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

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

Asst. Prof. Suraporn Onputtha, Ph.D.
Editor-in-Chief

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THE EFFECT OF MARKETING STRATEGY AND CUSTOMER RELATIONSHIP MANAGEMENT ON CUSTOMER SATISFACTION USING THE SERVICES FROM QINGDAO HENGXING EDUCATION GROUP

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ABSTRACT

Purpose – This study examines the effects of marketing strategies and customer relationship management on customer satisfaction among users of Qingdao Hengxing Education Group services in China, aiming to identify which specific dimensions of marketing mix and CRM practices most significantly influence satisfaction outcomes in private educational service contexts.

Methodology – A quantitative research design was employed using a structured questionnaire distributed to 400 customers through convenience sampling. The instrument measured marketing strategies (price, place, product, promotion), customer relationship management (customer retention, customer tracking, useful recommendations, customer feedback, customer relationship building), and customer satisfaction using 5-point Likert scales. Data were analyzed using descriptive statistics, independent samples t-tests, one-way ANOVA, and multiple regression analysis.

Results – Marketing strategies significantly influenced customer satisfaction, with promotion emerging as the most influential dimension, followed by product and price, while place showed non-significant effects. Customer relationship management also significantly affected satisfaction, with customer relationship building demonstrating the strongest impact, followed by customer retention and useful recommendations, whereas customer tracking and customer feedback exhibited non-significant influences. The models explained 53.5% and 60.3% of satisfaction variance respectively.

Implications – Educational institutions should prioritize promotional activities and relationship-building initiatives to enhance customer satisfaction. Management should strategically allocate resources toward effective communication strategies, trust development, and retention programs rather than distributing efforts equally across all marketing and CRM dimensions.

Originality/Value – This research contributes empirical evidence on the differential importance of marketing mix and CRM dimensions in private educational services within the Chinese context, providing actionable insights for educational service providers seeking competitive advantage through strategic customer satisfaction enhancement.

Keywords: Marketing strategies, Customer relationship management, Customer satisfaction, Educational services, Private education

Research Type: Research Article

INTRODUCTION

In the present digital economy, characterized by ever-tougher business competition, businesses in manufacturing as well as the service domain need to transform to create a sustainable competitive advantage. A product- or service-centric perspective is no longer enough: the organization needs to be customer-centric, as the customer is the prime mover and engine of growth of business (Sheth et al., 2000). This is especially true for the educational field, which is an academic service field with

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special characteristics and heavy competition. Customers satisfaction, such as that of students or parents' is seen as an end that increases the likelihood of repeat business and relationship marketing (Hennig-Thurau et al., 2001). Two important tools that businesses use to achieve this are marketing strategy and CRM. This is because marketing enables a company to communicate to the target market the value of the pedagogical services through properly designed products, pricing, channels of delivery, and other related promotional efforts (Akroush, 2011). At the same time, customer relationship management is a business practice that involves the identification and pursuit of opportunities and the management of a company's active interaction with current and future customers. This is done by listening to customer requirements and providing a service that surpasses expectations. At the end of the day, both of these approaches aim to provide the customer with the most satisfaction (Payne & Frow, 2005).

Despite the fact that several studies have evaluated the impact of marketing strategy on customer satisfaction (Al-Msallam, 2015) and others have appraised the impact of the adoption of customer relationship management on customer satisfaction (Osarenkhoe & Bennani, 2007), some research gaps exist. First, most of the studies have only considered separately the impact of marketing strategy or the impact of customer relationship management. A gap, therefore, exists in our understanding about how these two practices, operating conjointly in the same firm, impact customer satisfaction and which of the two may have the most important effect. Second, the research context is relatively limited in the education industry (e.g., private non-formal education institutions in China have different competitive relationships and consumer characteristics than those in other Western countries or universities) (Guo, 2021). Finally, the current literature is more feature-driven, with little role of in-depth case studies from studying a single organization, namely Qingdao Hengxing Education Group. A case-study strategy yields rich, meaningful findings that have direct application to the organization being studied (Yin, 2018). Thus, it is very necessary to develop research that combines the two theories in the particular context of a Chinese education class.

Based on the aforementioned significance, the researcher is interested in studying the effect of marketing strategy and customer relationship management on customer satisfaction using the services from Qingdao Hengxing Education Group. The main purpose of this study is to address these gaps by investigating and examining—using empirical data and significant testing—the impact of marketing strategies (product, price, place, and promotion) and customer relationship management (customer retention, customer tracking, useful recommendations, customer feedback, and relationship building) on customer satisfaction in the setting of a private educational organization located in Qingdao, China. The findings of this study will provide benefits in two dimensions. Practically, the administrators in Qingdao Hengxing Education Group can obtain useful and dependable theoretical implications that could help in the current and prospective marketing and in the CRM improvement in terms of performance. This will enable them to understand their customers even more and satisfy them, which has the potential to provide a durable competitive advantage. It will also be used as common sense for other entrepreneurs in the same business. Academically, by offering new, under-researched evidence on the interrelations of this triad, this study will enrich the literature on this subject. The theoretical model in this study may also be a model for other research.

LITERATURE REVIEW

Marketing Strategies

Marketing strategies represent comprehensive, coordinated approaches that organizations employ to systematically plan, implement, and control their marketing efforts to achieve organizational objectives while considering specific target markets (Fauziah et al., 2022; Amalia et al., 2022). The development of marketing mix strategies has advanced from the conventional 4Ps model—Product, Price, Place, and Promotion—to more complex models such as the 7Ps for services marketing and the 8Ps for social marketing to demonstrate variation in terms of marketing tactics depending on specific industry (Dewi et al., 2023; Saud, 2022). Marketing strategies are not limited to promotion of products, as the earlier concept would implicate, but include all efforts in adding value, improving customer experience, and establishing long-term

relationships based on market dynamism, technological development, and changing expectations of customers (Peralta et al., 2024). The literature suggested that elements of the marketing mix affect consumers' behavioral and organizational performance in various industries; empirical evidence showed that. Abdullah et al. (2023) found that ASEAN consumers' purchase intention of organic products is influenced by product, price, and promotion strategies, and cultural differences have moderated the relationship between the Malaysian and Chinese markets. Similarly, Al Thabbah et al. (2022) identified the role of pricing strategy as the most significant factor in affecting prescription practices among physicians in pharmaceutical firms—whereas Paramesta (2021) showed that integrated 7Ps strategies could effectively deal with business competition within Islamic economy environments. These results indicate the need for context-specific marketing mix optimization in order to gain competitive advantage and market success.

Customer Relationship Management

Customer relationship management constitutes a cohesive strategic initiative integrating advanced technology, meticulous processes, and a customer-centric philosophy to create, exchange, communicate, deliver, and enhance customer knowledge throughout the long-term lifecycle (Guerola-Navarro et al., 2024; Chatterjee et al., 2024). The modern CRM system has grown beyond the old limitations to become a well-developed platform that applies big data analytics, artificial intelligence (AI), and machine learning technologies in order to process large amounts of customer information for precise prediction of a variety of customer behaviors, churn patterns, and buying intentions (Xiahou & Harada, 2022). CRM is critically hailed as a tool that can change transaction-based contact between companies and their stakeholders into partnerships with the help of a systematized collection of information, through which an organization offers individualized principal value propositions across various touchpoints in order to maximize customer satisfaction, loyalty, and lifetime value (Pynadath et al., 2023; Suoniemi et al., 2022). Evidence from researchers has consistently supported the significance of CRM to organizational success. Al-Bashayreh et al. (2022) reported that technological readiness, customer pressure, and customer satisfaction had positive effects on e-CRM system success, while customer satisfaction played a significant mediating role between trust and system effectiveness. Binsaeed et al. (2023) showed us the relevance of CRM assets to stimulate customer engagement and innovation performance, underscoring that trust could inhibit both relations. Furthermore, Chen et al. (2020) found frequent use of the CRM system in a financial service setting to be positively related with frontline employees' performance behaviors through their adaptive behaviors. Together these findings underscore the multi-faceted nature of CRM's influence on customer relationships and firm performance.

Customer Satisfaction

Customer satisfaction is a multifaceted and multidimensional judgment in which customers compare their consumption experiences with products, services, or organizations to their expectations prior to consumption, being composed of both cognitive evaluations associated with perceptions of functionality and affective responses developed along various touchpoints at different stages in the customer journey (Gabriel Filho et al., 2023; Santos Neto et al., 2022). This construct has developed from rudimentary gap in expectation-*performance narrow reviews to complex models including emotional, behavioral, and relational elements, which all play a significant role in customer loyalty and organizational success (Kim & Kim, 2022; Flores et al., 2020). The importance of customer satisfaction measurement is not limited to simply monitoring performance but rather to developing strategies in the decision-making process that link customer experiences with business outcomes such as loyalty, retention, or profits (Li et al., 2020; Baquero, 2022), which requires intricate systems capable of combining quantitative measures and qualitative analyses. Satisfaction has been widely recognized as a key response in various services capes, from an empirical point of view. Santos Neto et al. (2022) reported that trust, quality, and value together mediated customer satisfaction in electricity distribution services using structural equation modeling on longitudinal data of 86,175 households. Li et al. (2020) used three-factor theory to investigate hotel guest satisfaction, indicating that room quality was

the primary determinant for domestic guests and service quality was the most significant factor for foreign guests, suggesting a moderating effect of culture. Additionally, Malhotra et al. (2023) identified satisfaction as an essential antecedent of customer engagement behavior, where cognitive and affective mediators actually facilitated the process by which a level of firm-level benefits would eventually materialize in higher education settings through positive word-of-mouth and better human capital performance.

Hypothesis Development

The existing theoretical and empirical bases in relevant literature support a priori articulation of linkages between marketing strategies, CRM, and customer satisfaction. For H1, that customer satisfaction is affected by marketing strategy before effective integration of various components in the marketing mix affects perceptions and outcomes for consumers has been widely proven. Abdullah et al. (2023) also reported remarkable and positive effects of product, price, and promotion strategies on consumer purchase behavior for organic products; this showed that properly created marketing strategies increase the quality of customer responses, as well as their satisfaction. Dewi et al. (2023) found that the marketing mix had a significant positive impact on purchase intention, indicating the importance of integrated marketing theorizations in developing favorable consumer attitudes. Furthermore, Nagarathinam et al. (2021) demonstrated how Nestlé's strategic blending of the marketing mix tools that included product innovation, competitive pricing, intensive distribution, and promotional strategies ensured market competitiveness and customer satisfaction. With regard to H2, in the case of suggesting that customer relationship management has an impact on customer satisfaction, empirical support is also strong. Al-Bashayreh et al. (2022) found that satisfaction was an important mediator of e-CRM system success, with trust having a significant impact on satisfaction, which means that good skills in CRM make customers happy. Malhotra et al. (2023) found evidence of positive service relationships that produce value for both customers and firms in terms of engagement behaviors and human capital outcomes. Additionally, Binsaeed et al. (2023) proved that CRM capabilities have effects on customer engagement, which then led to boosted relationship quality as well as innovation performance. The overlap of these outcomes makes a strong rationale to analyze how marketing strategies and CRM practices independently drive customer satisfaction improvement in educational services. Accordingly, the conceptual framework can be drawn as follows:

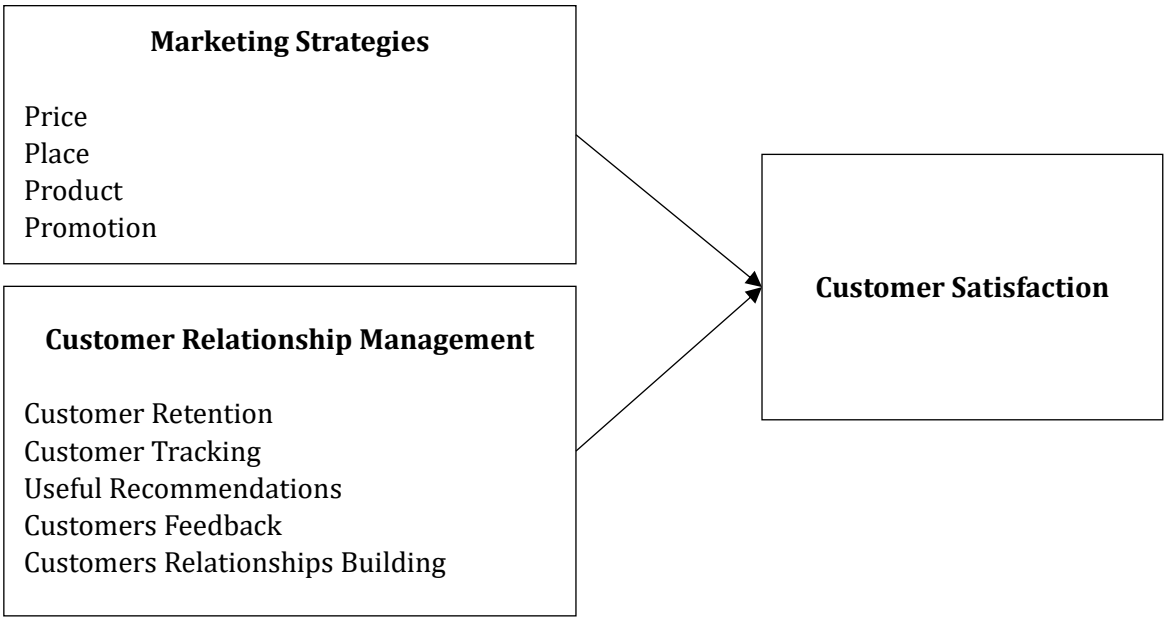

Figure 1. Conceptual Framework

METHODOLOGY

Based on a quantitative research method, the study aimed to explore the impact of marketing strategy and customer relationship management on customer satisfaction of Qingdao Hengxing Education Group service users. The target sample was all customers who have, or who currently do, use services offered by the Hengxing Group of Education Institutions in Qingdao (PRC), including students studying various courses and their parents and individuals using counseling and additional services. The sampling size of 400 respondents was selected on the basis that it would be suitable for an advanced statistical analysis, such as multiple regression analysis, to be conducted where a sample should be large enough to provide reliability and power in terms of statistics (Umam & Jermsittiparsert, 2019). The sampling method employed was non-probability sampling, to be specific convenience sampling; data were gathered from individuals that fulfilled certain requirements and could be reached during the period when the data were gathered, like customers who visited the institution for their queries or services. The researcher concedes the limitations of such an approach in terms of representativeness; however, data collection was spread throughout several time periods to reduce bias and increase diversity in response rates while minimizing unique variance introduced through systematic sampling from a convenience sample method.

The research instrument consisted of a structured questionnaire comprising four distinct sections designed to comprehensively measure all variables under investigation. Part 1 collected general demographic information through seven variables, including gender, age, marital status, current occupation, monthly income, work experience, and interested study level, measured using nominal and ordinal scales appropriate for categorical and ranked data. Part 2 assessed marketing strategies through 20 items distributed equally across four dimensions: price, place, product, and promotion, with five indicators per dimension, consistent with the traditional marketing mix framework (Fauziah et al., 2022; Abdullah et al., 2023). Part 3 evaluated customer relationship management using 25 items covering five key constructs: customer retention, customer tracking, useful recommendations, customer feedback, and customer relationship building, with five indicators per construct, reflecting contemporary CRM measurement frameworks (Guerola-Navarro et al., 2024; Al-Bashayreh et al., 2022). Part 4 measured customer satisfaction through five carefully developed indicators assessing overall contentment, expectation fulfillment, and positive emotional responses (Malhotra et al., 2023; Santos Neto et al., 2022). All items in Parts 2, 3, and 4 employed a 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), generating interval-scale data suitable for parametric statistical analysis. The instrument's validity was established through expert review by three specialists in marketing and business management who evaluated the Index of Item-Objective Congruence (IOC), retaining only items scoring 0.50 or higher. Reliability was confirmed through pilot testing with 30 participants sharing similar characteristics with the target population but excluded from the final sample, achieving Cronbach's Alpha coefficients of 0.70 or higher for all constructs, thereby demonstrating acceptable internal consistency and measurement reliability for social science research.

Primary data were collected directly from the target population using self-administered questionnaires personally distributed at Qingdao Hengxing Education Group facilities to ensure direct access to respondents and higher response quality. The researcher introduced the study objectives, obtained informed consent from all participants prior to questionnaire distribution, and emphasized confidentiality by assuring that all personal information would be protected and analyzed anonymously at the aggregate level only. This approach facilitated immediate clarification of any questions respondents might have regarding the questionnaire items, thereby enhancing data quality and completeness. The data collection process was conducted across multiple timeframes to capture diverse customer perspectives and minimize temporal bias. Secondary data were gathered from credible third-party sources to provide theoretical foundations supporting the literature review and contextual understanding of the case organization (Ferreira, 2019; Nagarathinam et al., 2021). These sources included peer-reviewed academic articles from international journals, official institutional websites, industry reports analyzing educational services, textbooks on marketing and customer relationship management,

theses and dissertations from university repositories, and comprehensive research reports providing insights into contemporary educational service delivery and customer behavior patterns in the Chinese educational context.

Data analysis employed both descriptive and inferential statistical techniques to address the research objectives comprehensively. Descriptive statistics were utilized to summarize and describe the fundamental characteristics of collected data, with frequency distributions and percentages applied to general demographic information to profile the sample composition, while means and standard deviations were calculated for all rating-scale variables, including marketing strategies dimensions (price, place, product, promotion), customer relationship management constructs (customer retention, customer tracking, useful recommendations, customer feedback, customer relationship building), and customer satisfaction indicators, providing clear overviews of central tendencies and variability in respondent opinions (Dewi et al., 2023). Inferential statistics were employed to test research hypotheses and generalize sample findings to the broader population. Hypotheses H1 and H2, positing that marketing strategies and customer relationship management, respectively, influence customer satisfaction, were tested using multiple regression analysis with the enter method (Umam & Jermsittiparsert, 2019). To ensure the validity of multiple regression analysis, key statistical assumptions were verified, including normality of distribution (through skewness and kurtosis), absence of multicollinearity (Variance Inflation Factor: VIF < 10), linearity and homoscedasticity (through residual plots), and independence of observations. All diagnostic tests confirmed that the data satisfied the required assumptions for parametric statistical analysis.

RESULTS

Profiles of Respondents

The demographic profile of the 400 respondents revealed diverse characteristics across multiple dimensions. Regarding gender distribution, the majority of respondents were female (44.5%), followed by those who preferred not to disclose or identified as other (33.3%), and male respondents (22.3%). Age distribution showed that respondents aged 18-25 years constituted the largest group (30.0%), followed by those under 18 years (28.5%), 26-35 years (22.5%), 36-45 years (13.5%), 46-55 years (3.5%), and 56 years and above (2.0%). For marital status, single respondents represented the majority (51.0%), followed by married individuals (38.8%), and divorced or widowed respondents (10.3%). Current occupation distribution indicated that government officers or state enterprise employees formed the largest group (33.3%), followed by private company employees (26.3%), students (19.5%), business owners or freelancers (16.0%), and homemakers (5.0%). Average monthly income analysis revealed that the 5,001-10,000 CNY bracket was most common (32.8%), followed by below 5,000 CNY (23.5%), 10,001-20,000 CNY (21.0%), 20,001-30,000 CNY (15.5%), and above 30,000 CNY (7.3%). Work experience distribution showed that respondents with less than 3 years of experience represented the largest proportion (31.5%), followed by those with no work experience (28.0%), 3-5 years (22.0%), 6-10 years (10.8%), and more than 10 years (7.8%).

Marketing Strategies, Customer Relationship Management, Customer Satisfaction

Table 1. Descriptive Statistics of Marketing Strategies, Customer Relationship Management, and Customer Satisfaction (N = 400)

Variables	Mean	Std. Deviation	Opinion Level
Marketing Strategies			
Price	4.24	0.57	Strongly agree
Place	3.96	0.62	Agree
Product	3.93	0.67	Agree
Promotion	3.94	0.68	Agree
Total	4.02	0.59	Agree

Table 1. (Cont.)

Variables	Mean	Std. Deviation	Opinion Level
Customer Relationship Management			
Customer Retention	3.94	0.65	Agree
Customer Tracking	3.89	0.69	Agree
Useful Recommendations	3.95	0.70	Agree
Customers Feedback	3.63	0.77	Agree
Customers Relationships Building	3.71	0.79	Agree
Total	3.82	0.67	Agree
Customer Satisfaction			
Customer Satisfaction	3.98	0.63	Agree

Note: 1.00–1.80 = Strongly Disagree, 1.81–2.60 = Disagree, 2.61–3.40 = Neutral, 3.41–4.20 = Agree, 4.21–5.00 = Strongly Agree

The descriptive analysis of marketing strategies, customer relationship management, and customer satisfaction variables revealed varying levels of respondent agreement. For marketing strategies, the overall mean score was 4.02 (SD = 0.59), indicating an "Agree" level of opinion. Among the four dimensions, price received the highest mean score of 4.24 (SD = 0.57) at the "Strongly agree" level, followed by place with a mean of 3.96 (SD = 0.62), promotion with a mean of 3.94 (SD = 0.68), and product with a mean of 3.93 (SD = 0.67), all at the "Agree" level. For customer relationship management, the overall mean score was 3.82 (SD = 0.67), reflecting an "Agree" level of opinion. The five constructs showed that useful recommendations achieved the highest mean of 3.95 (SD = 0.70), followed by customer retention with a mean of 3.94 (SD = 0.65), customer tracking with a mean of 3.89 (SD = 0.69), customer relationship building with a mean of 3.71 (SD = 0.79), and customer feedback with the lowest mean of 3.63 (SD = 0.77), all maintaining an "Agree" level. Customer satisfaction demonstrated a mean score of 3.98 (SD = 0.63), indicating an "Agree" level of opinion among respondents regarding their overall satisfaction with services from Qingdao Hengxing Education Group.

Hypothesis Testing

H1: Marketing strategies have an effect on customer satisfaction

Table 2. Multiple Regression Analysis of Marketing Strategies on Customer Satisfaction

Marketing Strategies	Coefficients			t	Sig.	Collinearity Statistics	
	B	SE	Beta			Tolerance	VIF
(Constant)	1.082	0.164		6.605	0.000***		
Price	0.138	0.064	0.124	2.137	0.033*	0.347	2.881
Place	-0.095	0.087	-0.095	-1.099	0.273	0.159	6.295
Product	0.260	0.095	0.277	2.746	0.006**	0.115	8.659
Promotion	0.424	0.083	0.457	5.079	0.000***	0.146	6.867
$R = 0.732$; R^2: = 0.535; Adjusted R^2: = 0.531; S.E.E. = 0.430; Durbin-Watson = 1.761; Sig. = 0.000							

Note. SE = Standard Error; * = p < .05; ** = p < .01; *** = p < .001.

The multiple regression analysis examining the effects of marketing strategies on customer satisfaction revealed significant findings. The constant term was 1.082 (SE = 0.164, t = 6.605, p < 0.001). Among the four marketing strategy dimensions, promotion demonstrated the strongest effect with a standardized coefficient of 0.457 (B = 0.424, SE = 0.083, t = 5.079, p < 0.001), followed by product with a standardized coefficient of 0.277 (B = 0.260, SE = 0.095, t = 2.746, p = 0.006), and price with a standardized coefficient of 0.124 (B = 0.138, SE = 0.064, t = 2.137, p = 0.033). Place showed a non-significant negative effect with a standardized

coefficient of -0.095 (B = -0.095, SE = 0.087, t = -1.099, p = 0.273). The overall model demonstrated strong predictive power with R = 0.732, R^2 = 0.535, and Adjusted R^2 = 0.531, indicating that marketing strategies explained 53.5% of the variance in customer satisfaction. The standard error of estimate was 0.430, and the Durbin-Watson statistic of 1.761 suggested no serious autocorrelation concerns. Collinearity statistics showed tolerance values ranging from 0.115 to 0.347 and VIF values ranging from 2.881 to 8.659, with the overall model achieving statistical significance (p < 0.001).

H2: Customer relationship management has an effect on customer satisfaction

Table 3. Multiple Regression Analysis of Customer Relationship Management on Customer Satisfaction

Customer Relationship Management	Coefficients			t	Sig.	Collinearity Statistics	
	B	SE	Beta			Tolerance	VIF
(Constant)	1.103	0.125		8.832	0.000***		
Customer Retention	0.252	0.069	0.260	3.668	0.000***	0.201	4.980
Customer Tracking	0.110	0.077	0.122	1.437	0.151	0.141	7.117
Useful Recommendations	0.177	0.069	0.197	2.561	0.011*	0.170	5.896
Customers Feedback	-0.020	0.071	-0.025	-0.283	0.777	0.132	7.578
Customers Relationships Building	0.224	0.064	0.282	3.506	0.001**	0.156	6.416
R = 0.777; R^2: = 0.603; Adjusted R^2: = 0.598; S.E.E. = 0.398; Durbin-Watson = 1.754; Sig. = 0.000							

Note. SE = Standard Error; * = p < .05; ** = p < .01; *** = p < .001.

The multiple regression analysis examining the effects of customer relationship management on customer satisfaction yielded significant results. The constant term was 1.103 (SE = 0.125, t = 8.832, p < 0.001). Among the five constructs, customer relationship building exhibited the strongest effect with a standardized coefficient of 0.282 (B = 0.224, SE = 0.064, t = 3.506, p = 0.001), followed by customer retention with a standardized coefficient of 0.260 (B = 0.252, SE = 0.069, t = 3.668, p < 0.001), and useful recommendations with a standardized coefficient of 0.197 (B = 0.177, SE = 0.069, t = 2.561, p = 0.011). Customer tracking showed a non-significant positive effect with a standardized coefficient of 0.122 (B = 0.110, SE = 0.077, t = 1.437, p = 0.151), while customer feedback demonstrated a non-significant negative effect with a standardized coefficient of -0.025 (B = -0.020, SE = 0.071, t = -0.283, p = 0.777). The overall model exhibited strong predictive capability with R = 0.777, R^2 = 0.603, and Adjusted R^2 = 0.598, indicating that customer relationship management explained 60.3% of the variance in customer satisfaction. The standard error of estimate was 0.398, and the Durbin-Watson statistic of 1.754 indicated no substantial autocorrelation issues. Collinearity statistics revealed tolerance values ranging from 0.132 to 0.201 and VIF values ranging from 4.980 to 7.578, with the overall model achieving statistical significance (p < 0.001).

DISCUSSION AND IMPLICATIONS

The results provide strong evidence that marketing strategies significantly influence customer satisfaction among Qingdao Hengxing Education Group users, with the model explaining 53.5% of variance in satisfaction. Among the four marketing dimensions, promotion emerged as the strongest predictor, suggesting that integrated marketing communication strategies, brand awareness campaigns, and promotional activities are critically important in educational service contexts. This aligns with Abdullah et al. (2023) and Nagarathinam et al. (2021), who demonstrated the effectiveness of comprehensive promotional strategies in enhancing customer satisfaction and brand loyalty. Product quality also showed significant positive influence, consistent with Paramesta (2021), who emphasized service quality as fundamental to successful marketing strategy in service industries. Price strategies demonstrated moderate yet significant

effects, supporting Al Thabbah et al. (2022) regarding the importance of competitive pricing in service marketing. However, place showed non-significant negative effects, which warrants careful interpretation. This finding may reflect the digital transformation of educational service delivery, where online platforms, virtual classrooms, and hybrid models have diminished the importance of physical location (Hodges et al., 2020). In urban Chinese contexts like Qingdao, advanced transportation infrastructure and mobile technology may have reduced location-related barriers, making physical place less differentiating among competitors. For high-involvement educational services, factors such as service quality, value perception, and brand reputation may overshadow location considerations. This suggests that physical location serves as a necessary hygiene factor but not a sufficient differentiator for enhancing customer satisfaction in the modern educational landscape, where delivery methods continue evolving with technological advancement and changing consumer expectations.

The findings strongly support the influence of customer relationship management on customer satisfaction, with the model explaining 60.3% of variance, indicating slightly stronger explanatory power than marketing strategies. Customer relationship building emerged as the most influential dimension, emphasizing the critical importance of trust development, commitment nurturing, and long-term relationship cultivation in educational settings, consistent with Guerola-Navarro et al. (2024). Customer retention demonstrated significant positive effects, supporting Binsaeed et al. (2023) regarding CRM capabilities' impact on engagement and relationship quality. Useful recommendations also showed significant influence, aligning with Pynadath et al. (2023) on the value of data-driven personalization. However, customer tracking and customer feedback showed non-significant effects requiring explanation. Customer tracking's non-significance suggests that systematic monitoring may function more as an operational tool than a direct satisfaction driver unless translated into tangible personalized benefits (Kumar & Reinartz, 2018). The unexpected negative coefficient for customer feedback, though statistically insignificant, may reflect survey fatigue in educational contexts where students and parents face multiple evaluation demands (Porter et al., 2004), or indicate that feedback collection without demonstrable action does not enhance satisfaction (Homburg & Fürst, 2005). Cultural factors in the Chinese context may also influence feedback provision, as concerns about face-saving or potential consequences may inhibit honest feedback (Guo, 2021). These findings suggest that relationship-oriented practices emphasizing trust, retention, and personalized recommendations directly enhance satisfaction, while data collection mechanisms may operate indirectly through their impact on other relationship quality dimensions, consistent with Al-Bashayreh et al. (2022) regarding satisfaction's mediating role in CRM effectiveness.

