

# **The Use Of Automation Systems In Managing Retail Business Operations In The Lower Northern Region Of Thailand**

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## **Abstract**

This study investigates the use of automation systems in managing retail business operations in the lower northern region of Thailand, focusing on their impact on service quality and business performance. The objectives were threefold: (1) to examine the extent of automation adoption, (2) to assess its role in improving service quality and operational performance, and (3) to evaluate retailers' readiness for automation. A quantitative research design was employed using a survey method. Data were collected from 157 retail operators, managers, and supervisors across nine provinces through purposive sampling. The structured questionnaire included demographic factors, retail operating system variables, and outcome measures. Reliability testing confirmed strong internal consistency (Cronbach's alpha > .70). Descriptive statistics indicated that respondents rated automation adoption across five domains operational technology, product display, customer engagement, data management, and analytics/profitability at high levels, with particular emphasis on mobile applications, social media promotions, and modern data storage. Inferential analysis using multiple regression revealed that data management ( $\beta = .509$ ,  $p < .001$ ) and operational technology ( $\beta = .207$ ,  $p = .003$ ) significantly predicted service quality ( $R^2 = .370$ ), while data management ( $\beta = .381$ ,  $p < .001$ ) and operational technology ( $\beta = .186$ ,  $p = .014$ ) predicted business performance ( $R^2 = .225$ ). Operational technology also modestly predicted sales ( $\beta = .187$ ,  $p = .035$ ). No significant differences were found across demographic subgroups. The findings highlight data management as the most influential factor, underscoring the need for integrated analytics and customer data utilization. The study concludes that combining robust data practices with customer-facing technologies enhances service quality, operational outcomes, and competitiveness, providing a foundation for sustainable retail growth in Thailand's lower northern region.

**Keywords:** Automation Systems, Retail Business Operations, Digital Transformation.

## **Introduction**

Retail business is one of the most significant economic activities that drive national development, contributing not only to economic growth but also to improvements in social welfare and standards of living. By functioning as an intermediary between producers and consumers, the retail sector plays a critical role in ensuring that goods and services are widely accessible. Over the past two decades, the rapid expansion of modern retail formats has intensified competition within the industry, requiring firms to adopt new strategies, diversify marketing channels, and introduce innovative practices to meet evolving consumer demands (KPMG, 2017). At the same time, the emergence of e-commerce and online marketplaces has accelerated global retail transformation, reshaping consumer behavior and creating both opportunities and challenges for traditional retailers. Thailand, like many countries in Southeast

Asia, has experienced profound shifts in consumer habits. The increasing accessibility of the internet and mobile technologies has facilitated widespread adoption of online shopping across all demographic groups from Baby Boomers to Generation Z reflecting global trends of convenience, price sensitivity, and round-the-clock accessibility (Electronic Transactions Development Agency [ETDA], 2018). According to ETDA, more than 85% of surveyed consumers reported that online shopping saves time and effort, while 53.4% valued faster product delivery, and 51.4% were motivated by discounts and promotional offers. These findings underscore the increasing diversity of online consumers and highlight the transformative impact of digital platforms on the retail sector. The rapid growth of e-commerce has also blurred the traditional boundaries between online and offline retail. The “Omni-Channel” model, which integrates physical stores with digital platforms, has become a dominant approach in many markets. Retailers are now expected to deliver seamless shopping experiences across multiple platforms, combining brick-and-mortar stores, company websites, social media channels, and third-party online marketplaces (Kasikorn Research Center, 2016). This phenomenon is not unique to Thailand; in the United States, major retailers such as Macy’s, JC Penney, and Sears have closed hundreds of outlets due to shifting consumer preferences and broader economic challenges (The Economist, 2017). Similarly, research in India by Saha (2015) demonstrated that online retail significantly affected traditional businesses in Guwahati, leading to reduced profitability, increased employee turnover, and intensified price competition.

