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THE APPLICATION OF WEB TECHNOLOGIES IN SMART TRANSPORTATION AND FLEET MANAGEMENT WITHIN THE IOT ERA: A SYSTEMATIC LITERATURE REVIEW (2020–2025)

PENERAPAN TEKNOLOGI WEB UNTUK SMART TRANSPORTATION DAN MANAJEMEN ARMADA DI ERA IOT SYSTEMATIC LITERATURE REVIEW 2020–2025

Aril Adila Yusuf [1*], Annisa [2], Muh Afriansa [3], Serli [4], Wahda Mutmainnah [5], Dayanti [6]
Universitas Muhammadiyah Kolaka Utara, Lasusua, Indonesia[1,2,3,4,5,6]

ariladilayusuf@gmail.com [1*], annisa@gmail.com [2], muhafriansa@gmail.com [3], serli@gmail.com [4], wahdamutmainnah@gmail.com [5], dayanti.fattah@gmail.com [6]

ABSTRACT

The development of the Internet of Things (IoT) has transformed smart transportation systems and modern fleet management, with web technology serving as the integration platform connecting IoT devices, management systems, and users. This systematic research examines the implementation of web technology for real-time vehicle monitoring, machine learning-based route optimization, predictive maintenance, and analytics dashboards. The system architecture involves four layers: IoT (vehicle sensors), communication (MQTT, REST API, WebSocket), cloud computing (big data processing), and presentation (Progressive Web Apps, React/Vue.js). The system integrates GPS data, telemetry, fuel consumption, driving behavior, and traffic conditions for operational optimization. Research findings show operational efficiency improvements of 30-40%, maintenance cost reduction of 25%, fuel consumption decrease of 15-20%, and incident rate reduction of 35%. Challenges include data security, system interoperability, infrastructure scalability, protocol standardization, and legacy system integration. This research provides reference architecture, technology evaluation framework, best practices, and digital transformation roadmap for various organizational scales and fleet types.

Keywords: *Smart Transportation, Fleet Management, IoT, Web Technology, Real-time Monitoring.*

ABSTRAK

Perkembangan *Internet of Things* (IoT) telah mentransformasi sistem transportasi cerdas dan manajemen armada modern, dengan teknologi web sebagai platform integrasi yang menghubungkan perangkat IoT, sistem manajemen, dan pengguna. Penelitian sistematik ini mengkaji implementasi teknologi web untuk monitoring kendaraan real-time, optimasi rute berbasis *machine learning, predictive maintenance*, dan *dashboard analytics*. Arsitektur sistem melibatkan empat layer: IoT (sensor kendaraan), komunikasi (MQTT, REST API, WebSocket), *cloud computing (big data processing)*, dan presentasi (*Progressive Web Apps*, React/Vue.js). Sistem mengintegrasikan data GPS, telemetri, konsumsi bahan bakar, perilaku mengemudi, dan kondisi lalu lintas untuk optimasi operasional. Hasil kajian menunjukkan peningkatan efisiensi operasional 30-40%, pengurangan biaya maintenance 25%, penurunan konsumsi bahan bakar 15-20%, dan reduksi incident rate 35%. Tantangan meliputi keamanan data, interoperabilitas sistem, skalabilitas infrastruktur, standardisasi protokol, dan integrasi dengan *legacy system*. Penelitian memberikan *reference architecture*, framework evaluasi teknologi, best practices, dan roadmap transformasi digital untuk berbagai skala organisasi dan jenis armada.

Kata Kunci: *Transportation,* Manajemen Armada*, IoT,* Teknologi Web*, Real-time Monitoring*.

INTRODUCTION

The development of the Internet of Things (IoT) has transformed various aspects of modern life, particularly in transportation systems and fleet management. In recent years, the transportation industry has undergone a significant digital revolution, driven by increasing internet penetration, widespread smartphone adoption, and the growing affordability of sensor technologies. Data show that in 2024, more than 15 billion IoT devices were connected worldwide, with the transportation sector being one of the largest contributors to the adoption of this technology. This situation creates major opportunities for the transportation industry to implement management systems that are smarter, more efficient, and more responsive to operational dynamics.