This study offers important theoretical and managerial contributions. Theoretically, it demonstrates that marketing mix and CRM dimensions exert differential rather than uniform influence on satisfaction in educational service contexts, with promotion and relationship building showing the strongest impacts while place and customer feedback show non-significant effects. This challenges assumptions of homogeneous construct importance and confirms that service industry models must account for dimension-specific effects, particularly in high-involvement contexts where intangible service characteristics and relational exchanges weigh more heavily than tangible elements. By simultaneously examining marketing strategy and CRM in an integrated model, the research reveals that CRM dimensions explain slightly more variance than marketing strategies, suggesting the primacy of relationship-oriented approaches in service satisfaction. Managerially, educational institution leaders should prioritize investments according to demonstrated effect sizes: primary focus on integrated promotional strategies encompassing traditional and digital channels to build brand recognition and communicate value propositions; secondary emphasis on relationship building through personalized communication, trust development, and long-term engagement strategies; substantial investment in service quality enhancement and retention programs including curriculum improvement and teaching quality development; and maintenance of competitive pricing with transparent value communication. The non-significant effects of place and customer feedback suggest these should be treated as operational foundations rather than primary strategic investments. In the Chinese educational context, strategies must be adapted to cultural

frameworks emphasizing Guanxi relationships, collective decision-making, and reputation consciousness rather than directly transplanting Western marketing frameworks.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

This study has several methodological and contextual limitations that need to be addressed when considering the findings. The first limitation is the adoption of a convenience sampling approach, which has poor external validity in terms of generalizability to the population from which education service users are drawn; hence, respondents were selected based on availability rather than random probability-based methods, increasing the chances that selection bias may have occurred. Second, the cross-sectional nature in which data is collected does not allow for investigating causality as well as time dynamics when concerning marketing strategies and customer relationship management in terms of satisfaction over a long period. Third, this study concentrates only on Qingdao Hengxing Education Group in China, thus reducing potential results' generalizability to other schools or different areas or cultures wherein customers' expectations and standards of service evaluation could be greatly different. Fourth, the data source of the self-reported questionnaire may cause common method bias, social desirability effects, and subjectivity measurement errors.

There are several promising directions for future work to relax these limitations. Longitudinal research using panel data designs would provide insight into how marketing initiatives and CRM practices affect satisfaction trajectories over time to show dynamic patterns among relationships and long-term durability of interventions. However, by comparing across institutions, geographies, and cultures to expand cross-level understanding, an opportunity arises to develop a more nuanced understanding of how contextual factors moderate the direct effects of marketing and CRM on satisfaction, which may manifest along local (culture-specific) or institutional (institution-specific) lines. These sorts of mixed-method approaches that combine qualitative interviews, focus groups, and observational data along with quantitative method are the types of tools that could potentially yield such insights about underlying mechanisms and user experiences, which you can't get at if you're just looking at quant. Accordingly, future research should examine mediating factors like perceived value, trust, commitment, and service quality that can account for the effect of marketing and CRM on satisfaction. By exploring the interaction effects between marketing strategies and CRM practices, studies would offer insights into synergies or trade-offs. Future study can also examine the moderator effects of such customer characteristics, types of services, and intensity of market competition. Last, experimental or quasi-experimental designs with specific marketing interventions or CRM initiatives as the treatment would help cultivate direct evidence for practical decision-making in the management of educational services.

CONCLUSION

This research suggests some evidence that marketing strategy and customer relationship management factors affect customer satisfaction in private educational services in Qingdao Hengxing Education Group users. The results indicate that both marketing strategies and customer relationship management practices significantly affect customer satisfaction; however, in different magnitudes across dimensions. As we try to interpret these results, promotion has become the most important marketing element, and attracting relationships seems to be the biggest driving factor in customer relations with a firm; then clearly transferring communication activity is needed for building trust. These findings are helpful for educational institutions in their distribution to allocate resources merely to have students satisfied. The study concludes that all marketing and CRM elements are not equally important, which means the educational service providers should focus more on relationship-oriented strategies and communicative-focused plans rather than transactional motives. The study contributes to advancing the theoretical bases for educational marketing and relationship management, in addition to offering practical implications for practitioners who wish to improve service quality and customer retention within competitive private education markets.

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CONFLICTS OF INTEREST

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

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DIGITAL EMPLOYEE COMPETENCY AND DIGITAL WORK ENVIRONMENT INFLUENCING JOB PERFORMANCE: A CASE OF HISENSE HOME APPLIANCES GROUP, CHINA

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ABSTRACT

Purpose – This study examines the influence of digital employee competency and digital work environment on job performance among employees at Hisense Home Appliances Group, China, a manufacturing enterprise undergoing intensive digital transformation.

Methodology – A quantitative research approach was employed with 400 employees selected through purposive sampling from multiple organizational departments. Data were collected using a structured questionnaire measuring digital employee competency (five dimensions), digital work environment (three dimensions), and job performance. Multiple regression analysis was conducted to test the hypothesized relationships.

Results – Both digital employee competency and digital work environment significantly influence job performance. Among competency dimensions, ethics, technical proficiency, and continuous learning demonstrated significant positive effects, while cybersecurity awareness and troubleshooting showed non-significant relationships. All three digital work environment dimensions—psychological, sociological, and physical environments—significantly predicted job performance, with psychological environment emerging as the strongest predictor.

Implications – Organizations should prioritize creating supportive digital work environments alongside developing employee competencies. Investments in psychological well-being, collaborative relationships, and technological infrastructure complement competency development initiatives in driving performance during digital transformation.

Originality/Value – This study demonstrates that environmental factors exert stronger influences on job performance than individual competencies, challenging traditional human resource development paradigms and providing empirical evidence from the Chinese manufacturing sector.

Keywords: Digital employee competency, Digital work environment, Job performance, Digital transformation, Manufacturing industry

Research Type: Research Article

INTRODUCTION

In the age of the fourth industrial revolution, digital transformation was considered a key approach for any organization around the world, particularly for manufacturers, to be competitive. This transformation is not just about new technologies but requires a radical restructuring of organizational form, work processes, and culture (Butt, 2020). The world's factory, China, has introduced the "Made in China 2025" policy to transform its manufacturing industry toward smart manufacturing, and facing such tremendous pressure, requirements as Hisense Home Appliances Group has been crushed. Investing does not necessarily lead to success and to higher job performance (Hess et al., 2016). The root issue is human capital, the people who

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work for the company. For employees to utilize digital technologies, they need to be digitally competent and have a digital working environment that is supportive and facilitative (van Laar et al., 2017). Hence, the investigation of how these two elements affect employee job performance is crucial in order to ensure organizational success in the digital era.

While there is considerable literature that recognizes the role of digital technology in organizational performance, there are several important research voids in this area. First, many related studies adopt a rather broad perspective; for instance, the focus is on technology or technology acceptance in general, often omitting the micro-level elements of digital competence that individual 'employees should have (e.g., awareness about cybersecurity or technical troubleshooting skills), which are essential in the contemporary workplace (Petruk, & Klescheva, 2021). The idea of the digital work environment also tends to be understood in a very material way, involving the presence of up-to-date tools or software. Studies that investigate sociological and psychological aspects influence employees' cognitions and behaviors concerning technology are scarce (Trittin-Ulbrich et al., 2021; Gfrerer et al., 2021). Finally, few studies have examined relationships among these factors within a unified model, especially in the specific context of the home appliance industry in China (Liu et al., 2014).

Given this importance, this study aims to examine how digital employee competence and the digital workplace impact job performance, using Hisense Home Appliances Group of China as a case study. The purpose of the current study is to advance the understanding of the linkage between employee competence and digital work environment influencing job performance. The results would be practical in Hisense Group and other similar companies in the management and human resources departments. They can contribute to designing and establishing focused training interventions in which essential digital competencies are further enhanced and establish a real supportive digital work environment. It will also support the improvement of the organization's long-term competitive advantage. Theoretically, the empirical results of this project will further knowledge by supporting an integrated model of digital competency and environment and add to the foundation for other researchers working within different contexts.

Beyond operational efficiency, digital transformation has significant financial implications for manufacturing firms. Enhanced digital employee competency and supportive digital work environments can directly impact key financial metrics, including return on investment (ROI), cost reduction through process optimization, and overall financial performance (Verhoef et al., 2021). For manufacturing companies like Hisense, understanding how digital competencies and work environments influence job performance is crucial not only for operational excellence but also for maintaining financial competitiveness and shareholder value in an increasingly digitalized market.

LITERATURE REVIEW

Digital Employee Competency

The digital employee competency is a broad multidimensional construct that includes the professional skills, knowledge, and attitudes required by employees to be able to meet challenging demands of specialized work performed in highly technologically driven environments. Huu (2023) has described digital employee competency as the general skill to tap technology effectively for accessing, evaluating, using, and creating information by focusing on lifelong learning or innovation. This interpretation is consistent with Martínez-Bravo et al. (2022), who defined it as the ability to consume and use responsibly technology in a critical manner across different life domains, integrating six dimensions: critical, cognitive, operational, social, emotional, and projective competencies. The fundamental elements of digital employee competence are underpinned by five critical dimensions, which, combined, characterize work effectiveness in a digital environment. Cybersecurity awareness is an elementary part in which employees know about security threats and protective behaviors such as password management, phishing identification, or incident reporting practices (Basilotta-Gómez-Pablos et al., 2022). Technical skills encompass operations, which are the necessary techniques to efficiently operate digital tools, platforms, and software applications (Liu et al., 2022), while troubleshooting

involves problem-solving methods toward systematically recognizing and solving technical issues (Dingelstad et al., 2022). Continuous learning is the adaptive ability to a continuous quest for reading knowledge and acquiring necessary skills in response to technological change (Bansal et al., 2023), and ethics denotes moral values that regulate responsibility when using technology as well as digital citizenship (Martínez-Bravo et al., 2022). The value of digital employee skills has been further emphasized due to the COVID-19 pandemic, which resulted in sped-up tech transformations and revealed major skill gaps across different sectors (Bansal et al., 2023). In line with recent evidence, digital skills have a direct impact on employees' innovation at work and innovative work behavior; Huu's (2023) study, for example, reveals that workers who demonstrate more digital autonomy show commitment in innovative activities leading to performance of jobs and organization empowerment. As a result, digital employee competencies affect job performance.

Digital Work Environment

The digital work environment is a holistic technology environment that includes all emerging technologies, communication tools, and intelligent processes to provide flexible, collaborative, and productive experiences for employees. Shen et al. (2022) describes it as a process of integration of digital technology and systems into traditional organizational practices that change them at their core, thus strategically challenging the organization through its structure and other resources in order to increase performance. This model is extended to Martin et al. (2022), who focused on technical and social hardware of remote working, such as groupware, workflow systems, web-based conferencing, or instant messaging. There are three important interrelated components of the digital workplace and how these impact employee experiences and organizational outcomes. The physical aspect includes technological infrastructure, ergonomic workstation design, quality of internet connectivity, and the environmental conditions that facilitate useful digital work (Russo et al., 2021). The sociological context is comprised of collaboration and socio-cultural ties as well as communication practices in the digitally mediated places of work, where knowledge sharing and employee mobility explained 75% of variance in engagement among employees (Hizam et al., 2023). Psychological environment refers to mental health, stress coping, work-life balance, and psychological safety elements that have a direct effect on the satisfaction levels of the digital workforce and their productivity (Abdul Hamid, 2022). The attention to well-designed digital work environments has become even more pronounced in the wake of COVID-19, with increased demands on organizations to quickly adjust to remote and hybrid work arrangements (Shen et al., 2022). Thus, the digital work environment impacts job performance.

Job Performance

Job performance is a multidimensional concept that encompasses how effective and efficient employees are in their roles while contributing to the organization's objectives. Afrin et al. (2023) defined job performance as quality, productivity, and teamwork efficiency tasks that are influenced by compensation; satisfaction at work; leadership style; motivation; and work environment. This view is congruent with Chen et al.'s (2019) description of job performance as behaviors supportive of an organization's goals assessed in four dimensions, including task performance, contextual performance such as paying attention to norms and rules, adaptive or innovative work activity, and extra-role behavior, and the fact that different patterns of motivation predict variance in employees' prediction-bearing. Current models acknowledge that effective work performance is not only limited to the completion of job tasks but also comprises contextual and innovative behavior. Miao et al. (2022) defined job performance in terms of two major dimensions: task performance, reflecting the achievement of formally assigned tasks effectively and timely, and contextual performance, which includes extra behaviors promoting organizational effectiveness beyond one's formality. Ramdhan et al. (2022) elaborated on this conceptualization by adding adaptive, innovative, and contextual performance dimensions, reflecting employees' ability to respond to uncertain circumstances in the environment and to

overcome barriers of their own work environment as well as to generate feasible ideas for improvement. Adaptive performance was considered particularly important for employees working in a technology-rich environment, as employees' ability to adapt performance to managing new situations or problems within their job through creative problem-solving and stress management is crucial. Job performance is being measured using not only the quantitative results but also qualitative behavior indicators, as in the studies of Kumar et al. (2022) on task performance versus creativity. performance differentiated by them and showing high internal consistency for the two dimensions, they point out that modern work calls for the fulfillment of tasks as well as creative output. For instance, related studies show nuanced associations between the factors of a digital workplace and performance outcomes and Hackney et al. (2022) that show work at home producing overwhelmingly positive performance effects prior to the pandemic but considerably less robust results during COVID-19, indicating mandatory versus voluntary remote work contexts to be a strong moderator of performance outcomes. Additionally, Hizam et al. (2023) found that knowledge sharing, and employee mobility are the most powerful predictors of engagement, which has a positive effect on performance in e-work.

Conceptual Framework

Drawing from the literature reviewed above, this study develops an integrated conceptual framework examining how digital employee competency and digital work environment influence job performance in the context of digital transformation at Hisense Home Appliances Group. The framework proposes two primary hypotheses: H1 posits that digital employee competency—comprising technical proficiency, cybersecurity awareness, continuous learning, digital ethics, and troubleshooting skills—positively influences job performance. Employees with higher digital competencies can more effectively utilize technologies and adapt to digital changes, leading to improved performance outcomes (van Laar et al., 2017). H2 proposes that the digital work environment—encompassing psychological, sociological, and physical dimensions—positively influences job performance. A supportive digital environment provides the necessary infrastructure, culture, and conditions that enable employees to perform optimally in digitalized workplaces (Gfrerer et al., 2021). This framework uniquely integrates individual and organizational factors to provide a comprehensive understanding of performance determinants in digital transformation contexts. The conceptual model is presented in Figure 1.

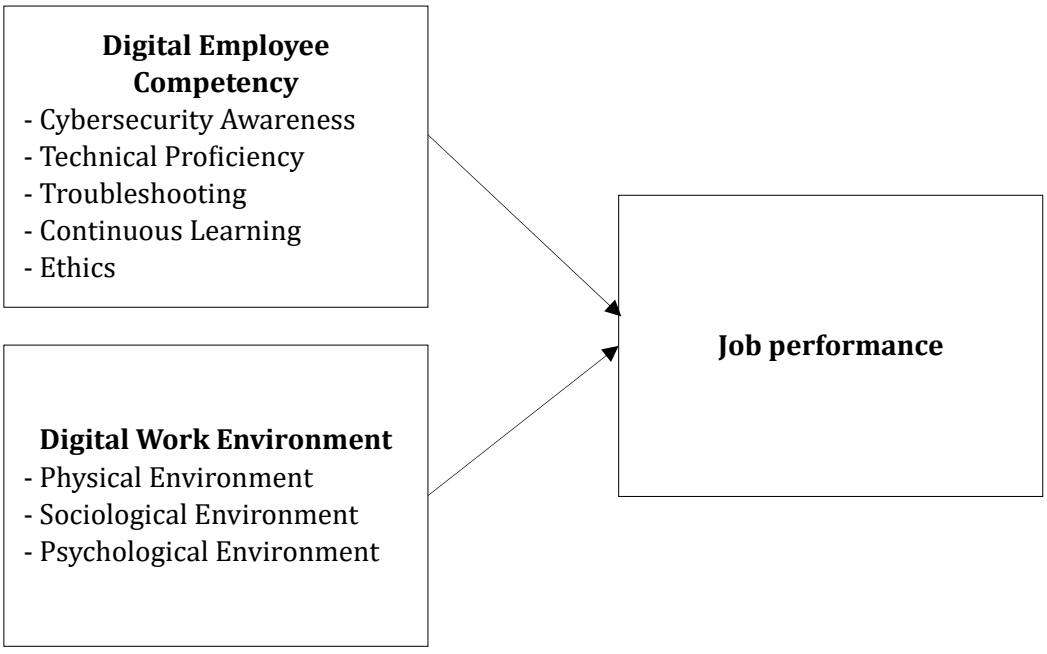

Figure 1. Conceptual Framework

METHODOLOGY

This research used a quantitative approach to examine the impact of digital staff capability and digital workplace on job performance using Hisense Home Appliances Group in China as an empirical model. The quantitative approach was chosen because it afforded the ability to assess variables systematically, evaluate hypotheses through statistical inference procedures, and later transfer the findings to other organizations. The participants in the study were employees from Hisense Home Appliances Group in China, which is a large-scale international enterprise with intensive attempts at digital transformation, and they are thus suitable primary sources for the investigations of digital competencies, digital work environment, and performance consequences. A minimum sample size of 400 employees was considered appropriate for inferential statistics, especially multiple regression analysis that forms the basic statistical tool for hypothesis testing in this research. Such a sample size is large enough to have good statistical power to test the hypothesized relationships among variables and, at the same time, small enough to minimize estimation errors about population parameters. In addition to the variety of respondent backgrounds, this study sought to attain representativeness through recruitment of study participants from different sections within an organization, such as production, marketing, research and development, and human resource, and others, the sample has been diverse enough to represent various digital work context experiences. For sampling method, the research used purposive sampling as a non-probability technique of selection because the researcher needed to select participants who meet particular inclusion criteria for reasons of validity. The eligibility criteria included regular employees at Hisense, company tenure of at least 1 year to get familiar with the organization's culture and workflow, and active use of digital tools or systems in their job practices. The participant recruitment was worked out with the assistance of the company's human resources department; they invited qualified employees who were willing to respond to a self-administered questionnaire.

The research instrument consisted of a structured questionnaire developed through a rigorous six-step process to ensure validity and reliability. Initially, extensive literature review was conducted examining theoretical frameworks and empirical studies related to digital employee competency (Huu, 2023; Martínez-Bravo et al., 2022), digital work environment (Shen et al., 2022; Martin et al., 2022), and job performance (Afrin et al., 2023; Chen et al., 2019) from academic sources including international journals and research reports. The questionnaire comprised four distinct sections: demographic information of respondents, digital employee competency assessment, digital work environment evaluation, and job performance measurement. The demographic section utilized nominal scales for categorical variables such as gender and ordinal scales for hierarchically ordered variables including age, monthly income, work experience, and education level. The second section measured digital employee competency across five dimensions—cybersecurity awareness (Basilotta-Gómez-Pablos et al., 2022), technical proficiency (Liu et al., 2022), troubleshooting (Dingelstad et al., 2022), continuous learning (Bansal et al., 2023), and ethics (Martínez-Bravo et al., 2022)—employing a five-point Likert scale ranging from strongly disagree to strongly agree. The third section assessed digital work environment through three dimensions: physical environment encompassing technological infrastructure and ergonomic conditions (Russo et al., 2021), sociological environment including collaborative relationships and communication patterns (Hizam et al., 2023), and psychological environment comprising mental well-being and work-life balance factors (Abdul Hamid, 2022). The final section evaluated job performance incorporating task performance, contextual performance, and adaptive performance dimensions (Miao et al., 2022; Ramdhan et al., 2022), also utilizing a five-point Likert scale with responses treated as interval data for statistical analysis purposes.

Content validity was addressed by expert judgment of the content, which included three experts that judged item-objective fit with the use of the Index Item-Objective Congruence (IOC). Each expert scored items as consistent with, uncertain, or inconsistent, and only items that had

an IOC score of 0.50 and above were retained in the final instrument. Statements that did not meet this criterion were revised based on expert suggestions or removed to guarantee more optimal content validity. Instrument reliability was then tested with a pilot study conducted among 30 respondents having the same characteristics as the target population except that they were not part of the final sampling frame. The reliability analysis yielded the following Cronbach's Alpha values for each construct and dimension: digital employee competency, comprising technical proficiency (α = 0.836), cybersecurity awareness (α = 0.751), continuous learning (α = 0.823), digital ethics (α = 0.788), and troubleshooting skills (α = 0.742); digital work environment, including psychological dimension (α = 0.857), sociological dimension (α = 0.881), and physical dimension (α = 0.798); and job performance (α = 0.863). All reliability coefficients exceeded the threshold of 0.70, confirming the internal consistency and reliability of the measurement instrument across all constructs.

After successful validation processes, the finalized questionnaire that fulfilled validity and reliability criteria was used for the primary data collection. The data was collected with the help of an online survey tool, in which a survey link was sent to employees of Hisense Company who met the predetermined inclusion criteria, and this respondent recruitment technique was chosen to enable access to sample populations distributed throughout different locations and also to limit the time frame for data collection. Furthermore, secondary data were collected from academic databases, for instance, Google Scholar, Emerald Insight, ScienceDirect and organizational sources, for instance, company websites and annual reports, industry magazines to aid in establishing the conceptual framework and reviewing related literature of the study.

Data analysis was performed using both descriptive and inferential statistical techniques to address the research objectives comprehensively. Descriptive statistics including frequency distributions and percentages were calculated for demographic variables to characterize the sample profile, while means and standard deviations were computed for the primary research variables—digital employee competency and its five sub-dimensions, digital work environment and its three sub-dimensions, and job performance—to summarize central tendencies and variability within the dataset. For hypothesis testing, inferential statistics were employed to examine relationships between variables and draw population-level inferences. The hypotheses, digital employee competency influences job performance (H1) and digital work environment influences job performance (H2) were tested through multiple regression analysis using the enter method, with job performance specified as the dependent variable and digital work environment and digital employee competency as independent variables.

RESULTS

Profiles of Respondents

The demographic analysis of 400 respondents from Hisense Home Appliances Group revealed the following characteristics. Regarding gender distribution, female employees comprised 58.8% (n=235) of the sample, while male employees accounted for 41.3% (n=165). The age distribution showed that the largest group was employees aged 35-44 years at 43.8% (n=175), followed by those aged 25-34 years at 25.3% (n=101), 45-54 years at 22.3% (n=89), below 25 years at 5.8% (n=23), and 55 years and above at 3.0% (n=12). For monthly income levels, the highest proportion earned 20,001-30,000 CNY at 38.3% (n=153), followed by 30,001-40,000 CNY at 29.5% (n=118), 10,001-20,000 CNY at 17.8% (n=71), below 10,000 CNY at 7.8% (n=31), and 40,001 CNY and above at 6.8% (n=27). Work experience distribution indicated that 35.3% (n=141) had 6-10 years of experience, 25.8% (n=103) had 1-5 years, 21.8% (n=87) had 11-15 years, 9.5% (n=38) had more than 15 years, and 7.8% (n=31) had less than one year. Educational level data showed that 55.0% (n=220) held Bachelor’s degrees, 28.5% (n=114) held Master’s degrees, 10.3% (n=41) had education below Bachelor’s degree, and 6.3% (n=25) held Doctoral degrees.

Digital Employee Competency, Digital Work Environment, and Job Performance

Table 1. Mean, SD, and Level of Opinion on Digital Employee Competency, Digital Work Environment, and Job Performance

Variables	Mean	S.D.	Level of opinion
Digital Employee Competency			
- Cybersecurity Awareness	4.04	0.38	Agree
- Technical Proficiency	4.04	0.37	Agree
- Troubleshooting	3.99	0.44	Agree
- Continuous Learning	3.98	0.40	Agree
- Ethics	3.98	0.45	Agree
Total	4.03	0.29	Agree
Digital Work Environment			
- Physical Environment	3.91	0.48	Agree
- Sociological Environment	4.04	0.41	Agree
- Psychological Environment	3.92	0.43	Agree
Total	3.96	0.33	Agree
Job Performance			
- Job Performance	4.06	.37	Agree

The descriptive analysis of the research variables in Table 1 revealed the following mean scores and standard deviations. For digital employee competency, the overall mean score was 4.03 (S.D.=0.29), indicating an "agree" level of opinion. When ranking the five dimensions from highest to lowest mean scores, technical proficiency recorded the highest mean of 4.04 (S.D.=0.37), followed by cybersecurity awareness with a mean of 4.04 (S.D.=0.38), Troubleshooting obtained a mean of 3.99 (S.D.=0.44), continuous learning demonstrated a mean of 3.98 (S.D.=0.40), and ethics showed a mean of 3.98 (S.D.=0.45), with all dimensions reflecting an "Agree" level of opinion. For digital work environment, the total mean score was 3.96 (S.D.=0.33) at an "Agree" level. The three dimensions ranked by mean scores showed that sociological environment recorded the highest mean of 4.04 (S.D.=0.41), followed by psychological environment with a mean of 3.92 (S.D.=0.43), and physical environment obtained a mean of 3.91 (S.D.=0.48), all indicating an "Agree" level of opinion. Job performance demonstrated a mean score of 4.06 (S.D.=0.37), representing an "Agree" level of opinion among respondents.

Hypothesis Testing

H1: Digital employee competency influences job performance.

Table 2. Multiple Regression Analysis of Digital Employee Competency on Job Performance

Digital Employee Competency	Coefficients			t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.680	0.247		6.813	0.000		
- Cybersecurity Awareness	0.026	0.047	0.027	0.554	0.580	0.847	1.180
- Technical Proficiency	0.198	0.051	0.196	3.860	0.000	0.771	1.297
- Troubleshooting	0.068	0.044	0.080	1.552	0.121	0.751	1.331
- Continuous Learning	0.134	0.051	0.143	2.638	0.009	0.675	1.481
- Ethics	0.166	0.043	0.202	3.824	0.000	0.713	1.403
$R = 0.465$; R^2: = 0.217; Adjusted R^2: = 0.207; S.E.E. = 0.332; Durbin-Watson = 2.018; Sig. = 0.000							

The multiple regression analysis with enter method examining the influence of digital employee competency dimensions on job performance revealed significant findings as presented in Table 2. The overall regression model demonstrated statistical significance (Sig. = 0.000) with a multiple correlation coefficient of R = 0.465, indicating a moderate positive relationship between the predictor variables and job performance. The coefficient of determination (R^2 = 0.217) indicated that digital employee competency dimensions collectively explained 21.7% of the variance in job performance, with an adjusted R^2 of 0.207 accounting for the number of predictors in the model. The Durbin-Watson statistic of 2.018 suggested no substantial autocorrelation issues in the residuals. Examining individual predictors, technical proficiency emerged as a significant positive predictor (β = 0.196, t = 3.860, Sig. = 0.000), followed by ethics (β = 0.202, t = 3.824, Sig. = 0.000) and continuous learning (β = 0.143, t = 2.638, Sig. = 0.009), all demonstrating statistically significant positive influences on job performance at the 0.05 significance level. In contrast, cybersecurity awareness (β = 0.027, t = 0.554, Sig. = 0.580) and troubleshooting (β = 0.080, t = 1.552, Sig. = 0.121) did not show statistically significant relationships with job performance. Collinearity diagnostics revealed acceptable levels of multicollinearity, with all tolerance values exceeding 0.10 and variance inflation factor (VIF) values ranging from 1.180 to 1.481, well below the threshold of 10, indicating that multicollinearity did not pose a concern in this analysis. Based on the regression coefficients, the predictive model for job performance can be expressed through the following regression equation:

Job Performance = 1.680 + 0.198(Technical Proficiency) + 0.166(Ethics)
+ 0.134(Continuous Learning)

H2: Digital work environment influences job performance.

Table 3. Multiple Regression Analysis of Digital Work Environment on Job Performance

Digital work environment	Coefficients			t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.771	0.193		9.171	0.000		
- Physical Environment	0.116	0.037	0.151	3.126	0.002	0.800	1.251
- Sociological Environment	0.210	0.046	0.232	4.592	0.000	0.726	1.377
- Psychological Environment	0.250	0.040	0.290	6.188	0.000	0.849	1.178
R = 0.513; R^2: = 0.264; Adjusted R^2: = 0.258; S.E.E. = 0.321; Durbin-Watson = 1.923; Sig. = 0.000							

The multiple regression analysis with enter method examining the influence of digital work environment dimensions on job performance yielded significant results as shown in Table 3. The overall regression model was statistically significant (Sig. = 0.000) with a multiple correlation coefficient of R = 0.513, indicating a moderate to strong positive relationship between digital work environment dimensions and job performance. The coefficient of determination (R^2 = 0.264) revealed that digital work environment dimensions collectively accounted for 26.4% of the variance in job performance, with an adjusted R^2 of 0.258 after adjusting for the number of predictors. The standard error of estimate was 0.321, and the Durbin-Watson statistic of 1.923 indicated no serious autocorrelation concerns in the residuals. Analysis of individual predictors demonstrated that all three dimensions significantly influenced job performance at the 0.05 significance level. Psychological environment emerged as the strongest predictor (β = 0.290, t = 6.188, Sig. = 0.000), followed by sociological environment (β = 0.232, t = 4.592, Sig. = 0.000), and physical environment (β = 0.151, t = 3.126, Sig. = 0.002), all showing statistically significant positive relationships with job performance. Collinearity diagnostics indicated acceptable multicollinearity levels, with Tolerance values ranging from 0.726 to 0.849, all exceeding the 0.10 threshold, and VIF values ranging from 1.178 to 1.377, well below the critical value of 10,

confirming that multicollinearity did not compromise the validity of the regression results. Based on the regression coefficients, the predictive model for job performance can be expressed through the following regression equation:

Job Performance = 1.771 + 0.250(Psychological Environment)
+ 0.210(Sociological Environment)
+ 0.116(Physical Environment)

DISCUSSION AND IMPLICATIONS

The results of the multiple regression analysis on hypothesis 1 show that digital employee competency has a significant impact on job performance at Hisense Home Appliances Group. Ethics proved to be the most powerful predictor when compared with the other dimensions, and it was followed by technical proficiency and continuous learning, as they had all indicated a significant positive relationship with job performance. These results are consistent with Martínez-Bravo et al. (2022), who put continuous learning forward and state that responsible technology use and digital citizenship are important components of digital competence, which is crucial in relation to effective work performance. This may indicate that employees behaving responsibly with data, exhibiting competence, respecting intellectual property, and exhibiting ethical decision-making in digital environments contribute more to organizational performance, which is consistent with the findings of Dingelstad et al. (2022), who considered that essential competences in an environment based on data-driven decision-making were political astuteness and ethical awareness. The substantial effect of technical proficiency performance is consistent with Liu et al. (2022), who found performance and profitability improvement in technologically based organizations, which depend on operational competences with digital tools and platforms. Likewise, continuous learning organizations depend on continuous learning, which has positive effects. a positive effect, which supports Huu (2023), where it was argued that high digital autonomy and commitment to perpetual skills learning enable employees to demonstrate more innovative work behaviors in improving performance outcome. Notably, cybersecurity awareness and cybersecurity awareness and troubleshooting were not statistically significant to job performance despite the growing need to have security skills in the digital workplace (Basilotta-Gómez-Pablos et al., 2022).

