber. The study explores suitable policy models and measures in both short and long terms to facilitate the expansion of the rubber processing industry. Additionally, it investigates strategies to link agricultural institutions with the overall rubber processing industry of the country. The study evaluates the impacts of policies that promote the expansion of the rubber processing industry and rubber product manufacturing on the country's economy and employment, along with the overall effectiveness of these policies.

The analysis indicates that the overall impact on the regional economy is not substantial. The policy of increasing export tariff rates on natural rubber does not generate significant overall economic impact. Simultaneously, the policy of increasing the domestic use of natural rubber by 30% has limited economic growth and employment generation due to the modest existing structure of the domestic natural rubber processing industry. The use of natural rubber within the country is only 14%, reflecting the need for stronger links between the domestic rubber product manufacturing industry and the raw material, natural rubber.

On the contrary, the policy of increasing import tariff on rubber products significantly impacts the regional economic system. A 10% increase in import tariff on three industrial categories; Rubber Sheet and Block Rubber industry (28). Tyres and Tubes industry (29), and Other Rubber Products industry (30) results in substantial overall economic growth of 3.63%, equivalent to a value of 612,707.70 million THB. This policy elevates the prices of natural rubber and overall rubber products by 2.93%, creating a 6.69% increase in employment.

For the specific impact on the rubber and rubber product manufacturing industry, the policy of increasing export tariff rates on natural rubber aligns with the objective of stimulating the export of rubber products and domestically processed natural rubber. The simulated scenarios of a 5%, 10%, and 15% increase in export tariff rates demonstrate a minor expansion of the domestic rubber product industry. Importantly, there is no significant effect on rubber prices or the prices of rubber products.

In contrast, the policy of increasing the domestic use of natural rubber by 10%, 20%, and 30% from the current level only provides short-term expansion, with negligible sustainable growth. This is evident from a minimal increase (0.001%) in the quantity of rubber produced. Additionally, the prices of rubber products decrease by 0.011%-0.013%, indicating a limited impact on the industry. The study highlights the necessity for continuous long-term policies focusing on linking the rubber product manufacturing industry with the increasing utilization of natural rubber.

Moreover, the policy of increasing import tariff on rubber products shows a substantial impact. A 10% increase in import tariff on three industrial groups results in a considerable increase in product prices, particularly for rubber tyres and tubes, which experience the highest expansion of 13.27%. This policy stimulates significant growth in the domestic rubber product market. Importantly, the policy demonstrates a balanced approach, with import quantities decreasing by 0.872%, 1.484%, and 0.743% for the three respective categories. This reflects the policy's effectiveness and its ability to increase employment, particularly with a 10% increase in import tariff, which leads to a 9.848% increase in employment in the motor vehicle tyres and tubes industry.

In conclusion, the research suggests that an appropriate and beneficial level for expanding the industry is to implement a 10% increase in import tariff on rubber products. This policy provides a well-balanced and effective approach that promotes economic growth, stable rubber prices, and substantial employment generation in the rubber and rubber product manufacturing sector.

POLICY IMPLICATIONS

In order for Thailand's natural rubber to compete sustainably in a changing market landscape, it is essential to design a new strategy for natural rubber and implement the following policies:

1) Increase Import Tariff on Rubber Products

The government should consider raising import tariff on rubber products by 10% to support the country's rubber industry. This policy is projected to have a positive impact on the overall economy, with a growth rate of 3.63%, equivalent to a value of 612,707.70 million THB. It would elevate the prices of natural rubber and overall rubber products by 2.93%, creating a 6.69% increase in employment. However, compliance with international trade agreements, such as those under the World Trade Organization (WTO), may limit the use of tariff mechanisms. In such cases, non-tariff barrier measures should be explored at an equivalent level of 10%. Moreover, leveraging the Regional Comprehensive Economic Partnership (RCEP) framework is advised to expand the scope of trade in rubber products.

2) Holistic Management of the Natural Rubber System

The government should implement comprehensive management of the entire natural rubber supply chain. The existing link between raw natural rubber and rubber product manufacturing is currently weak and insufficient. Supports from the rubber product manufacturing industry, particularly from downstream activities like natural rubber latex, should be reinforced. This can be achieved by establishing conditions for the use of natural rubber in product manufacturing, fostering connectivity, setting fair rubber purchase prices, and focusing on value addition in the natural rubber industry across upstream, midstream, and downstream levels. Research and development efforts should be intensified to ensure high-quality and diversified products.

3) Domestic Use of Natural Rubber

The government should adopt a policy to encourage the domestic use of natural rubber to reach a sustained level of 30%. This initiative aims to promote short-term economic growth and employment. The restructuring of the natural rubber production system should establish stronger links between rubber products and natural rubber in the agricultural sector. This includes promoting the processing of rubber products, improving procurement regulations, setting criteria for domestic product points, and addressing regulations that hinder the growth and development of the natural rubber supply chain.

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CONFLICTS OF INTEREST
The author declares that there are no conflicts of interest found in this research.

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SUSTAINABILITY IN SUPPLY CHAINS: STRATEGIES AND PRACTICES FOR A GREENER FUTURE

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ABSTRACT

Purpose – The purpose of this study is to investigate the critical importance of integrating sustainability practices into supply chain management. It aims to explore strategies and best practices that businesses can adopt to mitigate environmental challenges, reduce greenhouse gas emissions, and transition towards greener supply chains.

Implications – The integration of sustainability into supply chain management has far-reaching implications for businesses, the environment, and society. By adopting sustainable practices, organizations can enhance their brand reputation, increase customer loyalty, achieve cost savings, improve risk management, foster innovation, and gain a competitive advantage. Additionally, the adoption of green supply chain practices contributes to environmental conservation, resource efficiency, and the mitigation of climate change impacts.

Originality/Value – This study offers a comprehensive analysis of sustainable supply chain practices, with a particular focus on Thailand's manufacturing sector. It provides valuable insights into the challenges and opportunities associated with implementing sustainability strategies across various industries. The research highlights best practices, case studies, and recommendations tailored to the Thai context, enabling businesses to navigate the transition towards greener supply chains effectively. Furthermore, the study emphasizes the significance of Thailand's sustainability efforts in influencing global standards and positioning the nation as a leader in responsible manufacturing practices.

Keywords: Sustainability, Supply chains, Green practices

Paper Type: Academic Article

INTRODUCTION

Supply chains have evolved significantly due to digitalization, e-commerce growth, and the emergence of new business opportunities in base-of-the-pyramid (BoP) markets. The impact of e-commerce on supply chains has led to operational challenges, emphasizing the need for firms to manage growth effectively and develop sustainable practices (Al Mashalah et al., 2022). Additionally, the BoP markets present unique challenges, requiring firms to rethink traditional business models and develop innovative supply chain solutions to cater to the needs of these markets (Khalid et al., 2022). Supply chain resilience is crucial in coping with unexpected turbulence, with digital tools playing a key role in enhancing visibility and collaboration within supply chains (Zouari et al., 2021). Furthermore, the green food supply chain is gaining popularity, with consumers increasingly concerned about environmentally friendly practices in food production and distribution (Khalid et al., 2022). The use of technology and digital transformation in supply chain management has the potential to address sustainability challenges and optimize efficiency. However, there is still a need for more focused efforts to integrate these technological advancements into a comprehensive understanding of sustainability in supply chains. With the rise in global consumption and the consequent intensive

demand for global resources, the attention of scholars and practitioners towards greener supply chains has grown over the years (Giuffrida & Mangiaracina, 2020). Businesses are gradually raising awareness of the impact of integrating supply chains and environmental management systems to create a sustainable business strategy.

Sustainability holds paramount importance in today's business landscape due to the increasing volatility and uncertainty caused by various crises like the COVID-19 pandemic, energy crisis, global supply chain issues, and conflicts (Markovic et al., 2023). Organizations are expected to positively impact society, reduce environmental footprints, and build authentic brands to stay competitive (Sassanelli & Terzi, 2023). Therefore, implementing sustainable practices in supply chains not only benefits businesses but also the environment (Giuffrida & Mangiaracina, 2020). The concept of corporate sustainability is crucial for organizations worldwide, with a focus on economic, environmental, and social goals that aim to create long-term value for all stakeholders involved (Politis & Grigoroudis, 2022). Integrating sustainability into core business functions is a significant challenge faced by modern enterprises, emphasizing the necessity of aligning brand values with sustainability efforts to build strong identities and reputations and gain a competitive advantage (Ajmal et al., 2018). The interconnectedness of people, businesses, and societies further underscores the need for sustainable practices to address the challenges faced by organizations in both public and private sectors and foster greater collaboration among supply chain partners to achieve shared sustainability goals (Visvizi, 2022).

In this context, the adoption of green supply chain management practices becomes crucial (Zailani et al., 2012). Green supply chain management refers to the integration of environmental considerations into all aspects of supply chain operations, including product design, sourcing, manufacturing, transportation, and disposal. This approach aims to minimize the negative environmental impacts associated with supply chain activities while maximizing efficiency and value creation. By implementing green supply chain management practices, businesses can reduce their carbon footprint, minimize waste generation, conserve natural resources, and promote the use of sustainable materials, all of which contribute to building a more sustainable business strategy (Sarwar et al., 2021). Furthermore, green supply chain management is aligned with the growing consumer preference for environmentally friendly goods and services (Zailani et al., 2012). Therefore, organizations that embrace green supply chain management gain a competitive advantage by meeting customer demands, reducing costs, and enhancing their reputation as socially and environmentally responsible entities (Sarwar et al., 2021).

This article examines how Thailand's manufacturing sector can leverage technology for sustainable supply chain management (SCM). A mixed-methods approach employing an extensive literature review alongside qualitative and quantitative analysis techniques explores challenges and opportunities in this specific context.

The literature review formed the foundation, utilizing databases like ScienceDirect and keywords like "sustainable supply chain" and "Thailand manufacturing" to identify relevant research (147 sources reviewed). This comprehensive approach provides a strong foundation for investigating sustainable SCM practices within Thailand's manufacturing sector.

ENVIRONMENTAL CHALLENGES IN SUPPLY CHAINS

Major environmental concerns associated with traditional supply chains include carbon emissions, resource depletion, and pollution (Gonzalez et al., 2022). Carbon emissions are a significant issue, leading to environmental degradation and climate change(Jæger et al., 2021). These emissions are a result of transportation, energy consumption, and manufacturing processes throughout the supply chain. To address this challenge, supply chain managers can focus on implementing sustainable transportation methods, adopting energy-efficient technologies, and promoting renewable energy sources. Additionally, traditional supply chains often contribute to resource depletion through inefficient practices and lack of sustainability measures (Homayouni et al., 2023). By adopting green supply chain practices, organizations can mitigate these challenges by implementing strategies such as waste reduction, recycling programs, and responsible sourcing of materials (Sarwar et al., 2021). Pollution is another critical concern, with supply chains in various industries exhibiting environmentally destructive

behaviors that harm ecosystems and communities (Sarkis et al., 2021). To combat pollution, organizations can prioritize the use of environmentally friendly materials and production methods, implement waste management systems, and enforce strict environmental regulations throughout their supply chain (Sarwar et al., 2021). Furthermore, the integration of sustainability into supply chain management practices requires collaboration and cooperation among various stakeholders. These issues highlight the urgent need for organizations to transition towards green supply chain practices to mitigate the negative environmental impacts of traditional supply chains and work towards a more sustainable future (Jæger et al., 2021). Incorporating sustainable practices in supply chain management can lead to reduced environmental impact, improved resource efficiency, and greater resilience in the face of environmental challenges (Sarwar et al., 2021). By addressing these concerns through sustainable logistics models, environmental regulations, and investments in pro-environment approaches, organizations can work towards greener and more sustainable supply chains.