Against this backdrop, retailers in Thailand’s lower northern region are under mounting pressure to adapt. This region, characterized by both traditional retail stores and the gradual emergence of modern trade formats, has faced growing exposure to digital disruption. Retailers, ranging from large shopping centers to small and medium-sized enterprises (SMEs), are increasingly aware that survival depends on innovation, differentiation, and operational efficiency. Many firms have experimented with strategies such as creating specialized consumer zones (e.g., educational spaces for children, co-working spaces for professionals) or focusing on niche and unique product selections to appeal to specific customer segments. However, the dynamic nature of the retail environment requires continuous transformation and the effective management of fixed assets to generate sustainable returns. Automation systems have emerged as a promising solution to these challenges. By leveraging technologies such as data analytics, artificial intelligence (AI), and digital process automation, retailers can optimize inventory management, streamline supply chain operations, and enhance customer relationship management. The use of big data and predictive analytics enables businesses to better understand consumer behavior, while AI-powered tools allow for personalized recommendations, dynamic pricing, and efficient customer service (Brynjolfsson & McAfee, 2017). These systems also facilitate integration between offline and online channels known as Online-to-Offline (O2O) which allows retailers to maximize sales potential while maintaining customer trust and loyalty.

For retailers in Thailand’s lower northern region, the adoption of automation systems is not merely a matter of operational improvement but a strategic necessity for long-term survival. The growing intensity of competition, the penetration of international e-marketplace platforms, and shifting consumer preferences all underscore the urgency of adaptation. Yet, while large multinational retailers have already adopted automation on a wide scale, smaller regional businesses often struggle with technological readiness, investment capacity, and human resource development (World Bank, 2020). These challenges highlight the importance of research that examines both the current status and future preparedness of regional retailers in implementing automation systems. Therefore, this study aims to investigate the use of automation systems in managing retail business operations in the lower northern region of Thailand. Specifically, it seeks to (1) explore the extent of automation adoption in the management of retail operations within the region, (2) identify ways to improve service quality and operational outcomes through automation, and (3) assess the readiness of retail businesses to integrate automation systems into their daily operations. By focusing on these objectives, the research intends to provide insights into how automation can enhance competitiveness, service delivery, and sustainability for retailers in this region. In sum, the retail sector in Thailand is at a crossroads, where traditional practices coexist uneasily with digital transformation. The integration of automation systems has the potential to bridge this gap, ensuring that businesses remain competitive while meeting evolving consumer expectations. The findings of this study are expected to contribute to both academic knowledge and practical strategies for managing retail transformation in Thailand, particularly in the context of regional development.

### **Research Objectives**

1. To examine the utilization of automation systems in managing the operations of retail businesses in the lower northern region of Thailand.

2. To enhance service quality and operational performance of retail businesses in the lower northern region of Thailand through the application of automation systems.
3. To assess the readiness of retail businesses in the lower northern region of Thailand for adopting and implementing automation systems in their operations.