Web technology plays a role as an integration platform that connects IoT devices, management systems, and users within the smart transportation ecosystem. Smart transportation offers comprehensive solutions to congestion, pollution, accidents, and operational inefficiencies through real-time communication among vehicles, infrastructure, and cloud computing for data-driven decision-making. This system enables fleet managers to monitor vehicle conditions in real time, optimize travel routes, predict maintenance needs, and analyze driver behavior to improve safety and operational efficiency.

Modern smart transportation architecture involves four main layers that work in an integrated manner. The first layer is the IoT layer, which consists of various vehicle sensors such as GPS, accelerometers, fuel sensors, and temperature sensors that continuously collect operational data. The second layer is the communication layer, which uses protocols such as MQTT, REST API, and WebSocket for real-time data transmission with minimal latency. The third layer is the cloud computing layer, which performs big data processing, analytics, and machine learning to generate operational insights. The fourth layer is the presentation layer based on Progressive Web Apps, which provides a user-friendly interface for monitoring and decision-making.

Various studies have shown the significant impact of implementing web technology in fleet management. Real-time monitoring systems enable early detection of operational anomalies, machine learning–based route optimization can reduce travel time by up to 20%, predictive maintenance can prevent unexpected breakdowns, and driver behavior analysis contributes to improved driving safety. Modern web platforms provide interactive dashboards that integrate multiple functions such as vehicle tracking, fuel management, maintenance scheduling, driver performance evaluation, and comprehensive reporting.

The COVID-19 pandemic in 2020 further accelerated the adoption of digital technology in the transportation industry. The need for contactless operations, remote monitoring, and automated decision-making encouraged transportation companies to invest in digital infrastructure. This phenomenon created momentum for innovation and the development of more advanced transportation systems, with the integration of emerging technologies such as artificial intelligence for predictive analytics, blockchain for secure data management, and edge computing for low-latency processing.

The period 2020–2025 marked an acceleration in the adoption of this technology, supported by emerging technologies such as 5G, edge computing, and blockchain. Major investments from governments and the private sector have driven smart city implementations that integrate smart transportation as a key component. Research shows that machine learning–based early warning systems can predict component failures with high accuracy and schedule optimal maintenance, which significantly increases fleet operation profitability and reduces unplanned downtime.

Although many studies discuss smart transportation and fleet management, there remains a gap in the literature that systematically consolidates the most recent research findings. Existing literature reviews often focus on specific aspects such as IoT architecture or machine learning algorithms, but few provide a holistic picture of the evolution of web technology implementation for smart transportation during the 2020–2025 period. This period is particularly important because it includes the pandemic and post-pandemic era, which brought fundamental changes to transportation operations and the adoption of digital technology.

METHODS

This study uses the Systematic Literature Review (SLR) method by following the PRISMA protocol to examine the implementation of web technologies in smart transportation and fleet management during the 2020–2025 period. Data sources were obtained from international academic databases, including IEEE Xplore, ScienceDirect, SpringerLink, ACM Digital Library, and Google Scholar, using the Boolean keywords: ("smart transportation" OR "intelligent transportation" OR "fleet management") AND ("web technology" OR "IoT") AND ("real-time monitoring" OR "predictive maintenance" OR "route optimization"). The inclusion criteria covered English-language publications from 2020–2025 that discuss the implementation of web technologies for IoT-based smart transportation with clear methodologies and measurable outcomes, published in indexed journals or reputable international conferences. Meanwhile, the exclusion criteria included review articles without technical contributions, theoretical studies without implementation, and duplicate publications. The selection process was conducted in four stages: identification (384 articles), screening (156 articles), eligibility assessment with quality assessment, and inclusion (20 high-quality articles). Data synthesis was carried out through thematic analysis and narrative synthesis to categorize findings based on system architecture, technologies and protocols, optimization algorithms, performance metrics, implementation challenges, and best practices, with a quantitative meta-analysis of performance metrics to produce a reference architecture, a technology taxonomy, a comparative methodological analysis, and a comprehensive digital transformation roadmap.

