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IoT in Courier Services: Impact on Customer Satisfaction and Supply Chain Sustainability

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ABSTRACT

The increasing importance of integrating the Internet of Things (IoT) within the courier service sector in today's digital landscape highlights the necessity for an in-depth examination of how IoT intricately affects customer satisfaction and the sustainability of supply chains in this industry. The objective of this study is to assess the impact of IoT on both customer service and the sustainability of supply chains, with a specific focus on electronic document management, route optimization, and real-time information. A random sampling survey technique was employed to collect data from 310 participants in the Malaysian courier service company in the year 2022. The data analysis primarily relied on quantitative methods, with the utilization of multiple regression analysis as a key technique for evaluating the effects. The outcomes of this study provide validation for our hypotheses concerning the positive influence of electronic document and route optimization, while also emphasizing the critical aspect of managing real-time information. These findings contribute invaluable insights for courier service companies striving to harness the capabilities of IoT to enhance service quality and promote sustainable operations. Future research directions may delve deeper into the intricate dynamics of IoT's role to explore its scalability and cost-effectiveness within courier service companies.

1. INTRODUCTION

Digital Supply Chain (DSC) is a smart, beneficial, and efficient process that helps organizations find new ways to make revenue and improve business value, as well as use new technological and analytical methods to try new things [1, 2]. Thus digital transformation like the Internet of Things (IoT) has been discussed in the past few years with several benefits to public and private organisations [3]. Understanding this technology's impact on economic and social development is crucial, as it enhances various social activities by enabling real-time data transfer among people and goods, fostering public value, and continuously boosting productivity across economic sectors. The IoT has also given rise to a blooming IT industry, with intelligent manufacturing scenarios serving as a prime example, benefitting both humans and machines [4]. Therefore potentially IoT provides a business platform with a comprehensive view of how their systems work, delivering data on everything from the operation of machinery to the company's supply chain and logistics [5]. Aside from that, IoT automates processes and reduces labour expenses for businesses. It lowers waste and improves service quality, as well as makes the manufacture and delivery of things less expensive and provides transparency in consumer transactions. The supply chain consists of many players and entities working together to cater to customer demand. As for in supply chain, IoT has been a great help in improving transparency as well as visibility in ensuring better customer service and ease of operation [6], which includes superfluous procedures that are being simplified with IoT application innovation [7, 8].

The deployment of IoT provides solutions to existing difficulties in supply chain management through the use of several tools that speed up regular operations. Due to supply chains relying on how well each actor in the industry connects, IoT provides a way for each player to have visibility of each phase of operation as well as accountability due to the transparency and openness of the entire process. It can be seen that many companies have adopted IoT in their operation because of the huge benefits that it provides in terms of operation as well as quality services. For example, the Amazon operation is known to the world for its state-of-the-art warehouse as well as the same-day delivery that is promised by the huge multinational [6, 9]. In a similar trend, the following courier service companies are implementing IoT's advanced technologies to enhance efficiency, transparency, and customer satisfaction. Such as, DHL has incorporated IoT technology to offer real-time tracking for packages and vehicles, as well as monitor temperature-sensitive shipments. This allows them to provide customers with accurate delivery status updates and ensure the safe transportation of delicate items [10]. FedEx has developed IoT sensors in its delivery

vehicles to monitor vehicle condition and driver behaviour to ensure customer satisfaction by providing real-time delivery updates [11]. This proves that the implementation of IoT does benefit companies in their supply chain management a lot. As it deals with end-users, it is critical to increase efficiency in courier services, which is part of the entire supply chain. In most circumstances, customers judge the efficiency of a courier service based on how quickly the items arrive at their destination. When it comes to courier services, numerous processes must be completed before the parcel can be delivered to its destination. Even though the processes are in place to ensure that items do not land in the wrong location, resulting in consumer discontent, the large number of steps does cause delivery delays for customers. With this attention, the companies need to find a way how to improve their efficiency to not be left behind in the competition [12].