The analysis of digital work environment dimensions on hypothesis 2 revealed a stronger overall influence on job performance compared to digital employee competency. All three environmental dimensions showed significant positive correlations with job performance, in which psychological environment was the strongest factor, followed by sociological environment and then physical environment. It is also consistent with Abdul Hamid (2022), who highlighted job meaningfulness, work-life balance, and psychological safety as important factors affecting employee effectiveness in the digital work domain. This is relevant considering the issues raised by Semaan et al. (2023) related to workplace telepressure, information overload, and the intensity of connectivity that negatively influences job engagement, which subsequently influences job performance. Empirical results of Hizam et al. (2023) are consistent with the strong effect of sociological environment on adoption behavior, who found knowledge sharing and coopetition explain significant variance of employee engagement as a predecessor to improved performance. The salience of this dimension underscores the paradigmatic transformation in which digital technologies mediate social interactions, as well as collaborative processes, that require organizational-level interventions in order to support maintaining strong affective ties despite being geographically dispersed (Radu et al., 2023). The relatively lower yet still significant role of physical environment supports Russo et al. (2021), who also identify technological infrastructure quality, ergonomic workstations, and reliable connectivity as key drivers of digital work effectiveness.

This study's results provide important theoretical and practical implications for organizations managing digital transformation projects. Theoretically, this study adds to the knowledge by showing that aspects of digital work environment dimensions have stronger direct

effects on job performance than individual-level digital competencies, which suggests that environmental contextualization theories deserve a space in the emerging field of digital workplace research. Together, the performance-related impacts of specific competency dimensions contradict the idea that digital skills tend to have a balanced effect upon performance, suggesting organizations might demand more detailed competency models that are focused on ethical technology use, technical skills, and ongoing learning activities at the expense of basic expectations regarding security awareness and troubleshooting activity, which may represent hygiene rather than motivational factors according to Herzberg (1966). In practice, Hisense Home Appliances Group and other manufacturing companies that are undergoing digital transformation may strategically invest to improve the psychological environment by creating policies to reduce the workload telepressure, setting up clear definitions for digital connectivity in terms of both time allocation and social meanings, and building up a good company culture where employees are more willing to take risks (psychological safety) by trying machines without worrying about failing. Companies should enforce sociological vibrations, which can be done through formal knowledge-sharing networks, multidisciplinary digital collaboration campaigns, and virtual team-building practices that sustain social bondedness in their distributed state. It is therefore recommended that leadership development programs focus on the articulation of clear digital visions and quality leader-member exchanges, as such two factors were found to greatly increase employee trust in technological transitions, according to Lau and Höyng (2023). The focus of human resource development on training for competency enhancement and learning that has real performance impact, like, for instance, advanced technical skills and continuous learning programs, instead of mere digital literacy programs, would align investment in competency development with its proven performance effects. Elsewhere, organizations must also come to understand that successful digital transformation is not a function of technological infrastructure implemented, or individual skills gained but is predicated on a holistic pursuit that concurrently optimizes physical, sociological, and psychological aspects of the environment while fostering crucial digital competencies shown capable of driving performance results.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

There are several limitations to note in the interpretation of findings and generalizability of this study. First, the study was cross-sectional in nature, and all data were collected at one point in time, and therefore causal relationships between digital employee competency, the digital work environment, and job performance cannot be established. However, stronger evidence for causal mechanisms and sequences of interaction could be obtained from longitudinal study designs that track these variables over long timescales. Second, self-reported measures through questionnaires only were used in this study; they could lead to common method bias and social desirability answering styles, such as sensitive constructs (i.e., job performance and ethical behavior) for which characteristics are collected. Potential measures that may improve measurement validity include objective performance factors, supervisor ratings, and triangulation of data sources. Third, the sample is restricted to one company in China (Hisense Home Appliances Group), a large manufacturing enterprise experiencing digital transformation, which may call into question the generalizability of results to different organizational settings, industries, and cultures. The specificity of the Chinese organizational culture, state-owned enterprise governance systems, and characteristics of the manufacturing sector could differ from these relationships in modes not applicable to service sectors, small- and medium-scale firms, or organizations located in other countries. Fourth, though the current study tested five dimensions of digital employee competence and three dimensions of digital work environment, the models only explained 21.7% and 26.4% of variance in job performance, respectively, suggesting that a considerable amount of variance is left unaccounted for by the predictors this study included. Other variables, for example, organizational culture, leadership styles, technological infrastructure quality, and individual difference factors such as personality traits and motivational orientations, may act as key moderators or mediators that were not examined in the current study.

These limitations could be addressed in future work, given several promising directions that would further both theoretical understanding and practical applicability. Longitudinal studies using panel data designs could investigate the temporal development of digital competencies and work settings and of their dynamic interplays with performance trajectories, tested for threshold effects, drivers of decreasing additional effects, or synergistic interactions that cannot be captured in cross-sectional analyses. Researchers could also consider moderating variables to further investigate whether the relationships are reinforced or weakened in the presence of organizational size, industrial sector and technological maturity stage, and cultural dimensions, for instance, individualism-collectivism, power distance, as Wallin et al. (2022) influences how employees perceive digitalization. Mediator analysis would inform the ways digital competencies and environments translate into performance, with potential candidates such as psychological empowerment, work engagement, innovative work behavior, and adaptive performance factors. It would be important to conduct such comparative studies across organizations, industries, and national contexts in order to deepen understanding of boundary conditions as well as how they are embedded within a particular context ("whether") or under what circumstances ("when" and "where") these effects apply most strongly. Furthermore, qualitative studies using interviews, focus groups, and ethnographic observations might yield rich understanding of the subjective experience of employees involved in such transformation initiatives by offering insights on implementation challenges, sources of resistance, and enablers that may inform or complement the quantitative results. Finally, it is recommended for future investigations to further investigate the unexpected non-significant results for cybersecurity awareness and troubleshooting dimensions. exploring if such competencies function as threshold determinants that operate in multiple contingency conditions and/or lead to different outcomes other than individual job performance, such as organizational security posture or team-level problem-solving effectiveness.

CONCLUSION

This study examined the influence of digital employee competency and digital work environment on job performance within Hisense Home Appliances Group, China, employing quantitative methodology with employee respondents from diverse organizational departments. Results suggest that digital employee competence and the digital work environment both play a crucial role in achieving job performance, with environmental dimensions having a greater impact overall than individual competencies. Within the competency model, ethics, technical proficiency, and continuous learning were found to be significant determinants of employee effectiveness; psychological environment, sociological environment, and physical environment are meaningful contributors to performance results. These findings highlight the need for an integrative approach to digital transformation that focuses on developing individual competencies while enhancing organizational environments. The study extends the literature on digital workplaces by suggesting that constructing sophisticated and supportive work environments could generate higher performance benefits than merely focusing on skill development, contrasting traditional human resource models. The results deliver some useful evidence for manufacturing organizations when navigating digital transformation, showing that investments into the psychological health and well-being of plant personnel are generally required to complement efforts aimed at collaborative relations and levels of technology infrastructure to warrant successful organizational outcomes during times of technological change.

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CONFLICTS OF INTEREST

This study has no conflicts of interest.

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IMPROVING COLD CHAIN LOGISTICS FOR MEDICAL SUPPLIES OF THAILAND

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ABSTRACT

Purpose – This study aims to improve cold chain transportation management for medical supplies in Thailand by identifying the key factors that influence operational efficiency and the preservation of product quality.

Methodology – A mixed-methods approach was employed, integrating quantitative data from 200 structured questionnaire responses with qualitative insights obtained through semi-structured interviews with 10 industry experts. Quantitative data were analyzed using descriptive statistics, independent-samples t-tests, and one-way ANOVA via SPSS, while thematic content analysis was used for the qualitative data.

Results – The findings reveal that inadequate equipment maintenance and poor communication with suppliers significantly reduce the reliability of cold chain systems. Furthermore, deficiencies in emergency response protocols and inconsistent cost-efficiency strategies contribute to systemic inefficiencies.

Implications – The results provide actionable insights for healthcare logistics stakeholders in Thailand, emphasizing the need for standardized maintenance practices, stronger supplier collaboration, and the adoption of cost-effective logistics strategies to enhance cold chain performance.

Originality/Value – This research offers a comprehensive and practical analysis of Thailand's medical cold chain logistics using a mixed-methods approach. It addresses a critical gap in the existing literature and provides a foundation for future improvements and studies in the field.

Keywords: Cold chain transportation, Medical supply chain, Optimization

Paper Type: Research Article

INTRODUCTION

Thailand's healthcare sector has experienced remarkable growth in recent years, driven by increasing domestic healthcare demand and the expanding medical tourism industry. It is projected that more than 3.07 million foreign patients will generate over 57 billion THB in 2024 (Kasikorn Research Center, 2023). This expansion has intensified the need for an efficient and reliable medical logistics system, especially for the cold chain, which plays a vital role in maintaining the integrity of vaccines, specialty pharmaceuticals, and biological products. However, Thailand's cold chain infrastructure continues to face challenges in rural accessibility, equipment maintenance, and real-time temperature monitoring (Global Cold Chain Alliance, 2022; PATH, 2011). These limitations threaten product quality and patient safety, particularly in remote healthcare settings. Consequently, strengthening the cold chain system is crucial to support Thailand's healthcare expansion, minimize losses from temperature deviations, and ensure the delivery of safe and effective medical supplies nationwide. Addressing these challenges will enhance the resilience of Thailand's healthcare logistics and reinforce its competitiveness as a regional healthcare hub.

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Despite continuous investment in healthcare logistics, the COVID-19 pandemic exposed significant weaknesses in Thailand's cold chain system, particularly in vaccine distribution. Issues such as delayed delivery, inconsistent temperature control, and fragmented coordination among stakeholders highlighted systemic inefficiencies (PATH, 2011). These problems stem from a lack of integrated technology and limited information sharing across supply chain actors. The absence of real-time temperature tracking systems, data-driven decision-making tools, and standardized operating protocols further weakens supply reliability (Chermala et al., 2025). In addition, rural areas face shortages in skilled personnel and technical capacity, increasing the risk of product spoilage and public health impacts. Such challenges underscore the need for a comprehensive investigation into Thailand's cold chain management practices. A focused study on technological adoption, operational optimization, and stakeholder collaboration can reveal improvement opportunities and strategic approaches to building a more efficient and resilient medical cold chain system that meets international standards.

Based on the above significance, the researcher aims to identify improvement opportunities in technology adoption, operational processes, and stakeholder collaboration within Thailand's cold chain logistics for medical supplies. The study seeks to propose strategic measures that enhance the efficiency, reliability, and sustainability of the medical cold chain system. The expected outcomes include practical recommendations for integrating advanced technologies, optimizing operations, and fostering multi-stakeholder partnerships. Ultimately, this research will contribute to strengthening Thailand's healthcare logistics capacity and supporting its long-term vision of becoming a leading medical service and logistics hub in the ASEAN region (TechSci Research, 2025; Kasikorn Research Center, 2023).

LITERATURE REVIEW

Cold chain logistics is critical for maintaining the efficacy of temperature-sensitive medical products such as vaccines and biologics, with the World Health Organization estimating that nearly 50% of global vaccine wastage occurs due to temperature control failures. This issue is particularly severe in Thailand, where the tropical climate and uneven rural infrastructure significantly intensify distribution risks, especially for vaccines and pharmaceutical products (Aung & Chang, 2014; Kuo & Chen, 2010). Key challenges in cold chain transportation include frequent temperature excursions affecting approximately 25% of shipments, while operational costs are 30–50% higher than conventional logistics systems. Moreover, rural and remote regions experience additional obstacles such as unstable electricity supply and inadequate transportation networks, which further compromise cold chain integrity and threaten public health outcomes.

To address these challenges, technological innovations such as IoT-based temperature monitoring and blockchain-enabled tracking systems have demonstrated strong potential for reducing spoilage and improving transparency. Evidence from pilot projects in Thailand indicates that these technologies can reduce vaccine losses by up to 28%. However, despite these benefits, high investment costs, complex system requirements, and limited technical capacity restrict widespread adoption, particularly in resource-constrained healthcare environments (Bottani et al., 2022; Pajic et al., 2024). Consequently, Thailand's cold chain infrastructure remains fragmented; approximately 30% of cold storage equipment fails to meet required standards, and nearly 40% of facilities lack effective monitoring and evaluation systems (Lu & Zhang, 2021). Furthermore, weak communication between logistics stakeholders and insufficient emergency response protocols continue to undermine consistent temperature-controlled distribution nationwide (Emigh et al., 2023; Feng, 2024).

Several advanced economies provide valuable models for strengthening Thailand's cold chain system. The United States emphasizes stringent regulatory oversight combined with extensive IoT integration, Germany promotes public–private incentive frameworks, and Japan leads in automation and standardized logistics operations. Together, these approaches highlight the importance of technological investment, institutional collaboration, and comprehensive regulatory frameworks in reducing spoilage and improving operational efficiency. By selectively adapting these international best practices, Thailand can significantly enhance the resilience and reliability of its cold chain logistics network.

Thailand's government has already initiated key measures to improve cold chain performance through policies such as the Smart Logistics Development Program, expanded public–private partnership (PPP) investments, and strengthened Food and Drug Administration regulations (National Economic and Social Development Council, 2022; PATH, 2011). These interventions have contributed to improved distribution efficiency, reduced vaccine spoilage, and increased Thailand's competitiveness in pharmaceutical and food exports (Global Cold Chain Alliance, 2022). Moving forward, sustained government commitment combined with deeper private-sector collaboration will be essential for building a robust, sustainable, and globally competitive cold chain ecosystem.

METHODOLOGY

Population and Samples

The study targets stakeholders in Thailand's cold chain logistics and medical supply sectors, including logistics operators, manufacturers, and healthcare professionals. Based on Cochran's formula (Cochran, 1977), the required sample size was calculated to be 196. A total of 200 valid responses were ultimately collected through structured surveys and semi-structured interviews. This ensures representative insights into cold chain optimization challenges.

Demographic Data

The sample included 200 professionals directly involved in Thailand's cold chain logistics, exceeding the calculated minimum (196) for statistical reliability. Respondents provided diverse perspectives through structured surveys and in-depth interviews.

Research Instruments

The study used questionnaires (200 responses) and semi-structured interviews (10 experts) to assess cold chain logistics across five key dimensions. Quantitative data was analyzed via SPSS (ANOVA, t-tests), while qualitative insights were thematically coded for deeper context.

Data Collection

A mixed-methods approach gathered data from 200 stakeholders, exceeding Cochran's minimum sample size (196). Surveys provided statistical insights, while interviews enriched findings with expert perspectives, ensuring a balanced analysis of Thailand's cold chain challenges.

Research Hypotheses

Based on the qualitative findings and relevant literature, the performance of Thailand's cold chain logistics system for medical supplies is influenced by multiple interrelated organizational and operational factors. Deficiencies in equipment quality and maintenance increase the likelihood of temperature deviations, which directly threaten product integrity. Inadequate system evaluation mechanisms limit the ability of organizations to detect failures and improve operational efficiency. Weak emergency preparedness further amplifies the consequences of system breakdowns, while high operational costs constrain the sustainability of logistics operations. In addition, ineffective communication and coordination with suppliers disrupt service continuity and responsiveness. These interconnected challenges collectively affect the efficiency and reliability of cold chain transportation, which is a critical determinant of healthcare service quality and patient safety. Therefore, this study proposes that improvements in these key factors will significantly enhance cold chain performance. Accordingly, this study examines five key factors affecting Thailand's cold chain logistics efficiency for medical supplies, including equipment quality, system evaluation, emergency measures, cost efficiency, and supplier coordination, leading to the formulation of the following research hypotheses.

H1: Equipment quality and maintenance has a significant impact on the efficiency and reliability of cold chain transportation for medical supplies in Thailand.

H2: Evaluation and efficiency of the cold chain system has a significant impact on the efficiency and reliability of cold chain transportation for medical supplies in Thailand.

H3: Emergency measures have a significant impact on the efficiency and reliability of cold chain transportation for medical supplies in Thailand.

H4: Costs and efficiency have a significant impact on the efficiency and reliability of cold chain transportation for medical supplies in Thailand.

H5: Communication and coordination with suppliers have a significant impact on the efficiency and reliability of cold chain transportation for medical supplies in Thailand.

Data Analysis

This study employed a mixed-methods data analysis approach to ensure comprehensive and robust findings. First, qualitative analysis was conducted through thematic analysis of in-depth interviews with ten experts to identify key challenges and best practices in Thailand's cold chain logistics system. Second, quantitative analysis involved the use of descriptive statistics and inferential statistics, specifically analysis of variance (ANOVA), to examine five dimensions of cold chain performance based on survey responses from 200 participants. Finally, triangulation analysis was applied to integrate and validate the qualitative and quantitative findings by systematically cross-referencing interview insights with survey results, thereby enhancing the credibility, reliability, and overall rigor of the research conclusions.

RESULTS

The thematic analysis findings from the expert interviews revealed three critical issues affecting cold chain performance. First, outdated equipment and poor maintenance were identified as major causes of temperature control failures, as aging infrastructure and delayed repairs increase the risk of product quality degradation. Second, weak supplier coordination was frequently reported, where slow responses and rigid operating procedures disrupt the timely delivery of urgent medical supplies. Third, the experts emphasized the presence of an ineffective emergency response plan, noting that system breakdowns exposed serious gaps in contingency measures, leading to preventable losses. Together, these themes reflect fundamental structural and managerial weaknesses within the healthcare cold chain system. The following figure presents the professional composition of the ten experts who provided the qualitative data supporting these findings.

Figure 1. 10 interviewees in this study

The content analysis of the ten experts further supports these findings and strengthens their credibility. As illustrated in Figure 1, the expert panel consisted of professionals from hospitals and clinics (40%), cold chain logistics providers (30%), pharmaceutical manufacturers (20%),

and third-party supply chain organizations (10%). Despite their diverse professional backgrounds, all groups consistently highlighted similar concerns regarding equipment deterioration, insufficient maintenance systems, ineffective inter-organizational coordination, and the lack of reliable emergency preparedness. This convergence of perspectives across stakeholder groups underscores the urgency of strengthening infrastructure investment, collaborative management practices, and systematic risk management to enhance the resilience and reliability of healthcare cold chain operations.

Table 1. Descriptive Statistics Analysis

Demographics data	**Frequency**	**Percent**
Gender		
Male	88	44
Female	112	56
Age		
Below23	34	17
23-41	121	60.5
42-53	26	13
54up	19	9.5
Nationality		
Thai	200	100
Education level		
High-school	43	21.5
(High)vocational certificate	63	31.5
Bachelor	47	23.5
Master	40	20
Doctoral-higher	7	3.5
Work position		
Operational	87	43.5
Management	49	24.5
Technical	64	32
Work function		
Operation-maintenance	68	34
Transportation-delivery	64	32
Quality-safety assurance	68	34
Work experience		
1-5 years	68	34
5-10 years	55	27.5
Over10 years	77	38.5
Total	200	100

From Table 1, the demographic data of the 200 respondents show that 56% were female and 44% were male. Most respondents were aged 23–41 years (60.5%), followed by those aged below 23 (17%), 42–53 years (13%), and 54 years and above (9.5%). All respondents were Thai nationals (100%). Regarding education level, 31.5% held a high vocational certificate, 23.5% held a bachelor's degree, 21.5% completed high school, 20% obtained a master's degree, and 3.5% held doctoral or higher qualifications. In terms of work position, 43.5% were in operational roles, 32% in technical positions, and 24.5% in management. The respondents' work functions were distributed among operation and maintenance (34%), quality and safety assurance (34%), and transportation and delivery (32%). Concerning work experience, 38.5% had over 10 years of experience, 34% had 1–5 years, and 27.5% had 5–10 years of experience.

Table 2. Anova

Variables		Sum of Squares	df	Mean Square	F	Sig.
efficiency1	Between Groups	63.917	28	2.283	1.165	0.272
	Within Groups	334.958	171	1.959		
	Total	398.875	199			
efficiency2	Between Groups	84.312	28	3.011	1.568	0.441
	Within Groups	328.443	171	1.921		
	Total	412.755	199			
efficiency3	Between Groups	65.16	28	2.327	1.147	0.291
	Within Groups	346.995	171	2.029		
	Total	412.155	199			
efficiency4	Between Groups	61.857	28	2.209	1.03	0.432
	Within Groups	366.898	171	2.146		
	Total	428.755	199			
equipmentQandM1	Between Groups	92.535	28	3.305	1.641	0.03
	Within Groups	344.345	171	2.014		
	Total	436.88	199			
equipmentQandM2	Between Groups	60	28	2.143	0.988	0.49
	Within Groups	371.02	171	2.17		
	Total	431.02	199			
equipmentQandM3	Between Groups	64.331	28	2.298	1.211	0.228
	Within Groups	324.424	171	1.897		
	Total	388.755	199			
equipmentQandM4	Between Groups	69.011	28	2.465	1.212	0.227
	Within Groups	347.784	171	2.034		
	Total	416.795	199			
EMGmearsures1	Between Groups	95.525	28	3.412	1.771	0.155
	Within Groups	329.43	171	1.926		
	Total	424.955	199			
EMGmearsures2	Between Groups	58.916	28	2.104	1.09	0.356
	Within Groups	330.204	171	1.931		
	Total	389.12	199			
EMGmearsures3	Between Groups	69.322	28	2.476	1.261	0.186
	Within Groups	335.633	171	1.963		
	Total	404.955	199			
EMGmearsures4	Between Groups	61.41	28	2.193	1.112	0.33
	Within Groups	337.31	171	1.973		
	Total	398.72	199			
costnefficiency1	Between Groups	62.221	28	2.222	1.176	0.261
	Within Groups	323.134	171	1.89		
	Total	385.355	199			
costnefficiency2	Between Groups	76.163	28	2.72	1.388	0.106
	Within Groups	335.117	171	1.96		
	Total	411.28	199			
costnefficiency3	Between Groups	109.023	28	3.894	1.957	0.005
	Within Groups	340.257	171	1.99		
	Total	449.28	199			

Table 2. (Cont.)

Variables		Sum of Squares	df	Mean Square	F	Sig.
costnefficiency4	Between Groups	59.792	28	2.135	1.096	0.349
	Within Groups	333.203	171	1.949		
	Total	392.995	199			
CnC1	Between Groups	80.758	28	2.884	1.396	0.102
	Within Groups	353.242	171	2.066		
	Total	434	199			
CnC2	Between Groups	74.203	28	2.65	1.359	0.121
	Within Groups	333.352	171	1.949		
	Total	407.555	199			
CnC3	Between Groups	58.717	28	2.097	0.997	0.477
	Within Groups	359.663	171	2.103		
	Total	418.38	199			
CnC4	Between Groups	70.273	28	2.51	1.234	0.208
	Within Groups	347.882	171	2.034		
	Total	418.155	199			

Table 2 presents the results of a one-way ANOVA conducted on 20 questionnaire items to examine differences in perceptions among respondent groups. The analysis showed that 18 items had p-values greater than 0.05, indicating no statistically significant differences among groups and suggesting a general consistency in respondents' perceptions of cold chain logistics practices. This overall similarity in responses may reflect the influence of standardized operational procedures commonly adopted across the industry.

However, two items demonstrated statistically significant differences. The first was equipmentQandM1 ($F(28, 171) = 1.641$, $p = 0.030$), which assessed perceptions of the reliability of cold chain transportation equipment in maintaining stable temperature control. The second was costnefficiency3 ($F(28, 171) = 1.957$, $p = 0.005$), which evaluated the adoption of cost-effective technologies to improve efficiency and reduce expenses. These findings indicate meaningful variations in perceptions related to equipment reliability and cost efficiency, providing empirical support for Hypotheses 2 and 4. Such differences may arise from variations in technological readiness, infrastructure quality, and resource availability across organizations and regions.

Table 3. Triangulation Analysis

Dimension	Survey results	Interview insights	Interpretation	References
Equipment Quality and Maintenance	Only one question showed statistical significance: "Our cold chain transportation equipment is reliable enough to maintain stable temperature control."	Aging equipment (over 10 years in use) with declining performance; inconsistent maintenance and lengthy repair times leading to temperature breaches and delays	Aging equipment and insufficient maintenance directly affect transportation quality, indicating the urgent need for system upgrades	Lu and Zhang (2021)

Table 3. (Cont.)

Dimension	Survey results	Interview insights	Interpretation	References
System Evaluation and Efficiency	No statistical significance observed in survey results	Frequent equipment failures during peak demand periods; operational efficiency impacted by outdated technology	Existing technological limitations fail to meet peak demand requirements, reflecting technological lag in cold chain logistics	Pajic et al. (2024)
Emergency Measures	No statistical significance observed in survey results	Emergency plans ineffective during execution (e.g., slow response for backup vehicles); poor coordination causing frequent delays	Weak emergency protocols and coordination represent a major operational vulnerability requiring improved response mechanisms	Emigh et al. (2023).
Cost and Efficiency	One question showed statistical significance: "We have adopted cost-effective technologies in our cold chain transportation to improve efficiency and lower expenses."	Slow supplier response times; insufficient investment in technology upgrades affecting both cost and efficiency	Limited adoption of cost-effective technologies constrains operational efficiency improvements	Bottani et al. (2022)
Supplier Communication	No statistical significance observed in survey results	Delayed supplier communication in urgent situations; inefficient responses affecting service quality and delivery timelines	Despite non-significant survey results, interviews reveal communication failures that substantially impair logistics performance	Feng (2024)

From Table 3, this study employed methodological triangulation by integrating survey data and expert interviews to validate findings related to the operational efficiency of Thailand's medical cold chain logistics. The convergence of both data sources consistently revealed four critical and interrelated challenges, namely aging equipment and inconsistent maintenance, delayed supplier response and poor communication, ineffective emergency measures, and lagging technological updates. The triangulated results indicate that equipment failures and maintenance delays remain systemic issues, particularly during peak operational periods, while supplier-side inefficiencies such as slow communication and weak responsiveness significantly disrupt

logistics performance. In addition, emergency plans were found to be poorly executed, resulting in operational delays and product losses, and outdated technology continues to function as a major bottleneck, as emphasized by multiple interviewees who stressed the urgent need for innovation and modernization. These findings align with previous studies, confirming that infrastructure gaps, limited technological adoption, and fragmented coordination are persistent obstacles in cold chain systems (Aung & Chang, 2014; Kuo & Chen, 2010). Overall, triangulation strengthens the reliability of the study's conclusions and highlights the necessity for coordinated improvements in equipment systems, supplier partnerships, crisis management protocols, and digital transformation.

DISCUSSION AND IMPLICATIONS

This study confirms that Thailand's medical cold chain logistics continues to face critical challenges, including aging equipment, ineffective supplier communication, fragmented coordination, and uneven adoption of cost-effective technologies. These findings are consistent with previous research emphasizing infrastructure deficiencies and coordination constraints in developing regions (Aung & Chang, 2014; Kuo & Chen, 2010). The ANOVA results revealed statistically significant differences in perceptions of equipment reliability and the adoption of cost-efficiency technologies, indicating that stakeholders experience these issues differently depending on organizational capacity, technological readiness, and resource availability. In contrast, the remaining hypotheses were not supported, suggesting a baseline level of standardized operational practices across the industry, albeit with uneven implementation.

Insights from 200 quantitative survey responses and 10 qualitative expert interviews further confirm the systemic nature of these challenges. Logistics providers and healthcare personnel consistently emphasized the lack of modern equipment, slow supplier responses—particularly during emergency situations such as vaccine distribution—and fragmented coordination between logistics teams and healthcare institutions, especially in rural and remote areas. The convergence of quantitative and qualitative evidence demonstrates that while standardized protocols exist, disparities in infrastructure investment, technology access, and organizational readiness create persistent performance gaps across Thailand's cold chain system.

