The Measurement of Technical and Cost Efficiency of Savings Cooperatives of Loei Province, Thailand Based on the Malmquist Data Envelopment Analysis

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Abstract

The research objectives were 1) to measure the technical efficiency of Savings Cooperatives, and 2) to measure the cost efficiency of Savings Cooperatives in Loei Province, Thailand by the Malmquist Data Envelopment Analysis. The secondary data were collected from the Cooperative Auditing Department database from 2018 to 2022 comprised of 8 savings cooperatives with 5 years. The total numbers were accounted for 40 observations. The data were analyzed by Malmquist Data Envelopment Findings showed that 1) there were 6 savings cooperatives in Loei Province had a technological efficiency index greater than 1. This indicated an improvement in technological efficiency for these 6 savings cooperatives in Loei Province, and 2) savings cooperatives in Loei Province were currently under consideration. They had an average technical efficiency of 43%, an average cost efficiency of 32%, and an overall average efficiency of 52%. Savings cooperatives in Loei Province were currently overusing input factors, they also lack efficiency in managing and organizing these factors to achieve an appropriate balance. Thus, there was a need for these cooperatives to improve their management practices to achieve a more balanced and efficient use of resources at the same level.

Keywords: Technical Efficiency, Cost Efficiency, Savings Cooperatives, Data Envelopment Analysis

Introduction

Savings cooperatives, also known as savings and credit cooperatives, function as member-owned financial institutions with a pivotal role in advancing financial inclusion and community development. This research essay investigates the organizational structure, advantages, and impact of savings cooperatives on individual members and local communities. Typically formed by individuals who share a common bond, these cooperatives involve the collective pooling of members' savings to provide financial

services within the community. This cooperative setup ensures democratic governance, granting each member an equal voice in decision-making processes (Mitchell, 2019). The combined savings of members serve as a funding reservoir for extending affordable loans and diverse financial products to fellow members.

In Thailand, the savings cooperatives known as the formation of organization aims to provide mutual support among its members. Members consistently deposit their earnings into the cooperative, contributing through shareholding and regular savings. Moreover, in instances of financial distress, the cooperative helps by providing loans at interest rates lower than those of conventional financial institutions. All members of the cooperative are part of the same entity and receive a steady monthly income (The Federation of Savings and Credit Cooperative of Thailand Limited, 2023).

According to the Federation of Savings and Credit Cooperative of Thailand Limited. (2023), Savings cooperatives have legal entity status according to cooperative laws, and the Ministry of Finance has declared that savings cooperatives can calculate interest on loans, like financial institutions, as per the Ministry of Finance announcement dated November 21, 1983.

In Overall of Thailand, the operation of the cooperative is funded through share capital and deposits from members, including both regular and savings deposits, without borrowing funds from foreign sources. Currently, there are a total of 1,227 savings cooperatives, and the total savings system (share capital and deposits). These funds are used to provide loans to members in need. The total assets of the cooperatives amount to more than 63.53 percent being allocated for member loans.

To ensure regular contributions and loan repayments, cooperatives utilize a deduction system at the payment location, ensuring a consistent cash flow every month. This operational approach contributes to the stability of the cooperative business, particularly when assessing the financial soundness of assets. The entire savings cooperative system had a provision for doubtful debts regarding member loans and potential doubtful debts for member loans at only 0.021 percent and 0.075 percent, respectively. This percentage is significantly lower compared to other types of financial institutions (Cooperative Auditing Department, 2023).

Loei is situated in the Isan region of upper northeastern Thailand and stands out as one of the less densely populated provinces in the country. It shares borders with Nong Khai, Udon Thani, Nong Bua Lamphu, Khon Kaen, Phetchabun, and Phitsanulok, while to the north, it adjoins Xaignabouli and Vientiane provinces of Laos (https://en.wikipedia.org/wiki/Loei_province).

Characterized by its mountainous terrain, Loei features a provincial capital, Loei, nestled in a fertile basin surrounded by mist-covered peaks and diverse flora. Notable mountains in the area include Phu Kradueng, Phu Luang, and Phu Ruea. The Loei River, a tributary of the Mekong, flows through the province, marking part of its northern boundary with Laos. Phu Thap Buek, the highest peak in the Phetchabun Range, is also found in Loei. Additionally, Phu Kradueng is situated within Phu Kradueng National Park. The western part of the province extends to the southern tip of the Luang Prabang Range within the Thai highlands. Forest coverage in Loei spans 3,382 km^2, accounting for 32.2 percent of the province's total area (https://en.wikipedia.org/wiki/Loei_province).