The integration of IoT technology into courier services represents a momentous advancement and a profound shift within the logistics sector. The main objective of this study is to assess the impact of IoT on both customer service and the sustainability of supply chains, with a specific focus on electronic document, route optimization, and real-time information. In today's rapidly evolving era, characterized by societal progress at breakneck speed, consumers express a robust demand for not only swift order fulfillment but also an equally significant yearning for transparency and reliability. IoT responds to this demand by facilitating instantaneous tracking and monitoring of shipments, thereby ensuring that customers are never left uninformed regarding the status of their parcels. This heightened level of transparency fosters trust and reassurance, ultimately resulting in elevated levels of consumer satisfaction. Beyond the mere adoption of technology, the significance of the Internet of Things (IoT) in the realm of courier services signifies a fundamental transformation in the operational processes and value delivery of courier organizations.

This study underlines the profound significance of the IoT in shaping the future of the logistics industry. IoT empowers courier firms to enhance operational efficiency and achieve cost reduction through the implementation of data-driven decision-making. This innovative technology equips these companies with the capability to optimize delivery routes, accurately forecast maintenance requirements, and efficiently manage resources. Moreover, in addressing the escalating demands of the flourishing e-commerce industry, the IoT enables courier firms to professionally handle substantial delivery volumes while upholding flexibility and steady reliability.

2. THEORETICAL FOUNDATION AND HYPOTHESIS DEVELOPMENT

2.1 IoT role in supply chain sustainability in courier industry

The courier services industry has become an essential element in the field of supply chain sustainability, facilitating the efficient transportation of goods. Within this specific context, the incorporation of the Internet of Things (IoT) has garnered significant importance [13]. The integration of sensors, tracking devices, and data analytics in courier services constitutes the IoT approach, which aims to monitor and enhance the efficiency of package delivery operations [14]. According to the study [15], this system serves the dual purpose of enabling real-time package tracking and supporting environmental sustainability initiatives through vehicle tracking and route optimization, effectively reducing fuel consumption and emissions. Furthermore, it promotes social sustainability by improving worker safety through the utilization of wearable Internet of Things (IoT) devices that monitor the health and safety conditions of employees [16, 17]. In the pursuit of improving operational efficiency, cost reduction, and customer happiness, courier services are increasingly adopting the integration of Internet of Things (IoT) technology. This strategic approach plays a crucial role in promoting both operational excellence and sustainability within the courier industry [18]. The adoption of this efficient procedure positively impacts both economic and environmental sustainability by minimizing unnecessary vehicle operations and their associated fuel usage. Furthermore, the integration of Internet of Things (IoT) technology for route optimization and vehicle maintenance has demonstrated a favorable influence on operational costs within the courier industry. This is achieved through the realization of fuel savings, reduced maintenance expenses, and minimized vehicle wear and tear. Consequently, these advancements contribute significantly to sustainability initiatives [18].

2.2 IoT role in enhancing customer service in courier industry

The integration of the Internet of Things (IoT) in courier services yields advantages that encompass the optimization of resources. The implementation of real-time tracking and monitoring systems in courier companies allows for the provision of accurate delivery predictions to consumers, leading to enhanced customer satisfaction and a decrease in instances of missed deliveries and returns [19-21]. The intricate role of IoT in the courier industry is expected to evolve further, thereby enhancing customer service satisfaction. As technology becomes more accessible, courier companies should proactively explore IoT solutions to maintain competitiveness and meet the escalating expectations of customers [22]. Nevertheless, it is crucial to address challenges concerning data security and privacy to preserve customer trust and safeguard sensitive information. In the courier services industry, which traditionally involves the transport and delivery of documents, parcels, and substantial shipments of goods, a pivotal factor influencing customer satisfaction has been reliability [23]. Specifically, attributes such as punctuality, successful delivery attempts, delivery completion, and cargo preservation have historically held paramount importance in assessing courier service quality. Conversely, factors related to visual identification and social responsibility have been comparatively less significant in shaping customer perceptions of service quality. With the advent of IoT technology, the impact on these critical dimensions of reliability and their subsequent influence on customer satisfaction in the courier industry warrants a closer examination [24]. Ensuring the timely delivery of packages is of utmost importance in delivering top-notch customer service. To precisely determine the optimal route for parcel deliveries, the development of an efficient system is essential, fostering seamless communication between courier service providers and customers. This system plays a pivotal role in not only enhancing customer satisfaction but also contributing to the sustainability of the supply chain [7]. Hence, technological

transformation is recognized as a prerequisite for sustainability in supply chain management, in conjunction with the formulation of policies to harness these technologies within the courier industry.