The environmental impact of supply chains can be quantified through various methods and examples provided in the literature. Studies highlight that green supply chains lead to improvements in resource conservation, energy reduction, environmental communication management, and pollution control, among other benefits. Environmental impacts in food supply chains are mainly attributed to land use change and agricultural production, with livestock having a higher footprint than plant based (Sutawidjaya et al., 2021). Additionally, emissions from transportation in supply chains contribute to air pollution and greenhouse gas emissions. To address these challenges, organizations can implement strategies such as optimizing transportation routes, using alternative fuel vehicles, and adopting lean manufacturing techniques to minimize waste and energy consumption. Analyzing the environmental evaluation of a swimming goggles distribution revealed that materials and manufacturing phases have the highest impacts, emphasizing the importance of quantifying and rationalizing environmental impacts in complex systems such as supply chains (Zailani et al., 2012). Additionally, the implementation of IoT technologies in food supply chains can help reduce environmental impacts by preventing food waste generation and associated impacts, such as greenhouse gas emissions from food spoilage and transportation.

Overall, the integration of green supply chain practices is crucial for organizations to address environmental concerns and promote sustainability. In order to achieve a greener future, organizations must recognize the importance of integrating sustainable practices into their supply chain management (Zailani et al., 2012). By doing so, they can identify and address operational bottlenecks that contribute to environmental challenges, such as poor inventory management, inefficient tracking and tracing, and the presence of counterfeit or sub-standard products. These practices, which include green purchasing, green packaging, green manufacturing, green design, and green marketing, can contribute to improved environmental performance and a reduced carbon footprint.

STRATEGIES FOR SUSTAINABLE SUPPLY CHAINS

In today's competitive landscape, organizations are increasingly recognizing the strategic importance of sustainable supply chain management (SSCM). This entails integrating environmental, social, and economic considerations into all aspects of the supply chain, from sourcing to end-of-life product management. By implementing robust SSCM strategies, companies can enhance operational efficiency, mitigate risk, and gain a competitive advantage.

Key Strategies for a Sustainable Supply Chain:
1. Sustainable Procurement: A Strategic Imperative for Resilient Supply Chains

In today's globalized marketplace, organizations are increasingly recognizing the strategic importance of sustainable procurement practices. This approach transcends traditional cost-centric purchasing by integrating environmental, social, and governance (ESG) considerations throughout the sourcing process. Implementing a robust sustainable procurement strategy fosters a more resilient and responsible supply chain, yielding a multitude of benefits for organizations.

1.1 Benefit of Sustainable Procurement:

1) Environmental Impact Reduction: By partnering with suppliers committed to sustainable practices (e.g., energy efficiency, waste reduction), companies can significantly contribute to minimizing their environmental footprint throughout the supply chain (Etse et al., 2023).

2) Enhanced Social Responsibility: Sustainable procurement empowers organizations to support suppliers who uphold ethical labor standards and responsible sourcing of materials, promoting positive social impacts within their supply networks (Hiep et al., 2021).

3) Risk Mitigation: A comprehensive assessment of a supplier's ESG performance helps identify potential risks associated with environmental regulations, social unrest, or resource scarcity within their operations, enabling proactive risk management strategies (Bratt et al., 2021).

4) Cost Optimization: Sustainable practices often lead to operational efficiencies for both you and your suppliers. This could involve aspects like reduced energy consumption, minimized waste generation, or the use of recycled materials, all contributing to long-term cost optimization (Bratt et al., 2021).

1.2 Implementing a Sustainable Procurement Strategy:

1) Supplier Evaluation with a Sustainability Focus

Traditional procurement practices often prioritize cost reduction as the sole selection criterion. To effectively integrate sustainability principles, organizations must adopt a more comprehensive approach for supplier evaluation. This involves incorporating Environmental, Social, and Governance (ESG) factors alongside traditional cost and quality metrics. This might involve evaluating a supplier's:

- Energy and resource efficiency initiatives
- Waste management protocols and recycling programs
- Labor standards and commitment to ethical sourcing
- Certifications related to sustainability (e.g., Fair Trade, Forest Stewardship Council)

2) Collaborative Partnerships: Building strong and collaborative relationships with suppliers is essential for achieving long-term success in sustainable procurement. Effective collaboration fosters continuous improvement in sustainability practices throughout the supply chain (Hahn et al., 2018).

- Open Communication and Collaborative Engagement: Establish open communication channels with your suppliers. Engage in collaborative discussions to identify opportunities for ongoing improvement in environmental and social responsibility.

- Knowledge Sharing Through Supplier Engagement: Consider organizing workshops or training sessions to equip your suppliers with the necessary knowledge and tools to enhance their own ESG performance.

3) Transparency & Communication: Be transparent about your own sustainability goals and expectations for your suppliers. Regularly communicate your progress in sustainable procurement practices and encourage your suppliers to do the same (Hahn et al., 2018).

- Clear Communication of Sustainability Expectations: Clearly communicate your organization's sustainability goals and the ESG criteria used during supplier evaluation.

- Tracking Progress and Transparent Reporting: Regularly monitor progress towards your established sustainability goals. Communicate achievements and challenges openly with stakeholders, including suppliers, customers, and investors.

- Regular Review and Adaptation: As your business and the sustainability landscape evolve, it is essential to periodically review your goals and evaluation criteria. This ensures they remain relevant and impactful in achieving your long-term sustainability objectives.

2. Sustainable Product Design & Lifecycle Management (SPDLCM)

Sustainable Product Design & Lifecycle Management (SPDLCM) is a strategic framework employed by leading organizations to achieve environmental and social responsibility throughout a product's entire lifespan. This holistic approach transcends traditional product design by meticulously considering a product's impact – from raw material extraction and

manufacturing to use, end-of-life management, and potential for reuse or remanufacture. By integrating SPDLCM principles, organizations can significantly contribute to a more circular economy, minimizing resource depletion, waste generation, and environmental footprint.

2.1 Core Tenets of SPDLCM:

1) Design for Disassembly & Remanufacture: SPDLCM prioritizes designing products for ease of disassembly. This allows for efficient component separation, facilitating reuse or remanufacture at the end of a product's useful life (Favi et al., 2019). This approach extends product lifespans, reduces reliance on virgin materials, and minimizes landfill waste.

2) Material Selection with Sustainability in Mind: Material selection is a critical aspect of SPDLCM. Opting for recycled or readily recyclable materials whenever possible minimizes environmental burdens associated with virgin material extraction, processing, and transportation throughout the supply chain (Vezzoli, 2014).

3) Energy Efficiency Optimization: SPDLCM emphasizes designing products that minimize energy consumption during their use phase. This can involve optimizing product functionalities, employing energy-efficient components, and providing clear user instructions for energy-saving operation (Favi et al., 2019).

4) Life Cycle Assessment (LCA) Integration: SPDLCM leverages Life Cycle Assessment (LCA) tools to comprehensively evaluate the environmental impact of a product across all stages of its lifecycle (Ingrao et al., 2021). LCA insights inform design decisions that promote environmental sustainability by identifying areas for improvement in resource utilization and waste reduction.

5) End-of-Life Management Strategies: Developing responsible end-of-life management strategies is paramount in SPDLCM. Take-back programs, robust recycling initiatives, and safe disposal options significantly minimize landfilling and promote the recovery of valuable resources (Favi et al., 2019).

2.2 Benefits of Implementing SPDLCM:

1) Reduced Environmental Impact: By minimizing resource consumption, energy use, and waste generation, SPDLCM contributes significantly to achieving environmental sustainability goals and mitigating climate change.

2) Enhanced Brand Reputation: Consumers are increasingly drawn to brands demonstrating a commitment to sustainability. Implementing SPDLCM practices fosters a positive brand image and attracts environmentally conscious customers.

3) Cost Optimization: Resource and material efficiency strategies inherent in SPDLCM can lead to cost savings throughout a product's lifecycle, from material sourcing to manufacturing and potentially even end-of-life management processes.

4) Innovation Opportunities: SPDLCM fosters innovation in product design, materials science, and the development of sustainable end-of-life management solutions.

2.3 Effective Implementation of SPDLCM:

1) Cross-Functional Collaboration: Effectively implementing SPDLCM requires fostering collaboration between design, engineering, manufacturing, and marketing teams. Integrating sustainability considerations into all stages of product development is crucial.

2) Strategic Supplier Engagement: Partnering with suppliers who share your commitment to sustainability is key. Aligning with suppliers who prioritize environmentally responsible practices and utilize sustainable materials strengthens your overall sustainability efforts.

3) Consumer Education & Engagement: Educating consumers about a product's sustainable features and proper end-of-life disposal practices empowers them to make informed choices and participate in a more circular economy.

3. Sustainable Operations & Logistics

Optimize transportation efficiency by consolidating shipments, employing fuel-efficient vehicles, and exploring alternative transportation methods like rail or sea freight, where feasible (Grant et al., 2017). Additionally, implement strategies to minimize waste generation throughout the supply chain. This could involve optimizing production processes, utilizing recyclable packaging materials, and exploring waste-to-energy solutions (Rabbani et al., 2018).

3.1 Transportation Optimization: Optimizing transportation networks and logistics planning is fundamental to SOL. Techniques such as consolidating shipments, adopting fuel-efficient or alternative fuel vehicles (e.g., electric, hybrid), and implementing route planning software can significantly reduce carbon emissions and overall fuel consumption within the supply chain (Grant et al., 2017). Here are some core strategies for transportation optimization:

1) Route Optimization: Utilize advanced routing software to plan the most efficient delivery routes. Consider factors such as distance, traffic patterns, delivery windows, and vehicle capacities to minimize fuel consumption and emissions while maximizing delivery speed (Rabbani et al., 2018).

2) Consolidation and Collaboration: Consolidate shipments whenever possible to reduce the number of vehicles on the road. Collaborate with other businesses or partners to share transportation resources and optimize delivery routes collectively, reducing empty miles and lowering carbon footprints (Rabbani et al., 2018).

3) Mode Shifting: Evaluate different transportation modes (e.g., truck, rail, ocean freight) and choose the most environmentally friendly and cost-effective options for each shipment. Where feasible, shift from road to rail or water transport for long-distance shipments to reduce greenhouse gas emissions (Schiller & Kenworthy, 2017).

4) Fleet Optimization: Invest in fuel-efficient vehicles and maintain them regularly to ensure optimal performance. Consider alternative fuel options such as electric, hybrid, or natural gas vehicles to reduce reliance on fossil fuels and minimize emissions (Rabbani et al., 2018).

5) Load Optimization: Maximize the payload of each vehicle to reduce the number of trips required for transportation. Use load planning software to efficiently utilize cargo space and minimize wasted capacity, thereby reducing the overall environmental impact per shipment (Schiller & Kenworthy, 2017).

6) Last-Mile Delivery Solutions: Implement innovative last-mile delivery solutions such as bicycle couriers, electric vans, or drone delivery for urban areas to reduce congestion and emissions associated with traditional delivery methods (Schiller & Kenworthy, 2017).

7) Real-Time Monitoring and Tracking: Utilize IoT (Internet of Things) technology and GPS tracking systems to monitor vehicle performance, track shipments in real-time, and identify opportunities for route optimization and efficiency improvements (Schiller & Kenworthy, 2017).

8) Reverse Logistics Optimization: Develop efficient processes for managing returns and reverse logistics to minimize transportation-related waste and emissions. Implement strategies such as product refurbishment, recycling, or resale to reduce the environmental impact of returned goods (Bratt et al., 2021).

9) Supplier Collaboration: Collaborate closely with suppliers to optimize transportation processes across the entire supply chain. Implement just-in-time inventory management practices to minimize storage and transportation costs while ensuring timely deliveries (Bratt et al., 2021).