Like other provinces in Thailand, people in Loei Province are coming together to establish a savings cooperative means the gathering or meeting of individuals or members with a common objective. This is done to create a conducive environment for establishing a cooperative that will provide various savings and financial services to the members within that group. The phrase "coming together" implies the pooling of resources, energy, or capabilities of the members to create strength and sustainability in establishing the savings cooperative. This process emphasizes cooperation and the mutual benefits of members in managing the cooperative being formed.

The primary objectives of savings cooperatives typically revolve around promoting financial well-being, community development, and member empowerment. While specific goals may vary, common objectives. The main objectives of savings cooperatives center on fostering financial inclusion, community development, and member-centric financial services, guided by the principles of cooperation and mutual benefit.

Table 1: Number of Members, Total Revenue and Total Expenses of Savings Cooperatives in Loei Province, Thailand

Name of Cooperatives in Loei Province	Number of Members (people)	Total Revenue ($)	Total Expenses ($)
Teachers' Savings Cooperative of Loei Province Limited	7,753	590,303.23	414,507.96
Police Savings Cooperative of Loei Province Limited	1,566	66,284.94	31,131.27
Hospital Savings Cooperative of Loei Province Limited	1,155	42,869.32	7,130.18

Savings Cooperative of Loei Province Limited	378	9,261.52	9,708.06
Military Savings Cooperative of Sri Song Rak Limited	640	10,001.31	4,862.51
Teachers' Savings Cooperative of the Department of General Education, Loei Province Limited	1,742	144,837.34	205,764.08
Public Health Savings Cooperative of Loei Province Limited	2,080	121,344.42	47,094.87
Army Department Savings Cooperative No. 21 Limited	789	2,317.04	576.24
Total	16,103	987,219.13	720,775.16

Source: Cooperative Auditing Department, 2023

According to table 1, there were 8 Savings Cooperatives in Loei Province, Thailand with the total of cooperatives' members of 16,103 persons, total revenue, and total expenses of $ 987,219.13, and $ 720,775.16 respectively.

Table 2: Total Assets, Share Capital, Total Funds of the Cooperatives and Total Debt of Savings Cooperatives in Loei Province, Thailand

Name of Cooperatives in Loei Province	Total Assets ($)	Share Capital ($)	Total Funds of the Cooperatives ($)	Total Debt ($)
Teachers' Savings Cooperative of Loei Province Limited	338,589,270.73	94,971,425.71	116,482,962.81	222,106,307.92
Police Savings Cooperative of Loei Province Limited	37,439,559.15	12,316,190.57	15,705,615.64	21,733,943.50
Hospital Savings Cooperative of Loei Province Limited	28,228,999.48	15,746,083.71	18,428,744.60	9,800,254.88
Savings Cooperative of Loei Province Limited	2,936,713.00	1,358,382.86	1,727,348.34	1,209,364.67
Military Savings Cooperative of Sri Song Rak Limited	5,378,174.51	1,959,716.86	2,425,480.61	2,952,693.90
Teachers' Savings Cooperative of the Department of General Education, Loei Province Limited	62,223,294.51	22,137,796.57	8,919,705.31	71,142,999.83
Public Health Savings Cooperative of Loei Province	72,412,006.50	32,032,112.86	37,533,659.99	34,878,346.50

Limited				
Army Department Savings Cooperative No. 21 Limited	1,454,302.33	1,123,754.29	1,227,270.79	227,031.55
Total	548,662,320.21	181,645,463.43	202,450,788.09	364,050,942.74

Source: Cooperative Auditing Department, 2023

According to table 2, there were 8 Savings Cooperatives in Loei Province, Thailand with total assets, share capital, total funds of the cooperatives of $548,662,320.21, $181,645,463.43, $202,450,788.09, and $364,050,942.74 respectively.

From past to present, based on the information provided, it seems that there are numerous research studies related to savings cooperatives in the Loei Province, focusing on financial status and operational aspects. However, there appears to be no prior research specifically addressing the "Technical and Cost Efficiency of Savings Cooperatives of Loei Province, Thailand Based on the Malmquist Data Envelopment Analysis."