Based on the literature review, this study employs a theoretical framework for examining the impact of IoT in courier services on both customer satisfaction and supply chain sustainability. This framework is based on the interconnectedness of technological innovation such as electronic documentation, route optimization, and real-time information or tracking systems. Figure 1 proposed the framework comprises three key independent factors and IoT impact on customer service and supply chain sustainability as the dependent variable.

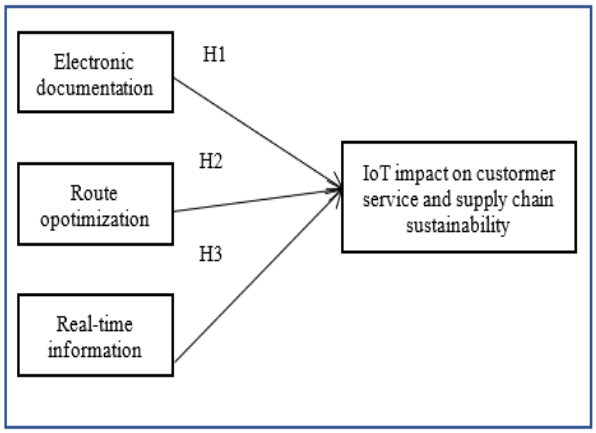

Figure 1. Theoretical framework of the study

3. HYPOTHESIS DEVELOPMENT

3.1 Electronic document impact on IoT in customer service and supply chain sustainability

Electronic documents (e-documents) have gained increasing attention as a pivotal component in modern supply chain management. The studies by Jervis et al. [25, 26] reviewed the role of e-documents, emphasizing their potential to streamline processes and enhance visibility within the supply chain. Simultaneously, the Internet of Things (IoT) has revolutionized courier services and supply chains by enabling real-time tracking and monitoring [27] highlighting the collaborative approach of IoT in logistics, demonstrating its ability to optimize processes and predict maintenance needs. Sustainability in supply chain management has become a critical focus, which underlined efforts to reduce emissions and resource consumption [28]. Combining these themes, [28, 29] explored how e-documents can contribute to sustainability in global trade by reducing paper usage and minimizing environmental impact. This literature provides the groundwork for a hypothesis that posits the integration of e-documents and IoT technologies in courier services and supply chains as a potential means of enhancing operational efficiency while simultaneously promoting sustainability goals. Such integration may offer improved visibility, tracking, and decision-making capabilities while reducing paper waste and optimizing resource utilization. Thus, the hypothesis is:

H_1: Electronic document has a positive impact on IoT in customer service and supply chain sustainability in courier service.

3.2 Route optimization impact on IoT in customer service and supply chain sustainability

The study conducted by Sykes [30] explores the advantages associated with the utilization of IoT-based route optimization in the field of logistics. The authors emphasize the IoT enabled sensors and real-time data to offer accurate insights into traffic conditions, weather patterns, and vehicle functionality. By utilizing this data, organizations have the ability to strategically optimize routes in real-time, resulting in decreased transportation expenses and delivery durations, while simultaneously mitigating the release of carbon emissions. Kuo and Routific [31] conducted a study that explores the impact of the IoT on improving customer service within the specific context of route optimization. The study highlights the potential of the IoT in enhancing the customer experience through the provision of real-time tracking and delivery updates. The enhancement of customer service not only leads to an elevation in client contentment but also plays a role in fostering supply chain sustainability through the mitigation of customer grievances and product returns [31]. Furthermore, the study conducted by Giuffrida et al. [32] delves into the application of the IoT in enhancing route optimization for last-mile delivery services. The authors emphasize that employing IoT devices for real-time monitoring contributes to improved delivery accuracy and assists drivers in avoiding traffic congestion, thereby reducing fuel consumption and enhancing sustainability. Moreover, by optimizing routes, organizations have the potential to reduce operational expenses, enabling the allocation of resources toward the implementation of sustainable initiatives. Thus the hypothesis is:

H_2: Route optimization has a positive impact on IoT in customer service and supply chain sustainability in courier service.

