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DRIVE-THRU REVOLUTION: ENHANCING CUSTOMER SATISFACTION THROUGH DIGITAL TWINS

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ABSTRACT

In business, understanding consumers is paramount. Digital Twins technology provides virtual representations of consumers and real-time insights. This study evaluates the implementation of Digital Twins in drive-thru services, focusing on efficiency and user experience. A survey was conducted with 2000 drive-thru consumers in the US and analyzed using SEM-PLS. The findings of this study indicate the significance of Digital Twins in purchase accuracy, interactivity, and satisfaction. The importance of strategic implementation is highlighted to maximize benefits and offer a framework for secure implementation. Limitations of this research include geographical constraints of the respondents, data collection methods, and limitations in relevant literature due to the new nature of Digital Twins technology in the context of drive-thru services. Future research needs to explore cross-cultural comparative research, longitudinal studies, and mixed-methods approaches to understand this technology's impact further.

Keywords: digital twins, drive-thru, consumer behavior, data security

A. INTRODUCTION

Business dynamics continue to change and coincide with technological developments as time passes. To achieve success, consumer insight through customer responsiveness is needed. Existing businesses tend to rely on traditional methods of gathering consumer insights. Telephone survey techniques, face-to-face interviews, and focus groups have long been the gold standard. Although these methods provide valuable insights, they have limitations such as taking a long time, being quite expensive, and lacking depth and breadth in understanding the modern consumer. The presence of Digital Twins confronts us with a virtual replica created by combining real-time data with sophisticated algorithms (VanDerHorn & Mahadevan, 2021). Relevant to consumer insight, Digital Twins become a virtual representation of consumers,

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reflecting their behavior, preferences and purchasing patterns. This technology is not just a new tool for marketers; it will redefine the entire consumer research landscape. In contrast to traditional research methods that involve months-long waiting periods, Digital Twins can provide insights almost instantly, enabling businesses to respond to market changes at unprecedented speed. Digital Twins is not only in the business realm, but Digital Twins has also been implemented in disaster mitigation in the transportation sector (see Figure 1).

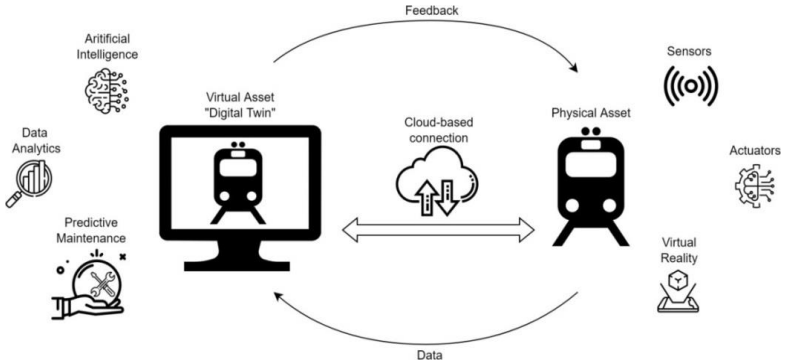

Figure 1. Implementation of Digital Twins in Disaster Mitigation

Source: Patandianan & Assidiq, 2022

Comprehensive data analysis is an advantage of Digital Twins, which can integrate multiple data points, from geolocation to online browsing habits, providing a multi-dimensional view of consumers (Lizar et al., 2023). For businesses with global operations, Digital Twins are a game changer created to represent consumers from different regions, ensuring insights that are culturally relevant and geographically specific (Hu et al., 2021). Traditional telephone surveys may capture feedback rate by rate from 50.000 consumers during a month. Conversely, Digital Twins can simulate feedback from 30,000 virtual consumers within a single day. Focus group sessions, which may cost as much as $6,000 per session, can be replaced by virtual product testing with the Digital Twins, resulting in potential savings of up to 80%. The ability of Digital Twins to simulate various market scenarios can reduce the product testing phase from several months to just a few days. With the ability to integrate real-time data, Digital Twins can predict consumer behavior with an accuracy rate of up to 90%, experiencing a significant jump from the 60-70% accuracy rate in traditional methods (Attaran & Celik, 2023).

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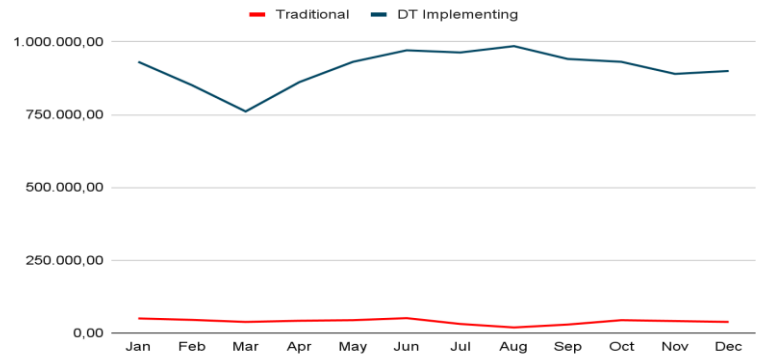

Figure 2. Performance comparison in traditional survey and DT implementation

Source: Jones et al., 2020

Digital Twins and its significant impact in various sectors, including banking, business and financial services, has provided a clear example of its implementation. However, there are still challenges and opportunities that need to be explored. Digital Twins in the banking, business and financial services sectors have demonstrated huge potential value in understanding customer behavior, improving security and providing deep insights into business risks (Heluany & Gkioulos, 2023). However, along with the success of technology, Digital Twins. In this sector, several aspects need further attention. In this context, the technological implementation of Digital Twins in the drive-thru-based service sector, such as at the drive-thru services, becomes an interesting research topic. Drive-thru is an innovative service that can provide convenience and comfort to customers in transactions.