From a practical and policy perspective, these findings highlight several urgent priorities. Logistics managers should accelerate the deployment of digital monitoring systems and IoT-enabled equipment to improve real-time temperature control and reduce human error, while healthcare authorities must strengthen supplier collaboration through integrated digital communication platforms to enhance responsiveness and reliability. At the policy level, targeted investment in rural cold chain infrastructure, along with the implementation of dynamic and regularly tested emergency protocols, is essential to strengthen national resilience against medical supply disruptions. Nevertheless, this study is subject to limitations related to sample scope and its focus on the Thai context. Future research should therefore examine the longitudinal impact of cold chain reforms and conduct comparative studies across ASEAN countries to improve the generalizability and policy relevance of future findings.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

This study acknowledges several limitations, including the concentration of data collection in urban areas and the potential for subjective bias in qualitative analysis, which may affect the generalizability of the findings. The results highlight persistent challenges in Thailand's medical cold chain logistics, particularly aging equipment requiring modernization (Suraratdecha, 2011), inadequate supplier coordination necessitating more streamlined communication protocols (Grant, 2024), and slow adoption of advanced technologies despite the demonstrated effectiveness of IoT-based solutions (Muridzi, 2024). Future research should therefore address regional disparities, systematically evaluate emerging technologies such as blockchain and artificial intelligence, and develop crisis-responsive logistics models. These efforts are essential to support infrastructure upgrades, accelerate digital transformation, and strengthen

institutional capacity, ultimately enhancing Thailand's cold chain resilience for medical emergencies and aligning the national system with global standards while closing critical local operational gaps (Langkulsen & Lambonmung, 2024).

CONCLUSION

This study provides comprehensive empirical evidence that Thailand's medical cold chain logistics system continues to face substantial operational and structural challenges that directly affect the efficiency and reliability of healthcare supply distribution. Through a mixed-methods approach combining quantitative analysis of 200 stakeholders and qualitative insights from 10 experts, the research identified persistent weaknesses in equipment quality and maintenance, supplier communication, emergency preparedness, and technological adoption. The ANOVA results confirmed statistically significant differences in perceptions regarding equipment reliability and cost-efficiency technologies, reinforcing the critical role of infrastructure quality and digital investment in cold chain performance. Moreover, triangulation of findings revealed that these challenges are systemic and interrelated, with particularly severe impacts in rural and resource-constrained settings. Collectively, the findings underscore the urgent need for coordinated improvements in technological modernization, supplier collaboration, emergency response mechanisms, and policy-driven infrastructure development. By addressing these priority areas, Thailand can strengthen the resilience of its medical cold chain, enhance patient safety, reduce economic losses from temperature deviations, and reinforce its strategic position as a leading healthcare and medical logistics hub in the ASEAN region.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest found in this research.

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A COMPARATIVE STUDY OF E-COMMERCE PLATFORMS IN CHINA AND THAILAND: A LOGISTICS PERSPECTIVE

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ABSTRACT

Purpose – This study compares logistics management practices of major Chinese and Thai e-commerce platforms by examining information, money, and material flows through the 7Rs logistics performance framework.

Methodology – A qualitative approach was employed using semi-structured interviews with eight senior logistics managers from four e-commerce platforms. Thematic analysis and cross-country comparison were applied to evaluate logistics performance across information, money, and material flows using the 7Rs framework.

Results – Findings reveal that Chinese platforms demonstrate superior logistics efficiency through advanced technology, integrated payment systems, and self-operated logistics networks, while Thai platforms rely heavily on third-party logistics and face challenges in information accuracy, reverse logistics, and infrastructure limitations.

Implications – The study suggests strategic investment in digital technologies, localized logistics systems, and reverse-logistics optimization to enhance service quality and competitiveness of e-commerce platforms in emerging markets.

Originality/Value – This research provides one of the first cross-national empirical comparisons of e-commerce logistics in China and Thailand using the 7Rs framework, offering practical insights for platform managers and policymakers.

Keywords: E-commerce logistics, China-Thailand comparison, Logistics efficiency, Infrastructure impact, 7Rs principle

Paper Type: Research Article

INTRODUCTION

The meteoric expansion of e-commerce has fundamentally re-engineered global trade patterns, and nowhere is this more evident than along the corridors shaped by China's Belt and Road Initiative (BRI). Launched in 2013, the BRI has channelled more than USD 900 billion into ports, rails, fiber-optic backbones, and digital free-trade zones across Asia (Gupta, 2014; Iqbal et al., 2023). These investments have not merely accelerated container throughput; they have created the physical and digital sinews that allow platforms such as JINGDONG (JD.com) and TAOBAO (Alibaba) to compress order-to-delivery lead times in China to under twenty-four hours in tier-one cities (Kang et al., 2022). Simultaneously, Southeast Asian markets—Thailand in particular—have experienced a compound annual growth rate (CAGR) in online retail of 29% since 2015, facilitated by BRI-financed submarine cables and the Thai 4.0 digital master plan. Yet these headline figures conceal a widening logistics performance gap: Chinese platforms leverage integrated express networks and real-time mobile payments, while Thai platforms still grapple with fragmented last-mile carriers and cash-on-delivery (COD) ratios exceeding 70%. Comparing these two markets therefore offers a natural experiment on how policy, infrastructure, and platform strategy jointly shape logistics performance.

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Within this macro context, e-commerce platforms have evolved from simple online storefronts into orchestrators of complex, multi-modal supply chains. JD.com's "211 program" promises delivery before 11 a.m. on orders placed before 11 p.m. the previous day, an offering underpinned by proprietary warehouse management systems (WMS) and automated sorting centers that process 2.1 million parcels per hour at peak. On the Thai side, LAZADA has adopted a hybrid model: it owns three mega-fulfillment centers in Bangkok's Eastern Economic Corridor, yet it outsources 82% of last-mile touchpoints to local third-party logistics (3PL) partners. TikTok Shop Thailand, launched only in 2022, has bypassed asset-heavy logistics altogether by integrating social-commerce checkouts with 3PL APIs, achieving same-day delivery in greater Bangkok but two-to-four-day delivery in up-country provinces. These distinct configurations raise critical questions about how effectively each platform manages the three canonical flows of supply chain management—information, money, and material—within the constraints of local infrastructure and consumer expectations.

The theoretical lens of the 7Rs principle—Right product, Right quantity, Right condition, Right place, Right time, Right cost, Right customer—offers a structured way to interrogate these configurations. Empirical studies in China indicate that JD.com scores above 90% on the "Right time" metric through AI-driven dynamic routing yet lags on "Right cost" due to heavy capex in fulfillment automation. Conversely, Thai platforms score higher on "Right cost" because of asset-light 3PL reliance but forfeit control over "Right condition," as evidenced by a 14% damage-in-transit rate compared to 4% in China. Such discrepancies underscore the need for granular, cross-national comparisons that move beyond aggregate logistics indices.

This study therefore sets out to achieve three objectives. First, it maps and benchmarks the end-to-end logistics practices—spanning information, money, and material flows—of four dominant e-commerce platforms: JINGDONG and TAOBAO in China, and LAZADA and TIKTOK in Thailand. Second, it evaluates each platform against the 7Rs framework to identify specific efficiency gaps and their root causes, whether technological (e.g., lack of warehouse automation), infrastructural (e.g., rural road quality), or behavioral (e.g., COD preference). Third, it distills actionable recommendations for practitioners and policymakers, pinpointing which levers—centralized data hubs, micro-fulfillment centers, tighter carrier KPIs—most effectively bridge these gaps. By synthesizing comparative evidence from two of Asia's most dynamic yet divergent e-commerce ecosystems, the study contributes original insights into how digital platforms can serve as integrative nodes within the broader BRI logistics network (Fomin et al., 2003; Gupta, 2014).

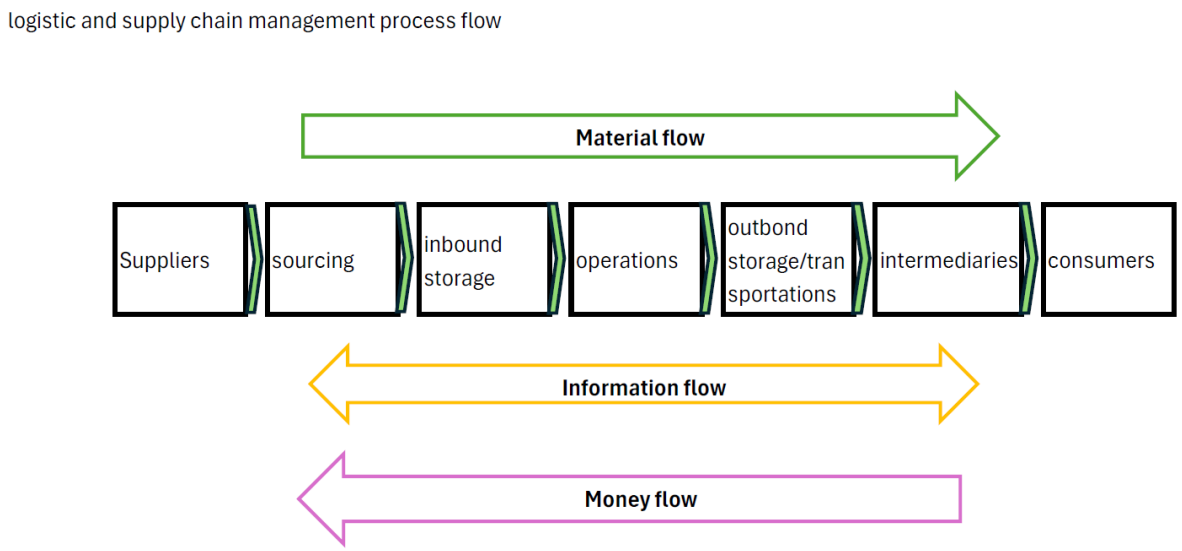

Figure 1. Logistic and supply chain management process flow (Gupta, 2014).

LITERATURE REVIEW

E-commerce logistics involves the application of electronic information technology, network interconnection, and modern communication systems to effectively manage commodity resources and transaction activities. In contemporary supply chains, e-commerce platforms function as critical intermediaries that coordinate the delivery of goods and services, manage customer orders, and integrate overall supply chain logistics operations (Fomin et al., 2003; Gupta, 2014). A fundamental framework for understanding these operations is the concept of the three flows of the supply chain: material flow, information flow, and money flow. Material flow refers to the complete process from production to final consumer delivery, including order processing, procurement, packaging, transportation, distribution, and customer service (Michlowicz & Smolińska, 2015). Information flow supports effective coordination by transmitting product information, marketing content, technical support, and after-sales service between suppliers and consumers (Gupta, 2014). Meanwhile, money flow represents the movement of capital accompanying the transfer of goods and ownership, encompassing payments, transfers, and settlements, with online payment systems playing a vital role in improving operational efficiency and customer satisfaction (Gupta, 2014).

This study draws on case examples from leading e-commerce platforms operating in China and Thailand. Lazada, founded in 2012 and acquired by Alibaba in 2016, has become one of Thailand's dominant platforms, emphasizing logistics efficiency and user experience, with logistics-related activities accounting for approximately 65–70% of its transactions (Luo, 2020; Ruanguttamanun & Peemanee, 2022). TikTok Shop has also rapidly expanded its presence in Thailand, capturing a 21% market share in 2023 by leveraging social media influence and a massive user base to stimulate e-commerce transactions (Profeta et al., 2024). In China, JINGDONG.com, established in 1998 and headquartered in Beijing, has developed a globally competitive position through strong supply chain management and advanced logistics technology (Luo, 2020). Similarly, TAOBAO, founded in 2003 in Hangzhou, maintains a significant market share with nearly 500 million registered users as of 2023, reflecting the scale and maturity of China's e-commerce ecosystem (Luo, 2020).

An efficient logistics and distribution system forms the operational backbone of e-commerce success. Such a system focuses on building fast and reliable delivery networks, minimizing logistics costs, and enhancing visibility and transparency throughout the supply chain (Salvén, 2013). Through optimized warehousing, transportation planning, and real-time tracking, e-commerce platforms can respond more effectively to customer demands while maintaining operational efficiency. These capabilities not only strengthen service reliability but also serve as a strategic advantage in increasingly competitive digital markets.

To further enhance logistics performance, the concept of logistics service quality is often explained through the 7Rs framework, originally proposed in 1974. This framework emphasizes delivering the right product, at the right time, to the right place, at the right price, using the right channel, in the right condition, and with the right information. Collectively, these seven standards guide organizations in maintaining service consistency, protecting product quality during transportation, ensuring accurate information exchange, and selecting appropriate delivery methods. Empirical studies indicate that effective implementation of the 7Rs significantly improves logistics service quality, strengthens customer satisfaction, and enhances overall supply chain efficiency (Li & Liu, 2014; Wang et al., 2018; Jiang, 2023; Tran, 2024).

METHODOLOGY

Population and Samples

The study focuses on four major e-commerce platforms in China and Thailand: JINGDONG and TAOBAO in China, and LAZADA and TIKTOK in Thailand. In 2023, JINGDONG and TAOBAO collectively held 65% of China's e-commerce market share, while LAZADA and TIKTOK accounted for 70% of Thailand's e-commerce market share.

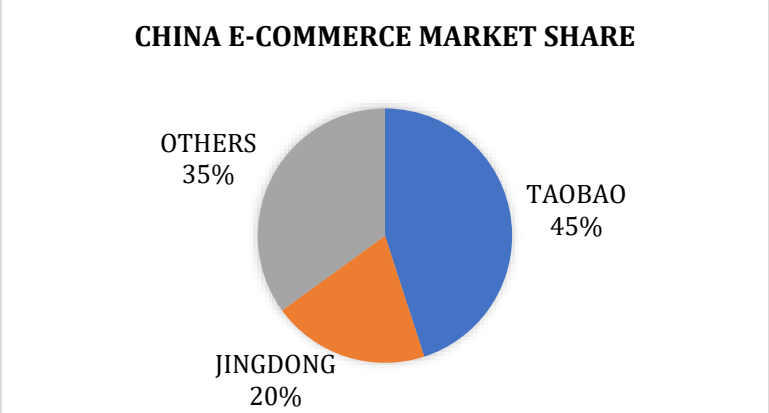

Figure 2. China e -commerce market share

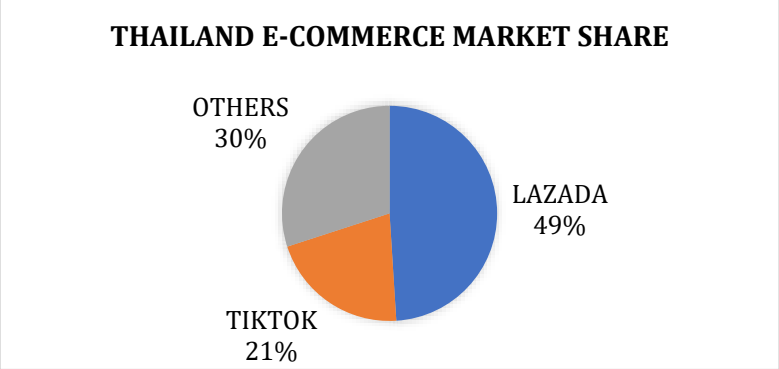

Figure 3. Thailand e -commerce market share

Research Instruments

The primary research instrument used in this study is expert interviews. Given the time constraints and geographical considerations, interviews were conducted via ZOOM. Each company's logistics manager, who is well-versed in the company's logistics operations, was interviewed. Additionally, industry professionals familiar with the logistics landscape of these platforms were included. The interviews aimed to gather in-depth insights into the logistics strategies and practices of the selected e-commerce platforms. China have 2 platforms are: JINGDONG and TAOBAO, In 2023, JINGDONG have 20%, TAOBAO have 45%, so in China JINGDONG and TAOBAO have 65% in total China e-commerce market share, Thailand have 2 platforms are: TIKTOK and LAZADA, In 2023, Lazada have 49%, TikTok have 21%, so in Thailand, LAZADA and TIKTOK have 70% in total Thailand e-commerce market share.

Data Collection

Data collection involved both secondary and primary sources. Secondary data included existing literature on logistics infrastructure, government policies, and industry reports. This data provided a foundational understanding of the logistics landscape in China and Thailand. Primary data was collected through interviews with key stakeholders, including logistics managers, policy makers, and e-commerce experts (2 people from each company).

Data Analysis

The data analysis process was conducted through several systematic steps to ensure comprehensive and reliable results. First, qualitative analysis was performed using thematic analysis of the interview transcripts in order to identify recurring themes and key insights related to logistics strategies. Next, a comparative analysis was undertaken to examine and contrast the logistics practices of JINGDONG and TAOBAO with those of LAZADA and TIKTOK, with particular emphasis on information flow, money flow, material flow, and the logistics 7Rs framework. Finally, a cross-country analysis was carried out to compare logistics systems between China and Thailand, highlighting both similarities and differences in operational structures and strategic approaches.

Validity and Reliability

To ensure the validity and reliability of the results, the study employed multiple data sources and rigorous analysis techniques. The inclusion of expert opinions from logistics managers and industry professionals added credibility to the findings. The thematic analysis of interview transcripts and comparative analysis of logistics practices across platforms ensured that the results were grounded in empirical evidence. Additionally, the cross-country comparison provided insights into the broader context of e-commerce logistics in China and Thailand.

RESULTS

Efficiencies and Inefficiencies in Each Market

Table 1. Information Flow

	LAZADA	TIKTOK	JINGDONG	TAOBAO
Efficiencies	- Invested heavily in technology for real-time tracking and efficient communication. - Fully managed JIT system for real-time inventory and order monitoring. - Centralized management of inventory, logistics, and customer service. Human customer service available 7 days a week, with intelligent customer service	- Fully managed model reducing the burden on merchants. - Leveraged social media for innovative tracking and communication. - Uses FLASH EXPRESS for comprehensive cargo tracking.	- Technology-driven data management for improved information communication. - Self-built logistics and smart sorting centers with AGV operating consoles. - Real-time monitoring system for business operations.	- Invested in RFID and IoT for real-time monitoring. - Uses third-party logistics for nationwide distribution. - CRM system for customer feedback and improved communication.
Inefficiencies	- Non-systematic processes relying on back-end labor for logistics abnormalities. - Issues with updating logistics tracking numbers and freight companies within 48 hours.	- Insufficient transparency in logistics information. - Data accuracy and security issues in logistics printing and order management.	- Slow inventory management response during peak seasons.	- High uncertainty and risk in logistics and distribution. - Poor information sharing between parties.

From the Table 1, the study indicated that all four e-commerce platforms demonstrate significant efforts in developing information flow through technological investment, real-time tracking systems, and integrated communication structures, while each platform also exhibits specific weaknesses related to system coordination, data accuracy, transparency, responsiveness, and information sharing within logistics operations.

Table 2. Money Flow

Theme	LAZADA	TIKTOK	JINGDONG	TAOBAO
Efficiencies	- Payment methods include transfer and cash on delivery. - Third-party financial platforms like PAYONEER for fund management.	- Payment methods include transfer and cash on delivery. Third-party financial platforms for fund management	- Payment methods include transfers, JD.com Baita, Alipay, and WeChat. - Fast refunds and self-operated financial platform "JD Finance."	- Payment methods include transfers, Alipay, and Huaibei. - Self-operated financial platform for faster management.

Table 2. (Cont.)

Theme	LAZADA	TIKTOK	JINGDONG	TAOBAO
Inefficiencies	- Long capital withdrawal cycles, especially for cash on delivery. Complex fund withdrawal issues and risks.	- Longer fund collection periods and increased risks.	- No significant issues reported.	- Unclear refund and compensation responsibilities.

From the Table 2, the study indicated that the four platforms employ diverse payment mechanisms and financial management systems, with notable differences in transaction efficiency, refund processing, fund management structures, and associated financial risks, particularly in relation to cash-on-delivery operations and fund withdrawal procedures.

Table 3. Material Flow

Theme	LAZADA	TIKTOK	JINGDONG	TAOBAO
Efficiencies	- Multiple delivery options with standard and fast delivery times. - Inventory management system with JIT technology. - Use of third-party logistics like FLASH and J&T.	- Big data for real-time consumer behavior analysis with FLASH EXPRESS for door-to-door delivery. - Use of multiple third-party logistics companies.	- Self-built logistics system for improved efficiency. - Intelligent handling and sorting processes. - Big data for predictive analysis and fast return services.	- Logistics evaluation system for continuous improvement. - Expanded logistics network with third-party logistics. - Use of AI and AR for product visualization.
Inefficiencies	- Lack of effective logistics and distribution networks. - Unstable transportation timeliness during promotions. - Low degree of standardization in logistics operations	- Weak logistics infrastructure and cumbersome shipping processes. - Prominent logistics and transportation problems with rapid growth.	- No significant issues reported.	- Inconsistent logistics policies affecting customer experience

From the Table 3, the study indicated that the platforms demonstrate varying levels of logistics capability in material flow management, reflecting differences in delivery structures, inventory control, technology utilization, logistics infrastructure, and operational consistency, alongside distinct challenges in network stability, standardization, and customer experience management.

Table 4. Logistics 7Rs

Theme	LAZADA	TIKTOK	JINGDONG	TAOBAO
Right Time	Ensures timely delivery through local logistics partners.	Real-time product information and social media influence for timely delivery.	Fast delivery options and efficient inventory management	Efficient supply chain management and data-driven predictions

Table 4. (Cont.)

Theme	LAZADA	TIKTOK	JINGDONG	TAOBAO
Right Place	Accurate delivery in remote areas with localized services	Door-to-door delivery with FLASH EXPRESS	Extensive logistics network for quick and accurate delivery.	Diverse logistics options for accurate delivery.
Right Product	Offers a wide range of products meeting diverse needs.	Diverse product range with engaging product displays	Genuine products through direct sales model	Wide range of products from small businesses and individuals.
Right Price	Flexible pricing strategy to adapt to market demands.	Controlled pricing within $10-$50 range	Competitive pricing with strict quality control	Flexible pricing based on market data.
Right Channel	Fully managed model with third-party logistics	Fully managed model with third-party logistics	Self-built logistics with third-party support	Self-operated financial platform for diverse payments.
Right Condition	Ensures product quality through appropriate packaging and transportation.	Ensures product quality during transportation	Advanced logistics technology for product quality.	Focus on packaging and protective measures
Right Information	Real-time order tracking and inventory management.	Real-time data monitoring and transparency in logistics	Real-time logistics updates and data-driven insights.	Comprehensive logistics information system with real-time updates

From the Table 4, the study indicated that the logistics performance of LAZADA, TIKTOK, JINGDONG, and TAOBAO can be systematically evaluated across all seven dimensions of the 7Rs framework, highlighting platform-specific strengths and operational practices in delivery timeliness, product availability, pricing strategy, distribution channels, product condition management, and information accuracy.

Table 5. Comparing the Four Companies

LAZADA	TIKTOK	JINGDONG	TAOBAO
- Significant presence in Thailand with localized logistics solutions. - Effective use of JIT systems and third-party logistics. - Needs further investment in logistics infrastructure.	- Innovative social commerce model with real-time interaction. - Relies heavily on third-party logistics. - Needs improvement in information flow management and logistics efficiency.	- Strong overall performance in logistics management. - Self-operated logistics system and advanced technology. - High efficiency in information flow and money flow. - Excellent implementation of the 7Rs principle.	- Increased focus on customer satisfaction and information flow. - Strong investment in localized logistics networks. - Needs improvement in logistics service quality management.

From the Table 5, the study indicated that the four platforms exhibit distinct strategic positions in logistics management, reflecting differences in infrastructure investment, technology adoption, reliance on third-party logistics, service quality management, and overall effectiveness in implementing logistics performance frameworks.

Table 6. Comparing China and Thailand

CHINA	THAILAND
- Emphasis on technology-driven logistics efficiency. - Use of automated warehousing and real-time tracking. - Strong infrastructure and advanced logistics systems.	- Need for more investment in logistics infrastructure. - Challenges in diverse geography and localized logistics solutions. - Growing market with potential for further technological adoption.

From the Table 6, the study indicated that China and Thailand demonstrate contrasting logistics environments, characterized by differences in technological development, infrastructure capacity, geographic challenges, and growth potential, which collectively shape the performance and strategic direction of e-commerce logistics in each market.

DISCUSSION AND IMPLICATIONS

Discussion

The research focused on the management of four key logistics flows—information flow, money flow, material flow, and their impact on logistics service quality. The study sought to identify the advantages of these companies in improving logistics service quality based on the 7Rs framework. The findings of this study align with existing literature in several key areas. Previous research has consistently highlighted the importance of advanced logistics infrastructure and technology in enhancing e-commerce efficiency. As summarized in Table 7, the current study found that Chinese ecommerce platforms, such as JINGDONG and TAOBAO, benefit significantly from their advanced logistics systems and robust infrastructure, which enable faster delivery times and better inventory management.

Table 7. Comparison of Chinese and Thai E-commerce Platforms

	Information Flow	Money Flow	Material Flow
Chinese Platforms	JINGDONG and TAOBAO have advanced systems for data collection, analysis, and sharing, enabling more informed decisions and improved customer satisfaction.	Established payment systems and integrated financial services allow for efficient payment processing and risk management	Benefit from better infrastructure and technology, optimizing inventory levels, reducing transportation costs, and improving delivery times
Thai Platforms	LAZADA and TIKTOK are improving but still face challenges in data accuracy and timeliness.	Developing payment systems but face challenges related to currency exchange rates and cross-border payment regulations.	Need to address issues such as warehouse capacity and transportation efficiency.

These findings strongly support the arguments of Fomin et al. (2003) and Gupta (2014) that the effective integration of information, money, and material flows is fundamental to achieving superior performance in e-commerce logistics systems. The dominance of Chinese platforms further confirms the conclusions of Wang et al. (2018) and Jiang (2023), who emphasize that advanced logistics infrastructure and technology-driven operations significantly enhance logistics service quality and customer satisfaction. In contrast, the persistent challenges faced by Thai platforms highlight the critical role of infrastructural readiness and system integration in shaping logistics competitiveness.

Based on the findings of this study, several recommendations are proposed to enhance logistics service quality in e-commerce platforms. First, platforms should continue to invest in advanced technologies such as artificial intelligence, the Internet of Things (IoT), and blockchain to improve information flow, enhance tracking capabilities, and optimize overall supply chain operations. In addition, greater localization of logistics services is essential to effectively serve diverse markets by taking into account cultural differences and varying consumer preferences. As e-commerce transactions continue to expand, platforms must also strengthen payment security by implementing multi-layer security measures and consistently updating network security practices to prevent financial losses and protect consumer trust. Furthermore, optimizing warehousing and distribution systems is crucial for reducing delivery time and increasing operational efficiency; therefore, strategies such as regional warehousing, timely inventory management, and partnerships with local logistics providers should be emphasized. Finally, with the growing volume of online returns, platforms should improve reverse logistics by simplifying return procedures, offering flexible return options, and efficiently managing returned products to enhance customer satisfaction and operational sustainability.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

This study acknowledges several limitations and proposes directions for future research. First, data availability was constrained due to limited access to detailed operational information from the selected platforms. In addition, the scope of the study was restricted to four major e-commerce platforms, which may not fully represent the diversity of the entire e-commerce market. Moreover, the geographical focus on China and Thailand limits the generalizability of the findings to other regions. In light of these limitations, future research could expand the scope by incorporating more platforms and countries to provide a broader market perspective. Longitudinal studies are also recommended to observe trends and changes over time. Furthermore, future studies should investigate the impact of emerging technologies on logistics service expansion and examine the role of customer feedback in improving logistics performance and customer satisfaction. Finally, greater emphasis on customer-centric research, particularly regarding user experience and satisfaction across different platforms, would provide valuable insights for both academics and practitioners.

CONCLUSION

The study provides a comprehensive analysis of the logistics management practices of major e-commerce platforms in China and Thailand. The findings highlight the importance of advanced technology, localized logistics services, secure payment systems, and efficient reverse logistics in enhancing logistics service quality. The study's contributions include providing actionable recommendations for improving logistics practices and identifying areas for future research. By understanding and optimizing these processes, e-commerce platforms can improve service quality, meet customer expectations, and gain a competitive advantage in the dynamic e-commerce environment.

CONFLICTS OF INTEREST

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

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DEVELOPMENT OF A PROTOTYPE INTELLIGENT STUDENT SHUTTLE SYSTEM TO INCREASE THE SAFETY STANDARD OF STUDENTS WITH RFID TECHNOLOGY ON THE NOTIFICATION SYSTEM VIA MOBILE APPLICATION

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ABSTRACT

Purpose – This research sought to create a prototype of an intelligent school bus system designed to enhance student safety by integrating radio-frequency identification (RFID) technology with a mobile application notification system. The system is capable of real-time monitoring of student boarding and disembarking, immediately dispatching alerts to parents and teachers through mobile devices. This mitigates the danger of students forgetting items or experiencing accidents while traveling.

Methodology – The research sample comprised 400 primary school pupils, their parents, and accompanying teachers from schools in Bangkok and the surrounding area. Data was gathered via questionnaires and a trial of the prototype system in real-world scenarios over a duration of six weeks. The sample comprised 300 parents of children and 100 onboard instructors and school staff. Results were evaluated by descriptive statistics and t-test hypothesis testing.

Results – The research findings indicated that the system recorded RFID usage data with an accuracy of 98.5%, while notifications through the mobile application remained consistent at 96.7%, 94.2% of parents reported satisfaction with the system and exhibited a statistically significant enhancement in confidence regarding student safety ($p < 0.001$). The system garnered favorable reviews on its user-friendliness and has the potential for expansion to facilitate systematic implementation at the school level.