### **Literature Reviews**

Retail management plays a vital role in shaping consumer experiences and ensuring the long-Retail management plays a central role in ensuring the sustainability of retail businesses by overseeing processes such as store layout, inventory control, merchandising, and customer service. Historically, retail management focused on transactional models emphasizing product availability and price competitiveness. Contemporary approaches, however, prioritize customer-centric strategies that create value and enhance shopping experiences. Levy, Weitz, and Grewal (2019) argue that this transition reflects broader changes in consumer behavior, where shoppers now seek memorable service encounters in addition to product acquisition. In Thailand, particularly in the lower northern region, traditional formats such as semi-wholesale outlets and supermarkets remain important but face increasing pressure to modernize in response to rising consumer expectations, evolving lifestyles, and intensifying competition from both domestic and international retailers. A key driver of modernization is retail technology, which encompasses digital tools such as point-of-sale (POS) systems, automated inventory controls, electronic payment platforms, and customer relationship management (CRM) software. Grewal, Roggeveen, Sisodia, and Nordfält (2020) note that such technologies not only streamline operations but also strengthen consumer engagement by reducing transaction times, minimizing errors, and supporting data-driven decision-making. In Bangkok and other urban centers, adoption has accelerated, but provincial retailers often encounter financial and human-capital constraints, widening the digital divide within the national retail sector. E-commerce has also become a transformative force. Defined as the buying and selling of goods and services via digital platforms, e-commerce integrates online marketplaces, mobile applications, and social media to provide consumers with real-time product access (Turban et al., 2018). In Thailand, adoption has expanded rapidly due to internet penetration and smartphone usage (Electronic Transactions Development Agency [ETDA], 2018). Omni-channel strategies, which integrate online and offline channels, are particularly relevant for the lower northern region, allowing businesses to extend market reach. Nonetheless, retailers face persistent challenges such as logistical limitations, intense competition, and uneven readiness. Looking ahead, automation systems, artificial intelligence (AI), and big data analytics are reshaping retail operations. Brynjolfsson and McAfee (2017) highlight technologies such as robotic process automation, AI-driven chatbots, and predictive analytics for demand forecasting. These tools allow businesses to reduce costs, optimize supply chains, and personalize services. However, implementation requires financial investment, staff training, and system integration. Finally, service quality remains central to retail success. Parasuraman, Zeithaml, and Berry (1988) propose the SERVQUAL framework, which identifies tangibility, reliability, responsiveness, assurance, and empathy as key dimensions. Automation can enhance service quality by improving speed, accuracy, and personalization (Grewal et al., 2020). For Thai retailers in the lower northern region, integrating automation is crucial to meeting the expectations of increasingly sophisticated consumers and maintaining competitiveness. In summary, retail management, technology, e-commerce, automation, and service quality are interconnected in shaping competitiveness. As consumer behavior shifts toward digital reliance, retailers in Thailand must embrace automation not only to improve efficiency and service quality but also to secure long-term sustainability and as shown in

Figure 1 Conceptual Framework.

