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Examining Organizational Factors Impacting IoT Implementation, Production, Services, and Performance in the Thai Manufacturing and Distribution Sector

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Abstract

Purpose: This study investigates the organizational factors including firm size, adaptive capability, absorptive capability, innovative capability, and executive support to determine internet of things, production and services, and organizational performance. **Research design, data, and methodology:** A quantitative methodology was employed, involving the distribution of surveys to 460 employees occupying managerial and strategic roles. These individuals have accrued a minimum of one year of experience within 20 leading manufacturing and distribution companies in Thailand, each boasting a workforce exceeding 250 employees. Sampling techniques utilized encompass judgmental, quota, and snowball sampling. Furthermore, analysis of the data was conducted through Confirmatory Factor Analysis (CFA) and Structural Equation Model (SEM). **Results:** The findings indicate that factors such as firm size, adaptive capability, absorptive capability, and innovative capability exert significant influence on the Internet of Things (IoT). In addition, IoT significantly impacts both production and services. Furthermore, the study highlights the significant influence of production and services on organizational performance. However, the anticipated relationship between executive support and IoT lacks support according to the results. **Conclusions:** This study highlights the transformative potential of IoT for the manufacturing and distribution sector, paving the way for enhanced efficiency, competitiveness, and sustainability in a rapidly evolving business landscape.

Keywords : Internet Of Things, Organizational Performance, Manufacturing, Distribution, Supply Chain

JEL Classification Code : M10, M31, L61, L62, O30

1. Introduction

The advent of the Internet of Things (IoT) has ushered in a new era of connectivity and efficiency across various industries worldwide (Sallam et al., 2023). In the context of the manufacturing and distribution sector in Thailand, the integration of IoT technologies holds immense promise for enhancing production processes, optimizing service delivery, and ultimately improving organizational performance. As the Thai manufacturing and distribution sector continues to evolve in response to global market dynamics and technological advancements, understanding the implications of IoT implementation becomes increasingly pertinent (Pimsakul et al., 2021).

The rapid growth of Information and Communication Technology (ICT) has led to the emergence of various

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technologies like cloud computing, the Internet of Things (IoT), and big data. These advancements have permeated nearly all sectors in Thailand's industrial landscape (Suebsook et al., 2020). The Internet of Things (IoT) has emerged as a transformative force within the manufacturing and distribution sector in Thailand, offering unprecedented opportunities for efficiency, productivity, and competitiveness (Sallam et al., 2023).

Thailand's manufacturing and distribution sector has witnessed a rapid uptake of IoT technologies in recent years, driven by factors such as technological advancements, increasing competition, and evolving consumer demands (Suebsook et al., 2020). IoT implementation encompasses a wide range of applications, including real-time monitoring of production equipment, supply chain optimization, predictive maintenance, and quality control (Farooq et al., 2023). These IoT-enabled solutions have the potential to revolutionize traditional manufacturing and distribution practices, leading to greater efficiency, flexibility, and competitiveness (Alabdulatif et al., 2023).

The integration of IoT technologies in the Thai manufacturing and distribution sector has profound implications for production processes and service delivery. Real-time data collection and analysis through IoT sensors enable manufacturers to optimize production schedules, minimize downtime, and reduce operational costs (Pimsakul et al., 2021). Additionally, IoT-enabled services such as predictive maintenance and remote monitoring enhance equipment reliability and uptime, thereby improving overall service levels and customer satisfaction (Ahmetoglu et al., 2023).

The adoption of IoT in manufacturing and distribution has significant ramifications for organizational performance in Thailand. By leveraging IoT-driven insights, companies can make data-driven decisions, streamline operations, and adapt to changing market conditions more effectively (Imran et al., 2018). Furthermore, IoT implementation facilitates innovation and agility, enabling organizations to stay ahead of the competition and drive sustainable growth in the long term (Martínez-Peláez et al., 2023).

In today's dynamic business environment, the integration of Internet of Things (IoT) technologies into manufacturing and distribution processes has become increasingly prevalent (Alahi et al., 2023). However, despite the growing interest in IoT adoption, there remains a gap in understanding the organizational factors that influence its implementation and subsequent impact on production, services, and organizational performance. Therefore, it is imperative to investigate how factors such as firm size, adaptive capability, absorptive capability, innovative capability, and executive support contribute to the successful adoption and utilization of IoT within the manufacturing and distribution sector.

This study addresses a significant research gap by investigating the organizational factors influencing IoT implementation and its impact on production, services, and organizational performance within the manufacturing and distribution sector. Sampling from multiple firms ensures diversity in perspectives and experiences, leading to a more comprehensive understanding of the manufacturing sector in Thailand. Its findings contribute to both theoretical knowledge and practical implications, thereby advancing understanding and facilitating informed decision-making in the realm of IoT adoption and digital transformation.

In summary, the implementation of IoT technologies in the Thai manufacturing and distribution sector has transformative potential across various dimensions, including production, services, and organizational performance. By embracing IoT-driven innovation, companies can enhance their competitive position, improve operational efficiency, and meet the evolving needs of customers and stakeholders in an increasingly digitalized marketplace.

2. Literature Review and Hypotheses

2.1. Organizational Context and Implementation of IOT

Opasvitayarux et al. (2022) suggest an analytical model rooted in the technological-organizational-environmental (TOE) framework, bolstered by a collaborative structure, to underscore the significance of the supply chain network. The study delves into organizational factors, encompassing firm size, adaptive capability, absorptive capability, innovative capability, and executive support, as pivotal determinants in the adoption of IoT technologies.