Implications – This study markedly enhanced the student's proficiency in RFID technology, specifically regarding a notification feature within a mobile application. The prototype may assist educational institutions in developing preventive strategies. The certificate issued to parents and teachers signifies policy endorsement for Smart Education and Smart City initiatives, which may be expanded to encompass a broader smart transportation framework. Researchers advocate for collaboration among schools, parents, and communities to enhance youth health engagement and foster trust.

Originality/Value – This research is significant due of its originality. A prototype is developed that combines RFID technology with a mobile application alerting system to improve student safety. The design is intuitive and adaptable to the requirements of parents, educators, and school officials. It concretely embodies the principles of Smart Education and Intelligent Transportation, generating both intellectual and practical value. It additionally functions as a prototype for forthcoming safety advancements.

Keywords: Alert system, RFID, Firebase cloud messaging, Arduino

Research Type: Research Article

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INTRODUCTION

The student transportation system is an essential educational support service, particularly for early childhood and primary school pupils who are not yet capable of traveling independently and safely. In Thailand, numerous students depend on school or private transportation systems. Nonetheless, concerns over student safety persist throughout transit, including instances of kids being abandoned on the bus, being dropped off at incorrect locations, or experiencing accidents. This results in parental worry and adversely affects the reputation of educational institutions (Office of the Basic Education Commission, 2022). News reports and case studies have demonstrated that neglecting students on school buses significantly affects their physical and mental health, alongside legal and ethical ramifications for school bus instructors and educational institutions as service providers (Department of Children and Youth Affairs, 2021). This issue underscores the necessity of utilizing technology to enhance safety standards and effectively manage school bus operations.

Radio Frequency Identification (RFID) technology is globally acknowledged as an efficient instrument for the automatic identification and tracking of human movement. It has been utilized in the educational sphere, namely, to oversee student boarding and disembarking at each pick-up and drop-off location. It can be linked to smartphone applications to deliver real-time notifications to parents and educators (Liu et al., 2020). In nations with advanced safety management in educational settings, including the United States, Japan, and Singapore, Smart School Bus systems have been extensively implemented, featuring RFID technology, GPS, and mobile applications that minimize student drop-off inaccuracies and provide real-time bus location tracking, thereby enhancing trust among parents and educational institutions (Roberts, 2006).

In Thailand, while certain schools have initiated pilot programs for these systems, there is a deficiency of empirical research that thoroughly develops and assesses these systems in practical settings and with an adequate population size. This project seeks to create a prototype of an intelligent school bus system utilizing RFID technology and a mobile application notification system, with an emphasis on improving safety efficiency, timely notifications, and user satisfaction among students, parents, and bus personnel in practical settings.

LITERATURE REVIEW

RFID technology and its applications in education

Radio frequency identification (RFID) technology is an automated system that employs radio frequencies to identify and monitor things or individuals. The system operates by the interplay of two primary components: a tag containing distinctive information and a reader that sends data from the tag (Want, 2006). RFID is a non-contact technology analogous to a barcode, capable of rapidly reading data even in motion, rendering it appropriate for environments necessitating speed, precision, and uninterrupted inspection. RFID technology is utilized in the educational sector for several purposes, including library resource management, monitoring student attendance, managing personal possessions, and enhancing student safety during travel (Ally & Gardiner, 2012; Ahsan et al., 2010). Radio Frequency Identification (RFID) technology is a system that identifies items or individuals by the transmission and reception of data between a tag and a reader using low, medium, or high frequency radio waves, eliminating the necessity for physical touch (Want, 2006). This technology has undergone ongoing development and is utilized across various sectors, including logistics, warehousing, healthcare, and research on RFID applications in attendance verification systems (Ayuthaya et al., 2024).

In education, RFID technology has been employed for resource management, including library book lending and returns, attendance tracking, and, more recently, student safety, particularly in nations where student risk management is critical, such as the United States and South Korea (Ally & Gardiner, 2012). Hassan and De Filippi (2021) created an RFID-based attendance monitoring system for Malaysian schools, achieving an accuracy above 98% and decreasing the attendance duration from an average of 8 minutes to under 1 minute for each classroom. It also relayed data to a centralized database for educators and parents to monitor in real time (Akpınar & Kaptan, 2010) and investigated the application of RFID technology for monitoring student attendance in secondary schools in China. The system diminished teachers' workload regarding attendance and enhanced the accuracy of attendance data to 97%. The data

may also be amalgamated with the student database for behavioral assessment and personalized management (Akpınar & Kaptan, 2010). Akpınar and Kaptan (2010) implemented RFID technology in a secondary school in China by putting readers at the entrance and exit gates. When a pupil passes, the information is automatically documented and communicated to parents through SMS or a mobile application. The trial results indicated a 35% decrease in unexcused absences and heightened parental involvement in overseeing their children.

Student Tracking System on School Bus (Smart School Bus)

The administration of school bus systems has transitioned from manual operations to intelligent transportation systems. IoT (Internet of Things), GPS, and RFID technologies are integrated to provide real-time monitoring, tracking, and notification of student status. This is particularly applicable to school buses. Each student is provided with an RFID tag, and readers are put at the bus entrances. Technology automatically records data and sends messages to parents or schools when students board or disembark from the bus (Liu et al., 2020). conducted research that established a Smart School Bus system employing RFID for student identification, alongside a GPS module and mobile application notifications. Information can be transmitted to parents' and instructors' devices instantaneously as pupils board or disembark from the bus. The system underwent testing in a primary school in Shanghai, revealing an identification error rate of under 2% for a duration of 6 weeks.

In Singapore, Roberts (2006) examined the deployment of an RFID-based student tracking system across five elementary schools. The technology decreased student drop-off errors by 83%, and more than 90% of parents expressed great satisfaction, as they could monitor their children's position in real time through a mobile application. RFID technology provides numerous benefits, such as rapid, precise, and contactless data reading capabilities (Akpınar & Kaptan, 2010). Nonetheless, it possesses certain disadvantages, like elevated installation expenses compared to barcode systems and vulnerability to environmental interference. The efficacy of RFID systems in education relies on adequate infrastructure, including networking, backup systems, and the collaboration of parents and school staff in the joint implementation of the system (Fazio, 2022).

The Smart School Bus system is designed to oversee student status during their route, encompassing boarding and alighting, tracking their whereabouts, and facilitating real-time communication with parents. It encompasses the subsequent essential technologies: RFID (Radio Frequency Identification) is employed to identify students by affixing tags to their ID cards, which are recognized upon boarding or disembarking (Akpınar & Kaptan, 2010). The Global Positioning System (GPS) is utilized for real-time bus location tracking and route planning assistance (Shaaban et al., 2013). Mobile Application and Notification System: promptly informs parents or teachers of students boarding and alighting from the bus through an application (Roberts, 2006). Liu et al. (2020) created an intelligent school bus system for educational institutions in Shanghai, China, incorporating RFID and IoT technology. Technology tracks student boarding and disembarking in real time and transmits notifications to parents through a mobile application. Experimental findings indicated that the technique could diminish student counting errors by 96% and substantially alleviate parental concerns over their child's safety. In India, Shaaban et al. (2013) developed and assessed a sophisticated tracking system for school transportation utilizing RFID and GPS technology integrated with a mobile application. Parents can monitor the bus's whereabouts and the student's boarding and disembarking status through a smartphone application. The solution attained an average satisfaction rating of 4.7 out of 5.0 and reduced the school's routing expenses by 18% through the study of individual student usage patterns. In a study conducted by Roberts (2006), an RFID-based student tracking system implemented in five primary schools in Singapore showed an 83% reduction in accidents or unwanted situations stemming from miscommunications between instructors and parents. It facilitated expedited communication by push notifications, which are superior to communication via telephone or paper (Ayuthaya et al., 2024).

Creation of real-time notification apps within the realm of security

Real-time notification systems (RDS) are mechanisms that transmit information or messages to users instantaneously following an incident, without requiring prior user solicitation. This notification type is essential in safety-related situations, such accident alerts, individual tracking, or risk management in public spaces (Wang et al., 2019). In the realm of education, specifically

regarding student safety management, real-time notifications through mobile applications enable parents to promptly obtain information about their students' location or status, including when students board or disembark from a bus or when an anomaly arises during a trip (Liu et al., 2020).

Mobile applications that facilitate real-time notification systems are crucial for enhancing communication between caregivers and end users, particularly in student safety systems that necessitate prompt information for effective responses or actions. Fazio (2022) examined the evolution of real-time notification applications in public transportation systems and determined that push notification communication, which incorporates data from sensors or RFID devices, is more effective in alerting end users than conventional SMS or email systems and is increasingly favored in applications concerning child and youth safety. Zhou et al. (2022) created a smartphone application to alert parents when their children board and disembark from the school bus. The user experience assessment revealed that the majority of users provided elevated satisfaction ratings, particularly in the categories of "notification speed" and "clarity of information received."

The creation of real-time notification applications within a security framework frequently depends on foundational technologies such as Push Notification, which facilitates message delivery to user devices regardless of app status (Google Firebase, Apple Push Notification Services); Real-Time Database/MQTT, employed for immediate data transmission, exemplified by Firebase Realtime Database or the MQTT protocol that enables low-latency communication (Ramírez et al., 2025), and Geo-fencing, which establishes a virtual boundary to trigger notifications when a device enters or exits a designated area (Saleem et al., 2020).

METHODOLOGY

This study constitutes a research and development (R&D) initiative. The aim is to create a prototype of an intelligent school bus system that incorporates RFID technology alongside a real-time notification system using a mobile application, and to assess the prototype's efficacy by conducting tests with a substantial target group. The research has three phases: system study, analysis and design, prototype production, and evaluation of user efficacy and satisfaction. The researcher possesses the subsequent research purpose.

1. To investigate the factors contributing to accidents involving school buses, including an examination of the constraints of the school bus safety standards framework.
2. To provide an economical sensor system for notifying student boarding and dropping statuses, as well as for real-time GPS tracking of shuttle bus conditions.
3. To establish a real-time status notification system utilizing Firebase Cloud Messaging.

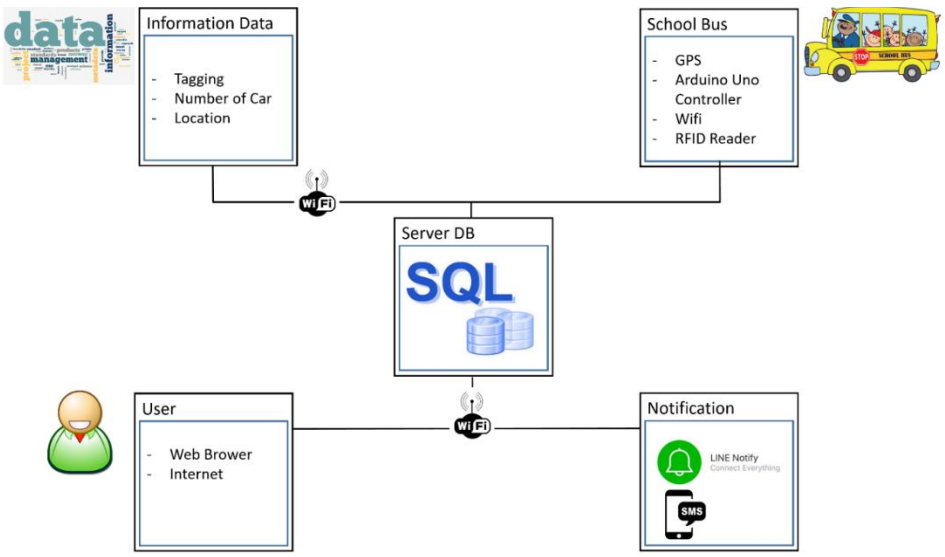

Figure 1. Conceptual framework for research on the creation of a prototype for an intelligent school bus system aimed at enhancing student safety standards through RFID technology integrated with a mobile application notification system.

Figure 1 illustrates the conceptual framework of the research, which focuses on the design and development of a prototype intelligent school bus system aimed at enhancing student safety standards through the integration of RFID technology, GPS tracking, and a mobile application–based notification system. The framework presents the overall system architecture and data flow among key components, including data acquisition units installed on school buses, a central server database, user access interfaces, and notification services. At the operational level, the school bus is equipped with an Arduino Uno controller functioning as the core processing unit. This controller is connected to a global positioning system (GPS) module for real-time location tracking, an RFID reader for student identification and attendance verification, and a Wi-Fi communication module for data transmission. Each student carries an RFID tag, which is scanned upon boarding and alighting the bus. The RFID data are processed by the controller and combined with bus identification data, including vehicle number, tagging status, and current geographic location. All collected data are transmitted via wireless internet connectivity to a centralized SQL-based server database. The server database functions as the main data management layer, responsible for storing, organizing, and processing information related to student attendance, bus routes, time stamps, and location data. This centralized architecture ensures data integrity, traceability, and real-time accessibility for authorized users. On the user side, parents, teachers, and school administrators access the system through a web-based interface using standard internet browsers. This interface allows users to monitor bus locations, verify student boarding and drop-off status, and review historical transportation records. The system is designed to support decision-making and supervision by providing timely and accurate information relevant to student transportation safety.

In addition, the framework incorporates an automated notification subsystem to enhance proactive communication. Notification services are delivered through mobile application platforms, such as LINE Notify, and Short Message Service (SMS). These notifications are automatically triggered by predefined events, such as student boarding or leaving the bus, delays, or deviations from planned routes. This feature is intended to improve parental confidence and enable rapid response in case of abnormal situations. From a research methodology perspective, the population of this study comprised parents, educators, and school administrators who are directly involved in the use of primary and secondary school bus services in Bangkok and its surrounding metropolitan areas. The sample consisted of 400 participants, including 300 parents and teachers and 100 school administrators. The sample was selected using purposive sampling, based on criteria such as regular school bus usage and readiness to adopt mobile application–based systems. The research instruments included.

1. The prototype of the intelligent school bus system includes an RFID module for monitoring student boarding and alighting, a microcontroller board, and a mobile application (compatible with both Android and iOS) linked to a cloud infrastructure featuring a real-time dashboard for schools to oversee student and bus data.

2. A questionnaire was administered to parents and bus teachers to gather supplementary quantitative data regarding their experiences with system usage. Satisfaction and system efficiency were assessed using content validity evaluations conducted by three experts. The questionnaire's reliability was determined using Cronbach's Alpha, yielding a value of 0.91. The questionnaire variables were designed to evaluate users' perceptions and satisfaction regarding the prototype intelligent school bus system, emphasizing safety, notifications, and overall system utilization, which comprised the following two components. Section 1, Demographic details of the respondent, gender, age, relationship to students, and prior experience with the smart shuttle system and Section 2, Contentment with the Smart School Bus Prototype System.

These instruments were aligned with the conceptual framework to ensure consistency between system design, data collection, and analysis. Overall, the framework demonstrates a systematic integration of hardware, software, and user interaction components to support the research objective of improving student safety through intelligent transportation technology.

Research Procedure and System Development Process

1. Investigate the issues and requirements by gathering data from parents and educational institutions regarding travel safety concerns.

2. Develop a prototype system adhering to IoT system protocols and UX design principles for mobile applications, prioritizing security, user-friendliness, and precision.

3. Construct a prototype and implement the system in accordance with the design, including internal testing prior to field testing.

4. The prototype system underwent testing in three medium-sized schools, each with around 150 kids, utilizing the new technology alongside the shuttle bus for a duration of two weeks.

5. Gather data from questionnaires and interviews to evaluate satisfaction and identify issues experienced during use.

6. Conduct a comprehensive analysis and synthesis of the results employing both quantitative and qualitative methodologies.

Analysis of quantitative data, descriptive statistics

Descriptive statistics were employed to summarize the demographic characteristics of the sample and to examine users' perceptions toward the prototype intelligent school bus system. Frequency and percentage distributions were used to describe general respondent information, including gender, age group, and user type. In addition, the mean and standard deviation (SD) were calculated to evaluate the levels of satisfaction and perceived efficiency of the prototype system across key assessment dimensions. As shown in Table 1, the overall satisfaction level of system users was high, with a mean score of 4.35 (SD = 0.58) on a five-point Likert scale, indicating an extremely high level of satisfaction. When considering individual aspects, the safety check for students received the highest mean score (Mean = 4.45, SD = 0.49), reflecting strong user confidence in the system's ability to enhance student safety during school bus transportation. This finding suggests that the integration of RFID technology and real-time monitoring effectively addressed primary safety concerns among parents and school personnel. The user-friendliness of the mobile application also demonstrated a high satisfaction level (Mean = 4.40, SD = 0.50). This result indicates that the system interface and functional design were perceived as easy to use and suitable for users with varying levels of technological familiarity. Similarly, the precision of notifications achieved a high mean score (Mean = 4.35, SD = 0.55), suggesting that users trusted the accuracy and timeliness of the alerts provided by the system, which is a critical factor in transportation safety management. Comprehensive contentment, which reflects users' overall impressions of the system, yielded a mean score of 4.30 (SD = 0.68). Although this dimension showed slightly greater variability compared to other aspects, the satisfaction level remained within the "extremely content" category. This variation may reflect differing expectations or contextual usage conditions among parents, teachers, and school administrators.

Table 1. Analysis of quantitative data

Assessed aspect	Mean	SD	Level of satisfaction
1. User-friendliness of the application	4.40	0.50	Extremely content
2. Precision of notifications	4.35	0.55	Extremely content
3. Safety check for students	4.45	0.49	Extremely content
4. Comprehensive contentment	4.30	0.68	Extremely content

Inferential Statistics

The data quality was assessed, and the questionnaire's reliability was determined using Cronbach's Alpha, yielding a result of $\alpha = 0.91$, signifying high reliability (values exceeding 0.80 are deemed very good). A standard data test was conducted by evaluating the Skewness and Kurtosis values prior to employing inferential statistics. The instrument's reliability was assessed by content validity and reliability analysis using Cronbach's Alpha, with an approved threshold of $\alpha > 0.70$.

Table 2. Variable Measurement

Variable		Measurement	Adapted from
Hardware and tracking systems (Global Positioning System, Radio-Frequency Identification, Arduino)	System 1	1. The system can detect students getting on and off the bus correctly.	System factor
	System 2	2. Vehicle location using GPS is accurate.	
	System 3	3. The system works stably throughout the route.	
	System 4	4. RFID tag reading is fast.	
Data connectivity and database management systems	Connectivity 1	5. The connection between hardware and database is fast.	Connectivity factor
	Connectivity 2	6. The database can store student and vehicle data systematically.	
	Connectivity 3	7. There is no problem of delay or data loss during data communication.	
User-friendliness through Web/ Application	Convenience 1	8. Users can conveniently access student information via the Web.	Convenience Factor
	Convenience 2	9. The application supports proper use via mobile phones.	
	Convenience 3	10. The system interface is easy to understand and not complicated.	
Real-time alert system (LINE Notify / SMS)	Notify 1	11. Instant notification system when students get on or off the bus	Notification factor
	Notify 2	12. The notification format is clear and well communicated.	
	Notify 3	13. Parents can receive real-time information about their children's travel.	

The measurement of research variables was developed in alignment with the conceptual framework and the objectives of the study, ensuring methodological rigor and construct validity. As presented in Table 2, the variables were operationalized into four main factors, each representing a critical component of the intelligent school bus system. All measurement items were adapted from relevant system and technology acceptance factors and assessed using a five-point Likert scale, ranging from the lowest to the highest level of agreement.

The first factor, Hardware and Tracking Systems, focused on the technical performance and reliability of the core system components, including GPS, RFID, and Arduino-based controllers. This factor was measured through four indicators (System 1–System 4), which evaluated the accuracy of student detection during boarding and alighting, the precision of GPS-based vehicle location tracking, system stability throughout the bus route, and the speed of RFID tag reading. These indicators collectively reflect the effectiveness of the hardware infrastructure in supporting real-time monitoring and student safety.

The second factor, Data Connectivity and Database Management Systems, examined the efficiency and reliability of data transmission and storage. This factor comprised three measurement items (Connectivity 1–Connectivity 3), assessing the speed of communication between hardware devices and the central database, the systematic storage of student and vehicle data, and the absence of delays or data loss during communication. These indicators represent the system's capacity to manage real-time data flows accurately and consistently.

The third factor, User-Friendliness through Web/Application, addressed system usability and accessibility from the user perspective. This factor was measured by three indicators (Convenience 1–Convenience 3), which evaluated users' ability to conveniently access student information via the web, the suitability of the application for mobile phone usage, and the clarity and simplicity of the system interface. These items reflect the importance of ease of use in promoting user acceptance among parents, teachers, and school administrators.

The fourth factor, Real-Time Alert System, emphasized the effectiveness of communication and notification mechanisms delivered through LINE Notify and SMS. This factor included three measurement items (Notify 1–Notify 3), focusing on instant notifications when students board or leave the bus, the clarity and comprehensibility of notification messages, and parents' ability to receive real-time information regarding their children's travel status. This factor directly supports the study's objective of enhancing student safety through timely and reliable information dissemination.

Overall, the variable measurements were systematically structured to capture both technical performance and user-centered outcomes, providing a comprehensive evaluation of the intelligent school bus prototype in accordance with established research methodology standards. Table 3 presents the descriptive statistics of all observed variables based on 399 valid responses, with no missing data. The mean scores of all items ranged from 3.45 to 4.17, indicating a high level of agreement among respondents across system usage, hardware performance, connectivity, convenience, and notification dimensions. Standard deviation values were within acceptable ranges, reflecting moderate variability in responses. Skewness and kurtosis values fell within acceptable thresholds, suggesting that the data were approximately normally distributed. The 95% confidence intervals further confirmed the stability and consistency of the mean estimates, supporting the suitability of the dataset for subsequent inferential statistical analysis.

Table 3. Descriptive Data

	N	Missing	Mean	Std. error mean	95% CI mean lower bound	95% CI mean upper bound	Median	Standard deviation	Minimum	Maximum	Skewness	Std. error skewness	Kurtosis	Std. error kurtosis
Use 01	399	0	4.05	0.0353	3.98	4.12	4	0.705	2	5	-0.930	0.122	1.72	0.244
Use 02	399	0	4.03	0.0323	3.97	4.09	4	0.645	2	5	-0.536	0.122	1.10	0.244
Use 03	399	0	3.80	0.0491	3.70	3.89	3	0.980	2	5	0.094 7	0.122	-1.44	0.244
System 1	399	0	3.93	0.0340	3.86	4.00	4	0.680	2	5	-0.828	0.122	1.51	0.244
System 2	399	0	3.47	0.0387	3.40	3.55	3	0.772	2	5	0.574	0.122	-0.293	0.244
System 3	399	0	3.65	0.0577	3.54	3.77	4	1.15	1	5	-0.673	0.122	-0.452	0.244
System 4	399	0	3.45	0.0548	3.35	3.56	4	1.09	1	5	-0.511	0.122	-0.545	0.244
Connec 1	399	0	3.73	0.0512	3.63	3.83	4	1.02	1	5	-0.838	0.122	0.00960	0.244
Connec 2	399	0	3.83	0.0508	3.73	3.93	4	1.01	1	5	-0.761	0.122	0.0287	0.244
Connec 3	399	0	4.03	0.0379	3.95	4.10	4	0.758	2	5	-0.394	0.122	-0.277	0.244
Connec 4	399	0	4.17	0.0386	4.10	4.25	4	0.772	2	5	-0.967	0.122	1.06	0.244
Conven 1	399	0	3.95	0.0354	3.88	4.02	4	0.707	2	5	-0.786	0.122	1.21	0.244
Conven 2	399	0	4.00	0.0388	3.92	4.07	4	0.775	2	5	-0.321	0.122	-0.488	0.244
Conven 3	399	0	4.07	0.0394	4.00	4.15	4	0.788	2	5	-0.439	0.122	-0.465	0.244
Conven 4	399	0	4.15	0.0413	4.07	4.23	4	0.824	2	5	-0.822	0.122	0.247	0.244
Notify 1	399	0	4.00	0.0419	3.92	4.08	4	0.837	2	5	-0.770	0.122	0.285	0.244
Notify 2	399	0	4.06	0.0416	3.97	4.14	4	0.831	2	5	-0.869	0.122	0.523	0.244
Notify 3	399	0	4.15	0.0413	4.07	4.23	4	0.824	2	5	-0.822	0.122	0.247	0.244

Note. The CI of the mean assumes sample means follow a t-distribution with N - 1 degrees of freedom

Table 4. RESULTS of Correlation Matrix

		Sum User	Sum System	Sum Connec	Sum Conven	Sum Notify
Sum User	Pearson's r	—				
	df	—				
	p-value	—				
	95% CI Upper	—				
	95% CI Lower	—				
Sum System	Pearson's r	0.611***	—			
	df	397	—			
	p-value	< .001	—			
	95% CI Upper	0.669	—			
	95% CI Lower	0.545	—			
Sum Connec	Pearson's r	0.515***	0.829***	—		
	df	397	397	—		
	p-value	< .001	< .001	—		
	95% CI Upper	0.584	0.858	—		
	95% CI Lower	0.439	0.796	—		
Sum Conven	Pearson's r	0.471***	0.442***	0.535***	—	
	df	397	397	397	—	
	p-value	< .001	< .001	< .001	—	
	95% CI Upper	0.544	0.518	0.602	—	
	95% CI Lower	0.391	0.360	0.462	—	
Sum Notify	Pearson's r	0.636***	0.612***	0.633***	0.837***	—
	df	397	397	397	397	—
	p-value	< .001	< .001	< .001	< .001	—
	95% CI Upper	0.691	0.670	0.689	0.864	—
	95% CI Lower	0.573	0.546	0.570	0.804	—

Note. * p < .05, ** p < .01, *** p < .001

Table 5. Scale Reliability Statistics

	Mean	SD	Cronbach's α	McDonald's ω
Scale	3.92	0.580	0.931	0.936

Based on the results presented in Table 4. RESULTS of Correlation Matrix and Table 5. Scale Reliability Statistics, the mean (average = 3.92) indicates the overall score of the measure; for instance, in a 5-point questionnaire, an average of 3.92 suggests that respondents generally exhibit a relatively high level of agreement. SD - Standard Deviation (standard deviation = 0.580) indicates the dispersion of scores relative to the mean. The standard deviation score of 0.58 indicates that the respondents share similar ideas. Cronbach's α (Alpha = 0.931) is a statistic that assesses the reliability of a measure by evaluating the internal consistency of the questionnaire items. Interpretation criteria: > 0.9 = outstanding; 0.8–0.9 = very good; 0.7–0.8 = adequate. Consequently, a rating of 0.931 indicates exceptionally high reliability and outstanding internal consistency.

McDonald's ω (Omega = 0.936) is a frequently utilized dependability metric, as it demonstrates greater accuracy than Cronbach's α in certain instances. Elevated ω values (> 0.9), exemplified by 0.936, signify that the measure possesses a robust internal structure and exhibits good reliability.

The findings of this questionnaire exhibit a comparatively elevated average value. The respondents share identical viewpoints, and both Cronbach's Alpha and McDonald's Omega metrics are at elevated levels, signifying that the scale possesses substantial internal consistency and reliability, making it suitable for research purposes.

Table 6. Item Reliability Statistics

	Mean	SD	Item-rest correlation	If item dropped	
				Cronbach's α	McDonald's ω
Use 01	4.05	0.705	0.582	0.928	0.934
Use 02	4.03	0.645	0.620	0.928	0.933
Use 03	3.80	0.980	0.543	0.930	0.934
System 1	3.93	0.680	0.667	0.927	0.933
System 2	3.47	0.772	0.296	0.934	0.939
System 3	3.65	1.152	0.600	0.929	0.934
System 4	3.45	1.095	0.660	0.927	0.933
Connec 1	3.73	1.023	0.652	0.927	0.933
Connec 2	3.83	1.015	0.677	0.926	0.933
Connec 3	4.03	0.758	0.792	0.924	0.930
Connec 4	4.17	0.772	0.761	0.925	0.930
Conven 1	3.95	0.707	0.713	0.926	0.931
Conven 2	4.00	0.775	0.581	0.928	0.934
Conven 3	4.07	0.788	0.567	0.929	0.934
Conven 4	4.15	0.824	0.750	0.925	0.930
Notify 1	4.00	0.837	0.665	0.926	0.932
Notify 2	4.06	0.831	0.675	0.926	0.932
Notify 3	4.15	0.824	0.750	0.925	0.930

Based on the results presented in Table 6. Item Reliability Statistics, the Item Reliability Statistics table assesses the reliability of each item within the same questionnaire as the preceding table, evaluating the consistency of each question with the overall measure and identifying any items that may require elimination. This can be elucidated in accordance with the research technique as follows.

1. Correlation between items and rest, this assessment evaluates the extent to which the questions align with the overall score of the questionnaire. Criteria: A value of 0.30 or above is deemed acceptable. All items exhibited a value of > 0.296, with System 2's result of 0.296 deemed "near the standard" yet still permissible. This signifies that all items have a positive correlation with the total score and may be preserved for subsequent study.

2. Cronbach's α upon item removal (and McDonald's ω), This is utilized to ascertain whether the α and ω values of the questionnaire will augment or diminish upon the removal of an item. If the α value rises upon the removal of that item, then the item may be superfluous or diminish the scale's consistency. The table indicates that all values fall within the range of 0.924-0.934 (all items remain exceptionally high) and do not exhibit significant increases upon the removal of any item. This indicates that no item should be eliminated, as the questionnaire possesses good reliability and is not substantially influenced by the removal of any item.