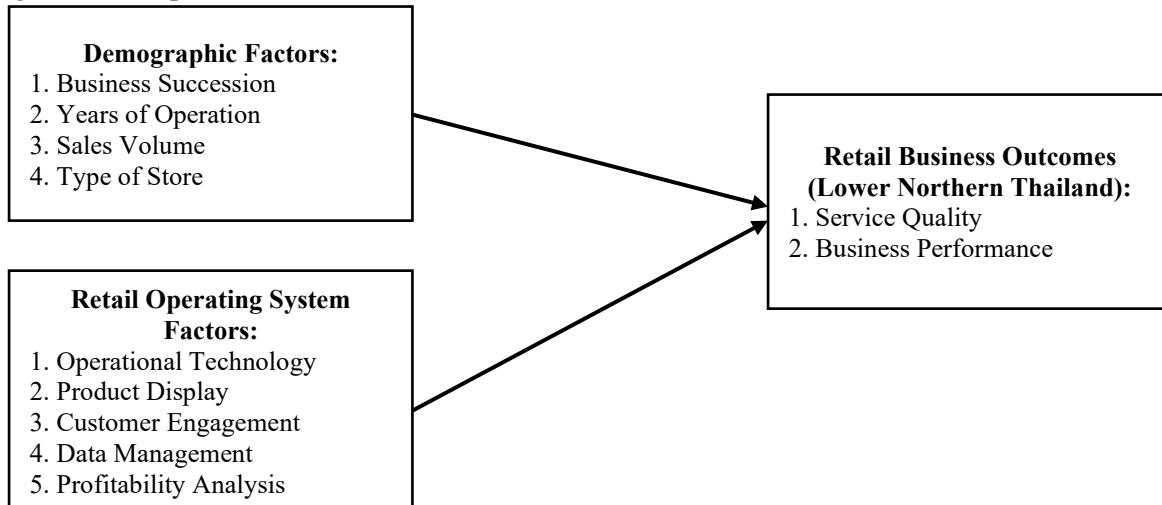


Figure 1 Conceptual Framework

### Research Methodology

This study, entitled “The Use of Automation Systems in Managing Retail Business Operations in the Lower Northern Region of Thailand”, employed a quantitative research design. The purpose of the methodology was to systematically collect, analyze, and interpret data in order to evaluate the relationships between demographic characteristics, retail operating system factors, and retail business outcomes such as service quality and business performance. The following subsections present the research design, population and sample, research instruments, data collection procedures, and statistical methods used for analysis. Research Design, The study applied a survey research method, which is appropriate for quantitative studies that seek to generalize findings from a sample to a larger population (Creswell & Creswell, 2018). A structured questionnaire was employed as the primary data collection instrument, allowing the researcher to measure perceptions and experiences of retail operators regarding the use of automation systems. The survey was designed with closed-ended questions, enabling standardized responses suitable for statistical analysis. Population and Sampling, The target population consisted of retail business operators, managers, or supervisors of traditional retail stores, semi-wholesale outlets, supermarkets, and minimarts operating in the lower northern region of Thailand. This region includes Kamphaeng Phet, Tak, Nakhon Sawan, Phichit, Phitsanulok, Phetchabun, Sukhothai, Uttaradit, and Uthai Thani provinces. Given the research focus on retail modernization, respondents were required to be decision-makers or individuals directly involved in retail operations. The sample size included 157 retail businesses, selected through purposive sampling. This non-probability sampling method was chosen to ensure that only businesses fitting the research criteria—specifically retail operators with some exposure to or potential for automation were included in the study (Etikan, Musa, & Alkassim, 2016). This method allowed the researcher to focus on respondents with relevant expertise and experience. Research Variables, The study examined two categories of independent variables and one dependent variable. 1) Demographic factors: business succession (GEN), years of operation, sales volume, and type of store. 2) Retail operating system factors: operational technology, product display, customer engagement, data management, and analytics and profitability. 3) Dependent variables: retail business outcomes measured in terms of service quality and overall business performance. Research Instrument, The primary research instrument was a structured questionnaire, divided into three sections. Section one contained screening and demographic questions in a checklist format. Section two addressed retail operating system factors, using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Section three assessed retail outcomes, including service quality and business performance, also measured on a five-point Likert scale. The use of Likert-type rating scales ensured that attitudinal data could be quantified for statistical testing (Joshi, Kale, Chandel, & Pal, 2015). Prior to full deployment, the questionnaire was tested for reliability and validity. Reliability was assessed using Cronbach’s alpha, with a coefficient above 0.70 considered acceptable for internal consistency (Hair, Black, Babin, & Anderson, 2019). Content validity was confirmed by experts in retail management and survey methodology. Data Collection Procedures, Data were collected between January and March 2019 using both in-person distribution and online surveys via Google Forms. Research assistants, who were

trained in survey administration, distributed questionnaires directly to target respondents in retail stores across the region. Simultaneously, digital questionnaires were disseminated via messaging applications to maximize response rates. Respondents were assured of confidentiality and anonymity, consistent with ethical research practices. Data Analysis, The data analysis was conducted using a statistical software package. Both descriptive and inferential statistics were employed. Descriptive statistics—frequency, percentage, mean, and standard deviation were used to summarize demographic characteristics and responses to operating system factors. Inferential statistics were applied to test hypotheses. Specifically: (1) Factor Analysis was employed to group correlated variables into unified constructs. (2) Independent Sample t-tests were used to assess differences in service quality and business performance across demographic groups such as gender, age, and sales volume. (3) Multiple Linear Regression Analysis was conducted to examine the predictive relationships between independent variables (demographics and operating system factors) and dependent variables (service quality and business performance). This combination of descriptive and inferential techniques provided robust insights into how automation systems influence retail management in the lower northern region of Thailand.