2.1.1. Firm Size

The significance of firm size in influencing the adoption of Internet of Things (IoT) technologies within organizational contexts has been widely acknowledged in the literature. Therefore, firm size has been identified as a key determinant of IoT adoption dynamics (Opasvitayarux et al., 2022). Empirical evidence from various studies lends support to the notion that larger firms tend to have a higher propensity to adopt IoT technologies in their supply chain operations. For instance, research conducted by Olushola (2019) indicated a positive correlation between firm size and IoT adoption within the context of the agricultural product distribution industry in China. Similarly, studies by Lin et al. (2016) and Shi and Yan (2016) further corroborated these findings, demonstrating a higher likelihood of IoT adoption among larger firms operating in supply chain environments. In the context of this study, firm size is believed to play an essential role in the implementation of IoT as proposed in a hypothesis:

H1: Firm size has a significant influence on implementation of Internet of Things.

2.1.2. Adaptive Capability

Adaptive capability denotes the firm's capacity for flexibility in utilizing its available resources effectively. Thus, the ability of an organization to respond effectively to changing environments and circumstances, has emerged as a critical factor influencing the adoption and success of Internet of Things (IoT) technologies (Opasvitayarux et al., 2022). Haleem Khan and Javaid (2021) emphasized the importance of adaptive capability in driving IoT adoption in manufacturing industries. Sievers et al. (2021) highlighted that organizations with greater adaptive capability were better equipped to overcome challenges associated with IoT implementation, such as technological complexity and organizational resistance to change. Gracias et al. (2023) found that cities with greater adaptive capability were more successful in implementing IoT solutions to improve urban infrastructure, enhance service delivery, and address emerging challenges related to urbanization and sustainability. Several studies have highlighted challenges faced by members of the food supply chain in allocating resources effectively (Hong et al., 2011; Jedermann et al., 2009; Walter et al., 2017). Subsequently, the following hypothesis is developed:

H2: Adaptive capability has a significant influence on implementation of Internet of Things.

2.1.3. Absorptive Capability

Absorptive capability, referring to an organization's capacity to assimilate and utilize external knowledge effectively, has emerged as a crucial factor influencing the adoption and success of Internet of Things (IoT) technologies (Lin et al., 2016). Junaid et al. (2022) demonstrated that organizations with higher levels of absorptive capability were better equipped to integrate IoT technologies into their healthcare systems, enabling them to leverage external knowledge and expertise to enhance patient care and operational efficiency. Arcidiacono et al. (2022) focusing on IoT adoption in the manufacturing industry, absorptive capability was identified as a key determinant of successful implementation, enabling them to innovate and adapt to changing market conditions more effectively. In addition to knowledge acquisition, the presence of proficient staff members is crucial. This includes metrics like the proportion of graduates in science, technology, engineering, and mathematics (STEM) among the overall workforce in Italy's transportation and logistics sector (Rey et al., 2021). Therefore, the following hypothesis is indicated:

H3: Absorptive capability has a significant influence on implementation of Internet of Things.

2.1.4. Innovative Capability

Innovative capability refers to an organization's ability to generate, adopt, and integrate new ideas, technologies, and processes into its operations to create value and maintain competitiveness (Teece, 2007). It encompasses various dimensions such as technological expertise, R&D investments, organizational culture, and strategic agility (Damanpour & Aravind, 2012). The integration of IoT in manufacturing processes has revolutionized traditional production systems by enabling real-time monitoring, predictive maintenance, and process optimization (Porter & Heppelmann, 2014). IoT devices embedded in machinery collect vast amounts of data, which, when analyzed, offer insights for enhancing efficiency, reducing downtime, and improving product quality (Lee, 2015). In the supply chain and distribution sectors, IoT facilitates end-to-end visibility, inventory tracking, and demand forecasting (Ivanov et al., 2014). Studies suggest that organizations with higher innovative capability are more likely to adopt and effectively utilize IoT technologies in their operations, especially in the transportation and logistics context (Opasvitayarux et al., 2022; Rey et al., 2021). From the previous literature discussed, the hypothesis for the study is proposed below:

H4: Innovative capability has a significant influence on implementation of Internet of Things.

2.1.5. Executive Support

Executive support refers to the endorsement and active involvement of top-level management in championing IoT initiatives and aligning them with organizational goals and objectives (Lin et al., 2016). Executive leaders play a crucial role in articulating the strategic vision for IoT deployment, allocating resources, and overcoming organizational barriers to change (Mubarak & Wan Yusoff, 2019). Within the manufacturing sector, executive support is instrumental in driving IoT adoption by fostering a culture of innovation, risk-taking, and experimentation (Allioui & Mourdi, 2023). By providing clear direction and securing buy-in from stakeholders, executives empower teams to explore IoT-enabled solutions for improving production processes, quality control, and supply chain management (Taj et al., 2023). In the supply chain and distribution sectors, executive support is essential for overcoming organizational silos and promoting cross-functional collaboration (Vatanpour et al., 2013). Executives who prioritize IoT investments recognize its potential to enhance visibility, traceability, and responsiveness across the supply chain, thereby gaining a competitive edge in a dynamic market environment (Hsu & Yeh, 2017). Based on the findings of the literature, this study proposes the following hypothesis:

H5: Executive support has a significant influence on implementation of Internet of Things.