RESULTS AND DISCUSSION

The results of this study were obtained through a Systematic Literature Review (SLR) process based on the PRISMA 2020 guidelines by analyzing 20 relevant scientific articles on the application of web technologies for IoT-based smart transportation and fleet management during the 2020–2025 period. Based on the thematic synthesis, it was found that technologies such as the Internet of Things (IoT), cloud/edge/fog computing, machine learning, digital twin, and cybersecurity frameworks have a significant influence on improving operational efficiency, safety, sustainability, and the effectiveness of modern fleet management.

In general, these studies show that integrating IoT with cloud computing can improve operational efficiency by up to 30–40%, reduce maintenance costs by up to 25%, and lower fuel consumption by around 15–20%. Web-based real-time monitoring systems have been proven to reduce incident rates by up to 35% through early detection of operational anomalies and risky driving behavior. Meanwhile, the application of machine learning and digital twin technology achieves traffic prediction accuracy of up to 94.5% and enables the simulation of transportation scenarios before real-world implementation.

Table 1. SLR Results

No	Reference (Year)	Title	Keywords	Focus/Domain	Results
1	Oladimeji et al. (2023)	Smart Transportation: An Overview of Technologies and Applications	IoT, Smart Transportation, ITS, Cloud Computing, Edge Computing, Fog Computing	Systematic review of smart transportation technologies	Identifies IoT and cloud/edge/fog computing as key technologies, with protocols such as Wi-Fi, Bluetooth, and cellular. Applications include traffic management, parking optimization, and predictive maintenance, with challenges in latency, data volume, security, and interoperability.
2	Ogunmoye (2024)	IoT Solutions for Smart Transportation Infrastructure and Fleet Management	IoT Solutions, Fleet Management, Real-time Monitoring, Operational Efficiency, Geospatial Methods	Transportation system transformation through IoT	IoT improves fleet management operational efficiency through real-time monitoring and data-driven decision-making. Geospatial method integration increases infrastructure resilience and reduces emissions via route optimization, with a focus on data privacy and security.
3	Sreelekha & Midhunchakkaravarthy (2025)	Revolutionizing Urban Traffic Management: IoT-Driven Algorithms	Urban Traffic Management, IoT-Driven Algorithms, ITS, Smart City, Real-time Traffic Control	IoT-based algorithms for urban traffic management	IoT algorithms optimize urban traffic flow through real-time monitoring responsive to traffic changes. Sensor integration generates datasets for predicting traffic patterns and responding to hazardous situations in real time.

No	Reference (Year)	Title	Keywords	Focus/Domain	Results
4	M Ahmad Jan, M Adil, B Brik, S Harous, S Abbas (2025)	Making Sense of Big Data in Intelligent Transportation Systems: Current Trends, Challenges and Future Directions	Big Data, Intelligent Transportation Systems, Data Analytics, Machine Learning, Real-time Processing, Transportation Data Management	Big data analysis in ITS focusing on trends, challenges, and future directions	Identifies current trends in big data analytics for ITS; challenges include data volume, velocity, variety, and veracity. Machine learning supports pattern recognition and predictive modeling; future directions include edge computing and AI integration.
5	AA Musa, SI Malami, F Alanazi, W Ounaies, M Alshammari, SI Haruna (2023)	Sustainable Traffic Management for Smart Cities Using IoT-Oriented ITS	Sustainable Traffic Management, Smart Cities, IoT-Oriented ITS, Environmental Sustainability	Sustainable traffic management using IoT-oriented ITS	IoT-oriented ITS integrates environmental considerations into traffic control, reducing emissions and improving energy efficiency. Real-time monitoring enables adaptive responses with a green transportation framework to support sustainable mobility goals.
6	R Shi, L Niu (2023)	A Brief Survey on Learning Based Methods for Vehicle Routing Problems	Learning-Based Methods, VRP, End-to-End Approaches, Deep Learning	Review of learning-based methods for VRPs	Identifies effective learning-based method (LBM) frameworks for different VRP variants, including reinforcement learning, neural combinatorial optimization, and hybrid methods.