3.2 Warehouse Optimization: Warehousing efficiency plays a critical role in achieving sustainability goals. Strategies such as implementing energy-efficient lighting and heating/cooling systems, maximizing space utilization through efficient layout design, and employing automation for repetitive tasks can significantly minimize energy consumption and the overall environmental footprint of warehousing operations (Wahab et al., 2021).

Here are some core strategies for warehouse optimization with a focus on sustainability:

1) Inventory Management: Implement lean inventory management practices to minimize excess stock and reduce storage space requirements. By accurately forecasting demand and maintaining optimal inventory levels, warehouses can minimize waste and energy consumption associated with storage and handling (Torabizadeh et al., 2020; Wahab et al., 2021).

2) Energy Efficiency: Invest in energy-efficient lighting, heating, ventilation, and cooling systems within the warehouse. Implement motion sensors and timers to automatically adjust lighting and HVAC systems based on occupancy and usage patterns, thereby reducing energy waste (Torabizadeh et al., 2020).

3) Green Building Design: Design or retrofit warehouses with sustainable building materials and practices to minimize environmental impact. Incorporate features such as natural lighting, rainwater harvesting systems, and solar panels to reduce energy consumption and reliance on non-renewable resources (Wahab et al., 2021).

4) Optimized Layout: Design warehouse layouts to minimize travel distances and optimize material flow. Group frequently picked items together and arrange storage locations based on demand patterns to reduce picking and transportation times, thereby improving overall efficiency and reducing emissions (Torabizadeh et al., 2020; Wahab et al., 2021).

5) Automation and Robotics: Implement warehouse automation technologies such as conveyor systems, robotic picking, and automated guided vehicles (AGVs) to improve efficiency and reduce labor and energy costs. Automation can also optimize space utilization and minimize the need for additional warehouse expansion (Torabizadeh et al., 2020; Wahab et al., 2021).

6) Packaging Optimization: Optimize packaging materials and design to minimize waste and maximize space utilization during storage and transportation. Use recyclable or biodegradable packaging materials whenever possible and implement packaging reusability programs to reduce environmental impact (Wahab et al., 2021).

7) Reverse Logistics Handling: Develop efficient processes for handling returns and reverse logistics within the warehouse. Implement systems for sorting, refurbishing, recycling, or disposing of returned products in an environmentally responsible manner to minimize waste and maximize resource recovery (Wahab et al., 2021).

8) Supplier Collaboration: Collaborate closely with suppliers to optimize inbound logistics and streamline receiving processes. Implement vendor-managed inventory (VMI) or just-in-time (JIT) delivery practices to reduce inventory holding costs and minimize transportation emissions associated with frequent deliveries (Torabizadeh et al., 2020; Wahab et al., 2021).

3.3 Sustainable Packaging: Rethinking packaging strategies is a key component of SOL. Utilizing recycled content in packaging materials, opting for minimal or biodegradable packaging solutions, and implementing product return programs can minimize waste generation and resource depletion throughout the supply chain (Ibrahim et al., 2022).

Here are some core strategies for implementing sustainable packaging practices:

1) Material Selection: Choose packaging materials that are renewable, recyclable, or biodegradable. Optimize for materials such as paperboard, corrugated cardboard, recycled paper, bioplastics, or compostable materials to reduce environmental impact (Ibrahim et al., 2022; Siracusa & Rosa, 2018).

2) Right-Sizing: Optimize packaging sizes to minimize material usage and maximize space efficiency during storage and transportation. Use packaging design software or consulting services to design packaging that fits products snugly, reducing the need for excess filler material (Siracusa & Rosa, 2018).

3) Reusable Packaging: Implement reusable packaging solutions such as pallets, containers, and totes to minimize waste and reduce the environmental impact of single-use packaging. Develop reverse logistics processes to recover and refurbish reusable packaging items for multiple cycles of use (Kozik, 2020).

4) Minimalist Design: Design packaging with simplicity and minimalism in mind to reduce material usage and waste. Avoid unnecessary embellishments, excessive layers, and non-functional elements that contribute to environmental harm without adding value to the product (Kozik, 2020).

5) Recycled Content: Use packaging materials with high levels of recycled content to reduce demand for virgin materials and support the recycling industry. Look for packaging suppliers that offer products certified by organizations such as the Forest Stewardship Council (FSC) or the Sustainable Forestry Initiative (SFI)(Ibrahim et al., 2022; Kozik, 2020; Siracusa & Rosa, 2018).

6) Biodegradable and Compostable Options: Explore biodegradable and compostable packaging options for products that require disposal after use. Ensure that

biodegradable and compostable packaging materials meet relevant industry standards and certifications to guarantee their environmental benefits (Siracusa & Rosa, 2018).

7) Packaging Innovation: Invest in research and development to explore innovative packaging solutions that reduce environmental impact while maintaining product integrity and functionality. Consider alternatives such as edible packaging, mushroom-based packaging, or seaweed-based packaging for specific applications (Ibrahim et al., 2022)

8) Supplier Collaboration: Collaborate closely with packaging suppliers to align sustainability goals and drive continuous improvement in packaging practices. Request sustainability information from suppliers and prioritize partnerships with vendors committed to environmental stewardship (Ibrahim et al., 2022).

9) Consumer Education: Educate consumers about the importance of sustainable packaging and provide guidance on proper disposal methods to promote recycling, composting, or reuse. Use packaging labels, marketing materials, and online platforms to communicate sustainability efforts and encourage responsible consumer behavior (Kozik, 2020).

10) Life Cycle Assessment: Conduct life cycle assessments (LCAs) to evaluate the environmental impact of packaging materials and processes across the entire product life cycle. Use LCA data to identify areas for improvement and guide decision-making towards more sustainable packaging options (Ibrahim et al., 2022; Kozik, 2020; Siracusa & Rosa, 2018).

3.4 Waste Reduction & Management: Developing comprehensive waste reduction and management strategies is essential for SOL. This could involve implementing source reduction practices in production processes, establishing robust recycling programs for various waste streams, and exploring waste-to-energy solutions (where feasible) to divert waste from landfills (Elsaid & Aghezzaf, 2015). Here are some core strategies for effectively reducing and managing waste in business operations:

1) Source Reduction: Minimize waste generation at the source by optimizing processes, reducing excess packaging, and eliminating unnecessary materials. Design products with durability and reusability in mind to extend their lifecycle and reduce disposal rates (Cucchiella et al., 2017).

2) Recycling Programs: Implement comprehensive recycling programs to capture and recycle materials such as paper, cardboard, plastics, glass, and metals. Provide easily accessible recycling bins throughout facilities and educate employees on proper recycling practices to maximize participation and diversion rates (Cucchiella et al., 2017).

3) Composting: Implement composting programs to divert organic waste from landfills and convert it into nutrient-rich compost for use in landscaping or agricultural applications. Collect food scraps, yard waste, and other organic materials separately and compost them on-site or through third-party composting facilities (Awasthi et al., 2021).

4) Waste Audits: Conduct regular waste audits to identify sources of waste generation, quantify waste streams, and pinpoint opportunities for waste reduction and diversion. Analyze audit findings to prioritize improvement initiatives and set measurable waste reduction targets (Elsaid & Aghezzaf, 2015).

5) Supplier Engagement: Collaborate with suppliers to minimize packaging waste, optimize packaging sizes, and source materials with recycled content. Encourage suppliers to adopt sustainable practices and provide incentives for waste reduction and recycling efforts throughout the supply chain (Awasthi et al., 2021; Cucchiella et al., 2017; Elsaid & Aghezzaf, 2015).

6) Product Redesign: Redesign products and packaging to minimize waste generation and facilitate end-of-life recovery. Use design principles such as lightweighting, material substitution, and modular design to optimize product recyclability, reusability, and disassembly for recycling or remanufacturing (Awasthi et al., 2021; Cucchiella et al., 2017; Elsaid & Aghezzaf, 2015).

7) Closed-Loop Systems: Implement closed-loop systems to recover and reuse materials within the production process. Collect and recycle manufacturing by-products, scrap materials, and obsolete products to minimize waste and conserve resources, reducing the need for virgin materials(Awasthi et al., 2021; Cucchiella et al., 2017).

8) Regulatory Compliance: Stay informed about waste management regulations and compliance requirements at the local, regional, and national levels. Ensure compliance with waste disposal regulations, hazardous waste management requirements, and reporting obligations to avoid fines and penalties (Elsaid & Aghezzaf, 2015).

3.5 Renewable Energy Integration: Investing in renewable energy sources such as solar or wind power to supplement or replace conventional electricity in facilities can substantially reduce greenhouse gas emissions and dependence on fossil fuels (Al-Shetwi, 2022). Here are core strategies for effectively incorporating renewable energy:

1) On-Site Renewable Energy Generation: Install renewable energy systems such as solar panels, wind turbines, or biomass generators on-site to generate clean electricity. Evaluate the site's renewable energy potential and invest in appropriate technologies to offset energy consumption from conventional sources (Al-Shetwi, 2022).

2) Power Purchase Agreements (PPAs): Enter into PPAs with renewable energy developers to procure electricity from off-site renewable energy projects. PPAs allow businesses to access renewable energy without the upfront costs of installation and maintenance, while supporting the growth of renewable energy infrastructure (Al-Shetwi, 2022).

3) Energy Storage Systems: Deploy energy storage systems such as batteries or pumped hydro storage to store excess renewable energy for later use. Storage systems enhance the reliability and stability of renewable energy sources, enabling better integration into operations and logistics (Al-Shetwi, 2022).

4) Energy Efficiency Improvements: Prioritize energy efficiency measures to reduce overall energy demand and optimize the performance of renewable energy systems. Implement lighting upgrades, HVAC system improvements, and equipment retrofits to minimize energy consumption and maximize renewable energy utilization (Al-Shetwi, 2022).

5) Smart Grid Integration: Integrate renewable energy systems with smart grid technologies to optimize energy distribution and consumption. Utilize demand response programs, energy management systems, and grid-connected inverters to balance supply and demand dynamically, leveraging renewable energy resources effectively (Le Guen et al., 2018).

6) Fleet Electrification: Transition fleet vehicles to electric or hybrid models powered by renewable energy sources. Invest in electric vehicle (EV) charging infrastructure and fleet management software to optimize charging schedules and routes, reducing fuel costs and emissions associated with transportation operations (Al-Shetwi, 2022).

7) Green Building Design: Design or retrofit facilities to meet green building standards and certifications, incorporating renewable energy generation, energy-efficient HVAC systems, and passive design strategies. Construct buildings with high-performance insulation, efficient lighting, and daylighting to minimize energy demand and reliance on non-renewable sources (Le Guen et al., 2018).

8) Carbon Offsetting: Offset remaining carbon emissions from operations and logistics through investments in carbon offset projects such as reforestation, renewable energy development, or methane capture. Partner with reputable offset providers and transparently communicate offsetting efforts to stakeholders (Al-Shetwi, 2022).

4. Collaboration & Transparency

Foster strong relationships with suppliers by collaborating on identifying and implementing sustainability improvements throughout the supply chain. Open communication and knowledge sharing are essential for achieving shared goals and fostering a culture of continuous improvement (Mason, 2020). Additionally, prioritize transparency by publicly disclosing sustainability efforts and performance metrics. This builds trust with stakeholders and demonstrates your commitment to responsible practices (Silvius & Schipper, 2019).

4.1 The Synergy of Collaboration:

1) Shared Sustainability Goals & Joint Initiatives: Collaborative partnerships enable the development of mutually beneficial sustainability goals across the entire supply chain. This collaborative approach fosters a sense of collective responsibility and facilitates progress towards shared environmental and social objectives. Joint initiatives, such as implementing eco-

friendly packaging solutions or reducing carbon footprints within transportation networks, demonstrate the power of collective action (Brun et al., 2020).