Digital Twins are very useful in helping various sectors. Research by Human et al. (2023) has revealed how Digital Twins can work in the consumer goods sector based on a reference architecture. The results enable systematic decisions that reflect complex systems. Other research results also show that implementing integrated procurement, production and distribution (PPD) has provided great benefits. Specifically, the study observed a 65% utilization of pasteurization and aging containers and an impressive 97% utilization of freezers. In addition, by implementing the DT model, the currently implemented model has resulted in a reduction in storage space capacity of 6%, which further simplifies operations and increases efficiency (Maheshwari et al., 2023). Deeper, Wu et al. (2023) research also show that Digital Twins have proven effective in managing staff safety, operational information, product quality assurance, and maintaining stakeholder loyalty, showing a real improvement in the Service

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Platform for Cold Chain Logistics. Han et al. (2023) show that digital twinning methods enable real-time and continuous control of related operational tasks and further encourage the development of digitalization, automation and intelligence in hospital operations.

Figure 3. Concept of using Digital Twins in various sectors

Source: Stavropoulos & Mourtzis, 2022

This research aims to understand how Digital Twins technology can be implemented effectively to improve drive-thru service efficiency, performance, and user experience from a consumer perspective. Besides that, the benefit of the study is intended to evaluate the impact of using Digital Twins on operational management, customer interactions, and other relevant aspects of the drive-thru environment. This research will also explore challenges related to data security and privacy, coordinating responses to change, and adapting to different scenarios. Thus, this research will contribute to understanding the concept of Digital Twins in the context of drive-thru services and detail potential problems and solutions in its implementation. By bringing together an understanding of the success of technology Digital Twins in related sectors and focusing on drive-thru implementation, this research aims to provide a holistic view of the potential benefits and challenges that can be faced in achieving optimal customer satisfaction.

B. LITERATURE REVIEW

Customers' expectations for service experiences are continuously rising, prompting organizations to explore novel methods for enhancing customer satisfaction and operational efficiency. One such innovation is the adoption of Digital Twins technology in drive-thru services. Digital Twins are virtual replicas of physical objects in the real world, facilitating real-time monitoring and analysis to enhance service efficiency and quality (Kang & Mo, 2024). This literature review will examine the Digital Twins concept and its implications for drive-thru services. Digital Twins represent an innovation that transforms our understanding

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and management of physical objects in the real world (Jeddoub et al., 2023). This concept entails generating precise virtual duplicates of tangible objects, which are subsequently interconnected with real-time data and scrutinized using sophisticated algorithms. Within drive-thru services, Digital Twins can mimic ordering, payment, and food delivery procedures, facilitating more effective monitoring and evaluation of operational efficiency and customer satisfaction (Pittaras et al., 2023).

The utilization of Digital Twins in drive-thru services provides several advantages, notably improving purchase accuracy. This technology allows companies to gather and analyze data regarding customer preferences and buying patterns, enabling them to offer more personalized menus and minimize order inaccuracies (Hunhevicz et al., 2022). Additionally, Digital Twins facilitates livestock monitoring, guaranteeing the presence of sought-after items for clients. Furthermore, interaction is pivotal in elevating client satisfaction in drive-thru facilities. By applying Digital Twins, enterprises can enrich client interaction by employing more user-friendly and adaptable interfaces. For instance, clients can utilize mobile applications to place advance food orders. Digital Twins can incorporate this information into the drive-thru procedure to ensure that their orders are prepared upon arrival (Ehemann et al., 2023).

Customer experience is integral to the success of drive-thru services. With Digital Twins, businesses can enhance customer experience by providing more personalized and responsive services (Human et al., 2023). For example, Digital Twins can recall customer preferences and buying patterns, thus providing more personalized suggestions and reducing waiting times. Additionally, Digital Twins contributes to operational efficiency by enhancing performance and customer satisfaction in drive-thru services. Using Digital Twins, companies can identify and resolve bottlenecks in service processes, thereby improving throughput and reducing wait times. For instance, Digital Twins can anticipate customer traffic patterns and coordinate food deliveries to prevent congestion. The performance of services is a crucial metric for operational success in drive-thru services. By leveraging Digital Twins, businesses can monitor service performance in real-time and pinpoint improvement areas. For example, Digital Twins can alert staff when wait times exceed a certain threshold, enabling them to expedite service. Security is paramount in drive-thru services, particularly regarding payment and food delivery. With

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Digital Twins, businesses can bolster security by monitoring real-time transactions and detecting suspicious activity. Service quality is a key factor in enhancing customer satisfaction in drive-thru services. Businesses can ensure service quality through Digital Twins by monitoring and analyzing interactions between staff and customers. Digital Twins can record conversations between staff and customers to evaluate customer satisfaction levels and identify areas for improvement (De Azambuja et al., 2024). Customer satisfaction is the ultimate measure of success in drive-thru services. With Digital Twins, businesses can improve customer satisfaction by providing faster, more responsive, and more personalized services (Durão et al., 2024). For example, Digital Twins can send notifications to customers when their orders are ready for pickup, thereby reducing wait times and enhancing overall customer satisfaction.