2.2. Internet of Things

IoT integration in manufacturing processes has revolutionized traditional practices, enabling enhanced automation, real-time monitoring, and predictive maintenance. According to Cohen et al. (2019), IoT-enabled smart factories facilitate agile production by connecting machines, sensors, and devices, thereby optimizing resource utilization and minimizing downtime. Moreover, IoT-driven data analytics empower manufacturers with valuable insights for improving efficiency and quality (Kusiak, 2018). In the realm of supply chain management, IoT technologies offer unprecedented visibility and transparency throughout the entire logistics network. Research by Ivanov et al. (2014) suggests that IoT-enabled supply chains enhance inventory management, reduce lead times, and mitigate risks through advanced tracking and tracing capabilities. According to Imran et al. (2018), Industry 4.0 achieves seamless operations across organizational boundaries in production and service sectors through integration with diverse applications and software arrangements, thereby establishing networked organizations. As literature mentioned above, this study proposes a hypothesis:

H6: Implementation of Internet of Things has a significant influence on production and services.

2.3. Production and Services

Production activities play a pivotal role in organizational performance across various sectors. Scholars such as Stevenson (2018) emphasize the importance of efficient production processes in enhancing operational effectiveness and ultimately improving overall performance. For instance, research by Adebanjo et al. (2020) highlights the significance of lean production practices in reducing waste and enhancing productivity, thereby positively impacting organizational performance metrics such as cost efficiency and quality. In parallel, the provision of services has emerged as a critical determinant of organizational success. Studies by Fitzsimmons and Fitzsimmons (2011) underscore the role of service quality in shaping customer satisfaction and loyalty, consequently influencing organizational performance outcomes. Furthermore, Grönroos (2007) emphasizes the pivotal role of service innovation in enhancing competitiveness and differentiation, ultimately contributing to improved performance in service-centric industries. Within the manufacturing, supply chain, and distribution sectors, the integration of production and services is paramount for achieving optimal performance. Scholars such as Christopher (2016) highlight the importance of aligning production processes with customer demand to minimize lead times and enhance responsiveness, thereby improving overall supply chain performance. Therefore, the interplay between production and services within organizational contexts has garnered significant attention due to its profound implications for organizational performance (Govorukha & Kuchkova, 2018; Imran et al., 2018), as shown in below hypothesis:

H7: Production and services have a significant influence on organizational performance.

2.4. Organizational Performance

Organizational performance is a multifaceted concept that encompasses various dimensions of success, including financial, operational, and strategic achievements (Opasvitayarux et al., 2022). In the context of manufacturing, supply chain, and distribution sectors, understanding and optimizing organizational performance are paramount for sustained competitiveness and growth (Imran et al., 2018). Numerous factors influence organizational performance in manufacturing, supply chain, and distribution contexts. Research by Marshoudi et al. (2023) emphasizes the role of strategic alignment between organizational goals and operational activities in driving performance outcomes. The adoption of technology and innovation plays a crucial role in driving organizational performance across manufacturing, supply chain, and distribution sectors. Scholars such as Porter and Heppelmann (2014) highlight the transformative impact of digital technologies, such as Internet of Things (IoT), big data analytics, and automation, in enhancing operational efficiency, visibility, and decision-making capabilities. Furthermore, research by Lee et al. (2004) emphasizes the role of innovation in product design, process optimization, and business model innovation as key drivers of competitive advantage and performance improvement.

3. Research Methods and Materials

3.1. Research Framework and Hypotheses

The research framework is derived from theoretical models established in prior studies. Imran et al. (2018) studied that Industry 4.0 plays a pivotal role in advancing

Pakistan's production and services sectors, significantly influencing their overall performance. This research stands as a pioneering investigation into the impact of Industry 4.0 on Pakistan's textile and logistics industries. Opasvitayarux et al. (2022) highlighted factors such as compatibility, trialability, adaptive capacity, innovative capability, executive support, pressure from value chain partners, presence of service providers, and information sharing had significant effects on attitudes toward adopting Quality Management (QM) Internet of Things (IoT). Thus, the subsequent framework and hypotheses, depicted in Figure 1, are suggested.