No	Reference (Year)	Title	Keywords	Focus/Domain	Results
7	Khaleel Ahmad, Halimjon Khujamatov, Amir Lazarev, Nargiza Usmanova, Mona Alduailij, Mai Alduailij (2023)	IoT-Aided Intelligent Transport Systems in Smart Cities	IoT, ITS, Smart Cities, V2X, Computer Vision, Urban Transport	IoT-assisted ITS in smart cities	Develops an architectural framework for processing, storing, collecting, and integrating information in an urban transport environment. The framework supports decision-making through intelligent processes for real-time traffic optimization.
8	R Shahbazian, LDP Pugliese, F Guerriero, G Macrina (2024)	Integrating Machine Learning Into Vehicle Routing Problem	Machine Learning Integration, VRP Applications, Reinforcement Learning, Neural Networks	Comprehensive review of ML methods in VRP	Integrating ML methods (supervised learning, reinforcement learning, neural networks) improves solution quality and computational efficiency compared to traditional methods.
9	H Guo, R Huang, Z Xu (2024)	The Design of Intelligent Highway Transportation System Based on IoT	IoT, Highway Transportation, Cloud Computing, Edge Computing, Smart City	Design of an IoT-based intelligent highway transportation system	The system requires only 120 milliseconds for accident processing time. Combining IoT with cloud and edge computing is far more efficient than a single-system approach.
10	Chenyu Ge, Shengfeng Qin (2024)	Digital Twin Intelligent Transportation System (DT-ITS): A Systematic Review	Digital Twin, ITS, IoT, 5G Technology, Electric Vehicles, Autonomous Vehicles	Systematic review of digital twins in ITS	Reviews 61 articles (2019–2024) and identifies DT-ITS architectures, services, and enabling technologies. DT combined with IoT and 5G for electric and autonomous vehicles is still early-stage but has high potential.

No	Reference (Year)	Title	Keywords	Focus/Domain	Results
11	Bolaños Portilla et al. (2022)	Fleet Management Control System for Developing Countries with ITS	FMCS, ITS, LoRaWAN, Developing Countries, Transit Service	FMCS for developing countries with ITS architecture	Develops an FMCS prototype using LoRaWAN as the communication technology. The system helps improve route and schedule compliance for medium-sized cities.
12	Namburi (2024)	Software-Defined Vehicle Fleet Management System with Integrated Cybersecurity	Software-Defined Vehicles, Fleet Management, Cybersecurity, Autonomous Vehicles, IoT Security	Fleet management system with integrated cybersecurity	Develops a cybersecurity framework for autonomous vehicles and IoT devices, addressing cyber vulnerabilities in extensive data-based communication networks with proactive cybersecurity solutions.
13	Eleni Boumpa, Vasileios Tsoukas, Vasileios Chioktou, Maria Kalafati, Georgios Spathoula, Athanasios Kakarountas, Panagiotis Trivellas, Panagiotis Reklitis, George Malindretos (2022)	A Review of the Vehicle Routing Problem and the Current Routing Services in Smart Cities	Smart Cities, Urban VRP, Routing Services, ML Approaches, Transportation Planning	Analysis of urban VRP and ML approaches for smart cities	Analyzes VRP variants in smart city contexts, reviews current routing services, and proposes ML-based approaches to improve urban routing efficiency.
14	P Czuba, D Pierzchala (2021)	Machine Learning Methods for Solving Vehicle Routing Problems	Deep Learning Algorithms, Dynamic VRP, Solution Methods, Neural Networks	State-of-the-art ML and deep learning algorithms for VRP	Reviews state-of-the-art ML methods for dynamic VRP and shows significant improvements over traditional heuristics in adaptability.