Considering conducting such research, it could potentially contribute valuable insights into the technical and cost efficiency of savings cooperatives in Loei Province using the Malmquist Data Envelopment Analysis method. This approach assesses changes in productivity over time and could shed light on the effectiveness of these cooperatives in terms of technical efficiency and cost management.

Literature Review

1. Savings cooperatives

Savings cooperatives, also known as savings and credit cooperatives, are member-owned financial institutions that play a pivotal role in promoting financial inclusion and community development. This research essay explores the structure, benefits, and impact of savings cooperatives on both individual members and local communities.

Savings cooperatives are typically formed by individuals with a shared bond, pooling their savings to provide financial services within the community. This cooperative structure ensures democratic governance, where each member has an equal say in decision-making processes (Mitchell, 2019). Members' pooled savings become a source of funds for providing affordable loans and other financial products to fellow members.

Benefits of Savings Cooperatives consisted of 1) Financial Inclusion: Savings cooperatives act as a bridge to financial services for individuals who might face barriers to access in traditional banking systems (Johnson et al., 2020). 2) Low-Cost Financial Services: Cooperative members often enjoy more favorable terms on loans and higher interest rates on savings compared to commercial banks (Smith & Brown, 2018). 3) Community

Development: Profits generated by savings cooperatives are often reinvested in local communities, supporting various development initiatives such as infrastructure projects, education, and healthcare (Roberts, 2017).

Research has shown that the presence of active savings cooperatives positively impacts local economies. A study conducted by Thompson et al. (2016) found that communities with well-established savings cooperatives experience increased financial stability, improved access to credit, and a boost in entrepreneurial activities. While savings cooperatives provide substantial benefits, they also face challenges, such as regulatory constraints and technological limitations (White, 2019). Addressing these challenges opens up opportunities for innovation, especially in leveraging technology to enhance financial services delivery (Johnson, 2021).

Savings cooperatives serve as crucial agents of financial inclusion and community development. Their member-centric structure, coupled with a focus on reinvesting in the local community, makes them powerful tools for economic empowerment. While challenges exist, the potential for positive impact on individuals and communities suggests that savings cooperatives remain a viable and valuable component of the financial landscape.

2. Savings Cooperatives in Thailand

Savings cooperatives in Thailand have emerged as vital components of the country's financial landscape, contributing significantly to financial inclusion and community development. This research essay aims to delve into the structure, benefits, challenges, and overall impact of savings cooperatives in Thailand, shedding light on their multifaceted role.

In Thailand, savings cooperatives, often referred to as "Sahakol" or "Kasikorn," are member-owned financial institutions that operate on cooperative principles. Members, typically with a common bond like occupation or residence, pool their savings to provide accessible and affordable financial services (Sombat, 2020). The cooperative structure ensures democratic governance, with each member having an equal say in decision-making processes.

Savings cooperatives in Thailand play a pivotal role in providing financial services to individuals who might otherwise face barriers in accessing traditional banking services (Boonchai et al., 2018). These cooperatives contribute to local economic development by reinvesting profits in the community, supporting initiatives such as education, healthcare, and small-scale entrepreneurship (Supachai, 2019). While Thai savings cooperatives bring significant advantages, they also face challenges such as regulatory constraints and the need for technological advancement (Prapapan, 2021). Addressing these challenges

presents opportunities for innovation, especially in leveraging digital technologies to enhance service delivery and accessibility.

Research indicates a positive impact of savings cooperatives on local communities in Thailand. A study by Kasikorn Research Center (2020) found that communities with active savings cooperatives experienced increased financial literacy, improved livelihoods, and a strengthened sense of community.

The regulatory environment significantly influences the operations of savings cooperatives in Thailand. The Bank of Thailand, through the Cooperative Promotion Department, plays a crucial role in overseeing and regulating these financial institutions (Bank of Thailand, 2017).

Savings cooperatives in Thailand stand as key contributors to financial inclusion and community development. Their member-centric approach, combined with a commitment to reinvesting in the local community, positions them as essential players in Thailand's financial landscape. While challenges persist, particularly in regulatory compliance and technological adaptation, the overall impact of savings cooperatives on individuals and communities in Thailand underscores their importance.

3. Technical Efficiency

Operational efficiency is a critical aspect of organizational performance, and technical efficiency serves as a key metric in evaluating the effectiveness of production processes. This research essay aims to provide a thorough examination of technical efficiency, exploring its definition, measurement, factors influencing it, and its implications for various industries.