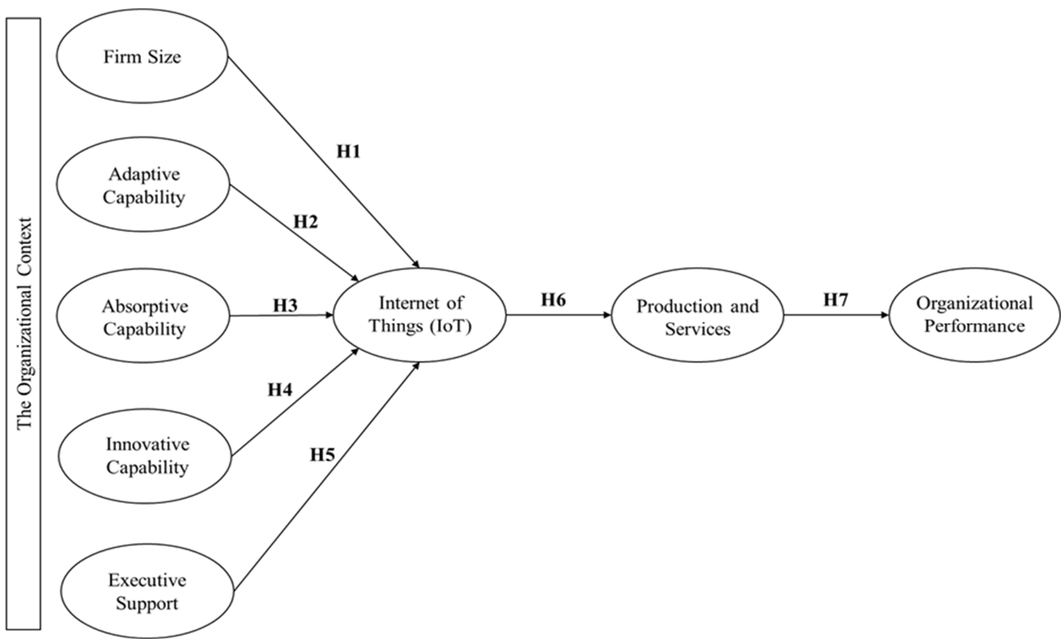


Figure 1: Conceptual Framework

H1: Firm size has a significant influence on implementation of Internet of Things.
H2: Adaptive capability has a significant influence on implementation of Internet of Things.
H3: Absorptive capability has a significant influence on implementation of Internet of Things.
H4: Innovative capability has a significant influence on implementation of Internet of Things.
H5: Executive support has a significant influence on implementation of Internet of Things.
H6: Implementation of Internet of Things has a significant influence on production and services.
H7: Production and services have a significant influence on organizational performance.

3.2. Methodology

The research methodology employed is quantitative, utilizing questionnaire distribution. The questionnaire comprises three sections: screening questions, 30 items rated on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5), and demographic information encompassing gender, age, educational level, and years of work experience. 30 items are presented in Table 1. Prior to data collection, the Item–Objective Congruence (IOC) index was employed, involving evaluation by four experts holding Ph.D. and c-level positions in manufacturing and distribution companies. All scale items received a score of 0.5 or higher. The reliability of the constructs was assessed using Cronbach's Alpha coefficient, achieving values of 0.70 or above during the pilot test involving 50 participants, in line with Nunnally and Bernstein (1994). Subsequently, the survey was disseminated widely to 460 employees occupying managerial and strategic roles. These individuals possessed a minimum of one year of experience within 20 prominent manufacturing and distribution companies in Thailand, each with a workforce exceeding 250 employees. Statistical software was utilized for data analysis. Confirmatory Factor Analysis (CFA) was conducted to assess reliability, validity, and goodness-of-fit indices. Furthermore, Structural Equation Model (SEM) analysis was employed to evaluate the goodness-of-fit of the model and test hypotheses.

Table 1: Scale Items

Variables	Source of Questionnaire (Measurement Indicator)	Scale Items
1. Firm Size (FMS)	Opasvitayarux et al. (2022)	FMS1: My firm is large enough to have more willingness to implement IoT FMS2: My firm is large enough to have more resources to implement IoT FMS3: My firm is large enough to have bigger chance to be successful in implementing IoT.
2. Adaptive Capability (ADC)	Opasvitayarux et al. (2022)	ADC1: Adopting the IoT technology will decrease hardware equipment cost. ADC2: Adopting the IoT technology will decrease operating cost and maintenance cost.
3. Absorptive Capability (ABC)	Opasvitayarux et al. (2022)	ABC1: My firm has IoT related technical knowledge such as RFID, cloud storage and other IoT-related programs. ABC2: My firm has IoT technology-related professionals. ABC3: My firm is dedicated to ensuring that employees are familiar with IoT.
4. Innovative Capability (OIN)	Opasvitayarux et al. (2022)	OIN1: It would be beneficial for the firm to look for ways to experiment with new technology, such as IoT OIN2: Among peers, my firm is usually the first to explore new technologies OIN3: My firm likes to experiment with new technologies, such as IoT OIN4: In general, I am confident to try out new technologies.
5. Executive Support (EXS)	Opasvitayarux et al. (2022)	EXS1: Top management actively participates in establishing a vision and formulating strategies for utilizing IoT plan. EXS2: Top management communicates its support (manpower, money, etc.) for the use of IoT plan. EXS3: Top management is likely to take risk involved in implementing IoT plan EXS4: Senior staffs seem to encourage employees to plan applying IoT in daily work.
6. Internet of Things (IOT)	Opasvitayarux et al. (2022)	IOT1: IOTs provides lower lead times for customers and lower overall costs. IOT2: IOTs helps to improve the production capacity. IOT3: IOTs provides the linkage of all devices to the internet which help in production processes. IOT4: IOTs provides a better communication between employees. IOT5: IOTs provides a link between customers and company, and increases the customer satisfaction level.
7. Production and Services (PAS)	Imran et al. (2018)	PAS1: Effective production inside the company increases the overall organizational performance. PAS2: Effective services to the customer increase the overall organizational performance. PAS3: Effective production and services increase the customer satisfaction level. PAS4: Effective production and services bring accuracy in the operations of the company.
8. Organizational Performance (ORG)	Imran et al. (2018)	ORG1: Overall performance of the company last year was far above average. ORG2: Overall performance of the company relative to major competitors last year was far above average. ORG3: Overall sales growth of the company relative to major competitors last year was far above average. ORG4: Relative to our largest competitor, during the last year, we had a larger market share. ORG5: Relative to our largest competitor, profitability was increased.