2) Knowledge Sharing & Collaborative Innovation: Collaboration fosters a dynamic knowledge-sharing environment. Businesses can learn from each other's sustainability best practices, explore innovative technologies jointly, and co-create solutions to address critical environmental and social challenges faced within the supply chain (Mason, 2020). This cross-pollination of ideas fosters a culture of continuous improvement and accelerates progress towards a more sustainable future.

3) Proactive Risk Mitigation & Enhanced Supply Chain Resilience: Collaborative partnerships empower businesses to proactively mitigate risks. By openly communicating potential disruptions or resource scarcity challenges, stakeholders can develop contingency plans and ensure supply chain continuity in the face of unforeseen circumstances (Brun et al., 2020). This collaborative approach enhances overall supply chain resilience and strengthens the network's ability to adapt to evolving market dynamics.

4.2 Transparency: Building Trust and Accountability

1) Open Communication & Information Sharing: Transparency is the cornerstone of trust and accountability within the supply chain. Businesses committed to sustainability should openly communicate their sustainability goals, progress metrics, and any challenges encountered with all stakeholders – suppliers, customers, and investors alike (Mason, 2020). This transparency fosters trust and strengthens stakeholder relationships.

2) Supply Chain Visibility & Traceability: Implementing robust traceability systems empowers businesses to track materials and products throughout their journey within the supply chain. This granular visibility allows for informed decision-making, facilitates the identification of potential issues like unethical sourcing practices, and ensures responsible production processes throughout the network (Mason, 2020).

3) Stakeholder Engagement & Feedback Integration: Creating open communication channels with stakeholders allows businesses to receive valuable feedback on their sustainability efforts. This feedback is instrumental in driving continuous improvement and ensuring alignment with evolving stakeholder expectations. Integrating this feedback into business practices demonstrates responsiveness and a commitment to responsible operations (Silvius & Schipper, 2019).

4.3 The Competitive Advantage of Collaboration and Transparency:

1) Enhanced Sustainability Performance: Collaboration and transparency are key drivers of improved sustainability performance across the entire supply chain. Working together with stakeholders allows for a more holistic approach, tackling critical issues like climate change, resource depletion, and ethical labor practices with greater collective impact. This collaborative effort fosters a more sustainable future for all stakeholders.

2) Increased Supply Chain Resilience: Open communication and information sharing pave the way for proactive risk mitigation and faster response times to disruptions. This collaborative approach strengthens the supply chain's resilience and adaptability, allowing it to navigate unforeseen challenges with greater agility.

3) Improved Brand Reputation & Customer Loyalty: Consumers are increasingly drawn to brands demonstrating a commitment to sustainability. Implementing collaborative and transparent practices builds trust and strengthens brand reputation, leading to increased customer loyalty and a competitive advantage in the marketplace.

MITIGATING GREENHOUSE GAS EMISSIONS IN THE SUPPLY CHAIN: A MULTI-PRONGED APPROACH

Mitigating greenhouse gas emissions is a crucial aspect of environmental sustainability in supply chains. The strategies outlined in the previous section, such as sustainable procurement, sustainable product design, and transportation optimization, all contribute to reducing greenhouse gas emissions.

The imperative for businesses to minimize their environmental impact has become increasingly clear. This section explores a comprehensive framework for mitigating greenhouse gas (GHG) emissions across the entire supply chain. This framework addresses multiple aspects such as transport, energy use, and waste management to identify and implement strategies for reducing emissions at each stage of the supply chain, from sourcing materials to product delivery. Implementing strategies to reduce greenhouse gas emissions across the entire supply chain is essential for organizations to minimize their environmental impact. Furthermore, integrating sustainability practices into the supply chain can also lead to cost savings and operational efficiencies.

A. Transportation Optimization: Achieving Efficiency Through Logistics Innovation

Innovations in transportation optimization, particularly in logistics, play a vital role in enhancing efficiency. Studies highlight various strategies such as Collaborative Logistics (CL), chemical reaction optimization (CRO), and Blockchain technology to streamline supply chain networks and reduce costs while minimizing (Ghomi et al., 2023; Islam et al., 2020; Kiani Mavi et al., 2022). Implementing these strategies can lead to optimized route planning, reduced fuel consumption, and lower greenhouse gas emissions in transportation operations. These innovations focus on optimizing truck-goods assignments, improving transportation scheduling, and enhancing visibility across global supply chains. By leveraging technologies like artificial intelligence, machine learning, and blockchain, companies can achieve resilient and sustainable transport networks that operate effectively even during crises like COVID-19 pandemic. Implementing efficient logistic systems for handling solid municipal waste is also crucial, requiring the development of relevant models and algorithms for waste transportation and recycling. Overall, integrating innovative approaches in logistics is essential for achieving operational excellence and cost-effectiveness in transportation networks. Implementing efficient logistic systems and adopting innovative approaches in transportation optimization is crucial for businesses to minimize their environmental impact and achieve operational excellence.

B. Clean Energy Adoption: Powering the Supply Chain with Sustainability

Clean energy adoption is a key strategy for greening the supply chain and reducing greenhouse gas emissions. By transitioning to renewable energy sources such as solar, wind, and hydroelectric power, organizations can significantly decrease their carbon footprint and reliance on fossil fuels (Xin et al., 2022). This transition can be achieved through various means, including installing solar panels at facilities, utilizing electric vehicles for transportation, and partnering with renewable energy providers. Adopting clean energy in the supply chain is crucial for sustainability and reducing environmental impact (Huang et al., 2023; Sharma et al., 2023; Wangsa et al., 2022). It not only helps in reducing greenhouse gas emissions but also promotes energy independence and resilience. By generating renewable energy on-site, companies can reduce their dependence on fossil fuel-generated electricity and contribute to a cleaner energy grid (Patel et al., 2022). This transition to clean energy in the supply chain requires collaboration between stakeholders, including suppliers, manufacturers, logistics providers, and customers. Studies highlight the benefits of investing in green technologies for transportation and warehousing, showcasing cost savings, emission reductions, and lead-time improvements (Waqas et al., 2022). Implementing clean energy adoption in the supply chain is not only beneficial for the environment but also helps organizations achieve operational excellence and cost-effectiveness. Implementing clean energy adoption in the supply chain is crucial for sustainability, reducing greenhouse gas emissions, and minimizing environmental impact. It is important for organizations to prioritize clean energy adoption in their supply chains as a key strategy for achieving sustainability goals, reducing greenhouse gas emissions, and minimizing environmental impact. Furthermore, the importance of incorporating sustainable practices like lean, green, and agile supply chain strategies is evident in promoting green innovation, competitive advantage, and sustainable firm performance. Overall, leveraging clean energy sources and sustainable practices not only drives environmental benefits but also enhances operational efficiency and long-term viability in the supply chain. Implementing clean energy

adoption in the supply chain is crucial for organizations to achieve sustainability goals, reduce greenhouse gas emissions, and minimize environmental impact (Patel et al., 2022).

C. Production Process Efficiency: Minimizing Environmental Impact at the Source

Efficient production processes play a crucial role in minimizing environmental impact at the source. By focusing on resource efficiency, companies can reduce their ecological footprint and conserve natural resources (Krämer & Engell, 2018). This can be achieved through strategies such as optimizing production processes, implementing waste reduction measures, and promoting the use of renewable materials (Patel et al., 2022). Environmental requirements are increasingly shaping manufacturing practices, with a significant impact on areas like metallurgical technologies (Besta et al., 2022). Additionally, the adoption of circular economy principles can further enhance production process efficiency by promoting the reuse and recycling of materials, reducing waste generation, and minimizing the consumption of virgin resources. Implementing models like the two-stage DEA approach can help in reducing undesirable outputs and enhancing efficiency in environmental units within the production process (Zoriehhabib et al., 2021). Greening the supply chain through clean energy adoption and production process efficiency is vital for organizations to achieve sustainability goals, reduce greenhouse gas emissions, and minimize environmental impact (Patel et al., 2022). Incorporating environmental impact assessments in all phases of process chain planning, considering energy and resource efficiency, is vital for sustainable production and minimizing environmental impact (Denkena et al., 2022).

Eco-efficiency process-improvement methods, combining life cycle assessment results and production costs, can identify areas for improvement and trade-offs, guiding the eco-design of new processes and products (Piccinno et al., 2018). Overall, a holistic approach to production process efficiency is essential for mitigating environmental impact from the outset. Incorporating environmental impact assessments and adopting eco-efficiency process-improvement methods can help organizations minimize their ecological footprint and promote sustainability in the production chain (Miah et al., 2015). In conclusion, implementing strategies for production process efficiency is crucial for minimizing environmental impact at the source (Zailani et al., 2012).

The prior section meticulously outlined a multi-pronged framework for mitigating greenhouse gas emissions throughout the entire supply chain. This framework emphasized a holistic approach, focusing on critical areas such as transportation optimization, clean energy adoption, and production process efficiency. While these strategies provide a robust roadmap for emission reduction, their successful implementation requires practical considerations and real-world applications.

LEVERAGING TECHNOLOGICAL INNOVATIONS FOR SUSTAINABLE SUPPLY CHAINS

The adoption of cutting-edge technologies has emerged as a crucial enabler for organizations to achieve their sustainability goals within their supply chain operations. These innovative solutions offer a range of benefits, from enhancing traceability and transparency to optimizing logistics and minimizing environmental impact. Three prominent technologies driving sustainability in supply chains are blockchain, artificial intelligence (AI), and the Internet of Things (IoT). Table 1. show the impact of technological innovation on sustainable supply chain.

Table 1. Impact of Technological Innovations on Sustainable Supply Chains

Technology	Benefits	Challenges
Blockchain	- Improved traceability & provenance - Enhanced transparency & accountability - Facilitated compliance with sustainability standards (Kouhizadeh et al., 2021; Saberi et al., 2019)	- Interoperability issues - Scalability concerns - Resistance to adoption (Kshetri, 2021)

Table 2. (Cont.)

Technology	Benefits	Challenges
Artificial Intelligence	- Optimized transportation routes & fleet management - Reduced fuel consumption & emissions - Improved inventory management & demand forecasting (Sanders et al., 2019)	- Data quality & availability concerns - Integration with existing systems - Skilled workforce requirements (Nozari et al., 2022)
Internet of Things	- Real-time environmental monitoring - Identification of inefficiencies & improvement opportunities - Facilitated compliance with environmental regulations (Yang et al., 2022)	- Cybersecurity & data privacy concerns - Interoperability issues - Upfront costs (Yang et al., 2022)

Successful implementation of these technological innovations requires careful planning and a strategic approach. Organizations should assess their specific supply chain needs, identify potential use cases, and develop a roadmap for adoption. Additionally, fostering collaboration with technology providers, building in-house expertise, and ensuring data security and privacy are crucial for realizing the full potential of these innovations in achieving sustainable supply chain operations.

CASE STUDIES AND BEST PRACTICES

Companies can look to successful case studies and best practices for guidance on how to effectively implement strategies for production process efficiency and minimize environmental impact. For example, in the automotive industry, companies like Tesla have successfully implemented sustainable manufacturing practices by focusing on energy efficiency, reducing waste through recycling and reusing materials, and implementing renewable energy sources in their production facilities. Additionally, companies like Patagonia have prioritized sustainability in their supply chain by implementing initiatives like the Worn Wear program, which promotes the repair and reuse of products to extend their lifespan and reduce the need for new production. Implementing strategies for production process efficiency requires a comprehensive approach that considers energy and resource efficiency, incorporates environmental impact assessments, and utilizes eco-efficiency process-improvement methods (Miah et al., 2015).