Technical efficiency refers to the ability of an organization or system to produce maximum output using the minimum amount of input resources (Farrell, 1957). It is a fundamental concept in production economics and management studies, focusing on optimizing the production process.

Measurement of Technical Efficiency: Various methodologies exist for measuring technical efficiency, with Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) being commonly employed (Coelli et al., 2005). DEA assesses efficiency by comparing the performance of similar units, while SFA estimates a production frontier and evaluates how close each unit comes to that frontier.

Factors Influencing Technical Efficiency: Several factors contribute to the level of technical efficiency within an organization. These include technology adoption, employee skills and training, managerial practices, and the quality of input resources (Charnes et al., 1978). External factors like market conditions and regulatory environments can also impact technical efficiency.

Implications for Industries: High levels of technical efficiency have significant implications for industries. Efficient production processes can lead to cost savings, increased competitiveness, and improved product quality. In sectors such as manufacturing and agriculture, where efficiency is directly tied to resource utilization, enhancing technical efficiency is crucial for sustainable practices (Färe et al., 1994).

Despite its importance, achieving and maintaining high levels of technical efficiency can be challenging. Factors such as outdated technology, inadequate infrastructure, and resistance to change within organizations can impede progress (Kumbhakar & Lovell, 2000). Identifying and addressing these challenges are integral to enhancing efficiency.

Technical efficiency is a vital concept in understanding and improving operational performance. Its measurement provides insights into how effectively organizations convert inputs into outputs. Industries that prioritize and invest in enhancing technical efficiency stand to gain not only in terms of cost-effectiveness but also in terms of competitiveness and sustainability.

4. Data Envelopment Analysis (DEA)

Data Envelopment Analysis (DEA) is a powerful mathematical technique employed in operations research and management science to assess and compare the relative efficiency of decision-making units (DMUs) within a set. This research essay explores the fundamentals of DEA, its application, and its significance in evaluating efficiency across various sectors.

DEA, developed by Charnes, Cooper, and Rhodes in the late 1970s, is a non-parametric method that evaluates the relative efficiency of DMUs based on multiple inputs and outputs (Charnes et al., 1978). Unlike parametric methods, DEA does not require specific functional forms or assumptions about the underlying production process.

The basic DEA model assesses each DMU's efficiency by comparing its output to input ratios with those of other units. The model identifies a benchmark, called the efficient frontier, representing the most efficient units. Units lying on the frontier are considered fully efficient, while those insides are deemed less efficient and potentially have room for improvement (Coelli et al., 2005).

DEA is versatile and can be applied to various contexts, including manufacturing, service industries, and public services. Inputs and outputs are defined based on the specific goals of the analysis. For instance, in a manufacturing setting, inputs might include labor and raw materials, while outputs could be the quantity and quality of produced goods.

DEA has seen several extensions and variations, accommodating different perspectives and complexities. These include models for handling multiple stages of production, incorporating environmental variables, and addressing undesirable outputs.

Radial and non-radial models offer flexibility in assessing pure technical efficiency and scale efficiency separately.

DEA has found applications in diverse fields, such as banking, healthcare, education, and agriculture. In the banking sector, DEA helps assess the efficiency of branches or financial institutions, considering inputs like capital and labor and outputs like loans and deposits. In healthcare, it aids in evaluating hospital performance based on inputs such as beds, staff, and outputs like patient services.

While DEA is a valuable tool, its application is not without challenges. Sensitivity to outliers, the choice of inputs and outputs, and the potential for bias in small sample sizes are considerations that researchers and practitioners must navigate (Coelli et al., 2005).

Data Envelopment Analysis stands as a robust methodology for evaluating and improving operational efficiency across various industries. Its non-parametric nature and flexibility make it a preferred choice for assessing relative performance, providing insights for organizational enhancement and resource optimization.

5. Cost Efficiency

Cost efficiency is a paramount consideration for organizations seeking to optimize resource allocation and enhance competitiveness. This research essay aims to delve into the intricacies of cost efficiency, exploring its conceptualization, measurement methodologies, influential factors, and implications for diverse industries.

Cost efficiency refers to the ability of an organization to achieve its objectives or deliver its products and services at the lowest possible cost. It involves optimizing the utilization of resources to minimize expenses while maintaining or improving the quality and effectiveness of operations (Freeman & Cunha, 2004).