## Research Results

This section reports the empirical findings for “The Use of Automation Systems in Managing Retail Business Operations in the Lower Northern Region of Thailand.” Results are organized to address the study objectives: (1) examine the use of automation systems among retail businesses, (2) identify how automation relates to service quality and operational performance, and (3) evaluate retailers’ readiness through perceptions of operating-system factors. 1) Sample characteristics, The sample comprised 157 retail businesses located across the lower northern provinces (Kamphaeng Phet, Tak, Nakhon Sawan, Phichit, Phitsanulok, Phetchabun, Sukhothai, Uttaradit, and Uthai Thani). Most respondents were male (59.2%), aged 31–40 years (36.9%), married/living together (51.6%), and held a bachelor’s degree (56.7%). A majority were store owners (64.3%); 47.8% reported operating in Generation 1 (business founded by the current operator). Tenure in operation clustered at 1–5 and 6–10 years (both 33.1%). Daily sales most frequently fell in the 40,001–80,000 THB band (26.2%). Most stores had fewer than six employees (39.5%) and were supermarkets (68.2%). These profiles indicate decision makers with direct control over operations, suitable for evaluating automation adoption. 2) Use and perceptions of automation-related operating factors, Perceived implementation of five operating-system factors was generally high: Operational technology: Overall “high.” Highest-rated items were mobile applications that help customers search information on their phones and Scan & Go tools that simplify purchasing, indicating active adoption of front-end digital touchpoints. Product display (visual merchandising), Highest overall among the factors. Top items were promotion/marketing via social media or smartphones and distinctive in-store displays, showing integration of online promotion with physical presentation. Customer engagement, Rated “highest.” The most endorsed items were product completeness that encourages participation/purchase, good service that promotes repeat visits, and staff courtesy, suggesting engagement is supported by both assortment and service behaviors. Data management, Rated “highest.” Leading items included using customer data to design promotions, analyzing statistics on service-use behavior, and having modern data storage, evidencing readiness for analytics-driven decisions. Analytics & profitability, Rated “high.” The strongest items were customer-centric strategies emphasizing experience and profits derived from new innovations, underscoring strategic orientation toward value creation. Taken together, these patterns indicate moderate-to-high readiness for automation in the region: retailers report meaningful investments in customer-facing technologies, data practices, and merchandising that connect online and offline channels. 3) Retail outcomes: service quality and business performance, Perceived service quality resulting from automation was high overall. Respondents most agreed that automation enables timely response to service needs, makes service delivery more explicit/transparent to customers, and increases confidence in the service received. Perceived business performance was also high. The most endorsed items were investment decision making in retail automation technologies and efficiency gains from automation, suggesting managers observe tangible operational benefits. 4) Differences across demographic groups, Independent-samples tests indicated no significant differences in service quality or business performance across business succession (GEN), years of operation, sales volume, or store type. Thus, perceived benefits of automation appear broadly shared across demographic subgroups in this regional retail context. 5) Regression analyses, Multiple linear regression was used to examine the predictive effects of operating-system factors on outcomes. (5.1) Service quality (Dependent variable), Model fit:  $R = .609$ ,  $R^2 = .370$ ,  $Adj. R^2 = .362$ ,  $F(2,154) = 45.289$ ,  $p < .001$ . Significant predictors, Data management ( $\beta = .509$ ,  $p < .001$ ) Operational technology ( $\beta = .207$ ,  $p = .003$ ). Standardized model:  $Z$  (Service Quality) =  $.509 \times$  Data

Management+.207×Operational Technology Interpretation: Stronger data practices and the use of operational technology are associated with higher perceived service quality, with data management exerting the larger effect. (5.2) Business performance (Dependent variable), Model fit:  $R = .474$ ,  $R^2 = .225$ , Adj.  $R^2 = .215$ ,  $F(2,154) = 22.333$ ,  $p < .001$ . Significant predictors, Data management ( $\beta = .381$ ,  $p < .001$ ) Operational technology ( $\beta = .186$ ,  $p = .014$ ). Standardized model: (Business Performance) =.381×Data Management+.186×Operational Technology. Interpretation: Both predictors contribute positively to performance, again with data management showing the stronger effect. (5.3) Sales (Additional performance indicator), Model fit:  $R = .187$ ,  $R^2 = .035$ , Adj.  $R^2 = .027$ ,  $F(1,125) = 4.537$ ,  $p = .035$ . Significant predictor: Operational technology ( $\beta = .187$ ,  $p = .035$ ). Interpretation: Operational technology shows a small but significant positive association with daily sales; other factors were not significant for sales in this specification. As show in Table 1 – Table 2. 6) Synthesis against objectives, Objective 1 (examine use): High ratings across all five operating factors indicate widespread, practical use of automation-related systems especially mobile touchpoints, social promotions, data storage/analysis, and customer-centric merchandising. Objective 2 (improve service quality/performance): Regression results confirm that data management and operational technology significantly improve service quality and business performance; operational technology additionally predicts sales and Objective 3 (assess readiness): The consistently high perceptions of technology, engagement, and data capabilities—together with significant outcome links suggest readiness at a moderate-to-high level, while the modest  $R^2$  for sales implies room for deeper process integration (e.g., advanced analytics, supply chain automation).