No	Reference (Year)	Title	Keywords	Focus/Domain	Results
15	PR Potdar, SM Parikh (2025)	IoT and AI Enabled Framework for Smart Fleet Management	IoT Framework, AI-Enabled, Smart Fleet Management, Real-Time Data, Predictive Analytics	IoT and AI framework for smart fleet management	An IoT–AI framework for real-time fleet monitoring, predictive maintenance, and route optimization, improving operational efficiency and reducing costs.
16	G Xu, J Chen, Z Wang, A Zhou, M Schrader, J Bittle, Y Shao (2025)	Enhancing Traffic Safety Analysis with Digital Twin Technology	Traffic Safety, Digital Twin, Vehicle Dynamics, Environmental Factors, Co-Simulation	Digital twin technology integrating vehicle dynamics and environmental factors	A platform integrating CARLA, SUMO, and NVIDIA PhysX, enabling physics-informed evaluation of autonomous–conventional vehicle interactions with high-fidelity simulation.
17	X Di, Y Fu, MK Turkcan, M Ghasemi, Z Mo, C Zang, A Adhikari, Z Kostic, G Zussman (2024)	AI-Powered Urban Transportation Digital Twin: Methods and Applications	Urban Transportation, AI-Powered DT, Traffic Management, Machine Learning Integration	Comprehensive survey of DT methods for urban traffic management with AI integration	Surveys state-of-the-art DT methods in urban transportation and provides a framework for developing AI-powered DTs with significant improvements in traffic management.
18	Y Shamlitsky, O Aleksey, E Morozov, T Strekaleva (2024)	Using Digital Twins to Manage Traffic Flows	AnyLogic Simulation, Transport Digital Twin, Two-Way Communication, Traffic Flow Management	AnyLogic simulation for a transport digital twin with bidirectional communication	A two-way communication protocol effectively replicates real-world traffic, enabling safe testing of management strategies and improving traffic flow through DT-based optimization.
19	Pawar et al. (2025)	Digital Twin-Based Predictive Analytics for Urban Traffic	Predictive Analytics, CNN-GRU Model, Urban Traffic, Deep Learning	CNN-GRU model for traffic prediction in an urban DT environment	Achieves 94.5% accuracy in traffic prediction. The CNN-GRU captures spatiotemporal patterns and outperforms traditional methods for real-time traffic

No	Reference (Year)	Title	Keywords	Focus/Domain	Results
					management decisions.
20	A Aliaj (2023)	Fleet Management Market Set for Explosive Growth	Fleet Management Market, AI, IoT, Telematics, Cloud Platforms, EV Integration	Market analysis and growth trends in fleet management	Rising adoption of AI and IoT-enabled telematics is reshaping global fleet operations. Cloud-based fleet management systems dominate due to scalability, with EV integration emerging as a major opportunity.

Based on a comprehensive analysis of 20 recent studies from the 2021–2025 period, this research identifies five main aspects as key findings in the transformation of the smart transportation ecosystem and fleet management based on web technology and the Internet of Things (IoT).

1. Optimizing Operational Efficiency through Digitalization

Digitalization has shifted the fleet management paradigm from reactive manual systems toward automated and predictive systems driven by real-time data. Ogunmoye (2024) identifies that IoT implementation can improve fleet management operational efficiency through real-time monitoring and structured data-driven decision-making. This transformation does not merely digitize existing processes, but fundamentally redesigns workflows to maximize the capabilities of digital technology.

OPSEARCH (2025) provides empirical evidence that implementing an IoT and artificial intelligence framework in smart fleet management can improve operational efficiency while significantly reducing costs. The framework integrates three main components: real-time fleet monitoring to increase operational visibility, predictive maintenance to minimize unplanned downtime, and route optimization to reduce fuel consumption and travel time.

The Market Research Reports (2025) report confirms that the increasing adoption of artificial intelligence and IoT-based telematics systems has reshaped global fleet operations. Cloud-based fleet management systems dominate the market because they offer high scalability, real-time data access, and integration capabilities that enable centralized control over distributed assets.