Case Studies in Sustainable Supply Chain Leadership

Case studies in sustainable supply chain leadership provide valuable insights into overcoming barriers and enhancing sustainability practices across various industries. Studies like those focusing on multi-tier food supply chains (Oyedijo et al., 2024), heavy vehicle and equipment industry (Shekarian et al., 2022), shed light on the challenges faced and strategies employed. These cases highlight the importance of factors such as ethical leadership, circular supply chain practices, and alignment with sustainability practices within the entire supply chain. By examining these case studies and best practices, companies can gain insights into the strategies and approaches that have been successful in promoting sustainability in supply chains. These case studies offer practical implications for managers to improve sustainability performance, address barriers, and optimize sustainable supply chain management strategies that show in Table 2.

Table 3. Sustainability Case Studies

Company	Challenge	Strategies	Impact
Patagonia (O'Rourke & Strand, 2017; Schillmann, 2020)	Minimize environmental footprint and ensure ethical sourcing in the garment industry	- Focus on durable, repairable products - Take-back and repair programs - Use of recycled materials - Ethical sourcing	Pioneer in circular economy practices and ethical labor standards in apparel industry
Tesla (Palmié et al., 2024; Yahdiyani et al., 2023)	Revolutionize transportation sector by reducing fossil fuel reliance	- Developing and manufacturing electric vehicles - Investing in battery technology - Building charging infrastructure	Disruptive force accelerating shift to electric vehicles and fostering sustainable automotive industry
Unilever (Murphy & Murphy, 2018)	Integrate sustainability across vast, complex multi-product supply chain	- Setting sustainability goals - Sustainable sourcing - Eco-friendly packaging - Consumer education	Benchmark for implementing comprehensive sustainability framework across global supply chains

These case studies that present in table 1 show how leading companies are implementing innovative strategies to achieve environmental and social responsibility. Remember, continuous improvement is essential. By learning from these leaders and adapting their successful approaches to your specific context, you too can contribute to building a more sustainable future.

Table 4. Thailand Sustainability Case Studies

Company	Strategies	Benefits	Challenges
Mitr Phol Sugar Group (Manivong & Bourgois, 2017)	- Precision farming techniques -Optimized resource usage (water, fertilizer) - Promotion of biodiversity - Renewable energy (biomass power)	-Reduced water consumption (30%) - Lower greenhouse gas emissions (25%) - Cost savings	- Training & capacity building for small farmers - Incentive programs for adoption
Indorama Ventures (Brooks et al., 2019)	- Recycled materials in production - Energy-efficient technologies - Responsible waste management - Renewable energy (solar power) - Bio-based & biodegradable packaging	- Reduced energy consumption - Lower water usage - Less waste generation - Competitive advantage (sustainable products)	- Coordination & training across facilities & suppliers - Investment in new technologies

These case studies (Table 3) highlight the real-world benefits of implementing sustainability strategies within Thai supply chains, such as resource efficiency, cost savings, and reduced environmental impact. They also demonstrate the challenges faced by companies in different sectors and the lessons learned, providing practical insights for readers interested in adopting sustainable supply chain practices.

BEST PRACTICES FOR BUILDING A SUSTAINABLE SUPPLY CHAIN
The table 5. present best practices for sustainable supply chain management. These practices can be categorized into four main areas: supplier engagement, supply chain transparency, optimizing for efficiency and circularity, and investing in green technologies.

Table 5. Sustainable Supply Chain Management: Key Practices

Best Practice	Description
Supplier Engagement	Conduct regular audits, establish collaborative partnerships, foster shared goals and accountability with suppliers (Correia et al., 2024)
Supply Chain Transparency	Map your supply chain, cultivate open communication with stakeholders to build trust and encourage collaboration (Shekarian et al., 2022).
Optimizing for Efficiency & Circularity	Conduct life cycle assessments, embrace circular economy principles by designing reusable and recyclable products (Correia et al., 2024)
Investing in Green Technologies	Explore energy-efficient technologies, renewable energy sources, and waste reduction programs (Correia et al., 2023).
Building a Broader Commitment	Partner with NGOs and sustainability organizations, implement data-driven practices to measure progress and ROI (Centobelli et al., 2023)

NAVIGATING THE GREEN PATH: CHALLENGES AND OPPORTUNITIES IN SUSTAINABLE SUPPLY CHAINS
The imperative for sustainability has become a cornerstone principle in modern supply chain management. Environmental concerns, consumer demands for eco-friendly products, and the need for long-term business resilience are driving organizations to adopt environmentally conscious practices. This shift presents a complex landscape with significant challenges, but also remarkable opportunities for those who embrace it.

Table 6. Sustainable Supply Chain Challenges and Opportunities

Category	Challenge	Opportunity	Benefit
Economic	Upfront investments in clean technologies, renewable energy, and responsible sourcing (Moxnes, 2023)	Implement eco-friendly technologies, sustainable materials, and circular economy principles (Correia et al., 2023)	Long-term cost savings through resource efficiency
Transparency	Difficulty tracking environmental impact across complex supply chains (Leal Filho et al., 2022)	Build robust traceability programs and collaborate with suppliers (Sarwar et al., 2021).	Enhanced brand reputation through demonstrably responsible practices

Table 7. (Cont.)

Category	Challenge	Opportunity	Benefit
Collaboration	Aligning interests of diverse stakeholders (Zarte et al., 2022)	Foster clear communication, a shared vision, and mutually beneficial solutions (Giuffrida & Mangiaracina, 2020).	Increased customer loyalty through transparency and ethical practices
Consumer Behavior	Price sensitivity and lack of awareness hindering market success of sustainable products sourcing (Moxnes, 2023).	Educate consumers about the value proposition and environmental benefits (Patel et al., 2022).	Competitive advantage by differentiating as environmentally responsible

In conclusion, while there are significant challenges on the road to sustainability, there are abundant opportunities for businesses that embrace sustainable supply chain practices. By addressing the challenges and seizing the opportunities, businesses can build a sustainable supply chain that not only benefits the environment and society but also leads to long-term business success.

POLICY AND REGULATORY LANDSCAPE FOR SUSTAINABLE SUPPLY CHAINS IN THAILAND

Thailand's commitment to sustainable development extends to its supply chains, evident in a robust policy framework. The National Economic and Social Development Plan prioritizes responsible resource management and green technologies across industries.

Government Agencies: The Ministry of Industry, through the Department of Industrial Works, spearheads sustainability efforts by establishing regulations promoting eco-friendly practices, waste management, and energy efficiency across sectors like automotive, electronics, and food processing. The Ministry of Energy complements these efforts by offering incentives that encourage businesses to adopt renewable energy sources in their supply chain operations. Additionally, the Ministry of Agriculture and Cooperatives plays a vital role in promoting sustainable agricultural practices, organic farming, and responsible resource utilization within the agricultural supply chain.

Industry Associations: Industry associations actively participate in advancing sustainable practices among their members. The Federation of Thai Industries (FTI) provides guidance, training, and support for implementing green supply chain initiatives encompassing sustainable sourcing, eco-friendly production processes, and responsible waste management. Similarly, sector-specific associations such as the Thai Automotive Industry Association (TAIA) (Ghazali et al., 2011) and the Thai Electrical and Electronics Institute (EEI) encourage sustainable practices within their respective domains (Manomaivibool & Vassanadumrongdee, 2011), focusing on areas like the use of eco-friendly materials, energy-efficient manufacturing, and responsible end-of-life vehicle and e-waste management, respectively.

International Standards: Thailand demonstrates its commitment to global best practices by adopting international sustainability standards. The ISO 14001 standard for environmental management systems (Bravi et al., 2020) provides a framework for businesses across sectors to measure and improve their environmental performance within their supply chains. Additionally, the Global Reporting Initiative (GRI) standards for sustainability reporting (Petera & Wagner, 2015) have been embraced by Thai companies, enhancing transparency and accountability in their sustainability practices and supply chain operations.

RECOMMENDATIONS FOR POLICYMAKERS

To further solidify Thailand's position as a leader in sustainable supply chain management, policymakers can consider several recommendations.

1) Strengthen environmental regulations and enforcement mechanisms to ensure compliance across all sectors and supply chain stages, including stricter penalties for non-compliance.

2) Introduce financial incentives, such as tax breaks or subsidies, for businesses investing in sustainable technologies, renewable energy sources, and eco-friendly supply chain practices.

3) Facilitate public-private partnerships and collaborations between government agencies, industry associations, and businesses to promote knowledge sharing, technology transfer, and best practice adoption in sustainable supply chain management.

4) Support the development of eco-industrial parks and green logistics hubs, providing infrastructure and incentives to create sustainable supply chain ecosystems.

5) Enhance stakeholder engagement and public awareness campaigns to increase consumer demand for sustainable products and services, driving market-based incentives for businesses to adopt green supply chain practices.

6) Encourage the adoption of international sustainability standards and certifications, such as ISO 14001 and GRI, to align Thai supply chains with global best practices and facilitate integration into international markets.

By leveraging the roles of government agencies, industry associations, and international standards, and implementing policy recommendations, Thailand can create a conducive environment for businesses across sectors to prioritize sustainability in their supply chain operations.

GLOBAL SUPPLY CHAIN INTERCONNECTIONS AND THAILAND'S ROLE IN THE GLOBAL SUSTAINABILITY LANDSCAPE

Thailand's Role in Global Sustainable Supply Chains

As a major manufacturing and exporting hub, Thailand's sustainability practices have far-reaching implications that extend beyond its borders. The country's supply chain ecosystem is deeply interconnected with global supply chain dynamics, influenced by international standards, collaborations, and market demands.

Aligning with International Standards and Certifications

To maintain competitiveness in global markets, Thai companies have recognized the importance of adhering to internationally recognized sustainability standards and certifications. These include the ISO 14001 environmental management system standard (Bravi et al., 2020), the Global Reporting Initiative (GRI) sustainability reporting framework (Petera & Wagner, 2015), and industry-specific certifications like the Responsible Business Alliance (RBA) Code of Conduct for the electronics industry (Neves, 2018).

Compliance with these standards not only enhances credibility and transparency but also facilitates integration into global supply chains, where sustainability performance is increasingly scrutinized by multinational corporations and conscious consumers.

Fostering International Collaborations

Sustainable supply chain management requires a collaborative approach that transcends national boundaries. Thailand has actively participated in international initiatives and partnerships aimed at promoting sustainability in supply chains.

For instance, the Thai government has partnered with the United Nations Development Programme (UNDP) to implement the Thailand Sustainable Supply Chain Transformation (Thai-SSCT) project, which aims to enhance the competitiveness of Thai businesses by adopting sustainable practices across various industries, including agriculture, manufacturing, and tourism.

Additionally, Thai companies have collaborated with global organizations such as the World Business Council for Sustainable Development (WBCSD)(Nelson & Grayson, 2017) and the Sustainable Apparel Coalition (SAC) (Poldner, 2017) to share best practices, access research and resources, and contribute to the development of industry-wide sustainability frameworks.

Contributing to Global Sustainability Initiatives
Thailand's efforts towards sustainable supply chains also contribute to broader global sustainability initiatives and goals. For example, the country's commitment to reducing greenhouse gas emissions and transitioning to renewable energy sources aligns with the Paris Agreement's objectives and supports the United Nations' Sustainable Development Goals (SDGs)(Carlsen & Bruggemann, 2022), particularly those related to climate action and responsible consumption and production.

Furthermore, Thailand's emphasis on sustainable agriculture practices, such as organic farming and responsible resource management, supports global efforts to ensure food security and promote sustainable food systems.

By aligning with international standards, fostering collaborations, and contributing to global sustainability initiatives, Thailand can position itself as a responsible and influential player in the global sustainable supply chain landscape. This not only enhances the country's competitiveness and reputation but also contributes to the collective effort towards a more sustainable and resilient global economy.