Based on this literature review, it can be concluded that implementing Digital Twins in drive-thru services has significant potential to improve operational efficiency and customer satisfaction. Through this technology, businesses can enhance the accuracy of purchases, interactivity, customer experience, process efficiency, service performance, security, service quality, and customer satisfaction. However, achieving its full potential requires collaboration among academics, practitioners, and technology developers to address challenges related to system integration, data security, and implementation costs. With effective cooperation, the implementation of Digital Twins in drive-thru services has the potential to transform the industry landscape and enhance the overall customer experience.

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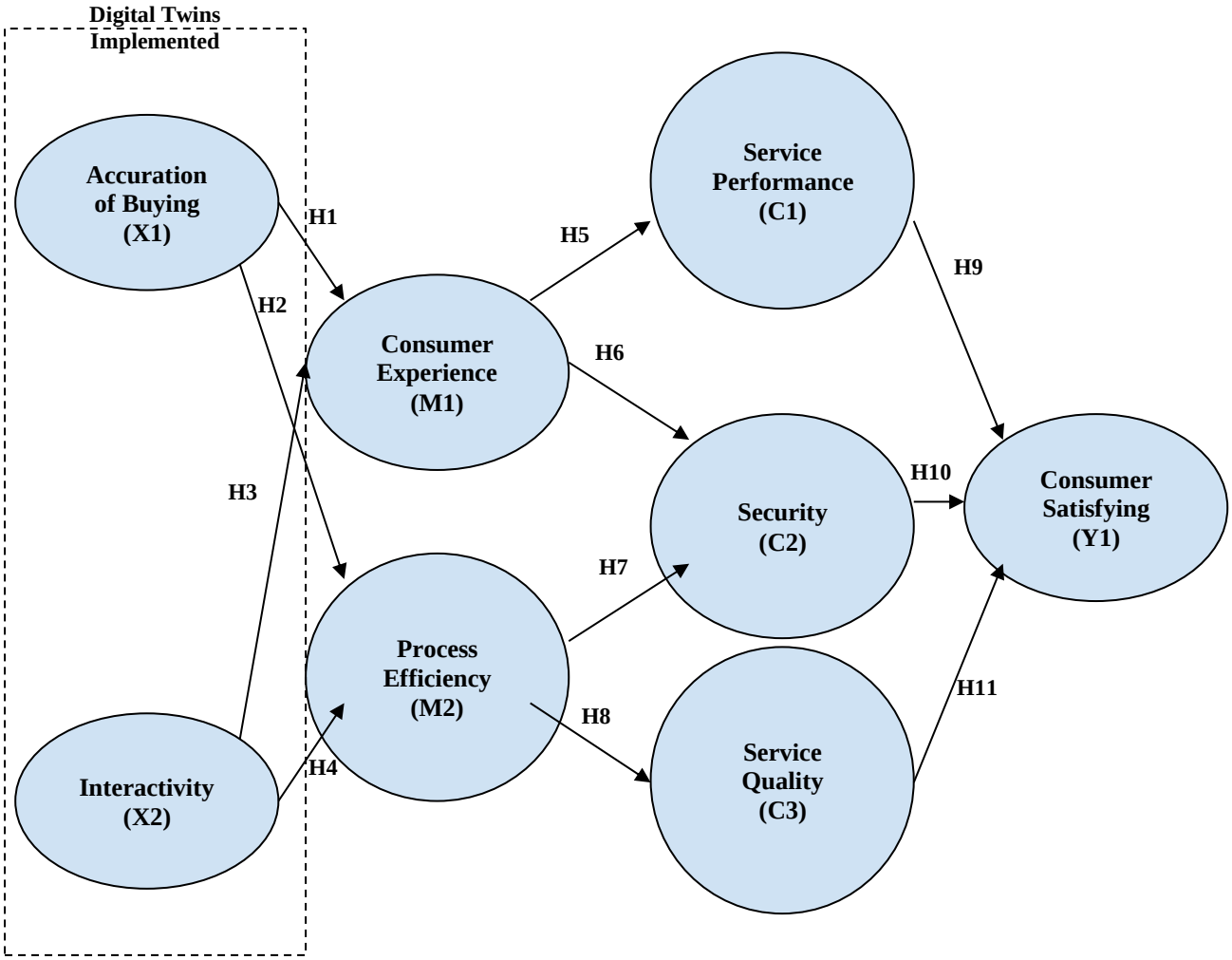