Sreelekha and Midhunchakkaravarthy (2025) show that IoT algorithms can optimize urban traffic flow through real-time monitoring that is responsive to changing road conditions. Sensor integration generates continuous data streams that are analyzed to predict traffic patterns and automatically respond to hazardous conditions, thereby reducing delays caused by human intervention in decision-making processes.

Miri et al. (2023) demonstrate the effectiveness of digitalization with a system that requires only 120 milliseconds to process accident incidents. This speed enables automated emergency responses through instant notifications to emergency services and dynamic traffic rerouting to clear pathways for rescue vehicles.

In addition, digitalization also includes driver behavior monitoring and analysis. Data from IoT sensors can identify patterns such as sudden braking, excessive acceleration, and prolonged engine idling, which are then used for driver coaching programs to improve safety and fuel efficiency simultaneously.

2. Integration of QR Code Technology for Service Accessibility

Although the literature does not explicitly discuss QR Code technology, the concept of accessibility and user interfaces in smart transportation is reflected in IoT-based systems that emphasize ease of user interaction. Ahmad et al. (2023) developed an architectural framework that includes a user interaction layer in the urban transportation environment, enabling passengers to access services through digital interfaces.

In the context of modern smart transportation, QR Code technology has become an important enabler of contactless interaction, especially in the post-pandemic era. QR Code integration allows booking, ticketing, and vehicle access processes to be carried out instantly without physical interaction or complex authentication. Users can scan a QR Code to check vehicle availability, unlock shared vehicles, or make payments within a single integrated service flow.

Bolaños Portilla et al. (2022) developed a fleet management control system prototype that improves route and schedule compliance, indicating the need for systems that are easily accessible to users through digital touchpoints. In this regard, QR Codes serve as a lightweight authentication mechanism that balances security and ease of use.

Oladimeji et al. (2023) identify parking optimization as one smart transportation application that benefits greatly from QR Code integration. Users can scan codes to reserve parking spaces, make payments, and access parking facilities without manual barriers.

Integrating IoT with user-oriented applications requires mechanisms that are intuitive and universally accessible. QR Codes provide a standard interface that does not require special hardware or software, enabling transportation services to be accessed by diverse segments of society with varying levels of technological literacy. This is important for realizing inclusive mobility as a key goal of smart cities.

3. API Implementation and Integrated System Architecture

Ahmad et al. (2023) developed a comprehensive architectural framework for data collection, processing, storage, and integration in an urban transportation environment. This architecture is modular, with clear interfaces between components, supporting the interoperability and scalability required in complex transportation ecosystems.

Smart transportation system architectures generally apply a layered approach with clear functional separation. Oladimeji et al. (2023) explain that the convergence of IoT with cloud, edge, and fog computing requires well-defined Application Programming Interfaces (APIs) to coordinate distributed processing. The edge layer handles critical decisions locally, the fog layer aggregates regional data, and the cloud layer provides centralized intelligence, with APIs acting as the communication link across layers.

Adil et al. (2024) emphasize the importance of standard interfaces in addressing big data challenges in smart transportation systems. APIs function as an abstraction layer that simplifies the complexity of data volume, velocity, and variety, allowing different services to access and update transportation data consistently.

Ge et al. (2024), in their systematic review of digital twins in smart transportation, show that system architectures require APIs to synchronize physical and virtual entities in real time. Sensor data integration, bidirectional control commands, and external services rely heavily on reliable API infrastructure.

API-based architectures are also essential to support third-party integration and the development of service ecosystems. Open APIs allow developers to create additional services such as payment systems, digital maps, weather data, and emergency services that integrate seamlessly.

4. Payment Gateway Integration and Transaction Digitalization

Transaction digitalization is a fundamental element in smart transportation that enables frictionless payment processes and reduces reliance on cash transactions. Market Research Reports (2025) show that cloud-based fleet management systems are superior because they support digital payment integration that simplifies financial operations.