IMPLICATIONS AND FUTURE RESEARCH
The long-term viability of Thailand's manufacturing sector hinges on a comprehensive approach to sustainability. Strategic investments in renewable energy technologies, the implementation of environmentally friendly manufacturing processes, and the adoption of digitalization and smart technologies are paramount. Additionally, exploring the use of sustainable materials and packaging, promoting sustainable agricultural practices, and bolstering climate change adaptation strategies are crucial for solidifying Thailand's position as a leader in sustainable manufacturing.

To further solidify Thailand's position as a leader in sustainable manufacturing, future research initiatives should prioritize three key areas:

1. Optimizing Sustainable Supply Chain Management:
    - Develop and implement energy-efficient Internet of Things (IoT) solutions tailored for supply chain monitoring and optimization.
    - Expand the scope and applications of sustainable green logistics and remanufacturing practices to enhance efficiency and reduce environmental impact.
    - Refine frameworks for measuring and evaluating the sustainability of supply chains to ensure accurate assessment and continual improvement.

2. Enhancing Renewable Energy Systems:
    - Research methods to optimize the economic operation of renewable energy systems, with a focus on maximizing efficiency and cost-effectiveness.
    - Explore the development of intelligent power-routing microgrid frameworks to create a more resilient and sustainable energy infrastructure.

3. Fostering Greener Technologies and Business Practices:
    - Emphasize the pivotal role of knowledge, innovation, and entrepreneurship in driving the development and adoption of sustainable technologies.
    - Investigate strategies for the decarbonization of manufacturing operations to mitigate environmental impact and promote sustainability.
    - Explore the implementation of circular economy models within Thailand's manufacturing sector to minimize waste and maximize resource efficiency.
    - Research the digitalization of logistics and supply chain management to facilitate the adoption of climate-neutral business practices and enhance overall sustainability.

Focusing research efforts on these critical areas will not only bolster Thailand's leadership in sustainable manufacturing but also pave the way for a more environmentally sustainable future

CONCLUSION

The integration of sustainability into supply chain management has evolved into an imperative in today's business landscape. Environmental concerns, coupled with consumer demands and the pursuit of long-term resilience, have reshaped organizational priorities, rendering the adoption of green practices across supply chains not merely an option but a necessity.

This comprehensive study underscores the critical importance of sustainable supply chain practices, encompassing sustainable procurement, product design, optimized logistics, clean energy adoption, and waste reduction strategies. Through the implementation of these approaches, organizations can effectively address environmental challenges, curb greenhouse gas emissions, and transition towards greener and more responsible supply chain operations.

The benefits of integrating sustainability into supply chains are diverse, spanning from enhanced brand reputation and increased customer loyalty to cost savings through resource efficiency, improved risk management, fostered innovation, and a competitive advantage in the marketplace. Case studies of industry leaders exemplify the potential of pioneering sustainable models, such as circular economies, renewable energy integration, and comprehensive green frameworks.

Thailand, as a major manufacturing and export hub, plays a pivotal role in accelerating the transition towards more sustainable supply chains. The country's contributions across industries like automotive, electronics, and agriculture position it as a leader in embracing sustainable practices within its supply chain ecosystems. This not only aligns with rising consumer expectations but also solidifies Thailand's reputation as a responsible steward of environmental stewardship on the global stage.

Despite persistent challenges, including economic barriers, transparency issues, and complexities in stakeholder collaboration, the opportunities presented by sustainable supply chains are significant and far-reaching. Addressing these challenges through collaborative efforts, policy support, and the adoption of innovative technologies can unlock the full potential of sustainable supply chain management.

As the world grapples with pressing issues like climate change, resource depletion, and environmental degradation, the imperative for sustainable supply chain practices has never been more evident. Therefore, it is imperative for organizations, policymakers, and stakeholders to embrace this paradigm shift, fostering a more sustainable and resilient future for supply chains, businesses, and the planet we share.

Recommendations

To advance sustainable supply chain practices, collaborative efforts among stakeholders are essential. Addressing transparency issues and promoting information sharing across supply chains can foster a culture of collaboration, leading to more effective implementation of sustainable practices. Additionally, policymakers should consider implementing incentives to encourage businesses to adopt sustainable practices. This could include tax incentives for investments in environmentally friendly initiatives or subsidies for companies transitioning to renewable energy sources. By aligning financial incentives with sustainability goals, governments can accelerate the adoption of green practices in the business sector. Furthermore, investments in research and development are crucial for driving innovation in sustainable technologies and practices. Particularly, focusing on areas such as renewable energy integration and circular economy models can pave the way for more efficient resource utilization and waste reduction. Industry-wide initiatives and partnerships are also key to scaling up sustainable supply chain practices. By collaborating across sectors, businesses can share best practices, pool resources, and collectively work towards achieving sustainability goals. Lastly, enhancing education and awareness programs is essential for empowering stakeholders with the knowledge and skills needed to embrace sustainable supply chain practices effectively. By providing training and

educational resources, organizations can ensure that individuals are equipped to make informed decisions and contribute to positive environmental outcomes.

CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest found in this research.

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RESPONSES TO DIGITAL HUMAN RESOURCE MANAGEMENT MODEL: SUGGESTIONS FROM DISRUPTIVE INNOVATION THEORY

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ABSTRACT

Purpose – Considering the popularity of digital technologies, the study aims to provide additional perspective of why managers have low commitment to digital human resource management (HRM) model and how they should interpret and respond to this model.

Body of knowledge – The study indicates that rushing to adopt digital HRM model is not encouraged, even though the model has potential benefits in terms of organizational efficiency and employee experience. However, the ignorance of its usage possibilities can make HR managers and professionals lose their control over HR activities to other business units.

Implications – Managers need to understand the driving factors of digital HRM model, do critical analysis of its relation to the current business model, and evaluate potential impacts of its adoption on the organization. Based on these analyses, managers can establish a suitable response plan to the disruption, which can range from ignorance at the first time to full integration in the long run.

Originality/Value – The emergence of digital technologies have disrupted the way organization operate their internal business processes. Compared to other functions, human resource management is likely to be overlooked in organization's digital transformation plan, even though human resource is considered to be an important resource for its competitive advantages in today's uncertain and fast changing world. The study contributes to drawing additional attention to the importance of digital HRM in organization's digital transformation plan and provides additional perspective to interpret and implement digital HRM.

Keywords: Digital HRM, Disruptive innovation, Managerial responses

INTRODUCTION

Digital technologies can be defined through three distinct but related elements—digital artifacts, digital platforms, and digital infrastructures (Nambisan, 2017). Digital artifacts are objects of which embedded functionalities are activated or edited by interaction with users and other digital objects, or by re-arrangement of their items and contents (Kallinikos et al., 2013). Applications, hardware or software are examples of how digital artifacts look like (Nambisan, 2017). Digital platforms are software-based systems that provide shared service or functionality for complementary software interoperating with them (Tiwana et al., 2010) such as Apple iOS or Google Android (Nambisan, 2017). Digital infrastructures refer to "digital technology tools and systems that provide communication, collaboration, and/or computing capabilities such as cloud computing, data analytics, online communities, social media, or 3D printing" (Nambisan, 2017: 1032).

Digital technologies have disrupted many industries and shifted the way organizations operate from traditional to more innovative models (Paul et al., 2023). They support organizations to improve customer experience process, leverage core competencies (Zhang and Chen, 2023), and

create new possibilities (Paul et al., 2023). In terms of HR function, the application of digital technologies can make HR processes more distinctive, efficient and consistent (Bondarouk et al., 2017b), thereby creating value for targeted employees and organizations (Bondarouk & Ruel, 2009). However, compared to other functions, human resource management (HRM) still has been lagging behind in terms of digital adoption or transformation (Thite, 2022). Low managerial commitment to HR digital transformation can be attributed to the lack of robust and consistent empirical evidence on the benefits of digital technologies for HRM processes and organizations (Bondarouk et al., 2017b; Vrontis et al., 2022). It can also be resulted from managers' personal factors such as capability, experience or perception, which has attracted inadequate attention in HR literature. Moreover, despite different possibilities brought by different types of digital HRM technologies, the role of types and characteristics of digital HRM in explaining the inconsistent effects of digital HRM and the ways to integrate digital HRM into traditional HRM system have been discussed to a limited extent (Priyashantha, 2023; Zhou & Zou, 2023).

Considering this background, by drawing upon the disruptive innovation theory and integrating this theory with current literature on digital HRM, the study aims to provide additional insights about factors leading to managerial ignorance of digital HRM adoption and practical implications for managers on how to effectively respond to HRM digitalization pressure. To achieve this goal, the study is organized into three parts. The first part is an overview of different types and characteristics of disruptive innovation. The second part is a general discussion about different possible responses to disruptive business models and factors underlying managers' non-response to disruptive innovation. Finally, based on these two sections, digital HRM is critically evaluated whether it is a disruptive innovation and then managerial implications for better responses to these disruptive changes are given.

METHODOLOGY

The study adopts research design for conceptual papers suggested by Jaakkola (2020). First, the disruptive innovation theory is selected as domain theory because it enhances understanding of digital HRM adoption and implementation. It does not only explain managerial paradoxes (Sandström et al., 2014) but also provide useful guidelines to avoid managerial myopia (Kim & Mauborgne, 2019) in adopting innovations, which are not explicitly mentioned in other adoption models such as TAM (technology acceptance model), IDM (innovation diffusion model) or TOE (technology, organization, environment, and people). Disruptive innovations bring both opportunities and challenges for organizations (Cozzolino et al., 2018; Kim & Mauborgne, 2019) and so does digital HRM. Through automation, information and collaboration (Theres & Strohmeier, 2023), digital HRM can generate positive outcomes such as employee productivity (Iqbal et al., 2019), organization innovation (Jani et al., 2023); HRM efficiency and effectiveness (William & Singh, 2023). However, it also creates problems such as increasing work-related stress (Blom et al., 2019), reducing quality of communication and social relationship in organizations (Chugunova & Danilov, 2022), or enhancing social discrimination (Tambe et al., 2019). Second, the study searched the Web of Science, Scopus and citations for relevant literature. The study used keywords "disruptive innovation theory" to identify articles that define characteristics and types of disruptive innovations, and provide ways to respond to disruptive innovations. The study then used keywords ("Digital human resource*" OR "digital* HRM" OR "e-HRM" OR "electronic human resource*" OR "HRM digitalization" OR "smart HRM" OR "smart human resource management") to search articles related to types of applied technologies and consequences of digital HRM. Since literature review is not the study's ultimate goal, the study used topic modeling software (Mallet) to analyze abstracts of identified articles and select articles that are highly correlated to the study's selected concepts and arguments.

Disruptive innovation

Innovation can be defined in different ways, yet in general, it refers to the process of creating and implementing something new or novel (Anderson et al., 2014). It is considered to be the key to competitive advantage in today's world of uncertainty and continuous change (Assink, 2006). It creates significant value to new entrants, yet it also generates disruption or disastrous effects on

the existing players in the market (Kim & Mauborgne, 2019). Specifically, although rapid advancements in digital technologies enable more innovative solutions for organizations, they also increasingly impose pressures on organizations to anticipate disruption in order to stay ahead of competitors and to retain customers (McCausland, 2023). This paradox may explain why disruption and innovation are often mistaken to be the same (Kim & Mauborgne, 2019) and Christensen et al. (2015) worried that disruptive innovation might have been wrongly labelled for "any situation in which an industry is shaken up and previously successful incumbents stumble". Managers and practitioners are even warned that disrupting industries or even their own companies is the only way to survive, succeed and grow (Kim & Mauborgne, 2019). This misperception about innovation, disruption and disruptive innovation make organizations overlook other types of innovations (Kim & Mauborgne, 2019) that ranges from incremental or sustainable innovation (remodeling functionality) to radical or disruptive innovation (breakthrough, paradigm shift) (Assink, 2006). More importantly, this misperception can make managers end up using the wrong tools for their context, thereby reducing their chances of success (Christensen et al., 2015:46).