3.3. Population and Sample Size

The target population is participants from managerial and strategic positions within 20 prominent manufacturing and distribution firms in Thailand, each with a workforce of 250 employees or more, offers several advantages. Employees who have been working in managerial and strategic roles for at least one year possess valuable experience and expertise. This ensures that they have a deep understanding of the organization's operations, challenges, and potential areas for improvement.

Focusing on large firms with substantial workforces ensures a robust sample size, enhancing the credibility and generalizability of the study findings. According to Kline (2011), a complex model typically requires a minimum sample size of at least 200. In this study, the survey was distributed to approximately 2,000 participants within a three-month period from August to October 2023. Ultimately, 460 responses were obtained per quota sampling, meeting the criteria for data analysis after passing the screening process.

3.4. Sampling Technique

Sampling techniques employed include judgmental, quota, and convenience sampling. Initially, judgmental sampling was utilized, whereby the researcher selected a group of 460 employees occupying managerial and strategic positions. These individuals possessed a minimum of one year of experience within 20 prominent manufacturing and distribution companies in Thailand, each with a workforce exceeding 250 employees. Second, quota sampling was implemented to determine the sample size proportionally, ensuring 23 participants per company to achieve a balanced representation. Due to consent considerations, the company names cannot be disclosed. Finally, convenience sampling was employed, distributing surveys both offline through human resources departments and online via email, social media platforms, and messaging applications throughout the period from August to October 2023.

4. Results and Discussion

4.1. Demographic Profile

According to Table 2, The demographic profile of 460 participants in this study provides key insights into the sample population. Gender distribution shows a slight predominance of males (56.1%) over females (43.9%). The age distribution is diverse, with the largest group aged 31-40 (31.7%), followed by 41-50 (25.9%), 30 and below (22.4%), and 51 and above (20.0%). Regarding education, most hold Bachelor's degrees (62.8%), followed by Master's (22.2%), Doctorate (9.3%), and Diploma/Below Bachelor’s Degree (5.7%). In terms of work experience, 6-10 years is the most common (28.0%), followed by 1-5 years (23.3%), 11-15 years (19.1%), 16-20 years (16.1%), and 21 years or more (13.5%). This diverse profile enriches the study's findings. In conclusion, the demographic profile of participants in the study reflects a diverse and representative sample population across various demographic factors. The balanced representation of gender, varied age distribution, diverse educational backgrounds, and broad range of work experience contribute to the richness and robustness of the study's findings and analyses.

Table 2: Demographic Profile

Demographic Results (N=460)		Frequency	Percentage
Gender	Male	258	56.1%
	Female	202	43.9%
Age	30 years old or below	103	22.4%
	31-40 years old	146	31.7%
	41-50 years old	119	25.9%
	51 years old or above	92	20.0%
Educational Level	Diploma/Below Bachelor’s Degree	26	5.7%
	Bachelor’s Degree	289	62.8%
	Master’s	102	22.2%
	Doctorate	43	9.3%
Year of Work Experience	1-5 Years	107	23.3%
	6-10 Years	129	28.0%
	11-15 Years	88	19.1%
	16-20 Years	74	16.1%
	21 Years or More	62	13.5%

4.2. Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) serves as a multivariate analysis, ensuring the validation of the measurement model. Table 3 presents the CFA results, assessed through various metrics including Cronbach’s Alpha, factor loadings, composite reliability (CR), and average variance extraction (AVE). The findings indicate that Cronbach’s Alpha coefficients are validated at 0.70 or higher, consistent with established standards (Nunnally & Bernstein, 1994). Factor loadings of 0.5 or above are deemed acceptable. Moreover, both composite reliability (CR) and average variance extraction (AVE) values surpass the recommended thresholds of 0.7 and 0.5, respectively (Fornell & Larcker, 1981). These outcomes collectively affirm the convergent and discriminant validities of the study, underscoring the significance of the CFA analysis results.

Table 3: Confirmatory Factor Analysis Result, Composite Reliability (CR) and Average Variance Extracted (AVE)

Variables	Source of Questionnaire (Measurement Indicator)	No. of Item	Cronbach's Alpha	Factors Loading	CR	AVE
1. Firm Size (FMS)	Opasvitayarux et al. (2022)	3	0.920	0.852-0.922	0.920	0.792
2. Adaptive Capability (ADC)	Opasvitayarux et al. (2022)	2	0.821	0.779-0.897	0.827	0.706
3. Absorptive Capability (ABC)	Opasvitayarux et al. (2022)	3	0.849	0.768-0.839	0.850	0.654
4. Innovative Capability (OIN)	Opasvitayarux et al. (2022)	4	0.916	0.860-0.891	0.917	0.734
5. Executive Support (EXS)	Opasvitayarux et al. (2022)	4	0.948	0.888-0.918	0.949	0.823
6. Internet of Things (IOT)	Opasvitayarux et al. (2022)	5	0.892	0.728-0.865	0.895	0.630
7. Production and Services (PAS)	Imran et al. (2018)	4	0.918	0.838-0.871	0.918	0.738
8. Organizational Performance (ORG)	Imran et al. (2018)	5	0.932	0.689-0.988	0.921	0.704

Note: CR = Composite Reliability, AVE = Average Variance Extracted

The examination of the square root of the average variance extracted reveals that all correlations exceed the respective correlation values for each variable, as indicated in Table 4 (Fornell & Larcker, 1981). According to Hair et al. (2006), the presence of multicollinearity is assessed through correlation coefficients, with the factor correlations remaining below 0.80. Consequently, this study does not encounter issues related to multicollinearity.