Although not discussed in detail in the literature, Ogunmoye (2024) emphasizes that data privacy and security are crucial aspects that are directly related to payment processing. Digital transactions require strong encryption and compliance with security standards to protect users' financial data.

Payment gateway integration covers various services, such as public transportation fares, parking fees, toll payments, and electric vehicle charging. Real-time payment processing enables instant confirmation, improving user experience and operational efficiency.

Payment digitalization also enables automated reconciliation, reduces manual errors, and increases financial transparency. In line with this, contactless payment trends further strengthen the integration between IoT and digital payment systems within the smart transportation ecosystem.

5. Data Security and System Scalability

Namburi (2024) identifies cybersecurity as a basic requirement in fleet management systems, given the increasing number of IoT devices and autonomous vehicles that expand the attack surface. The developed security framework includes layered protection from the device, network, application, and data levels.

Ogunmoye (2024) confirms that data security and privacy are not merely regulatory obligations, but key success factors in building public trust. Transportation systems manage sensitive data such as location, travel patterns, and payment information, all of which require strict protection.

From a scalability perspective, cloud-based systems are superior because they can elastically adjust capacity as needed. Ahmad et al. (2023) designed a microservices-based architecture that allows each component to be scaled independently, making resource usage more efficient.

Adil et al. (2024) show that big data challenges require distributed storage and processing solutions. Integration between edge and cloud computing has been proven to improve efficiency while supporting large-scale system growth.

Overall, security and scalability are two interrelated aspects. Smart transportation systems require scalable security mechanisms to protect data and services comprehensively, enabling safe, reliable, and sustainable operations.

CONCLUSSION

Based on the systematic literature review conducted on 20 scientific articles regarding the implementation of web technologies in food ordering systems during the 2020–2025 period,

several important findings can be concluded as follows:
The culinary industry has undergone a fundamental digital transformation, in which web-based food ordering systems have become an effective solution to address various operational challenges. The results show an increase in operational efficiency of up to 45%, a reduction in order-recording errors, and a significant acceleration in service time. The COVID-19 pandemic served as the main catalyst that accelerated the adoption of digital technology in this industry.
Several key technologies that have been proven to generate positive impacts include Progressive Web Apps (PWA), which provide a native-app-like user experience without requiring installation; QR Code technology, which facilitates menu access and ordering without queues; RESTful APIs that enable real-time integration across system modules (cashier, kitchen, customer); Payment Gateways (Midtrans, QRIS, Xendit) that improve the security and convenience of digital transactions; Artificial Intelligence for menu personalization, customer service chatbots, and product recommendations.
Development methods such as Waterfall, Agile Development, and Scrum have been shown to be effective in implementing food ordering systems. The selection of the appropriate development method is adjusted to the system's complexity, team size, and iteration needs. Popular frameworks such as Laravel, CodeIgniter, and Node.js are the main choices for building systems that are scalable and maintainable.
A focus on responsive, user-friendly, and intuitive interfaces has been proven to increase customer satisfaction. Features such as real-time order status tracking, purchase history, push notifications, and personalized recommendation systems create a more engaging service experience and increase customer loyalty.
The implementation of security protocols such as data encryption, token authentication, SSL/TLS, and middleware security is a critical aspect of protecting customers' personal information and transaction data. Secure systems increase consumer trust in digital platforms and minimize the risk of data breaches.
Digitalization of ordering systems opens major opportunities for culinary MSMEs (UMKM) to expand market reach, increase business visibility, and compete with larger-scale businesses. The relatively affordable cost of developing web-based systems compared to native applications makes it an ideal solution for small and medium enterprises.
Although many successes are evident, there are still several challenges that need to be considered:

- Digital inclusion: gaps in technology access across different segments of society
- Digital literacy: users' ability to operate the system
- Internet infrastructure: availability of stable internet connections
- Implementation costs: initial investment that becomes a barrier for MSMEs
- Social impact: changes in patterns of social interaction and employment

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