In conclusion, as illustrated in Figure 2. Correlation Heatmap, the questionnaire, had exclusively high-quality items, as stipulated by the research protocol. The item-rest correlation values predominantly exceeded the minimum threshold, indicating that each item was effectively associated with the primary variables. The reliability of the "if eliminated" dimension was consistently good (Cronbach's α > 0.92 and McDonald's ω > 0.93 for all items). Consequently, no items should be removed from the questionnaire, and it can be reliably utilized for data collection. The findings indicated that the questionnaire had exceptional internal consistency, aligning with Nunnally and Bernstein's (1994) criteria that suggests an alpha coefficient greater than 0.9 is suitable for evaluative research.

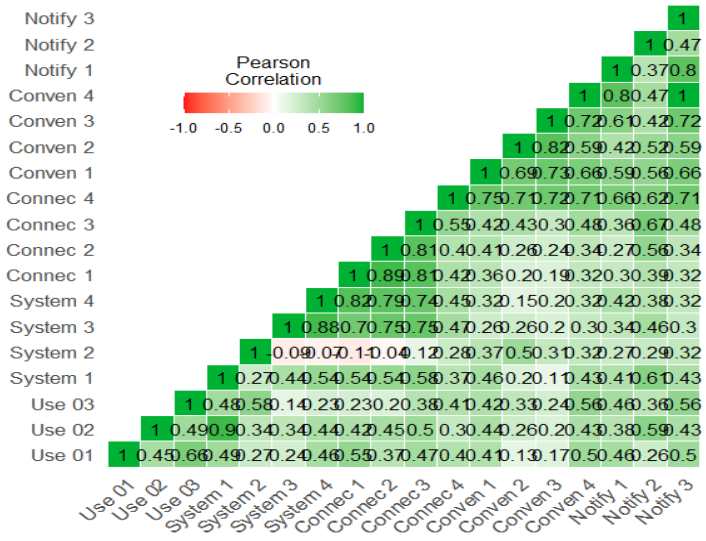

Figure 2. Correlation Heatmap

Table 7. Confirmatory Factor Analysis of Factor Loadings.

Factor	Indicator	Estimate	SE	95% Confidence Interval		Z	p	Stand. Estimate
				Lower	Upper			
Factor 1	System 1	0.3869	0.0319	0.324	0.4494	12.14	< .001	0.5697
	System 2	-0.0453	0.0395	-0.123	0.0322	-1.15	0.252	-0.0587
	System 3	1.0367	0.0450	0.949	1.1249	23.06	< .001	0.9010
	System 4	1.0582	0.0407	0.978	1.1380	26.00	< .001	0.9679
Factor 2	Connec 1	0.9537	0.0390	0.877	1.0301	24.47	< .001	0.9331
	Connec 2	0.9422	0.0387	0.866	1.0180	24.37	< .001	0.9298
	Connec 3	0.6682	0.0301	0.609	0.7271	22.22	< .001	0.8825
	Connec 4	0.3931	0.0373	0.320	0.4663	10.53	< .001	0.5100
Factor 3	Conven 1	0.5881	0.0295	0.530	0.6459	19.97	< .001	0.8328
	Conven 2	0.6357	0.0333	0.570	0.7009	19.11	< .001	0.8213
	Conven 3	0.7002	0.0320	0.637	0.7630	21.87	< .001	0.8901
	Conven 4	0.6738	0.0353	0.604	0.7430	19.06	< .001	0.8186
Factor 4	Notify 1	0.5537	0.0437	0.468	0.6394	12.66	< .001	0.6622
	Notify 2	0.4619	0.0429	0.378	0.5459	10.78	< .001	0.5566

The criteria for evaluation in research derived from the Confirmatory Factor Analysis table can be elucidated as follows.

Table 8. Criteria considered to pass.

Descriptions	Criteria considered to pass
Factor loading (standardized)	Greater than or equal to 0.50 (Hair et al., 2014)
p-value	Values below 0.05 indicate statistical significance.
Assess Value Orientation	Positive (directly correlates with the measurement based on the factor)

Based on the results presented in Table 7: confirmatory factor analysis of factor loadings and evaluated against the thresholds specified in Table 8: criteria considered to pass, the findings indicate that the measurement model is largely consistent with the proposed theoretical structure. For Factor 1 (System), Systems 1, 3, and 4 exhibit standardized factor loading values ranging from 0.567 to 0.968, which meet the acceptance criteria outlined in Table 8. However, System 2 demonstrates an estimated

loading value close to zero and is not statistically significant (p = 0.252), as shown in Table 7. This item fails to satisfy the established criteria and should therefore be considered for removal or revision prior to practical application. Regarding Factor 2 (Connection), all indicators (Connection 1–4) present factor loadings between 0.510 and 0.933, with statistical significance at p < 0.001. According to the criteria in Table 8, these results confirm that all items within this factor adequately represent the latent construct and can be retained as a reliable measurement dimension. For Factor 3 (Convenience), the factor loadings for Convenience 1–4 range from 0.816 to 0.890, all of which exceed the minimum thresholds and are statistically significant. These results, as reported in Table 7, indicate high-quality measurement items that strongly reflect the underlying construct. Similarly, Factor 4 (Notification) shows acceptable factor loadings for Notification 1–2, ranging from 0.662 to 0.748, with p < 0.001. Based on the criteria in Table 8, these indicators are appropriate for retention and effectively capture the notification construct. In summary, the CFA results in Table 7, when assessed using the criteria in Table 8, demonstrate that the questionnaire's factor structure aligns well with the theoretical framework. Most factor loadings exceed 0.50 and are statistically significant (p < .05), indicating adequate construct validity. Only the item System 2 does not meet the required criteria due to its low and non-significant loading, suggesting that it should be removed or improved before further implementation. Overall, the findings support an acceptable level of construct validity for the measurement instrument.

Table 9. Factor Estimates

				95% Confidence Interval				
Factor	**Indicator**	**Estimate**	**SE**	**Lower**	**Upper**	**Z**	**p**	**Stand. Estimate**
Factor 1	Factor 1	1.000[a]						
	Factor 2	0.891	0.0143	0.863	0.919	62.26	< .001	0.891
	Factor 3	0.305	0.0499	0.207	0.403	6.11	< .001	0.305
	Factor 4	0.692	0.0540	0.586	0.798	12.80	< .001	0.692
Factor 2	Factor 2	1.000[a]						
	Factor 3	0.417	0.0468	0.325	0.509	8.90	< .001	0.417
	Factor 4	0.711	0.0577	0.598	0.824	12.31	< .001	0.711
Factor 3	Factor 3	1.000[a]						
	Factor 4	1.058	0.0460	0.968	1.148	22.97	< .001	1.058
Factor 4	Factor 4	1.000[a]						

[a] fixed parameter

Within the framework of confirmatory factor analysis (CFA) and structural equation modeling (SEM), Factor 1 is composed of four observed indicators (Factor 1–Factor 4) representing the latent construct associated with Factor 1. Based on the results reported in Table 9: factor estimates, the factor loadings were estimated with a 95% confidence interval to assess the strength and precision of the relationships between the latent factor and its observed indicators. Specifically, Indicator 2 of Factor 1 demonstrates a high standardized factor loading, with an estimated value of 0.891 and a standard error of 0.0143. The corresponding 95% confidence interval ranges from 0.863 to 0.919, which does not include zero. This result, as shown in Table 9, indicates a statistically significant and strong association between Indicator 2 and Factor 1, providing empirical support for the convergent validity of the measurement model.

$$CI = \text{Estimate} \pm 1.96 \times SE$$

Z (Z-value or Critical Ratio)

$$Z = \frac{\text{Estimate}}{SE}$$

The standardized coefficient facilitates direct comparison of each indicator. Factor 1 Indicator 2 possesses a Stand. The estimated value is 0.891, signifying a strong association. Factor 1 Indicator 3 possesses a value of merely 0.305, signifying that this indicator represents a minimal portion of the hidden factor.

Table 10. Model Fit Test for Exact Fit

χ^2	df	p
2213	71	< .001

Fit Measures

				RMSEA 90% CI			
CFI	TLI	SRMR	RMSEA	Lower	Upper	AIC	BIC
0.649	0.550	0.171	0.275	0.265	0.285	10119	10311

The model fit test findings suggest $\chi^2(71) = 2213$, in Figure 10. Model Fit Test for Exact Fit, $p < 0.001$, demonstrating a considerable divergence between the baseline model and the empirical data. The CFI of 0.649 and TLI of 0.550 fall below the commonly recognized thresholds of 0.90 or 0.95, signifying inadequate variance explanation by the model. SRMR = 0.171 exceeds the commonly accepted threshold of ≤ 0.08, signifying that the correlation error remains substantial. RMSEA = 0.275, 90% CI [.265, .285] above the acceptable criterion (roughly ≤ .08, very good < .05), and the confidence interval does not encompass lower values, indicating that the model is unequivocally unsuitable. AIC = 10119 and BIC = 10311 are utilized solely for model comparison (the lower the values, the better), serving as a benchmark for the model refinement phase.

The CFA model fit analysis indicated that the initial model inadequately represented the empirical data ($\chi^2(71) = 2213$, $p<.001$), exhibiting a low model fit index (CFI=0.649, TLI = 0.550). Additionally, the root mean square error (RMSEA = 0.275, 90% CI [.265, .285]) and SRMR (0.171) exceeded the recommended thresholds, signifying insufficient model fit and necessitating further theoretical enhancements. The information criteria values AIC = 10119 and BIC = 10311 were documented in comparison with the subsequent enhanced model.

Table 11. Factor Loadings – Modification Indices.

	Factor 1	Factor 2	Factor 3	Factor 4
System 1	-	23.754	19.716	16.177
System 2	-	3.628	83.679	83.530
System 3	-	0.471	0.289	0.334
System 4	-	4.476	6.262	5.598
Connec 1	0.796	-	48.979	49.598
Connec 2	1.538	-	4.270	6.289
Connec 3	1.57e-4	-	25.284	26.108
Connec 4	0.791	-	257.000	276.108
Conven 1	12.885	18.970	-	6.224
Conven 2	5.730	1.561	-	5.519
Conven 3	16.558	28.917	-	13.907
Conven 4	14.290	10.328	-	4.186
Notify 1	5.091	20.701	13.770	-
Notify 2	5.269	31.330	5.166	-

Modification Indices (MI) in structural equation modeling (SEM) or confirmatory factor analysis (CFA) in Figure 11. Factor Loadings – Modification Indices, signify that altering the model by incorporating paths (factor loadings) between observed variables and latent factors may be warranted. Exceptionally high MI values, such as Connec 4 with Factor 3 (257.000) and Factor 4 (276.108), suggest that this indicator may not align with the original factor structure. The measurement or model framework should be reassessed. Consequently, for the interpretation of

study, System 2 has elevated MI values with Factor 3 (83.679) and Factor 4 (83.530), suggesting that this item may be associated with numerous factors rather than being confined to a single factor. Connec 1 and Connec 3 have elevated MI values with Factor 3 and Factor 4, signifying cross-loading. Notify 2 has elevated MI values with Factor 2 (31.330), indicating that Notification awareness may align more closely with Factor 2 than the initially defined model.

Strategic Inferences Indicators with exceptionally high MI values, such as Connec 4, warrant reevaluation to assess their compatibility with the prevailing conditions. The observed cross-loading, exemplified by System 2 and Notify 2, signifies intricate linkages. The model may require modification to accurately represent the actual theoretical framework, as the original model may be inadequate. Consequently, employing MI values as ancillary data will enhance the model's fit indices and accurately represent reality.

Post-Hoc Model Performance

The interpretation of the residuals from the observed correlation matrix is derived directly from the results presented in Table 13: Post-Hoc Model Performance (Residuals for Observed Correlation Matrix). As shown in Table 13, several residual correlations exceed the acceptable thresholds, indicating that the initial measurement model does not sufficiently explain certain relationships among the observed variables. Specifically, residual values for variable pairs such as System1–System2 (0.307), System2–Conven2 (0.512), and Conven1–Conven2 (0.575) surpass the criterion of |0.20|, which, according to the predefined standards, signifies substantial model misspecification. Furthermore, the concentration of high residuals within the Convenience (Conven1–Conven4) indicators, as reported in Table 13, suggests the presence of strong internal correlations that are not adequately captured by the original factor structure. This pattern implies that the Convenience construct may consist of underlying subdimensions or that certain indicators share correlated measurement errors or cross-loadings with other latent factors. Following the evaluation of overall model fit, the residual analysis in Table 13 was therefore employed as a post-hoc diagnostic tool to guide model refinement. Residuals exceeding |0.10| were interpreted as insufficiently explained by the model, while those greater than |0.20| were considered statistically and substantively significant. The post-hoc procedure involved (1) identifying indicator pairs with significant residuals, as summarized in Table 13; (2) examining the theoretical plausibility of additional model specifications, such as correlated error terms or the formation of subfactors; and (3) proposing an alternative model and systematically comparing its goodness-of-fit indices (CFI, TLI, RMSEA, AIC, and BIC) with those of the original model. Collectively, the evidence from Table 13 supports the conclusion that the measurement model requires structural enhancement to more accurately represent the empirical relationships among the observed variables.

Table 13. Post-Hoc Model Performance (Residuals for Observed Correlation Matrix)

	System 1	System 2	System 3	System 4	Connec 1	Connec 2	Connec 3	Connec 4	Conven 1	Conven 2	Conven 3	Conven 4	Notify 1	Notify 2
System 1		0.307	-0.076	-0.009	0.062	0.072	0.131	0.109	0.318	0.057	-0.042	0.289	0.145	0.392
System 2			-0.035	-0.012	-0.063	0.009	0.161	0.303	0.380	0.512	0.323	0.331	0.293	0.311
System 3				0.006	-0.049	0.008	0.045	0.059	0.027	0.032	-0.045	0.072	-0.070	0.109
System 4					0.019	-0.016	-0.022	0.005	0.076	-0.090	-0.065	0.076	-0.028	0.009
Connec 1						0.018	-0.011	-0.060	0.039	-0.124	-0.160	0.003	-0.141	0.021
Connec 2							-0.008	-0.074	0.086	-0.054	-0.100	0.022	-0.163	0.192
Connec 3								0.104	0.118	0.130	-0.032	0.179	-0.055	0.319
Connec 4									0.575	0.536	0.530	0.532	0.418	0.418
Conven 1										0.004	-0.013	-0.022	0.011	0.070
Conven 2											0.088	-0.086	-0.153	0.032
Conven 3												-0.014	-0.017	-0.100
Conven 4													0.225	-0.010
Notify 1														0.000
Notify 2														

Table 14. Residual Covariances – Modification Indices

	System 1	System 2	System 3	System 4	Connec 1	Connec 2	Connec 3	Connec 4	Conven 1	Conven 2	Conven 3	Conven 4	Notify 1	Notify 2
System 1		56.9	23.42	1.42	0.451	0.329	14.51	3.36	43.88	4.7063	94.8761	23.10559	10.47484	76.3462
System 2			3.22	2.97	41.565	2.596	36.40	44.78	2.66	42.4444	6.7834	0.00550	4.67691	11.2258
System 3				43.19	78.592	7.391	32.94	8.22	32.33	51.9687	0.6441	3.18357	5.03648	8.5344
System 4					70.810	11.752	37.12	1.07	2.57	43.1514	14.2900	0.18532	24.13922	64.7652
Connec 1						42.615	4.81	24.40	7.79	15.1451	1.3632	0.15721	0.60098	50.0596
Connec 2							2.48	34.63	6.39	0.8356	0.0505	9.70156	26.08326	26.3382
Connec 3								32.28	14.00	51.1092	21.6058	12.87854	0.79839	70.1929
Connec 4									3.33	9.4296	9.9629	0.42952	26.26889	5.6273
Conven 1										0.0431	5.7913	1.32631	0.00644	13.2990
Conven 2											99.4397	48.55999	46.70018	9.2736
Conven 3												1.58964	0.75265	18.4077
Conven 4													133.50401	0.0478
Notify 1														
Notify 2														

Residual Covariances – Modification Indices

The analysis of modification indices for residual covariances indicated that numerous variable pairs exhibited MI values exceeding the acceptable threshold (e.g., Notify 1- Notify 2 = 133.504, Conven 2- Conven 3 = 99.439, System 1 – Conven 3 = 94.876, System 3 – Connec 1 = 78.592), suggesting that the existing model inadequately captures the structural relationships within the data. This outcome suggests that certain pairings of indicators are more interconnected than the model presupposes. The model can be enhanced by augmenting the correlation of residuals among the variables or reassessing the categorization of indicators to align with theoretical and empirical evidence.

In Table 14, the modification indices demonstrates that the original model is deficient in completeness, especially within the Notify and Convenience groups, as well as in cross-factor interactions (System–Convenience, System–Connec). Model modifications could concentrate on permitting residual covariances solely for theoretically valid pairs, assessing the overlap of possibly repetitive questions, or reorganizing the factor structure (e.g., incorporating a subfactor for Convenience).

Detailed Response and Corrective Actions for Methodological Weaknesses

The study appropriately employs a research and development (R&D) methodology, particularly in the stages of prototype construction and preliminary data collection. However, critical methodological weaknesses emerge at the measurement validation stage, specifically in the application of Confirmatory Factor Analysis (CFA). These weaknesses undermine the robustness of the empirical validation of the research instrument and may compromise the reliability of conclusions drawn from latent constructs (Borg & Gall, 1989).

For the construct validity issue, the CFA results indicate that the measurement item “Vehicle location using GPS is accurate” (System 2) demonstrates a very low and statistically non-significant factor loading. This suggests that the item does not adequately represent the latent construct it is intended to measure and its implications (Anderson & Gerbing, 1988). The item fails to converge with other indicators within the same construct, indicating poor convergent validity. The observed variable may be conceptually misaligned, ambiguously worded, or interpreted inconsistently by respondents, and retaining such an item can distort construct measurement, inflate measurement error, and reduce composite reliability.

For model fit problems, the initial CFA model exhibits poor fit indices, with values significantly below established benchmarks (e.g., CFI, TLI < 0.90; RMSEA > 0.08). This indicates that the hypothesized measurement model does not adequately reflect the empirical data structure and implementations (Hair et al., 2019). The latent constructs may be specified. Cross-loadings or correlated measurement errors may exist but are unaccounted for; the model lacks structural coherence, limiting its explanatory power.

For interpretation and reporting of CFA results, the interpretation of CFA outcomes appears to overstate measurement validity despite statistical evidence indicating poor model performance and implementations (Cheung et al., 2024). These compromises methodological transparency and threaten the credibility of the study. Conclusions drawn from invalid measurement models may be misleading or non-replicable (Sathyanarayana & Mohanasundaram, 2024).

DISCUSSION AND IMPLICATIONS

The creation of a prototype smart student shuttle system utilizing RFID technology and a mobile application notification system illustrates the potential of employing information technology to improve student safety standards. The findings demonstrate that the incorporation of RFID technology for identity verification and monitoring bus entry and exit, alongside a mobile application that notifies parents and pertinent authorities, can significantly mitigate the danger of students forgetting or losing track of students during transit. A significant discovery is that the implemented system improves transparency and traceability of student travel (Shah & Singh, 2016). It fosters confidence among parents and educational institutions, consistent with prior study on the application of RFID in transportation management and safety (Nikita et al., 2020). Nevertheless, obstacles persist, such as network communication reliability, personal data protection, and user acceptance (Venkatesulu et al., 2021).

This research enhances the knowledge base on smart transportation and intelligent safety systems by illustrating the integration of RFID and mobile notification technologies for proactive safety management in educational settings. It further broadens the conceptual framework of IoT and ubiquitous computing within the realm of student mobility. This research provides recommendations for educational institutions and student transportation firms to improve safety protocols by investing in sophisticated tracking technologies capable of real-time monitoring of student status and implementing safeguards against data breaches. Moreover, this system can be augmented to interface with student databases, school management systems, and public safety systems.

LIMITATIONS AND FUTURE RESEARCH POSSIBILITIES

Future research ought to concentrate on extensive system testing, user experience evaluation, and the integration of complementary technologies such as GPS, machine learning for route forecasting, or cloud computing to enhance efficiency and scalability. This research demonstrates the actual development of a prototype for an intelligent student shuttle system that incorporates RFID technology and mobile application notifications; nonetheless, certain constraints warrant consideration. To further this matter, subsequent study should concentrate on the following domains. Extensive Implementation: Evaluate the system's efficacy across various educational institutions or heterogeneous transportation networks to determine its scalability. Technology Integration: Create systems in collaboration with other technologies, including GPS for real-time location monitoring, artificial intelligence (AI) for route forecasting, or cloud computing to improve data processing and storage efficiency (Shah & Singh, 2016). User Experience Research: Perform qualitative and quantitative investigations to assess satisfaction levels, usability, and elements that promote or obstruct real usage (Nikita et al., 2020). Economic Cost-Effectiveness and Social Impact Analysis: Evaluate the financial cost-effectiveness and social results, including enhanced parental confidence, diminished accident risk, and the formulation of new school safety standards. Policy and Regulatory Studies: Examine the implementation of the system within the national policy framework, ensuring adherence to personal data protection legislation such as the GDPR or PDPA, to guarantee the system's sustainability and alignment with international standards.

CONCLUSION

Investigations into the creation of a prototype intelligent school bus system utilizing RFID technology and a mobile application notification system indicate its capacity to markedly enhance student safety protocols. Technology enables parents and schools to monitor student boarding and disembarking in real time, enhancing transparency and traceability, mitigating the risk of loss or unsafe travel occurrences, and fostering confidence among all stakeholders.

Despite the system's limitations regarding testing in controlled environments, technological stability, and personal data security, this developmental strategy presents opportunities for scaling and enhancing the technology to establish safer student transportation systems in the future. Furthermore, the use of technologies such as GPS, AI, and cloud computing could enhance efficiency and expand applicability, positioning this prototype as a potential benchmark for student transportation safety in educational institutions. In summary, while the R&D methodology for system development and initial data acquisition is methodologically sound, the advanced statistical validation of the measurement instrument using CFA is currently inadequate. The primary issues relate to construct validity, poor model fit, and insufficient interpretation rigor.

To enhance methodological robustness and empirical credibility, the study should refine or remove problematic measurement items, re-specify and validate the measurement model through iterative testing, ensure theoretical justification accompanies all statistical decisions, and present CFA findings with appropriate methodological caution.

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CONFLICTS OF INTEREST

The authors assert that this research presents no conflicts of interest, whether financial or personal, that could influence the design, outcomes, or interpretation of the research data. The authors affirm that the research was executed and reported with transparency and independence from external influences.

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DYNAMICS OF TEACHING AND RESEARCH IN BUSINESS ADMINISTRATION: NAVIGATING THE PRE-COVID, COVID, AND POST-COVID LANDSCAPE

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ABSTRACT

Purpose - This article investigates the transformation of teaching and research methodologies in business administration education across the pre-COVID-19, COVID-19, and post-COVID-19 eras. It seeks to identify key trends, challenges, and opportunities resulting from the pandemic, and to propose recommendations for future adaptation.

Body of Knowledge - Before the COVID-19 pandemic, business administration education employed a variety of methods, including lectures, case studies, and experiential learning, alongside increasing integration of technology. Research primarily focused on emerging technologies, sustainability, and ethics. The onset of the COVID-19 pandemic necessitated a swift transition to online and remote instruction, which in turn shifted research priorities toward pandemic-related topics such as supply chain disruptions, marketing strategies, and organizational resilience, as well as new methodologies such as virtual data collection. The post-COVID-19 era is characterized by hybrid and blended learning models that incorporate advanced technologies (e.g., VR/AR, AI) and research concentrating on resilience, sustainability, and crisis management, with a strong emphasis on interdisciplinary and collaborative approaches.

Implications: This review offers valuable insights into the adaptability and resilience of business administration education and research during and after a global crisis. It underscores the necessity for agile industry-academia partnerships, the promotion of entrepreneurial mindsets, and the integration of technology and sustainability in curricula to sustain relevance and competitiveness. The findings provide a framework for curriculum development, pedagogical innovation, and research priorities within the evolving landscape of business administration.

Originality/Value: This article presents a distinctive comparative analysis of the dynamics of business administration education and research across three time periods. By examining the transformations instigated by the COVID-19 pandemic, the study enhances our understanding of the challenges and opportunities encountered by the field, revealing both similarities and differences in approaches across the pre-COVID, COVID, and post-COVID-19 eras. The identification of emerging trends and recommendations for future development significantly contributes to the field.

Keywords: Business administration, COVID-19, Digital transformation, Sustainability, Hybrid learning

Paper Type: Academic Article

INTRODUCTION

Overview of the Importance of Business Administration Education and Research

For decades, education and research in business administration have been vital in shaping the future of the business environment (Ermakova et al., 2016; Castro, 2018). Historically, business schools have adapted their curricula to incorporate emerging trends, from quantitative methods and management science to globalization and, more recently, sustainable business practices

Wongmahesak, K., Ghosh, U. K., & Wekke, I. S. (2025). Dynamics of Teaching and Research in Business Administration: Navigating the Pre-Covid, Covid, and Post-Covid Landscape. *RMUTT Global Business Accounting and Finance Review, 9*(2), 66-95. https://doi.org/10.60101/gbafr.2025.283109

(Zureigat et al., 2019; Islam & Ma, 2024). Recognizing the vital role of business administration education and research, this study examines the pandemic's significant and transformative impact, which has fundamentally reshaped the landscape and presented both challenges and opportunities. Furthermore, the strategic integration of new technologies has become increasingly critical. Business schools must equip students with the digital literacy and data analysis skills necessary to thrive in an increasingly technology-driven world, leveraging tools like learning management systems (LMS), virtual collaboration platforms, and data analytics software to enhance the learning experience and prepare graduates for the demands of the digital economy (Burch et al., 2015; Ilie et al., 2020).

In recent decades, business schools have experienced considerable growth, reflecting the rising need for business education. This expansion has been fueled by the acknowledgement that business administration education significantly affects market operations and society. Beyond traditional business functions, modern programs increasingly emphasize areas like entrepreneurship and innovation, recognizing the dynamic nature of the business landscape. This growth underscores the responsibility of academic leaders to provide the most effective and current curriculum, one that is aligned with industry needs and prepares students for the challenges and opportunities of the 21st century (Zureigat et al., 2019; Ilie et al., 2020).

Nonetheless, ongoing discussions have emerged about the limitations of conventional business education curricula. Researchers have noted that these curricula often lean too heavily on theory and fail to prepare students for entrepreneurship and real-world business challenges adequately. Moreover, insufficient integration of technology, particularly in practical applications, can leave graduates ill-prepared for the demands of today's digital business environment (Tenetilova et al., 2019; Lin et al., 2020). There is an increasing need to focus on hands-on learning opportunities, such as valuable apprenticeships, to connect academic knowledge with industry practices (Ile & Edokpolor, 2020).

Moreover, integrating sustainability, ethics, and corporate social responsibility (CSR) into business administration programs has become more essential. Scholars argue that a collective understanding of these topics and their effects on future business activities is vital for developing effective curricula and motivating students to critically engage with current and forthcoming business practices (Eagle et al., 2015; Chopra et al., 2024). Furthermore, technology plays a crucial role in advancing sustainability efforts by enabling businesses to track their environmental impact, optimize resource use, and promote ethical supply chain management.

Incorporating emerging technologies, like business intelligence and big data analytics, into business administration programs has become increasingly important. Researchers stress that business schools must keep pace with industry developments and ensure that graduates possess the skills and knowledge required to succeed in the digital era. These technologies enable data-driven decision-making, enhance operational efficiency, and facilitate the development of innovative business models. As such, a strong foundation in these technologies is essential for all business administration graduates (Khurram, 2020; Bueno, 2024).

In conclusion, education and research in business administration are crucial as they can shape the business sector's future, provide students with essential skills and knowledge, and respond to industry's changing demands. Ongoing initiatives to enhance and adapt business administration curricula are vital for maintaining the relevance and competitiveness of business education in a constantly evolving global landscape.

Significance of Understanding the Impact of the COVID-19 Pandemic on This Field

The COVID-19 pandemic has profoundly influenced business administration, requiring a more comprehensive understanding of its wide-ranging effects. The pandemic disrupted various aspects of business, including global supply chains, operational logistics, consumer behaviors, and workforce management, resulting in unprecedented challenges for organizations across diverse industries (Pearmunwai et al., 2022; Qun et al., 2022; Proykratok et al., 2025). Scholars have noted that the COVID-19 pandemic compelled businesses to rapidly adapt and modify their strategies in order to maintain continuity, ensure survival, and, in some cases, capitalize on emerging opportunities (Kang et al., 2021; Lutfi et al., 2020; Setiawan et al., 2021). The increased

need for digital transformation, acceleration of remote work, and the explosion of e-commerce have become essential for businesses to navigate the difficulties imposed by the pandemic (Nagel, 2020; Alkahtani et al., 2021; Yasir et al., 2021). For example, brick-and-mortar retailers were forced to develop online sales channels, while manufacturers struggled to secure raw materials and adapt production lines (McKinsey & Company, 2020).

In addition, the pandemic has dramatically affected the research priorities and approaches in business administration. Researchers have redirected their attention to pandemic-relevant topics, such as supply chain resilience, new marketing approaches in a disrupted environment, and the dynamics of remote work (Kang et al., 2021). Moreover, the pandemic has required changes in research methods and data gathering, with a stronger focus on virtual and remote techniques (Dubé et al., 2023).