3.3 Real-time information impact on IoT in customer service and supply chain sustainability in courier service

An increasing amount of scholarly investigation has explored the complex interaction of real-time information, in conjunction with the IoT, which has emerged as a transformative force in redefining customer service and advancing supply chain sustainability [33]. This interaction will improve positive visibility for all parties involved, including the shipper, the carrier and the driver. A more proactive approach to managing deliveries means better inventory and vehicle management, as well as better customer service because the delay is known upfront. Customer service can be improved by using the real-time track and trace system to manage the integrated logistical networks [34, 35]. Another study by He et al. [36] emphasizes the significance of IoT-enabled real-time information in supply chain management. IoT technologies facilitate seamless data gathering and transfer, providing supply chain operations with unprecedented insights and control. This enhanced visibility leads to positive improved demand forecasting, inventory management, and waste reduction, ultimately enhancing supply chain sustainability. Consequently, a more proactive approach to managing deliveries, better inventory and vehicle management, and improved customer service can be achieved. Thus, the hypothesis is:

H_3: Real-time information has a positive impact on IoT in customer service and supply chain sustainability in courier service.

4. METHODOLOGY

This study aims to provide evidence and test the hypothesis, unveiling the relationships between the independent factors (electronic documents, route optimization, and real-time information) and the dependent factor (supply chain sustainability) as illustrated in Figure 1. For better understanding, this study meticulously operationalizes key variables considered in this study. Among the independent variables, 'electronic documents' encompass digital records, invoices, and essential documentation within these industries. Route optimization' is analyzed quantitatively, drawing on routing data from selected courier services, to measure reductions in delivery time, trip distance, and fuel consumption achieved through optimization software or IoT systems. Real-time information evaluates the frequency and accuracy of updates provided to customers and logistics managers, utilizing both quantitative and qualitative methods to understand its impact on decision-making and customer satisfaction. The dependent variable, comprising customer satisfaction and supply chain sustainability, provides management operations, environmental concerns, and IoT support for sustainable courier company growth. This comprehensive operationalization provides insights into the multifaceted dynamics of these industries, enriching the discourse surrounding operational excellence, customer satisfaction, and sustainability. To meet the research objective, this study employed a quantitative method due to a wide range of data collection facilities providing objective insights that can be generalized to a broader population [37]. An online survey questionnaire was distributed to customers of selected courier companies to collect quantitative data regarding their satisfaction levels, experiences with IoT-enabled services, and perceptions of sustainability.

4.1 Data and sampling

A self-administrative questionnaire survey of the courier service company in Malaysia was conducted to collect data for empirical analysis. The instrument was developed based on a review of relevant literature and subsequently checked by the supply chain professional to ensure adequate content validity. This study employed probability sampling, this is because the total number of courier employees in 2020 provided by MCMC was 129,298 employees which included administration, call centre, pick up and despatch, sorting crew and other categories of courier service employees [38, 39]. A total of 310 respondents collected for this study who work in the courier service industry. The demographic part consists of gender, age, race, monthly income, position in the company, the status of working in the courier service industry, years been working in the courier service industry, and the year started working in the courier service industry. In the second part, using a five-point Likert scale ranging from ‘strongly disagree (1) to ‘strongly agree (5) to measure all constructs in Table 1.

Table 1. Questionnaire items

Factors	Items
Customer satisfaction and supply chain sustainability	The courier company is advancing towards sustainability in its operations.
	The traditional method, without the use of technology, will affect the workers' performance and customer satisfaction.
	The courier company is facing pressure to improve sustainability in its supply chain.
	The usage of the Internet of Things (IoT) in courier service is environmentally friendly.
	The implementation of the Internet of Things (IoT) in courier services is the solution to support sustainability.
Electronic document	The use of electronic documents in the courier service company contributes to sustainable supply chain management.
	The courier company uses electronic documents to contribute to sustainable supply chain management.
	The usage of electronic document is a tool for guiding my courier service company's decision-making process.
	The usage of electronic document is a tool for guiding my courier service company business transaction.
	The electronic documents is a tool to manage the records better in my courier service company.
Route optimisation	The route optimisation technology in the courier service industry contributes to sustainable supply chain management.
	The company using route optimisation technology to contribute to sustainable supply chain management.
	The route optimisation technology help to provide the best route for the drivers to take in an efficient way for delivery.
	The route optimisation technology selects the best route contribute to reducing the cost in the courier service company.
	The route optimisation technology helps to provide real-time information to the drivers to assist the delivery.
Real-time information	The real-time information technology in the courier service industry contributes to sustainable supply chain management.
	I believe my company using real-time information technology in contribute to sustainable supply chain management.
	The usage of real-time information increases the transparency in the courier service industry.
	The usage of real-time information improves the visibility in viewing the information in courier service supply chain.
	The usage of real-time information gets to improve the efficiency of the delivery process.