Figure 4. Research Conceptual Framework

Source: Author's Elaboration, 2023

Figure 4 illustrates the context of the relationships between variables, as described below:

a. X1 (Accuration of Buying): Directly influences C1 (Service Performance), C2 (Security), and C3 (Service Quality), and indirectly influences Y1 (Consumer Satisfaction) through its impact on the variable M1 (Consumer Experience).
b. X2 (Interactivity): Directly influences M1 (Consumer Experience), C1 (Service Performance), C2 (Security), and C3 (Service Quality), and indirectly influences Y1 (Consumer Satisfaction) through its impact on M1 (Consumer Experience).
c. M1 (Consumer Experience): Directly influences Y1 (Consumer Satisfaction) and indirectly influences Y1 (Consumer Satisfaction) through its impact on C1 (Service

Performance), C2 (Security), and C3 (Service Quality).

d. M2 (Process Efficiency): Directly influences C1 (Service Performance), C2 (Security), and C3 (Service Quality), and indirectly influences Y1 (Consumer Satisfaction) through its impact on M1 (Consumer Experience).
e. C1 (Service Performance), C2 (Security), and C3 (Service Quality): Directly influence Y1 (Consumer Satisfaction).

C. RESEARCH METHODS

This research adopts a quantitative approach to investigate in-depth consumer satisfaction with the application of technology Digital Twins Pada drive-thru (Esteban-Bravo & Vidal-Sanz, 2021). The research population consists of experienced consumers using the service drive through the United States. This was chosen because the drive-thru system implemented was quite implementable in the fast food sector and other buying and selling sectors where a drive-thru system is possible. A sample of 2000 respondents will be selected using purposive sampling (Gregori, 2023). The sample criteria were individuals who had used the drive-thru service at least once. The study was conducted from July to November 2023, a sufficient period to collect representative data and examine potential changes over time. The main instrument of this research is an online survey using an interval scale of 1-10 (Saris, 2021). This survey covers important aspects related to consumer satisfaction, perception of the effectiveness of Digital Twins, and preference for drive-thru service (See Table 1).

Table 1. Variable Distribution

Variable	Indicator	
X1 (Accuration of Buying)	X1.1	Accuracy of Product Information
	X1.2	Precision in Order Processing
	X1.3	Correctness of Transaction Amount
	X1.4	Accuracy in Delivery Time
X2 (Interactivity)	X2.1	Responsiveness of Customer Support
	X2.2	Ease of Navigation in the Interface
	X2.3	Availability of Real-time Assistance
M1 (Consumer Experience)	M1.3	Satisfaction with User Interface
	M1.2	Enjoyment in Navigating the Platform

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Variable	Indicator	
	M1.3	Overall Pleasure in the Shopping Experience
M2 (Process Efficiency)	M2.1	Timeliness in Order Processing
	M2.2	Efficiency in Payment Procedures
	M2.3	Speed of Conflict Resolution
C1 (Service Performance)	C1.1	Timeliness in Service Delivery
	C1.2	Accuracy in Order Fulfillment
	C1.3	Effectiveness in Handling Customer Inquiries
C2 (Security)	C2.1	Data Privacy Assurance
	C2.2	Secure Payment Transactions
	C2.3	Protection Against Unauthorized Access
C3 (Service Quality)	C3.1	Quality of Product Offerings
	C3.2	Reliability of Service Availability
	C3.3	Consistency in Service Standards
Y1 (Consumer Satisfaction)	Y1.1	Overall Satisfaction with the Service
	Y1.2	Willingness to Recommend to Others
	Y1.3	Likelihood of Repeat Purchase

Source: Author's Elaboration, 2023

The questionnaires were distributed through the Triaba survey service (Triaba, 2022) because it can help get respondents who match the research target. The ethical aspects of research will be maintained by the applicable research code of ethics, including data security and respondent privacy. Participation in this research is voluntary, and data will be processed anonymously to maintain the confidentiality of respondents' identities (Poth, 2021). Data analysis will be carried out using the SEM-PLS method with the support of SmartPLS 4.0 software. This method will be used to evaluate the relationship between research variables, allowing a deeper understanding of the impact of Digital Twins technology on consumer satisfaction in the context of drive-thru services.

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D. RESULTS AND DISCUSSION

Respondent Profile

Table 2. Respondent Profile

Cluster	Type	Amount	Present
Sex	Male	1137	56.85%
	Female	863	43.15%
Age Group	<22 Years	98	4.90%
	22 - 35 Years	977	48.85%
	35 - 42 Years	812	40.60%
	>42 Years	113	5.65%
Service Type	Fast Food	704	35.20%
	Retail Products	210	10.50%
	Funeral Home	107	5.35%
	Voting	102	5.10%
	Emergency	215	10.75%
	Prayer Room	227	11.35%
	Wedding	116	5.80%
	Law Firm	203	10.15%
	Bar/Club	111	5.55%
	Politician	5	0.25%
Frequency	1 - 2	127	6.35%
	3 - 5	1303	65.15%
	>5	570	28.50%

Source: Author's Elaboration, 2023

Table 2 contains the Respondent Profile, which is the focus of this research. Data is grouped into several clusters, including gender, age group, type of service used, and frequency of use of Digital Twins services. Respondents in this study consisted of 1137 male individuals, which accounted for 56.85% of the total respondents, and 863 female individuals, which accounted for 43.15%. In terms of age group, most respondents were in the 22-35 year age range (977 individuals or 48.85%), followed by the 35-42 year age group (812 individuals or 40.60%). The age groups under 22 and over 42 contributed 4.90% and 5.65%, respectively. The types of services used by respondents in this study cover various categories, with "Fast Food" services dominating (704 individuals or 35.20%), followed by "Prayer Rooms" (227

individuals or 11.35%) and "Retail Products" (210 individuals or 10.50%). This table provides a rich data foundation for analyzing user preferences and habits for implementing Digital Twins in various drive-thru services.