To avoid misunderstanding and ineffective application, Christensen and other original authors reemphasized two basic characteristics of disruptive innovations. First, disruptive innovations arise in two overlooked markets by incumbents: low end market and new market. Low-end market refers to customers who are price sensitive and look for good enough products or services, and are not willing or unable to pay for additional product attributes (Droege & Johnson, 2010). New market refers to non-consumers who are turned into consumers of specific products and services (Christensen et al., 2015). Second, disruptive innovations are initially considered inferior by mainstream customers, but then successfully penetrate into mainstream markets when their performance improves over time (Christensen et al., 2015). These characteristics provide two important implications. First, the theory implies neither guaranteed success for unit of disruptive innovation adoption nor failure of incumbents. Second, the theory does not really classify disruptive innovations, even though it enlists different forms of disruptive innovations such as discount department stores, low price or cheap mass-market products (Markides, 2006). Failure to categorize disruptive innovations into subgroups is problematic because different types of disruptive innovations can occur in different time (Cozzolino et al., 2018), have different potential disruptiveness (Habtay, 2012), thereby providing different competitive effects and requiring different responses from affected actors (Markides, 2006). The following section provides an overview about the three most common types of disruptive innovations have been discussed in literature: technology, product and business model.

Disruptive technologies

Technology generally refers to devices, systems or tools that are used to transform inputs such as labor, capital or information into outputs. Disruptive technologies are technologies that disrupt or redefine the established trajectory of performance improvement. They are initially unappealing to mainstream customers, yet valued in remote or emerging market (Christensen & Bower, 1996). Disruptive technologies are often a result of intensive research and development activities. They are not necessarily related to new products or new market development (Boer & During, 2001). They themselves do not paralyze incumbents, but rather bring opportunities that require the subsequent development of disruptive business model to capture and commercialize (Cozzolino et al., 2018). In other words, the disruptiveness of new technologies can be only achieved when they are integrated within a business model (Osiyevskyy & Dewald, 2015).

Disruptive business model

Business models can be defined as business logic or system of interconnected and interdependent activities (Amit & Zott, 2012) that determines how firms create, deliver, and capture value (Teece, 2010). A new business model is considered to be disruptive when it disrupts or redefines the way or the meaning of value creation and capture (Cozzolino et al., 2018); or when it increases economic benefits for organizations either by attracting new customers or encouraging current customers to purchase more (Markides, 2006).

Disruptive business models do not always require the emergence of disruptive technologies (Cozzolino et al., 2018) or involve new products or services (Markides, 2006). It can be driven by market demand that refers to the redefinition of the established value propositions or the role of firms in existing value chain or market (Habtay, 2012). For example, a company can disrupt the existing market by introducing a low-cost model of which effectiveness is reinforced further by the emergence of internet and digital technology. Media business industry is disrupted by the entry of technology companies such as Google or Facebook when these technology companies redefine how the news is created and revenue is generated (Cozzolino et al., 2018). However, disruptive business model may require time to emerge (Cozzolino et al., 2018) and may not be always superior to the established or traditional one (Christensen et al., 2015).

Disruptive products
Disruptive products are new-to-the-world products. These new products disrupt consumers because they disturb prevailing consumer habits and behaviors in a major way, and disrupt producers because their production requires different competences and complementary assets (Markides, 2006). Disruptive products are simpler, more convenient and less expensive, but inferior to the standards or value proposition of the mainstream customers (King & Baatartogtokh, 2015). They are driven by supply-push processes or those who are responsible for new technologies rather than by demand side (Markides, 2006).

These three types of disruptive innovations are closely related to each other and sometimes hard to separate clearly. Disruptive technologies and disruptive products need to be commercialized through a business model for benefits. This explains why disrupters tend to focus more on getting business models rather than only products (Christensen et al., 2015). Because of its importance and dominance, the following section provides different ways in which managers can response to the emergence of disruptive business models.

DIFFERENT RESPONSES TO DISRUPTIVE BUSINESS MODEL
Although a disruptive business model differs from an established one, it does not mean the former is always superior to the latter. Therefore, assumptions that disruption is the only way to survive, grow and succeed, and rushing to embrace new business models can be detrimental to established companies (Charitou & Markides, 2003). By considering the nature of disruptive innovation and organization's internal and external factors, there are a number of ways in which managers can react to the disruption caused by business model innovation as follow:

Ignore the innovation. It normally takes a long time for a new business model to emerge and function well (Cozzolino et al., 2018). The new model may not be financially attractive to pursue because it requires significantly different skills, competences and assets (Charitou & Markides, 2003). Moreover, the improvement rate of disruptive technologies that drive business model is not as fast as that of sustaining technologies (King & Baatartogtokh, 2015). Therefore, established organizations can ignore disruptive innovation and focus on making their core traditional business more attractive and competitive (Charitou & Markides, 2003). Literature shows that many incumbents with high technology can still be profitable by focusing on satisfying the most demanding but least price sensitive customers and ignoring disruptive innovation. For example, despite the arrival of digital cameras featured with light weight, small size, multiple functions and affordable price, analog cameras business with extremely high-resolution technology still remains profitable by focusing on serving professional photographers better (Yu & Hang, 2009). However, the theory of disruptive innovation suggests that disruptive innovations continue to improve and move upstream to find the next group of customers who provide higher margins and are less price sensitive (Droege & Johnson, 2010). Therefore, it is necessary for organizations to take actions to respond to the disruption in the long run.

Disrupt the disrupter. Because customer values or preferences may not be fully anticipated in advance (cf. Habtay, 2012), it is possible for established organizations to take actions to attack back the disrupters by launching another innovation so as to attract and retain customers. For example, both Apple and Sony responded to the introduction of cheap products in their business by launching and emphasizing style and design as attributes of their products (Charitou &

Markides, 2003). Or in credit card camera industry, the established disrupt the entrants by providing superior offerings (King & Baatartogtokh, 2015).

Adopt new business model. Although a disruptive business model is different from the existing one, the coexistence between these models are possible. In some cases, a new model can even benefit incumbents by allowing them to reach untapped customers (King & Baatartogtokh, 2015). Therefore, the established organizations can exploit opportunities arising from the disruption by either creating a new division (Christensen et al., 2015) or establishing an alliance and acquisition with disruptors and other incumbents (Cozzolino et al., 2018). To reduce potential negative impacts of disruptive models on organizations, some scholars such as Christensen et al. (2015), or Charitou and Markides (2003) suggest that organizations need to separate the new business division from core business and provide the new division with decision making autonomy on its own culture, values, budgetary and investment policies. In contrast, Cozzolino et al. (2018) indicated that integrating the new business model into the current one through enhancing similarity between them can facilitate positive transfer and then synergy between them. The authors also emphasized that alliance and acquisition may provide a faster and more secure way to compete when disruptive business is less likely to be related to traditional core business; and threats from disruption is in its early stage.

Transform into a new business model. It is also feasible for incumbents to abandon their existing ways of doing business and completely embrace the disruptive business model. First, with first-mover advantage or market leader status, it is not too difficult for the established firms to scale up the new model by using their strong financial and marketing resources (Kim & Marborgne, 2019). Moreover, their strong reputation and creditability in the market can make it easier for them to obtain acceptance from existing customers and potential customers for their changes in value propositions (Charitou & Markides, 2003). As a result, their profitability when transforming business model is less likely to be affected.

The way in which organizations respond to disruptive business model depends on their ability and motivation to respond, which are determined largely by the nature and size of conflict between traditional and new business model as well as the improvement rate of innovation (Charitou & Markides, 2003). Details about what kind of responses are suitable for what condition is beyond the scope of this study. However, in general, adopting a disruptive business model should be considered a priority when organizations enter a new market without first mover advantages, when the existing way of doing business is clearly inappropriate, and when organizations aim to scale up its disruptive products to the mass market (Markies, 2006).

MANAGERIAL FACTORS LEADS TO FAILURE OF DISRUPTIVE INNOVATION ADOPTATION

Despite the disruptiveness of disruptive innovations and the availability of different ways to respond, many managers still decide to ignore or fail to take action on this kind of innovation. This kind of managerial decision or reaction can be explained by the effects of uncontrollable external factors such as demographic changes, or institutional and social regimes (King & Baatartogtokh, 2015); the unavailability of enabling and complementary technologies (Petzold et al., 2019); organizational culture, organizational structure (Yu & Hang, 2009), or organizational politics (Henderson, 2006). However, according to the theory of disruptive innovations and related literature, this kind of managerial reaction can also be resulted from managers' own cognitive failures (Henderson, 2006) as below:

Misperception of disruptive innovation. When managers do not perceive disruptive innovations or new offerings as either opportunities or threats, they tend to remain inactive (Petzold et al., 2019) with or without improving their current ways of doing business (Charitou & Markides, 2003). For example, managers of Gillette decided to ignore the threats by disposable razors and focused on improving their competitive positions in the market (Charitou & Markides, 2003). Manager's misperception can be due to the fact that they are too captured or trapped with their current most profitable and demanding customers (Henderson, 2006). It can also be affected by their intuitive sense of the nature of disruptive innovation. Because disruptive innovations

normally starts at small size, managers consider them as inferior (Yu & Hang, 2009) and believe that disrupters cannot compete effectively against them (Henderson, 2006).

Low capabilities. Manager's failure to react to the disruption can result from their low capabilities (King & Baatartogtokh, 2015; Boer and During, 2001) to capture the value of disruptive innovation. For example, Xerox seemed to misunderstand the value of Canon's dry-toner innovation in reducing service costs and customer inconvenience (King & Baatartogtokh (2015). Similarly, despite the availability of analytics tools, HR analytic programs are still mostly used for historical reporting (Angrave et al., 2016), and many managerial decisions are still intuitive rather than data driven (Jewell, 2017). Managers can also be incompetent to manage organizational resources to respond to the disruption or to figure out the connection between the development of disruptive technologies and changes in consumer's latent preference and market conditions (Yu & Hang, 2009). For example, traditional chocolate confectionery fails to detect changes in consumer's latent preferences because they fail to search in broader market peripheral to their current one (Henderson, 2006). Managers who work in relationship management software had overlooked the threat by salesforce.com (King & Baatartogtokh, 2015).

Expectation of failures. In some cases, managers decide to remain inactive because they anticipate difficulties in changing ingrained habits and behaviors of current employees in the organization (Henderson, 2006). Moreover, because the adoption of disruptive innovation often involves risk and may not be profitable (Henderson, 2006), managers ignore the disruption in order to protect their expected rewards and incentives (Yu & Hang, 2009).

Disruption is a process, not an outcome (Christensen et al., 2015). Therefore, although it may not be necessary to make immediate changes in organizations, it is essential for managers to develop a strategic plan and get organizations prepared when facing disruptive innovations.

PRACTICAL IMPLICATIONS FOR RESPONSES TO DIGITAL HUMAN RESOURCE MANAGEMENT

Before providing suggestions for managerial responses to disruption caused by the digital HRM model, the study evaluates digital HRM model against characteristics of a disruptive innovation.