4.2 Data analysis

The purpose of this study is to examine the impacts of the usage of the IoT in supply chain sustainability in courier services for future improvement of its services towards customer satisfaction in Malaysia. Data has been conducted with SPSS in two stages. First, check the data normality using skewness and kurtosis to confirm data outliers. Furthermore, Cronbach's Alpha coefficient was used to determine the reliability of each instrument's items to fulfill the assumption of multiple linear regression analysis. In the second stage, the conceptual structure has been validated by using multiple linear regressions.

5. RESULTS

5.1 Descriptive statistics

Table 2. Descriptive statistics of respondent

Variables	Frequency (N = 310)	Percentage
Gender		
Male	182	58.7
Female	128	41.3
Age (Year)		
18- 27	162	52.3
28-37	110	35.5
38 - 47	35	11.3
> 48	3	1
Race		
Malay	174	56.1
Chinese	73	23.5
Indian	63	20.3
Monthly income (RM - Malaysian Ringgit)		
< 1000	25	8.1
1001 - 2000	93	30
2001 - 3000	124	40
> 3001	68	21.9
Position in the company		
Full-time	234	75.5
Part-time	51	16.5
Contract	25	8.1
Employment attachment in Courier service company		
Yes = Courier service company	258	83.2
No = Others	52	16.8
Total year of experience		
< 1	90	29
1-5	153	49.4
6-10	61	19.7
> 10	6	1.9
Starting work (Year)		
< 2010	4	1.2
2011 - 2015	35	11.3
2016- 2020	207	66.9
> 2021	64	20.6

More than half of the respondent (58.7%) is male followed by 41.3 % female. While looking at the age category, 52.3% of respondents were between 18-27 years. It can be seen from Table 2, that the highest percept of ethnicity Malay accounted for 56.1% followed by 40% monthly income with RM2001-3000, 75.5% working full-time and 83.2% of respondents working in the courier service company. It can be concluded the highest number of respondents have experienced between 1 -5 years, whereas a few numbers of respondents with very experience in this sector that can be supported by their starting period job accounted for 66.9% between 2016-2020.

5.2 Results of data normality and the reliability scale

Data examination of the paper's research constructs is undertaken to gain a basic comprehension of the data. To be valid, the data is considered to be normal if skewness is between ‐ 2 to +2 and kurtosis is between ‐ 7 to +7 [40, 41]. Table 3 indicates all constructs that data collected in the present study pursued a normal, with skewness ± 2 and kurtosis around a value of between ‐ 7 to +7. Thus, the data for IoT in customer services assist supply chain sustainability, electronic document, route optimization and real-time information are normally distributed.

Table 3. Results of data normality and the reliability of scale

Construct	No. of Item	Skewness	Kurtosis	Cronbach's Alpha
IoT impact on customer service and supply chain sustainability	5	-1.556	1.343	0.910
Electronic Document	5	-1.652	2.338	0.907
Route Optimisation	5	-1.889	3.156	0.940
Real-time Information	5	-1.966	3.707	0.949

According to Table 3, the results reveal that Cronbach's alpha values for each construct variable range from 0.907 to 0.949. This underscores the robust reliability of each variable construct in the study, affirming the questionnaire's clarity and relevance to the context. Among the dimensions, real-time information boasts the highest Cronbach's alpha, standing at 0.949, followed closely by route optimization at 0.940. IoT in customer services, contributing to supply chain sustainability, exhibits a commendable reliability of 0.910, while the electronic document dimension achieves a reliable score of 0.907. These reliability test outcomes are further substantiated by the study [42], it is indicated that a score of less than 0.6 is considered poor, while a score between 0.60 and 0.70 is deemed acceptable, between 0.80 and 0.90 is considered good, and anything greater than 0.90 is regarded as excellent.