Grasping the dynamics of education and research in business administration during the pre-COVID, COVID, and post-COVID phases is crucial for several reasons. First, it offers insight into the resilience and adaptability of business education and research amid a global crisis. Second, it emphasizes businesses' changing needs and priorities, which helps create more relevant and responsive curricula and research plans. Finally, it guides the strategies and policies needed to assist the recovery and growth of the business sector in the wake of the pandemic. Examining these three periods allows us to see not only the immediate disruptions caused by COVID-19 but also the longer-term adaptations and innovations shaping the future of business.

By investigating the effects of the COVID-19 pandemic on business administration education and research across these three distinct periods, stakeholders can better understand the challenges, opportunities, and fundamental changes within this discipline. This insight can aid in developing more effective and adaptable methods for teaching, research, and collaboration between industry and academia, ultimately enhancing the long-term resilience and competitiveness of the business sector.

BUSINESS ADMINISTRATION TEACHING AND RESEARCH IN THE PRE-COVID ERA

Prevailing Teaching Methodologies and Pedagogical Approaches

Before COVID, education in business administration employed various instructional methods and teaching styles to provide students with essential knowledge and skills (Strelchonok, 2018; Hou, 2019; Nandedkar & DiRusso, 2019). A typical teaching strategy in business administration was the lecture-based approach, which focused on the instructor's role in presenting course material to a large group of students. This method effectively taught students considerable theoretical knowledge, concepts, and principles (Nandedkar & DiRusso, 2019).

Moreover, case-based instruction became a widely recognized teaching method in business administration programs. This technique involved analyzing real-world business situations and case studies to engage students in critical thinking, problem-solving, and decision-making processes (Hou, 2019). The case-based method was particularly appreciated for its capacity to connect theoretical knowledge with practical application, enabling students to utilize their learning in realistic business contexts (Hou, 2019).

In addition to these traditional methods, interactive and experiential learning strategies—such as role-playing, simulations, and business games—were integrated into business administration curricula. These approaches improved students' practical skills, decision-making capabilities, and comprehension of business processes (Butzke et al., 2017).

Alongside these conventional teaching styles, there was an increasing focus on incorporating new technologies, like digital platforms and online learning tools, into business administration education. This trend sought to enhance the delivery of course materials, promote interactive learning, and better equip students for the digital business environment (Ukata & Silas-Dikibo, 2019; Izagirre-Olaizola & Morandeira-Arca, 2020). However, the extent of technology integration varied significantly across institutions, with some programs fully embracing digital tools while others remained more reliant on traditional approaches.

Assessment methods in pre-COVID business education typically included examinations, quizzes, written assignments, and presentations (Nandedkar & DiRusso, 2019). These methods aimed to evaluate students' understanding of course material, their ability to apply theoretical

concepts, and their communication skills. However, there was increasing recognition of the need for more authentic assessment methods that better reflected real-world business challenges.

Overall, the pre-COVID period in business administration education was marked by a variety of teaching methodologies and pedagogical strategies, each with its own advantages and drawbacks for knowledge acquisition, skill enhancement, and practical application (Strelchonok, 2018; Hou, 2019; Nandedkar & DiRusso, 2019).

Dominant Research Themes and Focus Areas

Before the COVID-19 pandemic, research in business administration encompassed a wide array of themes and focal points aimed at deepening understanding of various facets of business operations, management, and strategy (Issavarestagul, 2019; Somjai & Jermsittiparsert, 2019; Wangkit & Punpanich, 2019). Research methodologies commonly employed included quantitative surveys, qualitative case studies, and statistical analysis of large datasets, reflecting a commitment to both breadth and depth in understanding complex business phenomena.

A key area of research involved examining the effects of emerging technologies, including digital platforms and business intelligence, on business practices and performance (Haseeb et al., 2019a, 2019b). Scholars assessed how adopting these technologies could improve organizational efficiency, decision-making, and competitiveness (Wieczorek et al., 2021). Studies often focused on specific technologies such as cloud computing, blockchain, and artificial intelligence, analyzing their impact on various aspects of business, from supply chain management to customer relationship management.

Another primary research focus was sustainability, CSR, and ethical issues within business administration. Investigations examined how these concepts could be incorporated into business education and their implications for business practices and decision-making (Neungvanna et al., 2019; Thongrawd et al., 2019; Prianto et al., 2020). This research often involved exploring the relationship between corporate social responsibility initiatives and financial performance, as well as examining the ethical implications of various business decisions. For example, research explored the effectiveness of different CSR strategies in enhancing brand reputation and consumer loyalty.

Additionally, researchers explored the dynamics of business administration education, including teaching methods, pedagogical strategies, and the cultivation of relevant skills and competencies among students. These investigations aimed to connect academic theory with industry practices, ensuring the relevance and effectiveness of business administration programs (Sang, 2021). This research frequently compared different teaching approaches, such as case-based learning versus traditional lectures, to assess their impact on student learning outcomes.

Moreover, researchers examined how business administration fits within the broader economic and social framework, assessing its influence on economic development, public policy, and organizational performance. These studies intended to generate insights that could guide policymaking and augment the business sector's role in promoting societal welfare (Baldarelli et al., 2020). This research often involved analyzing the impact of government regulations on business performance and exploring the relationship between business activity and social inequality.

In summary, business administration research before COVID was marked by a diverse approach, covering technological advancements, sustainability, educational methodologies, and the broader social consequences of business activities.

Challenges and Limitations in the Pre-COVID Landscape

In the period before COVID-19, the field of business administration education and research faced various challenges and limitations that hindered its ability to effectively meet the changing demands of the business sector and equip students for the complexities of the contemporary business environment (Dziubaniuk & Nyholm, 2020). Prior to the pandemic, business administration education and research faced challenges related to practical application, technology integration, and industry alignment (Haseeb et al., 2019a, 2019b). COVID-19 exacerbated these issues, while also creating new opportunities for innovation. These limitations

manifested across multiple dimensions, including pedagogical practices, technological adoption, and the alignment of education with industry needs (Calzada, 2021; López et al., 2021).

A significant challenge was the dominance of conventional teaching methods, primarily lecture-driven instruction, which often faced criticism for their lack of practical applicability and minimal student engagement. While approaches such as case-based teaching and experiential learning were increasingly gaining popularity, their incorporation into the curriculum was often only partial or unsuccessful (Becheikh et al., 2022). Moreover, assessment methods often relied heavily on traditional examinations, which may not accurately reflect students' ability to apply knowledge in real-world business settings. One potential solution to this challenge could be the increased use of project-based learning and simulations that allow students to demonstrate their skills in a more authentic context (Catalán &Martínez, 2018).

Moreover, the adoption of emerging technologies, including digital platforms and business intelligence tools, within business administration coursework was often insufficient, failing to adequately prepare students for the increasingly digital business landscape (Tenetilova et al., 2019; Lin et al., 2020). These disconnects between academic programs and industry requirements presented a significant obstacle in ensuring the relevance and competitiveness of business administration graduates (Reynolds & Dang, 2015). For example, many graduates lacked proficiency with data analytics software, which is increasingly essential for decision-making across various business functions. Some universities addressed this challenge by partnering with technology companies to provide students with hands-on training in using these tools.

Additionally, the traditional emphasis on theoretical knowledge and conceptual understanding in business administration education was sometimes viewed as needing more focus on practical skills, entrepreneurial mindsets, and ethical decision-making (Carillo, 2017). The divide between academic theory and real-world practice limits business administration programs' ability to produce well-rounded, adaptable professionals (Stubbs, 2013). To overcome this limitation, some business schools incorporated entrepreneurship courses and ethics workshops into their curricula, aiming to cultivate these essential skills.

Another area for improvement was the integration of sustainability, CSR, and ethical considerations into the foundation of business administration programs (Bridgman et al., 2018). While these subjects were occasionally treated as separate modules or electives, their cohesive integration throughout the curriculum needed improvement, limiting students' ability to develop a comprehensive understanding of the social and environmental ramifications of business decisions (Lusoli, 2020). Several institutions are addressing this challenge by integrating sustainability principles into core courses and encouraging students to participate in community engagement projects.

Lastly, the pre-COVID environment was characterized by a notable absence of interdisciplinary collaboration and cross-fertilization of ideas between business administration and other disciplines, such as engineering, social sciences, and sustainability studies (Howlett et al., 2016). This compartmentalized approach hindered the development of innovative, holistic solutions to complex business issues (Rusinko, 2010; Laster & Russ, 2010). Some universities sought to bridge this gap by establishing joint research centers and offering interdisciplinary degree programs.

While these challenges were not unique to any single region, they were often exacerbated in developing countries due to limited resources and infrastructure.

In conclusion, the pre-COVID landscape of business administration education and research highlighted the need for more dynamic, practical, and interdisciplinary methods to enhance student preparedness for the realities of the modern business arena and to address the changing needs of the industry.

Emerging Trends and Innovations

In the pre-COVID era, the field of business administration witnessed the emergence of several innovative trends and approaches aimed at enhancing the relevance, effectiveness, and adaptability of business education and research (Smajlović et al., 2019). These trends reflected a

growing recognition that business education must evolve to respond to rapid technological advancements, increasing globalization, and heightened social and environmental concerns. While many of these trends showed promise, their widespread adoption and successful implementation were still in progress.

One prominent trend was the increased integration of technological innovation and digital transformation into business administration curricula. Researchers highlighted the importance of equipping students with the knowledge and skills to leverage emerging technologies, such as business intelligence, data analytics, and digital platforms, to drive business innovation and competitiveness (Smajlović et al., 2019). Many universities began offering specialized courses in areas like data science and digital marketing, and some even incorporated these topics into core courses across various business disciplines.

Additionally, there was a growing emphasis on integrating sustainability, CSR, and ethical considerations into the core of business administration education. Researchers advocated for a more holistic approach that would enable students to develop a comprehensive understanding of the social and environmental implications of business decisions (Marques et al., 2016). For instance, some business schools introduced mandatory courses on business ethics and sustainability, while others encouraged students to participate in social entrepreneurship projects.

Furthermore, the pre-COVID era saw the emergence of more interactive and experiential learning approaches, such as case-based teaching, simulations, and problem-based learning. These methods aimed to bridge the gap between academic theory and industry practice, enabling students to apply their knowledge to real-world business challenges (Bucherer et al., 2012). For example, some universities partnered with local businesses to provide students with real-world consulting opportunities, while others developed sophisticated business simulations that allowed students to manage virtual companies (Schiuma & Carlucci, 2018).

Alongside these pedagogical innovations, the pre-COVID era also witnessed advancements in business administration research, with a focus on exploring the dynamics of business model innovation, organizational learning, and the interplay between technological innovation and business strategy (Sitthiwarongchai et al., 2018; Yao et al., 2018; Smajlović et al., 2019). However, some of these initiatives faced challenges, such as limited faculty expertise in emerging technologies or difficulty in replicating real-world complexities in simulations. Some institutions saw early efforts fall flat before improving.

Overall, the pre-COVID era in business administration was marked by a concerted effort to enhance the relevance, responsiveness, and adaptability of business education and research by integrating technological advancements, sustainability considerations, and innovative pedagogical and research approaches.

ADAPTING TO THE COVID-19 PANDEMIC

Shifts in Teaching and Learning Modalities

1. Transition to Online and Remote Instruction

The COVID-19 pandemic forced a rapid and unprecedented shift in the delivery of business administration education, with a significant transition to online and remote instruction (López et al., 2021). This shift was driven by the need to adhere to social distancing measures and lockdown restrictions imposed to curb the spread of the virus (Johnson et al., 2020; Ogunleye, 2023). Before the pandemic, online and digital platforms in business administration education were limited, with a predominant focus on traditional, in-person teaching methods. However, the COVID-19 crisis accelerated the adoption of technology-enabled learning, as educational institutions were compelled to quickly adapt their teaching approaches to ensure the continuity of education (Johnson et al., 2020; Ashour et al., 2021; Ogunleye, 2023). For example, universities that previously offered a few online courses suddenly had to convert entire programs to a remote format within a matter of weeks, relying heavily on platforms like Zoom and Microsoft Teams. Researchers have highlighted that this transition presented both challenges and opportunities for business administration education. On the one hand, many faculty members and students lacked the experience and digital competencies to effectively engage in online learning, leading to

difficulties adapting to the new modalities (Johnson et al., 2020). Some instructors struggled with creating engaging online content, while students faced distractions and technical difficulties at home. On the other hand, the pandemic also accelerated the development of digital competencies and the integration of innovative teaching methods, such as virtual simulations, online case studies, and interactive webinars (Mustari et al., 2021; Ratten & Jones, 2021). However, the shift to online and remote instruction also raised concerns about the quality and effectiveness of business administration education, particularly regarding practical skill development and experiential learning. Researchers have emphasized the need for educational institutions to carefully design and implement online learning strategies that effectively replicate the interactive and immersive nature of traditional classroom settings (Ratten & Jones, 2021). For example, institutions have attempted to replicate the case study method through virtual breakout rooms and online collaboration tools, with varying degrees of success. Furthermore, student experience and feedback revealed the importance of clear communication, technical support, and a sense of community to foster engagement in online learning environments. While some adaptation attempts, such as relying solely on recorded lectures, proved less effective, others, like interactive simulations and virtual guest speaker sessions, were better received. Despite the challenges, the COVID-19 pandemic also presented opportunities for business administration education to embrace digital transformation and explore new pedagogical approaches to enhance the learning experience and better prepare students for the evolving business landscape (Ratten & Jones, 2021). The successful integration of online and remote instruction into business administration curricula will ensure these programs' continued relevance and adaptability in the post-pandemic era (Johnson et al., 2020; Ashour et al., 2021; Ogunleye, 2023).

2. Challenges and Opportunities in Virtual Learning Environments

The rapid transition to online and remote instruction during the COVID-19 pandemic presented both challenges and opportunities for business administration education in virtual learning environments (Curelaru et al., 2022; Khalid, 2022; Adomaitis et al., 2023). One key challenge was the need for more experience and digital competencies among faculty and students, which hindered their ability to engage effectively in virtual learning. Many educators needed help adapting their teaching methodologies and creating interactive, engaging online learning experiences (Khalid, 2022; Adomaitis et al., 2023). Similarly, students faced difficulties navigating the virtual learning environment and maintaining their motivation and focus (Curelaru et al., 2022). For instance, some students reported feeling isolated and disconnected from their peers and instructors. Additionally, the lack of face-to-face interaction and the absence of physical cues in virtual settings posed challenges in fostering a sense of community and social presence, which are crucial for effective learning (Kovaleva et al., 2021). Researchers have emphasized the need for educational institutions to prioritize developing virtual learning environments that replicate the social and collaborative aspects of traditional classroom settings (Curelaru et al., 2022). Furthermore, the transition to online learning raised concerns about the quality and effectiveness of practical skill development and experiential learning, which are integral to business administration education. Educators have had to explore innovative ways to recreate immersive, hands-on learning experiences in virtual environments, such as using virtual simulations, interactive case studies, and remote collaboration tools (Ratten & Jones, 2021). Despite these challenges, the COVID-19 pandemic also presented opportunities for business administration education to embrace digital transformation and leverage the benefits of virtual learning environments. Researchers have highlighted the potential of virtual learning to enhance the accessibility, flexibility, and personalization of educational experiences (Ruangvanich et al., 2019; Ademola, 2021). Additionally, integrating learning analytics and adaptive technologies in virtual learning environments can provide valuable insights into student engagement, performance, and learning outcomes, enabling more targeted and effective interventions (Ruangvanich et al., 2019; Ibarra & Lu, 2021). Furthermore, the pandemic accelerated the development of digital competencies among faculty and students, paving the way for more innovative and technology-enabled teaching and learning approaches in the post-COVID era. The successful integration of virtual learning environments into business administration curricula can contribute to these programs' continued relevance and adaptability to evolving industry demands (Ratten & Jones,

2021). For example, instructors became more adept at using online tools to create engaging lectures and facilitate group discussions. Overall, the challenges and opportunities presented by virtual learning environments in business administration education during the COVID-19 pandemic underscore the need for a comprehensive, strategic approach to digital transformation in higher education.

Transformations in Research Priorities and Methodologies

1. Increased Focus on Pandemic-Related Topics

The COVID-19 pandemic significantly transformed the research priorities and methodologies within business administration (Barreiro-Gen et al., 2020; Sampat & Shadlen, 2021). Researchers shifted their focus toward investigating the various impacts of the pandemic on business operations, strategies, and performance (Pearmunwai et al., 2022; Qun et al., 2022; Proykratok et al., 2025). One key research area examined the pandemic's effects on supply chains, logistics, and operations management (Proykratok et al., 2025). For example, studies analyzed how businesses adapted their supply chain strategies to mitigate disruptions, ensure business continuity, and enhance resilience (Barreiro-Gen et al., 2020). Additionally, studies investigated the role of digital technologies and data analytics in supporting supply chain agility and responsiveness during the crisis (Barreiro-Gen et al., 2020). There was a notable comparative shift from pre-COVID research focusing on general supply chain efficiency to during-COVID research emphasizing resilience and risk mitigation in the face of disruptions. Another prominent research focus explored the pandemic's impact on marketing and customer behavior. Researchers examined how businesses adjusted their marketing strategies, communication channels, and customer engagement approaches to navigate the changing market dynamics. Studies also investigated shifts in consumer preferences and purchasing patterns and their implications for business models and revenue streams (Qun et al., 2022; Samarkjarn & Pechinthorn, 2022). One example is the surge in research on e-commerce adoption and digital marketing strategies for businesses adapting to lockdowns and changing consumer behavior (Teresienė et al., 2021). Furthermore, the COVID-19 pandemic prompted researchers to investigate the organizational and managerial responses to the crisis, including adopting remote work, implementing business continuity strategies, and the role of leadership in fostering resilience (Sampat & Shadlen, 2021). These studies provided valuable insights into the challenges and opportunities businesses faced as they adapted to the pandemic's disruptions (Sampat & Shadlen, 2021). Alongside these pandemic-specific research topics, there was a growing emphasis on examining the pandemic's impact on broader societal and economic issues, such as sustainability, CSR, and businesses' roles in addressing global challenges. Researchers investigated how the pandemic influenced the prioritization of these issues within the business community and the potential long-term implications for integrating sustainability and social responsibility into business practices (Barreiro-Gen et al., 2020). Overall, the COVID-19 pandemic significantly reshaped research priorities within business administration. The focus was on understanding the crisis's multifaceted impacts across business operations, strategies, and the broader socioeconomic landscape.

2. Adaptations in Research Methods and Data Collection

The COVID-19 pandemic necessitated significant adaptations in research methods and data collection approaches within business administration (Molinari & Villiers, 2021). These adaptations posed methodological challenges regarding validity and access. One key adaptation was the increased reliance on virtual and remote data collection methods, such as online surveys, interviews, and focus groups. Researchers pivoted away from traditional in-person data collection techniques due to the pandemic's restrictions and safety concerns (Molinari & Villiers, 2021). This shift presented challenges and opportunities as researchers had to navigate the complexities of virtual engagement and ensure the validity and reliability of their data (Molinari & Villiers, 2021). One significant methodological challenge was ensuring sample representativeness when relying on online surveys, as access to technology and internet connectivity varies across demographic groups (Molinari & Villiers, 2021). Furthermore, researchers had to adapt their interview techniques to foster trust and rapport in virtual settings,

often facing difficulties in observing nonverbal cues and building strong connections with participants. Additionally, researchers have had to explore innovative ways to access and analyze data during the pandemic. The rapid pace of COVID-19-related research led to the development of new data processing and synthesis techniques, including the use of web-based data sources and real-time data analysis. These approaches enabled researchers to stay agile and responsive to the evolving situation while also addressing the challenges posed by the sheer volume of COVID-19-related literature (Fry et al., 2020; Vaghela et al., 2021). Data collection innovations included social media analytics, text mining of online news articles, and analysis of publicly available datasets to track real-time changes in consumer behavior and business operations. The innovative research methodologies and data collection techniques developed during this period offer opportunities for longer-term innovation in business administration. Furthermore, the pandemic prompted researchers to reconsider their methodological approaches, with a greater emphasis on interdisciplinary collaboration and the integration of diverse perspectives. Researchers recognized the need to draw insights from multiple fields, such as public health, psychology, and economics, to better understand the pandemic's multifaceted impacts on businesses and the broader socioeconomic landscape. For example, studies on the impact of remote work integrated psychological theories of stress and well-being to better understand the effects on employee productivity and mental health (Petitta & Ghezzi, 2025). However, the rapid pace of COVID-19 research also raised concerns about the methodological rigor and quality of some studies. Researchers highlighted the need for greater attention to research design, data validation, and peer review processes to ensure the reliability and validity of the findings (Jung et al., 2020; Cunningham et al., 2021; Stamm et al., 2021). The increased reliance on online data collection also raised ethical concerns about participant privacy and informed consent, prompting researchers to develop new protocols to ensure ethical conduct in virtual research environments. The lessons learned from addressing these challenges led to lasting improvements in virtual research methodologies, including enhanced protocols for ensuring data security and ethical considerations in online research. Overall, the COVID-19 pandemic significantly transformed research methods and data collection approaches within business administration, necessitating greater flexibility, innovation, and interdisciplinary collaboration.

Organizational and Institutional Responses

1. Strategies for Business Continuity and Resilience

The COVID-19 pandemic posed significant challenges to businesses, forcing them to develop and implement strategies to ensure business continuity and resilience (Setiawan et al., 2021; Apte et al., 2022; Khalil et al., 2022). These strategies varied across industries and regions, highlighting the importance of adaptability. One of the key strategies organizations adopted was implementing effective business continuity plans (BCPs). These plans enabled businesses to anticipate and respond to disruptions caused by the pandemic, ensuring the continuity of critical operations and preserving organizational resilience. Researchers highlighted that the successful implementation of BCPs was crucial in helping businesses navigate the crisis and maintain their competitiveness (Setiawan et al., 2021; Apte et al., 2022; Lievani, 2023). Examples of successful BCPs include establishing redundant supply chains, implementing remote work policies, and diversifying product lines. However, regional differences in government regulations and infrastructure affected the feasibility and effectiveness of these plans. For instance, businesses in developed countries with robust internet infrastructure found it easier to transition to remote work compared to those in developing countries with limited access to reliable internet services. Additionally, integrating digital technologies and adopting remote work and e-commerce solutions supported business continuity during the pandemic. Researchers emphasized that the effective utilization of digital tools and platforms enabled businesses to adapt to the changing market conditions, maintain customer engagement, and ensure the seamless delivery of products and services (Bai et al., 2021; Lepore et al., 2021; Khalil et al., 2022). Furthermore, researchers identified the importance of government support and fiscal stimulus policies in enhancing the resilience of businesses and tiny and medium-sized enterprises (SMEs). These policies provided much-needed financial assistance and resources to help businesses weather the storm and

maintain operations (Shafi et al., 2020; Khalil et al., 2022; Lievani, 2023). For example, government-backed loan programs and tax breaks helped many SMEs stay afloat during periods of reduced revenue. Alongside these strategies, researchers highlighted the role of entrepreneurial mindsets, intrinsic motivation, and adaptability in fostering business resilience during the pandemic. Businesses that quickly pivoted their strategies, innovated their business models, and demonstrated agility successfully navigated the crisis and emerged stronger (Yesmin et al., 2021; Jena, 2022; Mohammadifar et al., 2022). Overall, the COVID-19 pandemic underscored the importance of comprehensive business continuity planning, the strategic integration of digital technologies, government support, and entrepreneurial resilience to ensure businesses' long-term sustainability and competitiveness. The effectiveness of organizational and institutional adaptations also varied across regions, with developed economies often possessing greater resources and infrastructure to support these changes than developing nations. However, it is crucial to expand on the long-term implications of these emergency responses, including the potential for increased automation, the widening digital divide, and the need for re-skilling initiatives to prepare the workforce for the changing nature of work.

2. Role of Technology and Digital Transformation

The COVID-19 pandemic underscored the critical role of technology and digital transformation in enabling organizational and institutional responses to the crisis (Li et al., 2021; Bukar et al., 2022; Abedini et al., 2023). However, resource disparities significantly influenced access to these solutions. Technology supported organizational resilience during the pandemic by facilitating remote work and virtual collaboration. The rapid adoption of video conferencing, cloud-based platforms, and other digital tools enabled businesses to maintain operations and ensure business continuity despite physical distancing requirements (Zhabin, 2023). Case studies showed that organizations that had already invested in digital infrastructure before the pandemic experienced a smoother transition to remote work compared to those that had to scramble to implement new technologies on short notice. Furthermore, integrating emerging technologies, such as artificial intelligence, data analytics, and automation, helped organizations optimize operations, enhance decision-making, and better manage the pandemic's challenges. Researchers highlighted that the strategic deployment of these technologies was instrumental in supporting crisis management efforts and fostering organizational resilience (Browder, 2023; Jeyasingh, 2023). Additionally, the COVID-19 pandemic accelerated the digital transformation of businesses, with a greater emphasis on e-commerce, online customer engagement, and digital marketing channels. Researchers emphasized that the successful integration of digital technologies enabled organizations to adapt to changing market conditions and maintain competitiveness (Grace & Tham, 2020). However, the transition to digital and technology-driven solutions also posed challenges, particularly for SMEs that needed more resources and expertise. Researchers highlighted the importance of providing targeted support and capacity-building initiatives to help these organizations leverage digital technologies and navigate the crisis (Ratten & Jones, 2021). For instance, governments and industry associations launched programs to provide training and technical assistance to SMEs in areas such as website development, social media marketing, and cybersecurity. Overall, the COVID-19 pandemic has underscored the critical role of technology and digital transformation in enabling organizational and institutional responses to the crisis, from facilitating remote work and virtual collaboration to optimizing operations and supporting digital business models. The effectiveness of organizational and institutional adaptations also varied across regions, with developed economies often possessing greater resources and infrastructure to support these changes than developing nations. To ensure equitable access and success, targeted support is needed to mitigate resource disparities.

EMERGING TRENDS AND INNOVATIONS IN THE POST-COVID ERA

Advancements in Teaching and Learning

1. Hybrid and Blended Learning Models

The COVID-19 pandemic accelerated the adoption of hybrid and blended learning models in business administration education as educational institutions sought to adapt to the crisis's challenges (Thamrin et al., 2022; Islamia et al., 2023). The success of these models depends

heavily on effective technological integration. Hybrid learning models, which combine face-to-face instruction with online and digital components, have emerged as a promising approach to enhancing the flexibility, accessibility, and effectiveness of business administration programs. Researchers have highlighted that integrating synchronous and asynchronous learning activities in hybrid models can provide students with a more personalized and engaging learning experience (Thamrin et al., 2022; Islamia et al., 2023). Successful implementations often involve a carefully designed mix of in-person lectures, online discussions, and collaborative projects. Furthermore, incorporating problem-based learning (PBL) and other active learning strategies into hybrid learning models has improved students' critical thinking, problem-solving, and decision-making skills. By exposing students to real-world business challenges and enabling them to apply their knowledge in practical scenarios, these hybrid approaches can better prepare them for the demands of the modern business landscape (Lestari et al., 2022; Thamrin et al., 2022). Additionally, using adaptive technologies and learning analytics in hybrid learning environments can provide valuable insights into student engagement, performance, and learning outcomes, enabling educators to tailor their instructional approaches and provide more personalized support. This data-driven approach can help continuously improve and optimize hybrid learning models (Nasution et al., 2022). For example, learning analytics dashboards can track student participation in online discussions, identify struggling students, and provide personalized recommendations for additional resources. However, the successful implementation of hybrid learning models in business administration education requires careful planning, faculty development, and the provision of necessary technological infrastructure and support. Researchers have emphasized the importance of addressing digital literacy challenges, student engagement, and integrating hybrid learning into the curriculum (Ganovia, 2023). Effective assessment in hybrid environments requires innovative approaches beyond traditional exams, such as project-based assessments, simulations, and peer evaluations. One key challenge is ensuring that all students have equitable access to technology and reliable internet connectivity, regardless of their socioeconomic background. Overall, the emergence of hybrid and blended learning models in the post-COVID era represents a significant advancement in business administration education, offering the potential to enhance the relevance, flexibility, and effectiveness of these programs in preparing students for the evolving demands of the business world.

2. Integrating Technology and Digital Tools

The post-COVID era significantly accelerated the integration of technology and digital tools into business administration education (Alshammari, 2023). This trend was driven by the need to enhance the flexibility, accessibility, and effectiveness of teaching and learning approaches amid the pandemic's disruptions (Aniskin et al., 2020; Triplett, 2023). However, significant challenges remain in technology integration. One key aspect of this integration has been the increased utilization of virtual and augmented reality (VR/AR) technologies in business administration curricula. These immersive technologies have created interactive simulations, virtual case studies, and experiential learning environments that more effectively replicate real-world business challenges (Halim et al., 2022). For example, students can use VR to simulate managing a supply chain during a disruption or participate in a virtual negotiation with international partners. Furthermore, integrating artificial intelligence (AI) and machine learning (ML) tools has enabled the development of adaptive and personalized learning experiences for business administration students. These technologies can provide real-time feedback, personalized recommendations, and intelligent tutoring systems to support student learning and engagement (Chen et al., 2019; Iyer, 2022). Additionally, adopting cloud-based platforms, learning management systems (LMS), and collaborative digital tools facilitated the seamless delivery of online and hybrid learning experiences in business administration programs. These technologies enabled enhanced communication, collaboration, and data-driven decision-making in the teaching and learning process (Goldhaber et al., 2021). However, successfully integrating technology and digital tools into business administration education has been challenging. Researchers have highlighted the importance of addressing issues related to digital literacy, faculty development, and the alignment of technological integration with pedagogical approaches

(Atabek, 2019; Sholeh, 2023). Technology integration is ineffective if it is not aligned with sound pedagogical principles and if faculty lack training to use new tools effectively. Furthermore, equitable access to digital resources and the mitigation of the digital divide have emerged as critical considerations in ensuring that the benefits of technology-enabled learning are accessible to all students, regardless of their socioeconomic background (Ojukwu et al., 2021; Selialia, 2023). Overall, integrating technology and digital tools into business administration education in the post-COVID era represents a significant advancement in teaching and learning approaches, offering the potential to enhance these programs' relevance, flexibility, and personalization.