Digital human resource management as disruptive innovation

An early adoption of information technology in HRM was the mechanized employee information system appearing in the 1940s (DeSanctis, 1986). During 1960s and 1970s, the advancement in computing technologies together with the affordability of computers urged organizations to adopt HRIS (human resource information system) – a more sophisticated system to effectively manage personnel data (Kim et al., 2020). Later on, the widespread use of internet and the development of communication technology (Marler & Fisher, 2013) allow organizations to perform their HR activities regardless of time and geographical locations. More recently, more disruptive technologies such as artificial intelligent, robotics, blockchain, the Internet of Things or other advanced SMAC (social, mobile, analytics and cloud) technologies allow organizations to standardize HRM practices and improve the speed and quality of HRM decision-making process by reducing involvement of people (Ulatowska et al., 2023). Different terms such as virtual HRM, web-based HRM or e-HRM have been developed to reflect the continuous applications of digital technologies in HRM field over time. However, digital HRM is considered to be the broadest term to represent all applications of digital technologies to perform HRM practices (Theres & Strohmeier, 2023).

The study considers digital HRM as a disruptive innovation for two main reasons. First, human resource management function is generally overlooked by managers in organization's digital transformation plan (Bondarouk et al., 2017a), despite its importance in building and ensuring organizational capabilities to compete in turbulent business environment. Automation provided by digital HRM allows employees to have more time focusing on high-value tasks (Cooke et al., 2022). Connection through digital platforms such as organization's internal social network or e-learning allows employees to access different training resources both internal and external and learn at their own pace (Hamidianpour et al., 2016; Lin, 2011). Digital connection also

encourages and enables employees to adopt continuous learning as well as facilitates exchange of ideas, information and knowledge among employees (Nayak et al., 2022). As a result, organizations can improve their learning capabilities to adapt to changing business environment (Njoku and Ebie, 2015). Al-Hawary et al. (2020) found a positive relationship between e-HRM and organizational learning capabilities. The characteristic of being ignored of digital HRM somewhat satisfies low-end origin requirement of a disruptive innovation. The low-end status of HR areas in digital business strategy can be influenced by a long history of perceiving HR as supporting role (Belizón and Kieran, 2021), and by lack of tradition to measure and communicate HR results quantitatively (Mathis et al., 2017). Managers overlook the adoption of digital HRM simply because they perceive investment in digitally transforming HR processes and practices expensive and unprofitable (Bondarouk et al, 2017a). In some cases, they are tempted to ignore HRM digitalization because of its complexity (Wiblen & Marler, 2021). Unlike other organizational functions, outcomes of HR decisions such as recruitment or promotion generate serious consequences for individuals and society in terms of ethics and equity (Tambe et al., 2019), which may make automation of HR activities struggle to balance between economic value and social value.

Second, although it is empirically supported that digital HRM offers cost-saving solutions to perform transactional or administrative HR tasks (i.e Parry, 2011; Bondarouk & Ruel, 2009; Malik et al., 2022), it still underperforms traditional HRM model in the aspect of human reaction and quality of relationship at work (Thite, 2022). For example, using a chatbot in HR activities allows Ernst & Young to cut off the workload of HR staff by 10 000 hours within only six months in 2018 (Kokshagina & Schneider, 2023). IBM reduced its HR costs by 107 million USD by applying several AI applications in its subsidiaries around the world (Malik et al., 2022). Martínez-Morán et al. (2021) also found that digital tools help organizations to conduct their talent management process at lower costs, shorter time with higher objectivity and better person-job fit. Conversely, Palumbo (2022) found that digitalization constrained face-to-face organizational communication and negatively impacted interpersonal relationships at work. Gupta et al. (2022) also found that digital HRM technologies increased mistrust and conflict among employees. However, digital HRM technologies have been continuously improved. AI and other advanced digital technologies can offer numerous solutions that facilitate the individualization and personalization of HRM practices and social exchanges and thereby improving employee experience (Malik et al., 2022). The dark side and continuous development of digital HRM technologies satisfy the second requirement of disruptive innovation that is inferior to mainstream market but will penetrate into mainstream market over time.

Recommendations for managerial responses and interpretation

Three broad HRM goals consist of HRM efficiency, HRM effectiveness and strategic contribution to organizational performance. As digital technologies advance, traditional HRM approach also improves (Nankervis et al., 2021). Although it is not certain which one improves faster and full automation of HR practices may not be possible (Popkova & Sergi, 2020), it is impossible to delay digital transformation of HRM in the long run either. Chapano et al. (2023) found that despite challenges such as lack of organizational capabilities or other external factors, the adoption of digital HRM technologies are generally not slowed down in South Africa regardless of technology types. Disruptive innovation theory and related literature discussed above, therefore, can provide useful guidelines and warnings for managers when encountering new ways of defining and performing HRM practices as below:

Digital HRM is not the only way to achieve HRM goals. Despite its potential benefits, disruptive innovation does not guarantee success. Therefore, managers should not interpret that digitalization is the only key to make HR function more strategic and more efficient. Zavyalova et al. (2022) found no relationship between digitalization of HRM and organizational performance. The authors indicated that some companies could perform well, and even become leaders in key performance indicators without adopting information and communication technology to perform their HRM activities.

Distinguishing types and characteristics of digital HRM is an important prerequisite to any response plan. There are different types of digital HRM, ranging from very operational ones such as automation of cabinet filing and information sharing to sophisticated ones such as automation of decision making. Each type has different improvement rates, produces different consequences (Strohmeier, 2009) and requires different resources in case of adoption. For example, operational technologies such as HRIS need basic ICT skills and tend to provide time and cost savings; relational technologies such as employee self-service systems require HR skills and can improve communication and cooperation between HR and employees within organizations; and transformational technologies such as e-learning and knowledge management platforms or human capital management systems require HR skills, business acumen and analytic skills and can support organizational change and other strategic decisions (Martin & Reddington, 2010). Therefore, it is essential for managers to distinguish types and characteristics of digital HRM in order to have other meaningful analysis and avoid confusion and different interpretations among stakeholders about impacts of digital HRM on organizations before adoption.

Response to digital HRM is inevitable. As disruptive innovation, digital HRM redefines how HRM practices create and capture value. At functional level, as its performance improves over time, digital HRM probably diminishes the role of HR professionals in performing HR activities. Rapid advancements in digital technologies such as algorithm, artificial intelligent or virtual and social community are allowing digital HRM to not only to augment the speed and quality of managerial decisions (Tambe et al., 2019) but also provide employees with experience of social or human interaction and communication similar to traditional HRM (Suen & Chang, 2017). Therefore, if HRM managers do not capture possibilities of these technological advancements, they may see HRM function being controlled by other business functions (Tambe et al., 2019). At organizational level, failure to adopt digital HRM may reduce organizational attractiveness to job seekers and organizational commitment from employees because both job seekers and employees attribute technology usage with the modernity and growth of organizations (cf. Bondarouk et al., 2017a). Therefore, response to or the adoption of digital HRM should not be delayed in the long run.

Digital HRM can start at low value HR areas and in collaboration with other departments. Like other digitalization, HRM digitalization often requires time and large capital investment (Parry, 2011). The question is how managers can overcome these challenges. Drawing on the theory of disruptive innovation, managers can initiate digitalization process at low end areas of HRM to overcome large initial capital requirement. In the language of HRM field, low-end areas can be interpreted as administrative activities, while high-end or mainstream areas would be strategic activities because ultimate goals of HRM are to become strategic partners and contribute to organizational performance. Literature review supports this assumption. Many studies found that digital HRM has mostly happened in routine administrative HR tasks such as payroll or filing cabinet (i.e Chapano et al., 2023; Bondarouk & Ruel, 2009; Bondarouk et al., 2017b). To shorten learning curves for HRM digitalization, HRM managers also can cooperate with other organizational functions that are more familiar with digitalization such as marketing or operations to learn more from their experiences and expertise.

Conducting a critical cost and benefit analysis is an essential part of any effective adoption decision. Because of inherent conflicts between digital and traditional HRM, managers should conduct critical analysis of the nature and size of conflict, the impacts of digitalization as well as technological improvement rate when deciding what HR activities to digitalize and to what extent. Generally, if the traditional way to conduct an HRM activity proves clearly inappropriate especially when an organization aims to attract different segment of workforce, that activity can be a great candidate for digitalization.

CONCLUSION

Disruptive innovations can exist in different forms: technological changes, new products or redefinition of how organizations create and capture values. Each type of disruption generates different effects and requires different responses from organizations. The theory of disruptive innovation generally explains why organizations fail to respond to the disruption and suggests a

central role of managers' cognitive capabilities and perception in this failure. Although predictive power of theory is still under debate, it provides useful warning and suggestions for managers (King & Baatartogtokh, 2015). Drawing upon this theory, the study expands insights of how managers and HR professionals can interpret and react to disruption caused by digital HRM model. Human resources are considered an important source of competitive advantages in today's fast changing and competitive world (Jewell, 2017). While changes in people's preferences and values are not always predictable to managers, rapid advancements of digital technologies provide them with a lot of potential possibilities to adapt to changes including individualization and personalization of HRM activities that imitate the same employee experience provided by traditional HRM. Therefore, at organizational level, if managers continue to ignore the importance of digitalizing HRM practices compared to other functions, they can put their companies at the disadvantages. At functional level, if HR managers make intuitive judgements about digital HRM based on its initial inferior performance and do not take proper reactions towards it, they may see HRM activities and function be controlled by other business units such as finance and engineering.

However, managers should not consider digital HRM as the only solution to enhance the strategic position of HRM in organizations or rush to embrace it. Digital HRM not only exists in different types that have different characteristics and take time and cost to emerge, but also structurally differs from traditional HRM. Therefore, managers need to identify what HR activities to digitalize and to what extent based on a critical analysis of the nature and impacts of digital technologies on different HR functions in relation to organizational strategies. Managers can start digital transformation of HRM at low-end HR areas to overcome large initial capital requirement, and then gradually integrate it with the existing model and minimize structural tensions by enhancing the similarity between two models. HRM managers can also cooperate with other organizational functions to capitalize on their digitalization expertise and experience to shorten their learning curve.

CONFLICTS OF INTEREST
The author declares that there are no conflicts of interest found in this research

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BOOK REVIEW
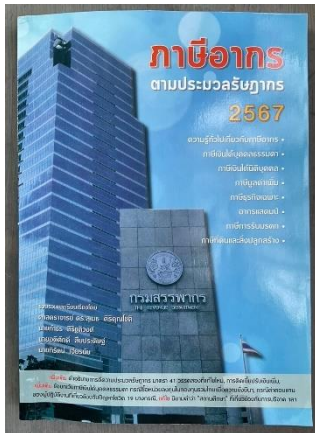
TAXATION BOOK ACCORDING TO THE REVENUE CODE 2024

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The 2024 edition of the Revenue Code's Taxation Book has been updated and revised to be more modern and comprehensive. The book comprises six parts and two supplementary sections: general knowledge about taxes, personal income tax, corporate income tax, value-added tax (VAT), specific business tax, stamp duty, inheritance tax (supplementary section 1), and land and building tax (supplementary section 2). The book also includes additional explanations on the interpretation of Section 41, paragraph two of the revised Revenue Code, calculation of surcharges, and additional exemptions for personal income tax in cases of purchasing investment units in Thai Sustainable Mutual Funds, compensation for workers involved in COVID-19 issues, and the revision of the term "educational institution" related to donations.

The end of the book includes the latest Cabinet resolution of June 4, 2024, approving tax measures to support domestic tourism. Individuals traveling to secondary cities and spending up to 15,000 baht on tours, accommodations, hotels, or Thai homestays can deduct this amount from their taxable income for personal income tax calculation. This measure is effective from May 1 to November 30, 2024.

The "Taxation Book According to the Revenue Code 2024, Revised June 2024" is compiled and edited by Professor Dr. Sumet Sirikunchoat, Mr. Kamthorn Sirichootiwong, Mr. Adisak Suebpradit, and Mr. Pirat Chiaranai. This book is extremely beneficial and suitable for use in undergraduate, master's, and doctoral studies, as well as for those involved in accounting and taxation, academics, entrepreneurs, investors, and the general public.