Table 4: Discriminant Validity

	EXS	FMS	ADC	ABC	OIN	IOT	PAS	ORG
EXS	**0.907**							
FMS	0.270	**0.890**						
ADC	0.261	0.570	**0.840**					
ABC	0.261	0.378	0.316	**0.809**				
OIN	0.382	0.589	0.376	0.340	**0.856**			
IOT	0.257	0.509	0.415	0.364	0.550	**0.794**		
PAS	0.233	0.566	0.416	0.474	0.454	0.439	**0.859**	
ORG	0.384	0.534	0.384	0.324	0.469	0.447	0.412	**0.839**

Note: The diagonally listed value is the AVE square roots of the variables

The measurement model underwent assessment to evaluate its goodness of fit within the Confirmatory Factor Analysis (CFA). This study employed various criteria including CMIN/DF, GFI, AGFI, NFI, CFI, TLI, IFI, and RMSEA, as detailed in Table 5. The findings revealed that all values indicated an acceptable fit after the adjustments. Consequently, the study's convergent and discriminant validities were validated.

Table 5: Goodness of Fit of Measurement Model

Index	Acceptable Values	Structural Model	
		Statistical Values Before Adjustment	Statistical Values After Adjustment
CMIN/DF	< 3.00 (Hair et al., 2006)	934.677/377 = 2.479	789.869/375 = 2.106
GFI	≥ 0.85 (Kline, 2011)	0.875	0.898
AGFI	≥ 0.85 (Kline, 2011)	0.845	0.873
NFI	≥ 0.85 (Kline, 2011)	0.921	0.933
CFI	≥ 0.85 (Kline, 2011)	0.951	0.963
TLI	≥ 0.85 (Kline, 2011)	0.943	0.958
IFI	≥ 0.85 (Kline, 2011)	0.951	0.964
RMSEA	≤ 0.08 (Hooper et al., 2008)	0.057	0.049
Model summary		**Unacceptable Model Fit**	**Acceptable Model Fit**

Remark: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normalized fit index, CFI = comparative fit index, TLI = Tucker-Lewis index, IFI = Incremental Fit Index, and RMSEA = root mean square error of approximation

4.3. Structural Equation Model (SEM)

The structural model was employed to ascertain the satisfactory fit of the Structural Equation Model (SEM), as outlined in Table 6. Initially, the model's fit needed alignment with empirical data. Following adjustments to the model, the fit values became acceptable, with parameters including CMIN/DF = 2.681, GFI = 0.877, AGFI = 0.851, NFI = 0.912, CFI = 0.943, TLI = 0.935, IFI = 0.943, and RMSEA = 0.061 meeting the criteria.

Table 6: Goodness of Fit of Structural Model

Index	Acceptable Values	Structural Model	
		Statistical Values Before Adjustment	Statistical Values After Adjustment
CMIN/DF	< 3.00 (Hair et al., 2006)	1183.276/388 = 3.050	1034.967/386 = 2.681
GFI	≥ 0.85 (Kline, 2011)	0.855	0.877
AGFI	≥ 0.85 (Kline, 2011)	0.827	0.851
NFI	≥ 0.85 (Kline, 2011)	0.899	0.912
CFI	≥ 0.85 (Kline, 2011)	0.930	0.943
TLI	≥ 0.85 (Kline, 2011)	0.921	0.935
IFI	≥ 0.85 (Kline, 2011)	0.930	0.943
RMSEA	≤ 0.08 (Hooper et al., 2008)	0.067	0.061
Model summary		**Unacceptable Model Fit**	**Acceptable Model Fit**

Remark: CMIN/DF = The ratio of the chi-square value to degree of freedom, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normalized fit index, CFI = comparative fit index, TLI = Tucker-Lewis index, IFI = Incremental Fit Index, and RMSEA = root mean square error of approximation

4.4. Research Hypothesis Testing Result

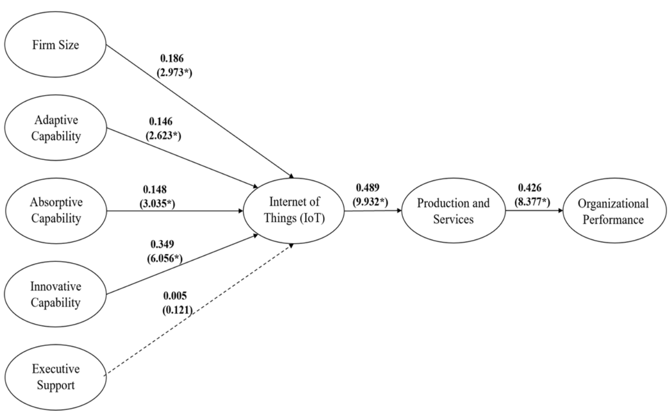
The research hypothesis testing results are derived from the analysis of standardized coefficients (β) along with their corresponding t-values, as illustrated in Table 7 and Figure 2. Standardized coefficients indicate the strength and direction of the relationships between predictor variables (e.g., firm size, adaptive capability, absorptive capability) and the outcome variable (e.g., Internet of Things, production and services, organizational performance) in the structural equation model.

The t-values associated with the standardized coefficients are used to determine the statistical significance of these relationships. A t-value greater than 1.96 (for a two-tailed test) or the critical value corresponding to the desired significance level indicates that the relationship is statistically significant at the specified alpha level, which in this case is $p = 0.05$.