Shifts in Research Focus and Methodologies

1. Emphasis on Resilience, Sustainability, and Crisis Management

The COVID-19 pandemic significantly shifted the research focus in business administration, with a growing emphasis on resilience, sustainability, and crisis management (Poberschnigg et al., 2020; YahiaMarzouk & Jin, 2022). Researchers recognized the critical importance of organizational resilience in enabling businesses to navigate and adapt to pandemic-related disruptions. Studies investigated factors that contribute to the development of resilience capabilities, such as environmental scanning and cross-functional integration. These insights provided valuable guidance for businesses in strengthening their ability to withstand and recover from crises (Poberschnigg et al., 2020; YahiaMarzouk & Jin, 2022). The methodological innovations used in these studies include network analysis to identify key actors in resilience networks and qualitative case studies to understand the processes involved in building resilience capacity. Furthermore, the pandemic highlighted the need for a greater emphasis on sustainability in business administration research. Researchers explored the crisis's impact on the prioritization of sustainability issues within organizations and the potential long-term implications for integrating environmental, social, and governance (ESG) considerations into business practices. These studies underscored the importance of aligning business strategies with the principles of sustainability and resilience. This involved exploring innovative business models that reduced environmental impact and enhanced social responsibility (Wongmahesak et al, 2024). Additionally, the COVID-19 pandemic prompted a surge in crisis management research, focusing on understanding the organizational and managerial responses to the crisis. Researchers investigated the strategies and approaches businesses employed to ensure business continuity, manage the pandemic's impact, and enhance their preparedness for future crises. These insights can potentially inform the development of more robust and adaptable crisis management frameworks for the business sector (Yacoub & Elhajjar, 2021; Çoban & Özel, 2022). However, research on resilience, sustainability, and crisis management in the post-COVID era also highlighted the need for a more holistic, interdisciplinary approach. Researchers emphasized the importance of integrating perspectives from various fields, such as psychology, sociology, and environmental science, to better understand the complex and multifaceted nature of these challenges (Adikaram & Sarangi, 2020; Yang et al., 2021). Overall, the post-COVID era in business administration research has seen a significant shift toward exploring resilience, sustainability, and crisis management, reflecting the urgent need for businesses to adapt and thrive amid unprecedented challenges.

2. Interdisciplinary and Collaborative Research Approaches

The post-COVID era has seen a growing emphasis on interdisciplinary and collaborative research approaches in business administration (Bolger, 2021; Beaulieu et al., 2023). Researchers recognized the need to draw insights from diverse disciplines, such as psychology, sociology, and environmental science, to better understand the complex, multifaceted challenges businesses face following the pandemic. This interdisciplinary approach enabled the development of more comprehensive and holistic solutions to address issues related to organizational resilience, sustainability, and crisis management (Bolger, 2021). Furthermore, the COVID-19 pandemic underscored the importance of collaborative research, where scholars from various fields and institutions work together to tackle common challenges. Researchers highlighted the benefits of such collaborative efforts, including leveraging complementary expertise, accessing a broader range of data sources, and enhancing the validity and impact of

research findings (Beaulieu et al., 2023). Successful collaborative projects often involve teams of researchers with expertise in fields such as marketing, finance, and information technology, who work together to address complex research questions. The benefits of collaborative research include leveraging complementary expertise, accessing a broader range of data sources, and enhancing the validity and impact of research findings. However, collaborative research also presents challenges, including coordinating efforts across different institutions, navigating disciplinary boundaries, and ensuring that all team members are adequately recognized for their contributions. However, the successful implementation of interdisciplinary and collaborative research approaches in the post-COVID era was not without challenges. Researchers emphasized the need to address issues related to disciplinary boundaries, institutional silos, and the development of appropriate methodological tools and frameworks to facilitate effective collaboration (Sankaran et al., 2020; Aguirre-Guerrero & Bernal-Jáquez, 2023). Strategies such as action research, participatory approaches, and the integration of boundary-spanning activities have been explored to overcome these challenges and foster more effective interdisciplinary and collaborative research (Sankaran et al., 2020). These strategies can help to break down institutional silos and foster a culture of collaboration among researchers from different disciplines. Additionally, the post-COVID era witnessed the emergence of innovative research methodologies, such as virtual collaboration platforms and data-driven synthesis techniques, to support interdisciplinary and collaborative research (Mynott & O'Reilly, 2022). Overall, the emphasis on interdisciplinary and collaborative research approaches in the post-COVID era reflects recognition that complex challenges require integrating diverse perspectives and the collective efforts of scholars from various disciplines.

Institutional and Organizational Adaptations

1. Fostering Entrepreneurial Mindsets and Innovation

The post-COVID era has emphasized fostering entrepreneurial mindsets and innovation within business administration education and organizational practices (Hasan et al., 2021; Massoudi, 2025). This involves addressing both cultural and resource-related challenges. Researchers have highlighted that the COVID-19 pandemic presented both challenges and opportunities for entrepreneurship, underscoring the need to equip students and organizations with the necessary skills and mindsets to navigate the evolving business landscape (Ahmed et al., 2020; Tucmeanu et al., 2022). One key aspect of this trend has been integrating entrepreneurship education into business administration curricula, with a focus on developing students' entrepreneurial skills, creativity, and problem-solving abilities. Studies have shown that entrepreneurship education can positively influence students' entrepreneurial intentions, self-efficacy, and ability to identify and exploit opportunities (Zhang et al., 2022; Batada, 2023). Institutions are offering courses on design thinking, lean startup methodologies, and business model canvas development to foster these skills. Furthermore, the pandemic has accelerated the need for innovative business models, products, and services as organizations strive to adapt to changing market conditions. Researchers have emphasized the importance of cultivating an entrepreneurial culture within organizations, where employees are encouraged to think creatively, take calculated risks, and contribute to developing innovative solutions (Liguori et al., 2021; Sentosa et al., 2022). Additionally, integrating digital technologies and adopting agile, data-driven approaches have supported entrepreneurial and innovative practices within business organizations. Researchers have highlighted the potential of these tools and methodologies to enhance organizational flexibility, responsiveness, and the ability to capitalize on emerging opportunities (Cater et al., 2021; Thian et al., 2022). However, successfully fostering entrepreneurial mindsets and innovation within business administration education and organizations takes time and effort. Researchers have emphasized the need for comprehensive support systems, including access to resources, mentorship, and a culture that celebrates and rewards entrepreneurial endeavors (Pech et al., 2021; Hasibuan et al., 2023). One major challenge is securing adequate funding for these initiatives and creating an organizational culture that is genuinely supportive of risk-taking and experimentation. Resource allocation issues often include prioritizing funding for entrepreneurship programs over more traditional areas of

business administration. The post-COVID era has seen a heightened focus on cultivating entrepreneurial mindsets and fostering innovation in business administration education and organizational practices to enhance adaptability, competitiveness, and long-term sustainability.

2. Strengthening Industry-Academia Partnerships

The post-COVID era emphasized strengthening industry-academia partnerships within business administration (Fabbe-Costes, 2022; Jantunen & Hynninen, 2022; Marijan, 2022). These partnerships facilitate the co-creation of knowledge but require careful management. Researchers have highlighted that effective collaboration between industry and academia can provide significant benefits to both parties, including the development of innovative solutions, the transfer of knowledge and technology, and the enhancement of the relevance and practical applicability of business administration education (Fabbe-Costes, 2022; Marijan, 2022). Examples include collaborative research projects, joint curriculum development initiatives, and student internships. One key aspect of this trend has been the integration of industry-based projects, internships, and experiential learning opportunities into business administration curricula. These initiatives enable students to apply their knowledge in real-world business settings while providing industry partners access to a pool of talented and motivated individuals (Soam et al., 2023). Furthermore, the COVID-19 pandemic has underscored the need for more agile and responsive industry-academia partnerships, as businesses have faced unprecedented challenges and sought innovative solutions. Researchers have emphasized the importance of fostering open communication, mutual understanding, and a shared commitment to addressing industry-specific problems (Felderer & Garousi, 2019; Garousi et al., 2019). Additionally, integrating emerging technologies, such as artificial intelligence and data analytics, has emerged as a key area of collaboration between industry and academia. These partnerships can enable the co-creation of knowledge and the development of innovative applications that can benefit both the business sector and academic research (Adli et al., 2024). However, successfully strengthening industry-academia partnerships is challenging. Researchers have highlighted the need to address issues related to intellectual property rights, incentive alignment, and the effective management of collaborative projects (Lee et al., 2020; Takieddine, 2019). Effective management of collaborative projects requires addressing intellectual property rights, aligning incentives and objectives, and establishing clear communication channels. Overall, the post-COVID era has seen a heightened focus on strengthening industry-academia partnerships in business administration to enhance these programs' relevance, innovation, and practical applicability.

COMPARATIVE ANALYSIS AND IMPLICATIONS

To clearly illustrate the key similarities and differences in teaching and research approaches across the pre-COVID, COVID, and post-COVID periods, Table 1 presents a comparative analysis. This table summarizes the evolution of curriculum focus, teaching methodologies, research foci, research methods, technology integration, industry-academia partnerships, and the challenges encountered in each era.

Table 1. Comparison of Teaching and Research in Business Administration Across Eras

Feature	Pre-COVID Era	COVID Era	Post-COVID Era
Curriculum Focus	- Theoretical knowledge, conceptual understanding	- Adapting strategies for business continuity and survival	- Entrepreneurial mindsets, innovation, digital transformation, sustainability, and social responsibility
Teaching Methodologies	- Lectures, case studies, experiential learning - Increasing technological integration	- Primarily online and remote instruction	- Hybrid and blended learning models - Advanced technologies (VR/AR, AI)

Table 1. (Cont.)

Feature	Pre-COVID Era	COVID Era	Post-COVID Era
Research Focus	- Emerging technologies, sustainability, ethics	- Pandemic-related topics (supply chain, marketing, resilience)	- Resilience, sustainability, crisis management - Interdisciplinary and collaborative approaches
Research Methods	- Traditional in-person data collection	- Increased reliance on virtual and remote data collection methods	- Interdisciplinary collaboration and integration of diverse perspectives
Technology Integration	- Growing use of digital platforms and online learning tools	- Rapid shift to online platforms and virtual tools	- Extensive use of VR/AR, AI, cloud-based platforms, and learning analytics
Industry-Academia Partnerships	- Growing recognition of the benefits of collaboration	- Increased need for agile and responsive partnerships	- Key focus on co-creation of knowledge and innovative applications
Challenges	- Dominance of conventional teaching methods - Insufficient technology adoption - Divide between theory and practice	- Lack of experience and digital competencies - Maintaining engagement in virtual environments	- Addressing digital literacy challenges - Ensuring equitable access to digital resources

As shown in Table 1, the curriculum focus has evolved significantly, shifting from a primarily theoretical focus pre-COVID to a strong emphasis on resilience, sustainability, and digital transformation in the post-COVID era. This evolution has driven corresponding changes in teaching methodologies, research focus, technology integration, and partnerships, ultimately aiming to better equip students for the complexities of the modern business world. However, each era also presents unique challenges, such as addressing digital literacy gaps and ensuring equitable access to resources, which must be addressed for successful implementation.

Similarities and Differences in Teaching and Research Across the Pre-COVID, COVID, and Post-COVID Periods

The COVID-19 pandemic profoundly impacted business administration, leading to significant transformations in teaching and research across pre-COVID, COVID, and post-COVID periods (Konkin et al., 2021; Vindača & Lubkina, 2021). The following analysis synthesizes the key similarities and differences across these phases.

Similarities

Increased Emphasis on Technology Integration: One key similarity is the heightened emphasis on integrating technology and digital tools into the educational and research landscape across all three periods. Prior to the pandemic, digital platforms, virtual simulations, and data analytics were gaining traction (Fleischmann, 2020). The COVID-19 crisis accelerated this as institutions rapidly transitioned to online and remote instruction (Konkin et al., 2021). This trend intensified post-COVID, with researchers focusing on developing hybrid and blended learning models (Zairul et al., 2023).

Importance of Industry-Academia Partnerships: All three periods emphasized the value of industry-academia partnerships. Before the pandemic, there was growing recognition of collaborative projects, internships, and experiential learning. The COVID-19 crisis underscored this need as businesses faced unprecedented challenges and sought innovative solutions. This emphasis continued post-COVID, with a particular focus on knowledge co-creation and developing innovative applications (Vindača & Lubkina, 2021).

Differences

Teaching Modalities: Pre-COVID teaching was primarily in-person, relying heavily on lectures with some integration of case studies and experiential learning. During the COVID-19

pandemic, a rapid shift to online and remote instruction occurred, presenting challenges due to limited faculty and student experience in this area. In the post-COVID era, the focus shifted to refining and leveraging these lessons learned to enhance the quality and effectiveness of hybrid and blended learning models (Konkin et al., 2021).

Research Priorities: In the pre-COVID era, research focused on broader themes like sustainability, ethics, and technological innovation. The COVID-19 crisis prompted a significant shift toward pandemic-related topics, including the impact on supply chains, marketing strategies, and organizational resilience. While these remain important, post-COVID research increasingly focuses on long-term implications of the pandemic and strategies to support recovery and growth (Vindača & Lubkina, 2021).

Addressing Technology-Related Challenges: Prior to COVID, technological integration was often constrained by limited resources and expertise. During COVID, the rapid shift exposed gaps in digital competency. The post-COVID period has focused on addressing these challenges through digital literacy initiatives and ensuring equitable access to technology.

Quantifiable Comparisons: One might look at the percentage of courses offered online, research funding allocated to pandemic-related topics, or the number of industry-academia partnerships formed during each period. Quantifiable measures, such as the percentage of courses offered online, research funding allocated to pandemic-related topics, and the number of industry-academia partnerships, could provide a more concrete understanding of the transformations across these periods. More data and specific examples would be needed to further strengthen this analysis.

Contrasts: Explicit contrasts between periods include the shift from predominantly theoretical pre-COVID curricula to post-COVID curricula focused on adaptability and resilience. Research shifted from long-term sustainability to immediate crisis response, then evolved into a balance of the two.

In conclusion, the COVID-19 pandemic catalyzed significant changes in teaching and research approaches within business administration, with both similarities and differences observed across these periods. The successful integration of these transformations is crucial in ensuring the continued relevance and adaptability of business administration, education, and research.

Factors Influencing the Dynamics of Change

The transformations witnessed in business administration education and research across the pre-COVID, COVID, and post-COVID periods were influenced by a complex interplay of various factors (Zhang, 2023). Understanding these factors is crucial for sustaining positive changes and avoiding unintended consequences.

Institutional and Organizational Culture: The institutional and organizational culture within educational institutions played a crucial role in shaping the dynamics of change. The willingness and readiness of faculty, staff, and administrators to embrace new teaching and research approaches significantly impacted the success of these transformations. Institutions fostering innovation, collaboration, and continuous improvement were better equipped to navigate the pandemic's challenges and implement effective changes (Zhang & Qu, 2021). For example, institutions with shared governance models where faculty had a voice in decision-making were more likely to successfully implement new teaching technologies. A detailed analysis of the impact of institutional culture on the pace and effectiveness of change is critical.

Resource Availability: Resource availability was a key factor influencing the dynamics of change. Institutions that had previously invested in digital platforms, learning management systems, and faculty development initiatives were better positioned to adapt to the rapid shift to remote instruction during the COVID-19 crisis. The prioritization of funding for innovation and transformation initiatives supported implementing new teaching and research approaches. Securing funding for technology upgrades, faculty development, and novel pedagogical and research methods enabled institutions to navigate the pandemic's challenges more effectively (Morimoto, 2022). For example, a comparative analysis of institutions with differing levels of resource availability could quantify this impact. It's also important to recognize that resource

availability is not just about funding, but also about access to expertise, technical support, and other non-financial resources. How the interplay between resources and institutional capabilities shapes the effectiveness of adaptation requires further analysis.

Technological Infrastructure and Digital Competencies: The availability of technological infrastructure and faculty and student digital competencies were crucial to enabling the transition to online and hybrid learning models (Zhang, 2023). Institutions that had previously invested in digital platforms, learning management systems, and faculty development initiatives were better positioned to adapt to the rapid shift to remote instruction during the COVID-19 crisis.

External Environmental Factors: Broader socioeconomic and political contexts shaped the dynamics of change. Government policies, regulatory frameworks, and societal expectations significantly shaped the field of business administration. Aligning institutional responses with evolving needs and priorities across the broader ecosystem was critical to ensure the long-term relevance and sustainability of these programs (Clark et al., 2022; Sala-Bubaré et al., 2023). External factors also include technological advancements, global economic trends, and changes in the labor market.

Here are a few examples of how the factors discussed above interact. An institution may have strong resource availability (Factor 2), but a lack of a supportive organizational culture (Factor 1) that values innovation can prevent resources from being used efficiently to drive change. Similarly, government policies that provide incentives for technology adoption (Factor 4) may have limited impact if educational institutions lack the technical infrastructure and digital competencies (Factor 3) to effectively implement new solutions.

In conclusion, the factors influencing change in business administration education and research were multifaceted and interdependent, requiring a comprehensive and strategic approach to navigating the transformations brought about by the COVID-19 pandemic.

Implications For Business Administration Education and Research

The transformations witnessed in business administration education and research across the pre-COVID, COVID, and post-COVID periods have significant implications for the future of these programs (Mousa, 2021; Ratten & Jones, 2021). These implications demand a strategic, actionable, and future-oriented approach.

Ensuring Relevance and Adaptability of Curricula: One key implication is the need to maintain the continued relevance and adaptability of business administration curricula amid evolving industry demands and societal needs. The COVID-19 pandemic underscored the importance of equipping students with the skills and knowledge required to navigate complex, dynamic, and uncertain business environments. This includes a greater emphasis on entrepreneurship, innovation, digital transformation, and integrating sustainability and social responsibility considerations into the core of business administration education (Ratten & Jones, 2021). These changes also call for curricula that are agile and can readily incorporate new trends.

Practical Application: To enhance practical application, institutions can incorporate simulations, real-world case studies, and collaborative projects with industry partners. These methods help students bridge the gap between theory and practice, preparing them for the challenges they will face in their careers. Furthermore, they should develop the curriculum by considering the impact of technological developments and shifts in market demand, such as the growing need for data analytics skills and expertise.

Strategic Deployment of Digital Technologies and Tools: Additionally, the successful integration of hybrid and blended learning models, along with the strategic deployment of digital technologies and tools, will be crucial to enhancing the flexibility, accessibility, and personalization of business administration programs. Researchers highlighted the potential of these approaches to better prepare students for the realities of the modern business world and enable more effective and engaging learning experiences (Ashour et al., 2021; Gul & Khilji, 2021). The long-term implications of this integration include enhanced accessibility and increased opportunities for personalized learning experiences.

Practical Applications: These changes should emphasize faculty training in effective methods for delivering online courses and develop assessment strategies that evaluate not just knowledge but also application skills.

Strengthening Industry-Academia Partnerships: Strengthening industry-academia partnerships will ensure the continued relevance and practical applicability of business administration education and research. Collaborative projects, internships, and the co-creation of knowledge can enable the development of innovative solutions that address the evolving needs of the business sector while also informing the design of more responsive curricula and research agendas (Hadar et al., 2020).

Potential Future Scenarios: It's important to consider scenarios in which industry-academia collaboration is crucial. For example, to prepare students to adapt to and contribute to emerging industries such as Fintech or the Metaverse, or to deal with increasing automation and AI.

Integrating Entrepreneurial Mindsets and Innovation: Institutions should also promote entrepreneurial mindsets and innovation. This includes developing comprehensive support systems, such as mentorship programs, access to resources, and a culture that celebrates and rewards entrepreneurial endeavors. Furthermore, institutions need to focus on integrating interdisciplinary approaches to business administration to foster innovation.

However, the successful implementation of these transformations will require a comprehensive and strategic approach that addresses the various factors influencing the dynamics of change, including institutional culture, technological infrastructure, faculty development, and alignment with broader socioeconomic and political contexts (Harits et al., 2022; Chen, 2023). For example, institutions should establish clear goals for their transformation efforts, develop a detailed implementation plan, and regularly evaluate their progress. This requires a cultural shift that fosters innovation and collaboration among faculty, students, and staff.

Overall, the implications for business administration education and research in the post-COVID era point to the need for a more agile, responsive, and collaborative approach that can effectively prepare students for the challenges and opportunities of the future business landscape. To effectively address these implications, institutions should prioritize faculty training in online pedagogy, invest in infrastructure for equitable access, and cultivate strong relationships with industry partners to ensure curriculum relevance and practical application. This will require ongoing investment in faculty development, technology infrastructure, and strong partnerships with industry.

Future Directions and Recommendations for the Field

As the field of business administration navigates the post-COVID era, the literature offers several key future directions and recommendations. These recommendations aim to build on the lessons learned and prepare the field for ongoing transformation.

1. Enhancing Adaptability and Responsiveness of Curricula: One critical area of focus should be the continued enhancement of the adaptability and responsiveness of business administration curricula. Researchers have emphasized the need to ensure that these programs remain relevant and aligned with the evolving needs of the business sector, incorporating emerging trends such as sustainability, digital transformation, and entrepreneurship (Wieczorek et al., 2021). It's crucial to establish feedback mechanisms and regularly update curricula to respond to current trends, considering the rate of technological advancement.

2. Strategic Integration of Technology: Additionally, the successful integration of hybrid and blended learning models and the strategic deployment of digital technologies and tools will enable more flexible, accessible, and personalized educational experiences. Institutions should invest in the necessary technological infrastructure, faculty development, and student support systems to ensure the effective implementation of these approaches (Batista-Toledo & Gavilan, 2025).

3. Practical Implementation Strategies: Beyond simply adopting technologies, faculty require training in effectively designing hybrid courses, creating engaging online content, and

utilizing learning analytics to personalize the learning experience. Furthermore, investment should be directed toward technology that can provide an equitable learning experience for all students, regardless of socio-economic status. To improve the level of technology in education, institutions should also emphasize the importance of emerging technologies, such as blockchain, metaverse applications for training and development, and AI for adaptive learning.

4. Strengthening Industry-Academia Partnerships: Strengthening industry-academia partnerships should be a key priority, as these collaborations can provide valuable insights into the skills and knowledge required by the business sector and inform the development of more responsive curricula and research agendas. Institutions should explore innovative ways to foster these partnerships, such as through joint research projects, industry-sponsored internships, and co-creating solutions (Esangbedo et al., 2024). To address collaboration challenges, it's essential to clarify intellectual property rights and establish clear guidelines for collaborative projects. This will lead to the creation of innovative solutions.

5. Integrating Entrepreneurial Mindsets and Innovation: Lastly, the field of business administration should also focus on enhancing the integration of entrepreneurial mindsets and innovation into educational and organizational practices. This includes developing comprehensive support systems like mentorship programs, resource access, and a culture that celebrates and rewards entrepreneurial endeavors (Rahman et al., 2023).

6. Resource Access: This means providing access to seed funding, business incubators, and mentorship programs, fostering a culture that celebrates innovation and risk-taking, and incorporating design thinking and lean startup methodologies into the curriculum.

Clearer Prioritization

A suggested more apparent prioritization of these would be:

1. Sustained funding and support for industry-academia partnerships to maintain real-world relevance in curriculum and research

2. Focus on Agile adaptation of curriculum and the need to continue to integrate entrepreneurial mindsets

3. Focused and equitable access to technology and infrastructure, and how to best leverage emerging technologies.

Ultimately, for the field of business administration to not only adapt to changes but also excel, it needs to be at the forefront of innovations and methods. The post-COVID landscape and changing societal norms create both a responsibility and an opportunity for the business administration field to take a leading role in innovative thought.

CONCLUSION

This comprehensive review synthesizes the intricate evolution of teaching and research in business administration across pre-COVID, COVID, and post-COVID landscapes, revealing both enduring themes and profound transformations. The pandemic served as a powerful catalyst, not merely accelerating existing trends but fundamentally reshaping methodologies and priorities, demanding unprecedented agility from academic institutions.

A central finding is the accelerated integration of technology and the amplified criticality of industry-academia partnerships. Pre-COVID trends toward digital tools and collaboration were immediately amplified during the pandemic, forcing a widespread pivot to online instruction and underscoring the urgent need for real-world solutions. Post-COVID, these elements are foundational: technology now underpins sophisticated hybrid learning models, integrating advanced digital tools such as AI, data analytics, and VR to support experiential learning. Robust partnerships are essential for knowledge co-creation, providing real-world data, and ensuring curriculum relevance, fostering an entrepreneurial mindset among students.

Crucially, distinct shifts emerged. The rapid, often challenging, transition to online teaching during COVID-19 highlighted significant hurdles in student engagement, digital equity, and faculty preparedness for virtual environments. This prompted a post-pandemic recalibration towards refined hybrid and experiential pedagogies, leveraging technology for interactive learning and diversified assessment strategies. Research priorities also reoriented dramatically.

Pre-COVID's broader focus on sustainability and ethics gave way to urgent pandemic-related inquiries into supply chain resilience, shifts in consumer behavior, crisis leadership, and organizational adaptability. Today, post-COVID research broadens to address long-term implications for policy, societal impact, and new resilient business models, necessitating agile and interdisciplinary methodologies.

In essence, the COVID-19 era solidified the imperative for dynamic adaptation in business administration. The most salient contributions are the undeniable need to seamlessly blend technology with effective pedagogy and the strategic importance of robust industry collaborations. These pillars represent fundamental re-imaginings, positioning the field to proactively address future disruptions, embrace continuous learning, and cultivate adaptable leaders equipped for an ever-evolving global business environment.

CONFLICTS OF INTEREST

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

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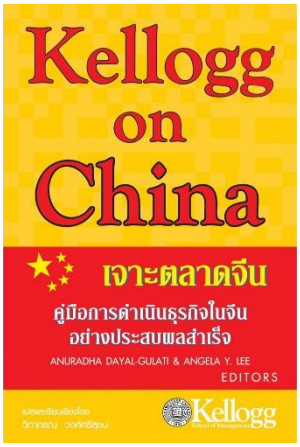
BOOK REVIEW



KELLOGG ON CHINA – TAPPING INTO THE CHINESE MARKET

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The book Kellogg on China – Tapping into the Chinese Market provides a comprehensive explanation of China's development in key dimensions including the economy, politics, and international relations, emphasizing the country's rising role as a major global power. At the same time, the book highlights the presence of economic uncertainties and domestic challenges that may influence both China's future direction and the global economy.

A central theme of the book is the importance of understanding China's economic and political transformation, particularly the reform policies initiated in 1978 under the leadership of Deng Xiaoping. These reforms marked the transition toward a more liberalized and market-oriented economy, which subsequently contributed to China's rapid economic growth. Despite these economic changes, China continues to operate under a communist political system. Therefore, investors and business practitioners are encouraged to develop a clear understanding of the political environment and regulatory frameworks that shape business operations in the country. The book further explains that companies operating in China encounter strong competition from local enterprises as well as a complex legal and regulatory structure.

Beyond economic considerations, the book gives significant attention to cultural dimensions of doing business in China. It emphasizes that building and sustaining business relationships extends beyond transactional exchanges and requires deep appreciation of Chinese values related to honesty, mutual respect, and long-term commitment. Such relationships are portrayed as long-term investments which, when carefully developed, can contribute substantially to business success in the Chinese market.

One of the major strengths of the book lies in its detailed discussion of the distinctive characteristics of the Chinese market, which integrates economic, cultural, political, and legal perspectives. Readers are provided with valuable insights that enhance their understanding of how business practices must be adapted to this multifaceted environment. In addition, the book offers strategic guidance for entrepreneurs and firms seeking to enter the Chinese market, particularly in terms of adjusting strategies to local conditions and consumer expectations.

At the same time, the book places strong emphasis on strategic analysis, which encourages readers to focus on long-term planning and market positioning. While this approach strengthens conceptual understanding, future readers may also benefit from complementary discussions related to specific operational functions such as logistics, transportation, and human resource management. Moreover, although the book highlights many successful industries and business cases, expanding the discussion to include a wider variety of industries could further enrich its practical value.

Overall, Kellogg on China presents important lessons for international businesses considering market entry into China. The book clearly demonstrates that successful operations require careful adaptation of business strategies to China's unique market characteristics, close attention to regulatory compliance, and the establishment of effective partnerships with local organizations. In addition, it underscores the necessity of maintaining flexibility in response to economic shifts, political changes, and evolving consumer demands. A strong understanding of Chinese culture is also identified as a crucial factor influencing consumer behavior and partner selection.

Finally, the book suggests that decentralized management and empowerment of local teams can significantly enhance a firm's ability to respond efficiently to market conditions. Taken together, these insights provide valuable guidance for foreign enterprises seeking sustainable success in the Chinese market.