Measurement of Cost Efficiency: Measuring cost efficiency involves assessing the relationship between inputs and outputs in production processes. Various methodologies exist, including the Cost Efficiency Index, which compares actual costs to the best achievable costs, and the Data Envelopment Analysis (DEA), which evaluates relative efficiency among decision-making units (Coelli et al., 2005; Farell, 1957).

Several factors contribute to the level of cost efficiency within an organization. Technological advancements, economies of scale, skilled workforce, and effective supply chain management are recognized as influential determinants (Diewert, 1992). External factors, such as market competition and regulatory environments, also impact cost efficiency.

High levels of cost efficiency translate into improved competitiveness, increased profitability, and better financial sustainability for industries. Sectors like manufacturing,

where production costs significantly impact profit margins, and service industries, where operational costs affect service pricing, are particularly sensitive to cost efficiency considerations (Banker & Natarajan, 2008).

Cost efficiency assessment methodologies vary based on industry characteristics and objectives. Activity-Based Costing (ABC), Total Cost Assessment (TCA), and Benchmarking are common tools used to identify and analyze cost drivers, allowing organizations to streamline processes and minimize unnecessary expenditures (Cooper & Kaplan, 1992).

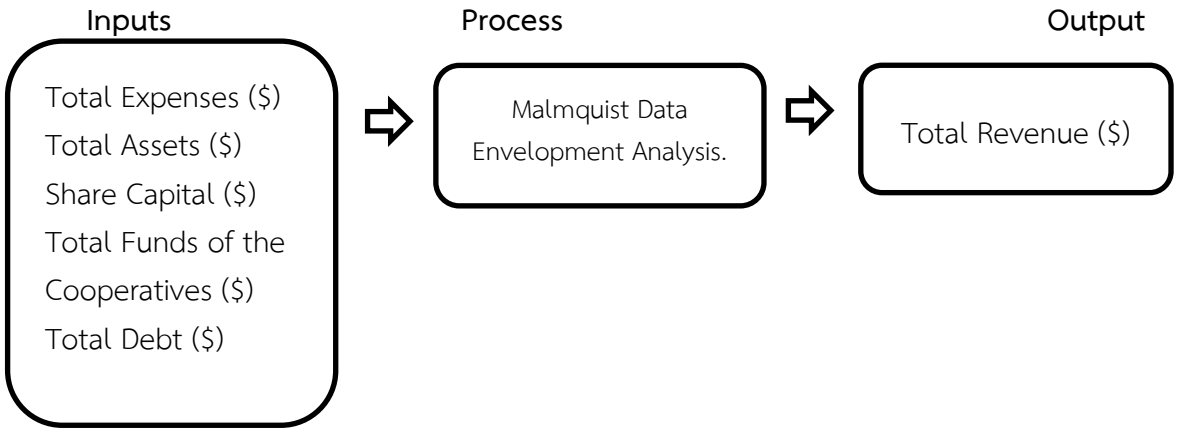
While achieving cost efficiency is a strategic goal, organizations often face challenges in implementation. Resistance to change, inadequate technology adoption, and market uncertainties are common impediments. Balancing cost-cutting measures with the need for innovation and quality improvement poses a delicate challenge (Dess & Beard, 1984). Cost efficiency remains a critical aspect of organizational success. Its measurement and enhancement contribute not only to financial sustainability but also to the overall competitiveness and adaptability of organizations in dynamic business environments.

Objectives

The research objectives were: 1) to measure the technical efficiency of Savings Cooperatives in Loei Province, Thailand and 2) to measure the cost efficiency of Savings Cooperatives in Loei Province, Thailand by the Malmquist Data Envelopment Analysis.

Concept theory framework

Following Coelli, T., Rao, D. S. P., & Battese, G. E. (2005). The concept theory framework would be expressed as:



Materials and Methods

Methodology

The methodology was quantitative research applying the Malmquist Data Envelopment Analysis to measure the technical efficiency of Savings Cooperatives in Loei Province, Thailand and the cost efficiency of Savings Cooperatives in Loei Province, Thailand by the Malmquist Data Envelopment Analysis. The presentation of the research methodology study and its details unfolded in the following manner:

1. Data Collection

The secondary data were collected from the Cooperative Auditing Department database from 2018 to 2022 comprised of 8 savings cooperatives in Loei Province which comprised of 1) total expenses, 2) total assets, 3) share capital, 4) total funds of the cooperatives, 5) total debt, and 6) total revenue. With 5 years and 8 savings cooperatives, the total numbers were accounted for 40 observations.