Table 7: Hypothesis Result of the Structural Model

H	Paths	(β)	S.E.	t-Value	Tests Result
H1	IOT<---FMS	0.186	0.056	2.973*	Supported
H2	IOT<---ADC	0.146	0.053	2.623*	Supported
H3	IOT<---ABC	0.148	0.056	3.035*	Supported
H4	IOT<---OIN	0.349	0.058	6.056*	Supported
H5	IOT<---EXS	0.005	0.037	0.121	Not Supported
H6	PAS<---IOT	0.489	0.053	9.932*	Supported
H7	ORG<---PAS	0.426	0.041	8.377*	Supported
H8	IOT<---FMS	0.186	0.056	2.973*	Supported

Note: *p<0.05



Remark: Dashed lines, not significant; solid lines, significant. *p<0.05

Figure 2: The Results of Structural Model

The analysis of standardized path coefficients reveals significant relationships between organizational factors and their influence on Internet of Things (IoT) adoption, as well as its impact on production, services, and organizational performance.

H1 posited that firm size has a significant influence on IoT adoption. The results indicate a positive standardized path coefficient of 0.186 (T-value = 2.973, $p < 0.05$), supporting the hypothesis. This suggests that larger firms are more likely to adopt IoT technologies compared to smaller ones. Hence, this finding establishes firm size as a pivotal factor influencing the dynamics of IoT implementation (Opasvitayarux et al., 2022).

H2 suggested that adaptive capability influences IoT adoption. The findings demonstrate a positive relationship with a standardized path coefficient of 0.146 (T-value = 2.623, $p < 0.05$), supporting the hypothesis. This implies that organizations with higher adaptive capabilities are more inclined to embrace IoT technologies, as aligned with several studies (Gracias et al., 2023; Hong et al., 2011; Sievers et al., 2021).

H3 proposed that absorptive capability affects IoT adoption. The analysis reveals a significant positive relationship, with a standardized path coefficient of 0.148 (T-value = 3.035, $p < 0.05$), supporting the hypothesis (Junaid et al., 2022; Lin et al., 2016). This suggests that organizations with enhanced absorptive capabilities are more likely to adopt IoT technologies effectively.

H4 hypothesized that innovative capability influences IoT adoption. The results demonstrate a strong positive relationship, with a standardized path coefficient of 0.349 (T-value = 6.056, $p < 0.05$), supporting the hypothesis. This indicates that organizations with higher innovative capabilities are more inclined to adopt IoT technologies to drive innovation and competitive advantage (Lee, 2015; Opasvitayarux et al., 2022; Porter & Heppelmann, 2014).

H5 suggested that executive support influences IoT adoption. However, the analysis reveals a non-significant relationship, with a standardized path coefficient of 0.005 (T-value = 0.121, $p > 0.05$), indicating that executive support does not significantly impact IoT adoption in this context, which is consistent to the study of Hsu and Yeh (2017) and Vatanpour et al. (2013).

H6 posited that IoT adoption influences production and services. The results show a significant positive relationship, with a standardized path coefficient of 0.489 (T-value = 9.932, $p < 0.05$), supporting the hypothesis. This suggests that IoT adoption positively impacts both production and service sectors (Imran et al., 2018).

H7 proposed that production and services influence organizational performance. The analysis reveals a significant positive relationship, with a standardized path coefficient of 0.426 (T-value = 8.377, $p < 0.05$), supporting the hypothesis. Imran et al. (2018) indicated that effective management of production and services leads to improved organizational performance.

Overall, these findings underscore the importance of various organizational capabilities, such as adaptive, absorptive, and innovative capabilities, in driving IoT adoption. Moreover, they highlight the significant impact of IoT adoption on both production and services sectors, ultimately enhancing organizational performance. However, the non-significant influence of executive support on IoT adoption suggests potential areas for further exploration and managerial intervention.

5. Conclusions and Recommendation

5.1. Conclusion and Discussion

The results of this study provide valuable insights into the factors influencing the implementation of Internet of Things (IoT) technologies and their impact on various aspects of organizational performance within the context of IoT implementation. The discussion will focus on the implications of these findings for organizations seeking to adopt and leverage IoT solutions effectively.

Firstly, the significant positive relationships observed between firm size, adaptive capability, absorptive capability, and innovative capability with IoT implementation underscore the importance of organizational readiness and capacity for technological innovation in the context of IoT adoption (Opasvitayarux et al., 2022). Larger organizations, as well as those with higher adaptive, absorptive, and innovative capabilities, are better positioned to embrace IoT technologies and navigate the complexities associated with their implementation (Rey et al., 2021). These findings highlight the need for organizations to invest in building the necessary capabilities and resources to support successful IoT implementation initiatives.

However, the non-significant influence of executive support on IoT implementation raises important considerations regarding the role of leadership in driving and supporting technological change within organizations. While executive support is often considered critical for facilitating organizational change, its limited impact on IoT implementation suggests potential challenges or barriers at the leadership level that warrant further investigation. Organizations must explore ways to engage and align executive leadership with IoT implementation initiatives, foster a culture of innovation, and provide the necessary resources and support to drive successful implementation efforts. Zhu and Kraemer (2005) examined post-adoption variations in the usage and value of e-business technologies in the retail industry and addressed the insignificant role of executive support in technology implementation and utilization.