Model Evaluation

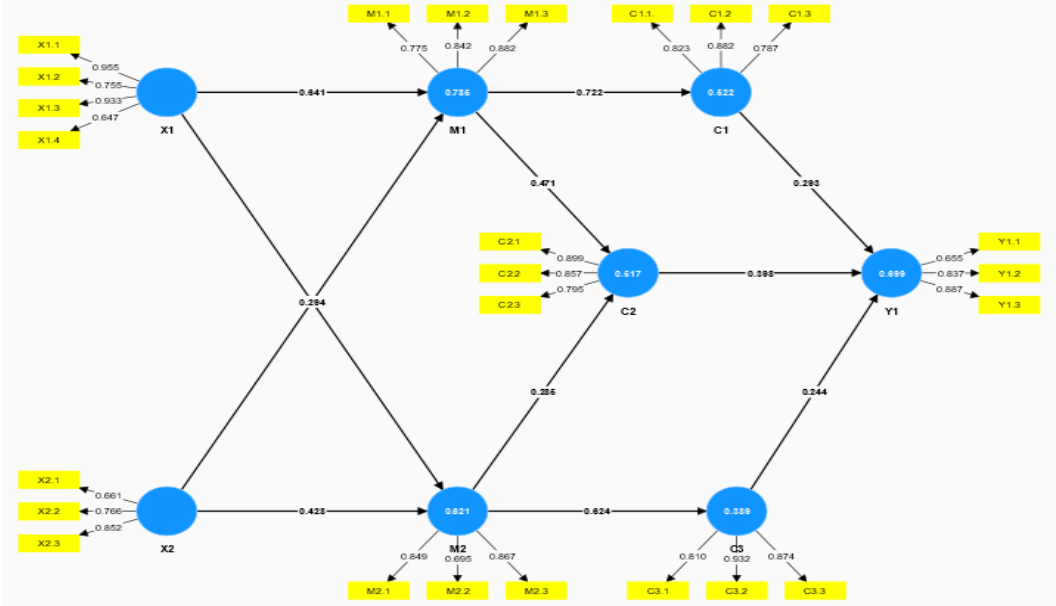

Figure 5. Pathway Analysis Results

Source: Author's Elaboration, 2023

This research tests the internal model's reliability using the convergent validity test. Convergent validity is evaluated by considering the Convergent Validity Test value, where the Minimum Average Variance Extracted (AVE) value is expected to exceed the threshold of 0.5. In addition, reliability testing is carried out by paying attention to the Composite Reliability value, which is desired to exceed 0.7, to ensure the reliability of the tested model (Hair, 2014).

Table 3. Reliability & Convergent Validity Test Results

Variable	Composite Reliability	AVE
X1	0.898	0.639
X2	0.806	0.583
M1	0.873	0.696
M2	0.848	0.652

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Variable	Composite Reliability	AVE
C1	0.870	0.692
C2	0.887	0.725
C3	0.906	0.762
Y1	0.840	0.639

Source: Author's elaboration, 2023

Table 3 shows all variables' Average Variance Extracted (AVE) values , consistently reaching figures above 0.5. These results indicate that the data collected in the context of this research can be considered valid. Furthermore, the Composite Reliability results show that the value for each variable exceeds the 0.7 limit. Therefore, it can be concluded that this research shows a significant level of reliability and validity of the data (Magno et al., 2022).

Table 4. R-Square Testing

Variable	R-Square
X1	0.522
X2	0.517
M1	0.785
M2	0.621
C1	0.522
C2	0.517
C3	0.389
Y1	0.699

Source: Author's elaboration, 2023

The structural model was also evaluated using the R-Square test, as shown in Table 4. The evaluation results show that the R-Square value is close to 1, although it has not yet reached the middle value of the R-Square test criteria range for variable C3, which ranges from 0 to 1. Thus, it can be concluded that the variation in the dependent variable in this study can be explained by a model with an appropriate level of adequacy (Westfall & Arias, 2020).