2. Data Analysis

The data were analyzed by Malmquist Data Envelopment Analysis to measure the technical efficiency of Savings Cooperatives in Loei Province, Thailand and the cost efficiency of Savings Cooperatives in Loei Province, Thailand. The inputs were total expenses, total assets, share capital, total funds of the cooperatives, and total debt. The output was total revenue shown in the concept theory framework.

Results

Following the research objectives, the measurement of technical and cost efficiency of savings cooperatives of Loei Provinces, Thailand Based on the Malmquist Data Envelopment will be expressed as follows:

Part 1. The technical efficiency of savings cooperatives of Loei Provinces, Thailand would be expressed in table 3.

Table 3: The Technical Efficiency of Savings Cooperatives in Loei Province, Thailand

Savings Cooperatives Name	effch	techch	pech	sech	tfpch
Teachers' Savings Cooperative of Loei Province Limited	1.080	1.824	1.000	1.080	1.971
Police Savings Cooperative of Loei Province Limited	1.395	1.989	1.392	1.002	2.774
Hospital Savings Cooperative of Loei Province Limited	1.511	2.597	1.488	1.015	3.925
Savings Cooperative of Loei	1.000	1.909	1.000	1.000	1.909

Savings Cooperatives Name	effch	techch	pech	sech	tfpch
Province Limited					
Military Savings Cooperative of Sri Song Rak Limited	3.450	1.979	3.330	1.036	6.828
Teachers' Savings Cooperative of the Department of General Education, Loei Province Limited	1.000	1.834	1.000	1.000	1.834
Public Health Savings Cooperative of Loei Province Limited	4.288	2.161	4.281	1.002	9.269
Army Department Savings Cooperative No. 21 Limited	1.400	2.232	1.000	1.400	3.125
Mean	1.619	2.053	1.527	1.06	3.323

Source: Calculation

Noted:

Effch = The Change of Technical Efficiency under the condition of Constant Return to Scale (CRS)

techch = The Change of Technology

pech = The Change of Technical Efficiency under the condition of Varible Return to Scale (VRS)

sech = The Change of Scale Efficiency

tfpch = The Change of Total Factor Productivity (TFP)

According to table3, the analysis of changes in efficiency and technology using the Malmquist DEA method reveals that 6 savings cooperatives in Loei Province had a technological efficiency index greater than 1. These cooperatives included the Teachers' Savings Cooperative of Loei Province Limited, the Police Savings Cooperative of Loei Province Limited, the Hospital Savings Cooperative of Loei Province Limited, the Military Savings Cooperative of Sri Song Rak Limited, the Public Health Savings Cooperative of Loei Province Limited, and the Army Department Savings Cooperative No. 21 Limited. This indicated an improvement in technological efficiency for these 6 savings cooperatives in Loei Province.

The analysis indicates that 2 savings cooperatives in Loei Province have a technological efficiency index equal to 1, signifying no change in technological efficiency. These cooperatives were the Savings Cooperative of Loei Province Limited and the Teachers' Savings Cooperative of Loei Province Limited. This suggested that these two savings cooperatives had maintained a constant level of technological efficiency without improvement or deterioration.

When considering changes in technology, it was found that all 8 savings cooperatives in Loei Province had improved their management technology. This was evident from the technological change index values exceeding 1 for each cooperative. This suggests that all the savings cooperatives in the province have undergone positive technological advancements in their management practices.

While examining the Total Factor Productivity Change (TFPC) for all savings cooperatives in Loei Province, it was observed that the TFPC values for each cooperative are greater than 1. This indicated that all 8 savings cooperatives in the province had experienced an increase in efficiency in managing their operations. The Total Factor Productivity Change considered changes in both technical efficiency and technological progress, suggesting an overall improvement in the productivity and management practices of the savings cooperatives in Loei Province.

Part 2. The cost efficiency of savings cooperatives of Loei Provinces, Thailand would be expressed in table 4.