**Table 1:** Key Demographics of Respondents

Characteristic	Dominant category	%
Gender	Male	59.2
Age	31–40 years	36.9
Marital status	Married / living together	51.6
Education	Bachelor's degree	56.7
Position	Store owner	64.3
Business generation (GEN)	GEN 1	47.8
Years in operation	1–5 yrs & 6–10 yrs	33.1 each
Daily sales	40,001–80,000 THB	26.x
Employees	< 6	39.5
Store type	Supermarket	68.2

**Table 2:** Multiple Regression Results (significant predictors only)

Outcome Variable	Predictors	Std. Beta ( $\beta$ )	R	R <sup>2</sup>	Adj. R <sup>2</sup>	F	Sig.
Service Quality	Data Management	.509***	.609	.370	.362	45.289	<.001
	Operational Technology	.207**					
Business Performance	Data Management	.381***	.474	.225	.215	22.333	<.001
	Operational Technology	.186*					
Sales	Operational Technology	.187*	.187	.035	.027	4.537	.035

Notes:  $p < .05$  (),  $< .01$  (),  $< .001$  (). Non-significant factors omitted for brevity. Demographic variables showed no significant group differences in service quality or performance.

Overall, the findings demonstrate that retailers in Thailand's lower northern region are actively employing automation-related tools and practices. Among these, data management emerges as the pivotal driver of service quality and business performance, while operational technology contributes to

both outcomes and to sales. For greater impact, managers should prioritize integrated data pipelines and customer-facing technologies, extending analytics from promotion design to inventory, pricing, and workforce scheduling to translate perceived gains into stronger financial outcomes.