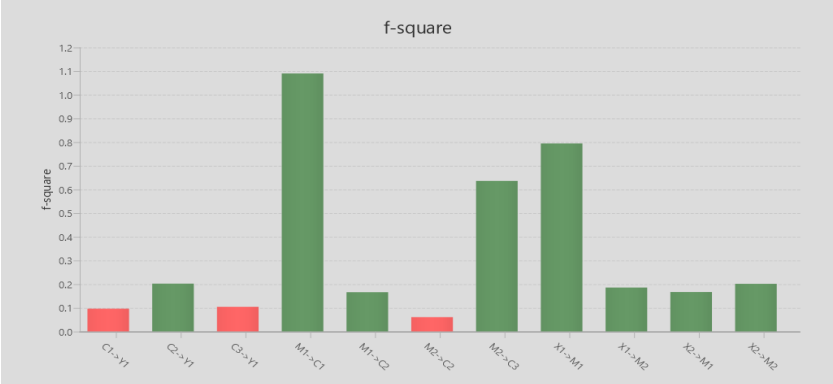

Figure 6. F-Square Test Results

Source: Author's Elaboration, 2023

The structural model was also evaluated using the f-square test. In Figure 4, the test results show that three of the eleven relationships tested are still below 0.1. Therefore, it can be concluded that there is a significant influence on the relationship between variables.

Total Effect Testing

Table 5. Total Effects Results

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistic	P Values
C1->Y1	0.293	0.265	0.141	2.072	0.038
C2->Y1	0.398	0.392	0.116	3.437	0.001
C3->Y1	0.244	0.275	0.112	2.182	0.029
M1->C1	0.722	0.714	0.107	6.722	0.000
M1->C2	0.471	0.473	0.215	2.191	0.028
M1->Y1	0.399	0.385	0.144	2.779	0.005
M2->C2	0.285	0.285	0.207	1.376	0.169
M2->C3	0.624	0.638	0.097	6.417	0.000
M2->Y1	0.265	0.288	0.119	2.225	0.026
X1->C1	0.463	0.466	0.093	4.959	0.000
X1->C2	0.419	0.424	0.103	4.085	0.000

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistic	P Values
X1->C3	0.256	0.250	0.109	2.345	0.019
X1->M1	0.641	0.654	0.081	7.888	0.000
X1->M2	0.411	0.383	0.143	2.879	0.004
X1->Y1	0.365	0.364	0.105	3.477	0.001
X2->C1	0.212	0.208	0.070	3.020	0.003
X2->C2	0.260	0.270	0.072	3.596	0.000
X2->C3	0.267	0.289	0.083	3.205	0.001
X2->M1	0.294	0.289	0.094	3.116	0.002
X2->M2	0.428	0.456	0.118	3.635	0.000
X2->Y1	0.231	0.244	0.065	3.534	0.000

Source: Author's elaboration, 2023

The results of the bootstrapping analysis in Table 5 reveal several key findings related to the total effect of the independent variable (X) on the dependent variable (Y) as well as the total effect between the control (C) and mediator (M) variables. First, there is a significant influence from C1 (Service Performance) to Y1 (Consumer Satisfaction), with a total effect of 0.293, indicated by a T statistic of 2.072 and a p-value of 0.038. Second, C2 (Security) shows a stronger influence on Y1 (Consumer Satisfaction) with a total effect of 0.398, accompanied by a T statistic of 3.437 and a p-value of 0.001, confirming its high significance. Furthermore, C3 (Service Quality) also made a significant contribution with a total effect of 0.244 and a T statistic of 2.182 (p-value 0.029). At the mediator level (M), M1 (Consumer Experience) shows a significant influence on C1 (Service Performance), C2 (Security), and Y1 (Consumer Satisfaction). At the same time, M2 (Process Efficiency) is only significant on C2 (Security) and C3 (Service Quality), with an insignificant influence on Y1 (Consumer Satisfaction). Furthermore, the independent variables X1 (Accuration of Buying) and X2 (Interactivity) significantly affect all related variables, strengthening their contribution to the model. Overall, the bootstrapping results provide strong support for the structure of the research model and

encourage the conclusion that the relationships between these variables have substantial statistical significance (Abdi, 2021).

Discussion

How Did Digital Twins Update the Drive-Thru Service Concept?

Based on the case data presented, Digital Twins can significantly contribute to drive-thru services' efficiency as a technological innovation. The restaurant case highlights the need for improvements in the drive-thru experience, emphasizing service speed and technology implementation (Suryawijaya et al., 2023). Through consumer surveys, it is known that long waiting times and lack of service friendliness are the main challenges faced by customers. In this context, using Digital Twins can help us better understand traffic lanes, order patterns, and staff performance at the drive-thru. By analyzing this data, restaurant owners can identify areas where efficiency can be improved, reducing wait times and increasing customer interactions. It is important to note that the use of technology in restaurants, including automation and artificial intelligence, was rated positively by most respondents (Tao et al., 2018). Thus, the future of DT computing involves advanced analysis and modeling techniques to meet the needs of the new agenda (Le & Fan, 2024). Therefore, integrating Digital Twins into drive-thru operations can be considered a step in line with consumer desires (Vrabič et al., 2018). For example, implementing AI voice assistants for faster ordering, personalized menus and smartphone payments can provide an effective solution to increase efficiency and customer satisfaction (Luna, 2023).

Figure 7. AI Assistant concept on Drive Thru service

Source: Luna, 2023

The retail business shows that the drive-thru concept can be applied in other sectors outside of fast food. For retailers, drive-thru can provide a quick and easy shopping experience without requiring customers to leave their vehicles (Zhong & Moon, 2020). At the retail business level, especially in retail stores and sales of non-food items, using a drive-thru can create an efficient solution for picking and delivering goods (Suryawijaya & Aqmala, 2023). By implementing Digital Twins, business owners can improve pick-up area design and overall operational coordination (Tao et al., 2019). Data analysis regarding customer preferences and shopping patterns has become invaluable for designing more personalized and efficient drive-thru experiences (Whitenack & Mahabir, 2022). Its significance is further elevated by the 'last mile' challenge in goods delivery, where Digital Twins-based drive-thru is emerging as a promising alternative.