Savings Cooperatives Name	TE	AE	CE
Teachers' Savings Cooperative of Loei Province Limited	0.7340	0.7000	0.5130
Police Savings Cooperative of Loei Province Limited	0.2640	0.5090	0.1340
Hospital Savings Cooperative of Loei Province Limited	0.1920	0.1240	0.0240
Savings Cooperative of Loei Province Limited	1.0000	0.8810	0.8810
Military Savings Cooperative of Sri Song Rak Limited	0.0070	0.5190	0.0040
Teachers' Savings Cooperative of the Department of General Education, Loei Province Limited	1.0000	1.0000	1.0000
Public Health Savings Cooperative of Loei Province Limited	0.0030	0.3180	0.0010
Army Department Savings Cooperative No. 21 Limited	0.2600	0.1360	0.0350
Mean	0.4320	0.5230	0.3240

Source: Calculation

Noted

TE = Technical Efficiency

AE = Allocative Efficiency = CE/TE

CE = Cost Efficiency

According to table 4, the 8 savings cooperatives in Loei Province are currently

under consideration. They had an average technical efficiency of 43%, an average cost efficiency of 32%, and an overall average efficiency of 52%. Remarkably, only one savings cooperative, namely the Teachers' Savings Cooperative of Loei Province Limited, was found to be efficient across all three types (with TE, CE, and AE values equal to 1). Additionally, it is noted that, on the whole, the savings cooperatives in Loei Province under consideration, totaling 7, exhibit higher levels of technical efficiency compared to cost efficiency. This suggests that these cooperatives tend to use input factors more than necessary.

Given the specified levels of input and output prices, it was recommended that the 7 savings cooperatives currently under consideration in Loei Province should reduce their use of input factors, as indicated by the technical efficiency index values lower than one.

Apart from the fact that these 7 savings cooperatives in Loei Province were currently overusing input factors, they also lack efficiency in managing and organizing these factors to achieve an appropriate balance. Thus, there was a need for these cooperatives to improve their management practices to achieve a more balanced and efficient use of resources at the same level.

In summary, the results obtained from the calculations indicate which savings cooperatives were less efficient in terms of technical efficiency, cost efficiency, and overall efficiency. Specifically, cooperatives with technical efficiency index values below one may be considered less efficient in utilizing input factors to produce outputs. Additionally, those cooperatives that exhibit a higher level of technical efficiency compared to cost efficiency suggest that they use input factors more than necessary. The overall efficiency reflects the combined performance in managing input factors and production outputs. Therefore, the analysis helped identify areas where savings cooperatives in Loei Province may need to improve their operational efficiency and resource management.

Conclusions and Discussion

Savings cooperatives, functioning as member-owned financial institutions, play a vital role in enhancing financial inclusion and supporting community development. An examination of efficiency and technological changes using the Malmquist Data Envelopment Analysis (DEA) method uncovered noteworthy findings in Loei Province, Thailand. The analysis revealed that six savings cooperatives in Loei Province exhibited a technological efficiency index greater than 1, indicating an enhancement in technological efficiency for these entities. On the other hand, two savings cooperatives had a technological efficiency index equal to 1, implying a stable level of technological efficiency

with no discernible improvement or decline. Examining the Total Factor Productivity Change (TFPC) for all savings cooperatives in Loei Province, it was observed that the TFPC values for each cooperative surpassed 1. This suggests that all eight savings cooperatives in the province experienced an upswing in efficiency in managing their operations. The TFPC considers changes in both technical efficiency and technological progress, pointing towards an overall improvement in the productivity and management practices of savings cooperatives in Loei Province.

Eight savings cooperatives currently under consideration in Loei Province exhibited certain efficiency metrics. On average, these cooperatives demonstrated a technical efficiency of 43%, a cost efficiency of 32%, and an overall efficiency averaging 52%. The overall efficiency metric encompasses the collective performance in handling input factors and producing outputs. These findings from the analysis shed light on specific areas where savings cooperatives in Loei Province might benefit from enhancing their operational efficiency and resource management. The breakdown of technical and cost efficiency provides valuable insights into the areas that may require attention for improvement, offering a targeted approach to optimize the overall performance of these financial institutions. The research results were consistent with the work of Sreethon, P. and Thoraneenitiyan, N. (2021). Who studied the measure of technical efficiency of large saving and credits cooperatives in Thailand. Purmiyati, A., Handoyo, R. D., and Wisudanto, A. (2022). Who studied technical efficiency analysis: management factor as determinants of saving and credit cooperatives' health in Indonesia. In addition, the research outputs were constent with Kimutai, C. J., Jagongo, A. and Kenyatta, O. (2019). Who studied technical efficiency of deposit taking savings and credit cooperative societies in Kenya.

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