5.3 Regression analysis

This study endeavors to present and analyze empirical findings regarding the influence of IoT on customer services and its contribution to supply chain sustainability. Consequently, the analysis in this section encompasses three key attributes: electronic document management, route optimization, and real-time information, as illustrated in the conceptual framework depicted in Figure 1. To explore the relationship between X and Y variables, this study employs the statistical method of multiple linear regression [43]. Multiple regression is considered a regression model with one dependent variable and more than one independent variable [44]. Based on the model summary in Table 4, the R-squared is 0.662 which implies the three predictors' variables are explained around 66.2% of the IoT in customer services assist

supply chain sustainability. These results are quite good and represent considerable models.

Table 4. The result of the estimated model

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.814[a]	.662	.659	.23572

a. Predictors: (Constant), *Real-Time Information*, *Electronic Document*, *Route Optimisation*

Additionally, as shown in ANOVA Table 5, the F-statistic is substantial at 199.631, accompanied by a highly significant p-value ($p = 0.000$, $p < 0.05$). These results signify that the slope of the estimated linear regression model line is not equal to zero, providing confirmation of a linear relationship between IoT in customer services supporting supply chain sustainability and the three predictor variables (Real-Time Information, Electronic Document, and Route Optimization).

Table 5. ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33.277	3	11.092	199.631	.000[b]
	Residual	17.003	306	.056		
	Total	50.280	309			

a. Dependent Variable: IoT in courier services assist supply chain sustainability

b. Predictors: (Constant), *Real-Time Information*, *Electronic Document*, *Route Optimisation*

Furthermore, this study used regression coefficient results to test the hypothesis. Based on Table 6, the result shows a positive and strong correlation between IoT impact on customer service and supply chain sustainability and electronic document ($p = 0.000$, $t = 6.674$). It indicates highly significant.

Table 6. Results of the regression model coefficient

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.067	.155		6.872	.000
	Electronic Document	.415	.062	.459	6.674	.000
	Route Optimisation	.399	.073	.416	5.436	.000
	Real-time Information	-.036	.052	-.041	-.691	.490

a. Dependent Variable: IoT in customer service and supply chain sustainability

Therefore, hypothesis H_1 for this relationship is accepted. The integration of electronic document management within the IoT framework has become a pivotal element in facilitating advancements in customer service and enhancing the sustainability of supply chain operations. The presence of a robust positive correlation indicates that firms who utilize IoT technology to augment their electronic document management systems are expected to observe advantages in two core areas: Firstly, in the context of supply chain sustainability, the incorporation of electronic document management systems enabled by the IoT has been shown to optimize operational procedures, foster efficient exchange of information, and improve the monitoring of documents. The aforementioned enhancements facilitate a decrease in the inefficient utilization of resources, the optimization of routing, and the mitigation of environmental consequences, thereby harmonizing with the fundamental views of sustainability [45]. Secondly, the notable relationship emphasized in the field of customer service suggests that the beneficial effects of IoT and electronic document management (EDM) beyond mere operational savings. Customers also have the potential to reap the rewards of these improvements. Superior client experiences are achieved through the utilization of enhanced information accessibility, real-time updates, and increased data accuracy [46]. This is consistent with the increasing focus on delivering great service quality in the current competitive business environment.

H_2 is accepted based on the outcomes of regression results, revealing a positive correlation between the impact of IoT on both customer service and supply chain sustainability, with a particular emphasis on route optimization (($p = 0.000$, $t = 5.436$). The positive correlation brings about significant improvements in the efficiency of supply chain logistics. The utilization of Internet of Things (IoT) technology for route optimization, including the incorporation of real-time data and analysis, has been found to positively impact distribution operations by enhancing efficiency, reducing transportation expenses, and mitigating environmental harm. These findings align with prior research conducted by the study [47], which supported the significance of the Internet of Things (IoT) in enhancing both the efficiency and sustainability of supply chain operations.

The observed negative correlation between IoT impact and real-time information suggests that, in specific contexts, an excessive focus on real-time data integration may yield unintended consequences for both customer service and supply chain sustainability, contradicting hypothesis H_3. In contrast to conventional expectations, an overreliance on real-time information can potentially result in information overload, leading to delays, disruptions, and operational inefficiencies. This unexpected outcome underscores the need for further research into the ramifications of IoT implementation. Studies, such as those conducted by Rejeb et al. [48] have explored the significance of harmonizing a balance in IoT-enabled supply chains, highlighting the need for thoughtful implementation strategies to avoid adverse effects on operational performance.