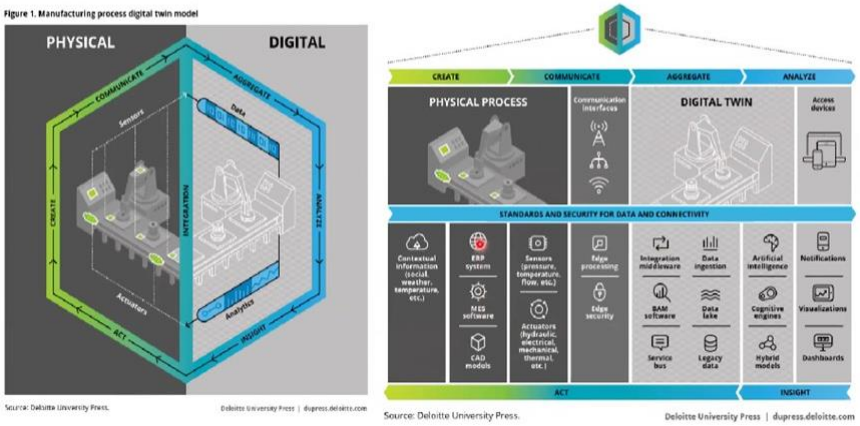

Figure 8. The process of translating physical and digital aspects of Drive Thru services

Source: Tao et al., 2018

Overall, the effectiveness of Digital Twins in drive-thru service can be interpreted as a progressive step to improve customer experience, reduce wait times, and provide solutions that are adaptive to consumer trends. By harnessing the potential of data, business owners can make smarter decisions to optimize drive-thru operations, taking this innovation to the next level in the retail sector. However, it is important to recognize that the efficiency of the process using Digital Twins still means there is a delay in queuing time for some customers, which makes them have to wait for orders (Lahrichi et al., 2020). This research shows that Digital Twins is a technological innovation that can significantly contribute to the efficiency of drive-thru services to increase customer satisfaction.

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Security in Using Digital Twins in the Business Sector

Digital Twins are poised to revolutionize industries' operations by moving from physical asset management to increasingly automated, data-driven remote working modes. However, this potential revolution also carries huge risks if something goes wrong. The threat of cyber attacks, supply chain fraud, errors, missed maintenance, and other issues can threaten system integrity and erode trust in the data generated and used (Alcaraz & Lopez, 2022). Moreover, twins operating with false data are not twins. Digital Twins systems are collections of different systems – disparate hardware and software components, physical environments, and actors that communicate and share data to create a holistic understanding of system operations and optimize decision-making. In this context, the need arises to consider security and trust as integral elements, where risks and responsibilities are shared, and actions taken by one party impact the other party (Hammar & Stadler, 2023). Therefore, Digital Twins security can be considered a team sport applicable to the technical and commercial domains.

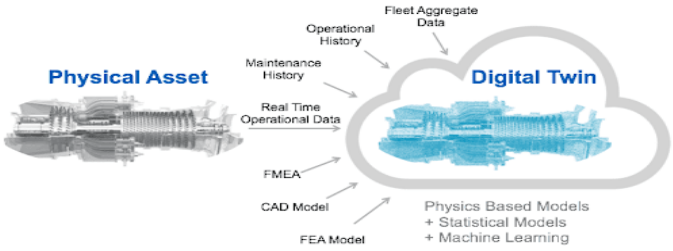

Figure 9. Digital Twins concept in supporting security systems

Source: Timperi et al., 2023

The Digital Twins Consortium is currently developing and documenting a security and trust approach that focuses on the specific and unique features of the Digital Twins system and its operations. The novelty of this research lies in presenting a comprehensive and detailed framework for properly assessing, adapting, and operating Digital Twins technologies and products, especially from a security perspective. This approach not only considers threat management in cyberspace but also explores the dimensions of regulatory compliance, personal safety protection, and appropriate investment management (Timperi et al., 2023). In addressing shared risks and responsibilities, this research offers a holistic view of the security of Digital Twins as a team sport. The main contribution of this research is to provide a framework that embraces the entire spectrum of security challenges, including less exposed

aspects such as investment management and regulatory compliance (Kurvinen et al., 2022; Suryawijaya & Aqmala, 2023). Thus, this research not only focuses on technical aspects but also involves broader considerations, making it a comprehensive guide for end users and system integrators who wish to implement Digital Twins safely and effectively.