## Discussion & Conclusion

This study examined how automation systems are used to manage retail business operations in the lower northern region of Thailand and how such systems relate to service quality and business performance. Three core findings emerge. First, retailers report high levels of adoption/readiness across five operating-system domains—operational technology, visual merchandising, customer engagement, data management, and analytics/profitability—indicating that automation has diffused beyond large metropolitan chains into regional formats such as supermarkets and semi-wholesale stores. This aligns with sectoral shifts documented in prior work showing that technology-enabled retailing is now integral to competitive strategy (Grewal, Roggeveen, Sisodia, & Nordfält, 2020; Turban et al., 2018). Second, the strongest statistical effects on outcomes arise from data management and operational technology. Multiple regression models show that data management ( $\beta = .509$  for service quality;  $\beta = .381$  for performance) and operational technology ( $\beta = .207$  for service quality;  $\beta = .186$  for performance) significantly predict favorable outcomes, with model fits of  $R^2 = .370$  and  $.225$ , respectively. These coefficients indicate practically meaningful relationships: standardized effects above  $.30$  are typically interpreted as moderate in behavioral research (Hair, Black, Babin, & Anderson, 2019). The prominence of data management supports the view that automation's value materializes when retailers capture, store, and analyze customer and operations data, converting digital exhaust into actionable decisions (Brynjolfsson & McAfee, 2017). In the present sample, the highest-rated practices using customer data to design promotions and maintaining modern data repositories are precisely those capabilities that enable downstream analytics and personalized service. That mechanism is also consistent with the SERVQUAL logic: improved reliability and responsiveness arise when inventory visibility, promotion targeting, and workflow timing are data-driven (Parasuraman, Zeithaml, & Berry, 1988). Third, operational technology modestly predicts sales ( $\beta = .187$ ;  $R^2 = .035$ ), whereas other factors do not. The small effect size suggests that short-run sales are influenced by additional constraints e.g., local demand, price competition, logistics that are not fully captured by front-end technologies alone. In other words, mobile apps and “Scan & Go” improve the shopping process and perceived service quality, but translating those process gains into consistent revenue uplift may require deeper integration into supply chain, pricing, and assortment analytics (Grewal et al., 2020). The high ratings of visual merchandising and engagement further indicate that many stores combine omni-channel promotions with in-store experience consistent with national trends in internet and smartphone adoption (Electronic Transactions Development Agency [ETDA], 2018) yet these practices, while beneficial to perceptions, may need stronger ties to replenishment and margin analytics to move bottom-line results. Notably, no significant differences in service quality or performance were found across demographics (business generation, years in operation, sales, store type). This suggests that perceived benefits from automation are broad-based and not confined to any single demographic profile in the region. From a managerial perspective, the absence of subgroup differences implies that capability building in data and technology is universally relevant across formats and firm lifecycles. Methodologically, reliability and validity procedures (structured instrument, Likert scales, factor/regression analyses) follow best practice for survey-based, explanatory designs (Creswell & Creswell, 2018; Hair et al.; 2019, Pongwirithon, K., 2023), lending credibility to inference. Nevertheless, the cross-sectional design prevents causal claims; longitudinal tracking would be needed to test whether improvements in data practices precede and produce performance gains over time. Implications. To move from “high readiness” to “high returns,” managers should (a) strengthen the data pipeline (collection → cleaning → integration) to support predictive models for demand, churn, and promotion lift; (b) link operational technology (apps, Scan & Go, POS) with back-end replenishment and dynamic pricing; and (c) train staff to act on analytics, closing the loop between insights and execution. Policy makers and industry bodies can facilitate adoption in regional markets via shared data standards, vendor-neutral training, and incentives for SME digitization. The study set out to (1) examine the use of automation systems in regional Thai retailing, (2) evaluate their association with service quality and performance, and (3) assess readiness for adoption. Evidence from 157 retailers indicates substantial adoption of automation-related practices and positive, statistically significant relationships between data management and operational technology

and the key outcomes of service quality and business performance. Operational technology also shows a small but significant association with sales. No outcome differences were detected across demographic subgroups, implying that automation benefits are widely accessible across store types and business generations in the lower northern region. The central conclusion is that data capability is the fulcrum of automation's value. Retailers that invest in modern data management paired with customer-facing technologies are more likely to deliver reliable, responsive service and to report better operational results. Future research should use longitudinal and quasi-experimental designs to quantify causal impact, incorporate objective KPIs (e.g., transaction logs, margin data), and test mediating mechanisms (e.g., inventory accuracy, queue times, promotion lift). For practitioners, the path forward is to couple front-end digital touchpoints with back-end analytics and process automation, translating readiness into measurable performance and sustained competitiveness.

## Recommendations

### 1. Practical Recommendations

The findings indicate that data management and operational technology are the strongest drivers of service quality and business performance. Retail managers should therefore prioritize investments in integrated data pipelines that capture, store, and analyze customer and operational information. Linking these data practices to customer-facing technologies such as mobile applications, Scan & Go, and point-of-sale systems will ensure that insights translate into improved service and efficiency. Training programs should be developed to enhance staff capabilities in using analytics for decision-making, ensuring that technology investments generate measurable benefits. Retailers should also integrate front-end technologies with back-end processes, including inventory control, pricing, and supply chain management, to move beyond readiness toward sustainable revenue growth. Policymakers and industry associations can support these efforts by offering vendor-neutral training, developing shared data standards, and providing incentives for SME digital adoption.

### 2. Recommendations for Future Research

Future research should adopt longitudinal or quasi-experimental designs to establish causal links between automation practices and performance outcomes. Comparative studies across regions and store formats could test whether observed patterns are unique to the lower northern region or generalizable nationwide. Mixed-methods approaches, combining surveys with transaction data and staff interviews, would provide richer insights into how automation is implemented and perceived. Finally, future studies should explore mediating factors such as inventory accuracy, queue times, and promotion lift to clarify the mechanisms through which data management and operational technology generate value.

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