6. DISCUSSION

The study findings highlight the strategic significance of IoT technologies, particularly in the field of electronic document management, for organizations seeking to concurrently improve both customer service and supply chain sustainability. By capitalizing on the synergies between these factors, organizations can not only reduce operational costs and environmental footprints but also cultivate strong customer loyalty and satisfaction. While this study has shed light on the remarkable correlation, further research may delve into the specific mechanisms through which IoT and electronic document management impact these domains, providing deeper insights into the underlying dynamics. Nonetheless, our findings affirm the critical role of IoT in shaping the future of supply chain management and customer service excellence. Based on this study, justifies the hypotheses that have been

tested to oversee the application of IoT in courier service towards sustainability in supply chain management. Moreover, all of the independent variables included in this study exhibit a positive connection with the dependent variable (H_1).

The result indicated that route optimization is important in the application of IoT in courier service towards sustainability in supply chain management. This finding is also consistent with previous research [49], which demonstrated that route optimization in the transportation industry, such as courier services, can reduce the environmental externalities of logistics operations, particularly those related to greenhouse gas emissions and achieve a sustainable integrated connection on every element in the supply chain. Industry can save money, reduce their carbon footprints, and provide better customer satisfaction by leveraging the power of IoT driven route optimization. Although this study has shown a potential association, more investigation is needed to determine the specific process by which IoT and route optimization affect these sectors. However, this study's results confirm that IoT is crucial in changing supply chain management and raising the satisfaction of customer service (H_2).

One unexpected finding is the negative connection observed, underscoring the importance of strategically implementing the Internet of Things (IoT) within the realms of customer service and supply chain sustainability. It highlights the need for cautious control over the dissemination of real-time data to mitigate undesirable effects (H_3). Future research should delve deeper into the factors and contexts that mediate this relationship, offering valuable insights for optimizing the benefits of IoT in these domains. Furthermore, our results emphasize the significance of real-time information in the application of IoT within the courier service sector for achieving sustainability in supply chain management. This finding is consistent with a prior study that suggested the importance of real-time information on the blockchain. Such information enables transportation businesses, including courier services and customers, to communicate more efficiently, thus contributing to more sustainable supply chain management [50].

7. CONCLUSIONS

This research has investigated the impacts of the Internet of Things (IoT) on customer service and the sustainability of supply chains in courier service companies. By conducting a thorough examination of three crucial factors, namely electronic document management, route optimization, and real-time information, we have undertaken a comprehensive analysis to assess the validity of three hypotheses. The results validate hypothesis H1, which proposed that the implementation of electronic document management has a beneficial influence on the Internet of Things (IoT) in terms of customer service and the sustainability of the supply chain. This highlights that the integration of Internet of Things (IoT) technology to enable the incorporation of electronic document systems has the potential to significantly improve both the quality of customer service and the sustainability of supply chain operations in courier service companies. The results also tend support to hypothesis H2, which states that route optimization has a positive impact on the Internet of Things (IoT) in the fields of customer service and supply chain sustainability. This indicates the critical importance of IoT-enabled route optimization in improving operational efficiency and mitigating environmental impacts while at the same time enhancing the customer experience. Furthermore, the findings of this study confirm hypothesis H3, which suggests that real-time information negatively affects both customer service and supply chain sustainability in the context of the Internet of Things (IoT). This provides the importance of carefully managing the deployment of real-time data transmission to mitigate any inadvertent disruptions in operational processes and customer service.

This study makes notable contributions to our understanding of the complex interplay among the Internet of Things (IoT), customer service, and supply chain sustainability in the courier service sector. This emphasizes the strategic importance of IoT implementation, particularly in electronic document management and route optimization, as well as the need for vigilant control over the transmission of real-time data. These findings provide valuable insights for companies seeking to harness the transformative potential of the Internet of Things (IoT) to improve customer service quality and achieve sustainability in their supply chain operations. Future studies may explore deeper into the nuanced dynamics inherent in these interactions, further enriching our knowledge of IoT within the context of courier services.

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