Future Challenges Services by Consumer Viewpoints

Consumers play a significant role in the success of implementing this technology, as their experiences and perceptions will influence the adoption and acceptance of this innovation. Through the consumer perspective, we can understand how Digital Twins technology is perceived, accepted, and responded to by them in the context of drive-thru services (Heluany & Gkioulos, 2023). Consumer perspective refers to consumers' viewpoint or opinion regarding a product or service. Research findings indicate that consumers' perspective on Digital Twins technology in the drive-thru transaction experience shows significant acceptance but is not accepted from a security standpoint (Hammar & Stadler, 2023). Integrating Digital Twins technology with service enhancement is a strategic step in improving efficiency and service quality in the drive-thru industry. Integrating Digital Twins technology enables drive-thru business owners to understand order patterns, traffic flow, and employee performance more deeply. This allows them to identify areas where efficiency can be improved and provide more targeted solutions to enhance consumer service quality. By implementing Digital Twins technology, business owners can optimize the ordering process, reduce wait times, and improve order accuracy (Attaran & Celik, 2023; Westfall & Arias, 2020).

Additionally, the integration of Digital Twins technology also allows for the adoption of innovations such as AI voice assistants, personalized menus, and smartphone payments, which can enhance consumer convenience and satisfaction (Suryawijaya & Wardhani, 2023). Digital Twins technology's challenges and future directions are a significant focus of this discussion. Despite its great potential to improve efficiency and service quality, Digital Twins technology faces several challenges that must be addressed for successful implementation (Alcaraz & Lopez, 2022). Furthermore, the future direction of Digital Twins technology also needs to be considered, including the potential security aspects, which align with the findings of this research. With a deep understanding of the challenges and future directions of Digital Twins technology, we can identify strategic steps that need to be taken to maximize the benefits of

this technology in improving efficiency and service quality in the drive-thru industry and other industries.

E. CONCLUSIONS

In conclusion, this research underscores the promising prospects of integrating Digital Twins technology into drive-thru services to enhance operational efficiency and elevate customer experience. By leveraging insights from consumer surveys, it becomes evident that addressing issues like extended wait times and service quality deficiencies is paramount for drive-thru establishments. Through implementing Digital Twins, restaurant owners gain invaluable insights into customer behavior, traffic flow, and staff performance, enabling them to streamline operations and optimize service delivery. The findings suggest that AI voice assistants, personalized menus, and mobile payment solutions can significantly mitigate common pain points that drive-thru patrons encounter, thereby fostering greater satisfaction and loyalty. Consequently, the successful integration of Digital Twins holds profound implications for the drive-thru industry, paving the way for a more seamless and tailored customer experience while driving business growth and competitiveness.

Several key avenues can be explored in future research on integrating Digital Twins technology in drive-thru services. Firstly, a cross-cultural comparison could be conducted to investigate how cultural factors influence the adoption and effectiveness of Digital Twins in drive-thru services across different countries or regions. This comparative approach would offer insights into tailoring the technology to specific cultural contexts and improving its global applicability. Secondly, a longitudinal study could be undertaken to track the evolution of customer perceptions and behaviors regarding Digital Twins in drive-thru services over an extended period. This longitudinal approach would provide a deeper understanding of the long-term impact and effectiveness of the technology, as well as identify any changing trends or challenges. Thirdly, a mixed-methods approach could be employed, combining qualitative and quantitative methods to gain a comprehensive understanding of the effects of Digital Twins on drive-thru operations and customer experiences. Qualitative data could provide rich insights into customer perceptions and behaviors, complementing the quantitative survey data.

Additionally, exploring the integration of Digital Twins with other emerging

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technologies, such as augmented reality (AR) or Internet of Things (IoT) devices, could further enhance drive-thru operations and customer experiences. This investigation could explore how these technologies could work together synergistically to improve efficiency and personalization. Furthermore, conducting in-depth case studies of drive-thru establishments that have successfully implemented Digital Twins could provide valuable insights and best practices for other businesses looking to adopt the technology. Lastly, exploring how the implementation of Digital Twins in drive-thru services can contribute to sustainability and green practices could be another avenue for research. This could include studying how the technology can optimize energy use, reduce waste, and promote environmentally friendly practices in drive-thru operations. These suggested research avenues aim to deepen the understanding of Digital Twins in drive-thru services by exploring dimensions such as cross-cultural differences, long-term effects, integration with other technologies, and sustainability aspects.

The limitations of this research encompass several aspects. Firstly, there is a geographical constraint as the study focuses solely on drive-thru customers in America, potentially limiting the generalizability of the findings to a global or non-American population. Variations in other countries' cultural contexts, consumer preferences, and business infrastructures may yield different results. Secondly, the data collection method through online surveys via Triaba service may introduce selection bias, as respondents who are less tech-savvy or lack internet access might be underrepresented in the sample. Thirdly, the study only includes respondents who have used drive-thru services at least once, possibly overlooking the diversity in user experiences that could influence their perceptions and attitudes towards Digital Twins technology. Fourthly, while the research covers various types of drive-thru services such as fast food, retail stores, and polling stations, other types of drive-thru services are not addressed in this study, limiting the generalizability of the findings to other service types. Additionally, the research was conducted within a limited timeframe from July to November 2023, which may impact the understanding of long-term dynamics in adopting Digital Twins technology in drive-thru services. Lastly, challenges were encountered in sourcing relevant literature due to the emerging nature of Digital Twins technology in the context of drive-thru services, which might have constrained the depth of the literature review.

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