Moreover, the significant positive relationship between IoT implementation and both production and services sectors highlight the transformative potential of IoT technologies in optimizing business processes and enhancing operational efficiency, as supported by Imran et al. (2018). By integrating IoT solutions into production processes, organizations can improve resource utilization, enable real-time monitoring and control, and streamline operations. Similarly, in the services sector, IoT implementation can enhance service delivery, improve customer experiences, and enable new business models and revenue streams. These findings underscore the need for organizations to leverage IoT technologies strategically to drive innovation and value creation across their operations.

Furthermore, the positive relationship between production/services and organizational performance emphasizes the critical role of effective management of core business functions in driving overall organizational success in the context of IoT implementation (Imran et al., 2018). Organizations that effectively manage their production and service operations are better positioned to achieve operational excellence, deliver value to customers, and maintain a competitive edge in the market. By focusing on enhancing production and service capabilities through IoT implementation, organizations can drive improvements in key performance metrics such as productivity, quality, customer satisfaction, and profitability.

In conclusion, the findings of this study underscore the importance of organizational capabilities, leadership support, and effective management practices in driving successful IoT implementation and realizing its potential benefits. Organizations must prioritize investment in building adaptive, absorptive, and innovative capabilities, engage executive leadership in supporting IoT initiatives, and leverage IoT technologies strategically to drive innovation and value creation across their operations. By doing so, organizations can position themselves for success in an increasingly digital and interconnected business environment, driving improvements in operational efficiency, customer satisfaction, and overall organizational performance through effective IoT implementation.

5.2. Recommendation

Based on the findings and analysis presented in this study, several recommendations can be made to organizations seeking to implement Internet of Things (IoT) technologies effectively to enhance production, services and organizational performance:

Invest in Organizational Capabilities: Organizations should prioritize investment in building adaptive, absorptive, and innovative capabilities to support successful IoT implementation. This includes providing training and development opportunities for employees to enhance their skills and knowledge related to IoT technologies and fostering a culture of innovation and continuous learning within the organization.

Engage Executive Leadership: Executive leadership plays a critical role in driving and supporting IoT implementation initiatives. Organizations should actively engage executive leaders in IoT strategy development, decision-making processes, and resource allocation to ensure alignment with organizational goals and priorities. Executive leaders should champion IoT initiatives, provide visible support and endorsement, and actively promote a culture of innovation and change throughout the organization.

Leverage IoT for Operational Optimization: Organizations should strategically leverage IoT technologies to optimize business processes, improve operational efficiency, and enhance productivity across various functions, including production, services, supply chain management, and customer service. By deploying IoT sensors, devices, and data analytics solutions, organizations can gain real-time insights into their operations, identify areas for improvement, and drive continuous process optimization and innovation.

Focus on Customer Value: Organizations should prioritize the use of IoT technologies to create value for customers by enhancing the quality of products and services, improving customer experiences, and delivering personalized and customized solutions. By leveraging IoT data and insights, organizations can better understand customer needs and preferences, anticipate future demand, and develop innovative products and services that meet or exceed customer expectations.

Ensure Data Security and Privacy: With the proliferation of IoT devices and sensors collecting vast amounts of data, organizations must prioritize data security and privacy to protect sensitive information and maintain customer trust. Organizations should implement robust cybersecurity measures, including encryption, authentication, access controls, and data encryption, to safeguard IoT data from unauthorized access, breaches, and cyberattacks.

Foster Collaboration and Partnerships: Given the complex and interconnected nature of IoT ecosystems, organizations should foster collaboration and partnerships with industry stakeholders, technology providers, research institutions, and government agencies to share knowledge, expertise, resources, and best practices. Collaborative initiatives can accelerate innovation, drive ecosystem growth, and address common challenges and barriers to IoT adoption and implementation.

Monitor and Evaluate Performance: Organizations should establish key performance indicators (KPIs) and metrics to monitor and evaluate the performance and impact of IoT implementation initiatives. By tracking KPIs such as operational efficiency, cost savings, revenue growth, customer satisfaction, and market share, organizations can assess the effectiveness of their IoT strategies, identify areas for improvement, and make data-driven decisions to optimize outcomes and achieve their strategic objectives.

Overall, successful IoT implementation requires a strategic and holistic approach that encompasses organizational capabilities, leadership support, customer focus, data security, collaboration, and performance monitoring. By following these recommendations, organizations can unlock the full potential of IoT technologies to drive innovation, create value, and achieve sustainable competitive advantage in today's digital economy.

5.3. Limitation and Further Study

While this study provides valuable insights into the factors influencing Internet of Things (IoT) adoption and its impact on organizational performance, there are several limitations that warrant consideration for future research. First, the findings of this study are based on a specific sample population and context, which may limit their generalizability to other industries, regions, or organizational contexts. Future research could explore the applicability of these findings in different settings to enhance the generalizability of the results. Second, the study did not account for potential external factors or contextual variables that may influence IoT adoption and organizational performance, such as industry trends, regulatory environment, technological advancements, or market dynamics. Future research could consider these external factors to provide a more comprehensive understanding of the phenomenon. Last, the study primarily relied on quantitative data analysis, which may overlook nuanced or contextual factors that influence IoT adoption and organizational performance. Future research could incorporate qualitative methods such as interviews or case studies to gain deeper insights into the experiences and perceptions of stakeholders involved in IoT initiative.

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