Digital Transformation and Operational Efficiency in Fast-Moving Consumer Goods Companies: A Systematic Review of Industry 4.0 Applications

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ABSTRACT

Today, technology plays a crucial role in the growth and competitiveness of companies, enabling improvements in operational efficiency and process optimization within dynamic business environments. This systematic review aims to examine the influence of digitization and the implementation of advanced technologies on operational efficiency in fast-moving consumer goods (FMCG) companies, based on empirical studies published between 2019 and 2024. The review followed the PRISMA 2020 guidelines, identifying and analyzing 25 empirical studies from the Scopus database, selected according to relevance, timeliness, and methodological rigor. The findings reveal a growing trend toward the adoption of advanced technologies: approximately 60% of the studies address the use of artificial intelligence (AI) to enhance decision-making and production planning, 40% focus on automation to improve efficiency and reduce operational costs, and nearly 24% explore computer vision applications for quality control and inventory management. Despite the benefits, the implementation of these innovations presents challenges, such as the need to adapt to organizational change and invest in infrastructure and employee training. Nevertheless, digitization and automation emerge as key drivers for improving performance and strengthening the market position of consumer goods companies. In conclusion, the results suggest that organizations should develop comprehensive and sustainable digital strategies that promote the effective adoption of advanced technologies, ensuring operational efficiency aligned with the principles of sustainable development and the United Nations Sustainable Development Goals (SDGs), particularly Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation and Infrastructure), and Goal 12 (Responsible Consumption and Production).

1. INTRODUCTION

Current literature shows that innovation trends are transforming business performance, particularly in fast-moving consumer goods (FMCG) companies. The sector's specific characteristics—such as high production volume, product perishability, and demand volatility—create a constant need for efficiency and adaptation [1-4]. These conditions make digitalization and automation strategically important, as they enable firms to respond rapidly to market changes while maintaining service quality and competitiveness.

Technology plays a crucial role in enhancing managerial decision-making, and artificial intelligence (AI) has emerged as a key tool for optimizing resources and anticipating consumer preferences [5]. Nevertheless, its implementation requires responsible management practices to minimize risks related to data privacy and ethical concerns. Recent studies also highlight that digital transformation, supported by emerging technologies, has revolutionized communication processes within organizations [6-9].

In the FMCG sector, digital transformation aims to strengthen competitiveness while promoting sustainable development through efficient resource use, inclusive growth, and the adoption of cleaner production models. According to Henostroza Diaz and Marquez Yauri [10], the convergence of AI and digital transformation has given rise to Marketing 4.0 and 5.0 frameworks, which support omnichannel integration and highly personalized customer experiences.

Despite the growing interest in business digitalization, there remains a lack of studies specifically analyzing how digital transformation and AI affect the performance of FMCG companies. Most previous systematic reviews have concentrated on manufacturing or technology-based industries, overlooking the distinctive features of mass consumption, where rapid turnover and competitive pressures require differentiated digital strategies. To address this gap, Table 1 summarizes key systematic reviews and meta-analyses on digital transformation and innovation in business management, identifying their scope, analyzed sectors, and the distinct

contribution of this review.

Studies	Main Focus	Identified Gap
[1]	Innovation in business sectors	It does not address emerging technologies or AI
[2]	Frugal innovation and business expansion	Lack of analysis of digitization and competitiveness
[4]	Intellectual capital and performance	Does not consider digital transformation
[5]	ICT in business management	Does not analyze specific sectors
[7]	Technology and competitive advantage	Does not address AI or focus on fast-moving consumer goods (FMCG)
[10]	Marketing 4.0 and 5.0, AI, and personalization	Lacks a sectoral approach and organizational management

1.1 Conceptual foundations of digital transformation

Digital transformation refers to the integration of advanced digital technologies that reshape organizational processes and enhance performance across multiple business functions. The literature emphasizes that digital transformation is not limited to technological adoption but involves a comprehensive organizational shift supported by data-driven decision-making, automation, and new forms of value creation [7, 9]. Within this paradigm, Industry 4.0 constitutes a fundamental framework that incorporates cyber-physical systems, interconnected devices, AI, and real-time analytics to modernize production systems and optimize operational efficiency [11].

Furthermore, studies highlight that digital transformation promotes the development of internal capabilities related to organizational learning, innovation, and flexible structures capable of responding to environmental changes [12, 13]. The adoption of digital tools strengthens the alignment between strategic objectives and operational processes, enabling more efficient use of resources and improving the capacity to monitor, control, and adapt production dynamics. These conceptual foundations help explain why digital transformation is regarded as a critical enabler of competitive advantage in contemporary organizations, particularly in sectors facing rapid market fluctuations and operational pressures.

1.2 Theoretical perspectives on innovation and operational efficiency

Innovation theories provide an essential framework for understanding the mechanisms through which digital transformation contributes to improvements in operational efficiency. Scholars argue that innovation in products, processes, and organizational models drives firms' ability to enhance productivity, reduce errors, shorten production cycles, and strengthen overall performance [3, 14]. From this perspective, operational efficiency is conceptualized as the optimal utilization of organizational resources, achieved through the integration of technologies that facilitate automation, real-time monitoring, data analytics, and predictive modelling [15, 16].

The literature also identifies the strategic role of technological innovation in improving competitiveness, particularly in industries with high operational demands. Technologies such as AI, machine learning, and computer vision have been shown to enhance forecasting accuracy, optimize inventory management, and reduce waste in production systems [17, 18]. Moreover, innovation theories emphasize that the effectiveness of these technologies depends on organizational capabilities, including digital skills, leadership support, and a culture conducive to technological adaptation [19, 20].

In sectors such as FMCG, where production conditions require speed, standardization, and large-scale coordination, these theoretical perspectives provide a solid foundation for understanding how emerging technologies can strengthen efficiency and performance. Thus, innovation is not only a driver of technological change but also a mechanism through which organizations transform operational structures to sustain competitiveness.

1.3 Digital transformation in the fast-moving consumer goods sector

The literature recognizes that the FMCG sector operates under particular constraints that make digital transformation especially relevant. High production volumes, rapid turnover, and demand volatility require companies to adopt dynamic and efficient operational systems capable of maintaining product quality and service levels [1, 18]. Technologies such as AI, big data analytics, and robotic process automation (RPA) have been increasingly integrated into FMCG operations to address these challenges, enabling improved forecasting, reduced human error, and optimized production workflows [21, 22].

Computer vision technologies are also gaining prominence, as they allow automated inspection, defect detection, and real-time monitoring of production lines, enhancing the consistency and accuracy of operational processes [17, 22]. These tools support firms in ensuring product quality, strengthening traceability, and responding more quickly to fluctuations in consumer demand.

Despite these advancements, studies acknowledge that FMCG firms face barriers that differ from those in highly industrialized or technology-focused sectors. Limited digital capabilities, infrastructural gaps, and organizational resistance can restrict the successful implementation of advanced technologies [23, 24]. These constraints reinforce the relevance of conducting sector-specific analyses that explain how digital transformation influences operational efficiency in FMCG contexts, especially in environments characterized by narrow margins, intense competition, and high logistical complexity.

2. METHODS

A systematic review was conducted in accordance with the PRISMA 2020 guidelines, with the aim of identifying empirical evidence on the influence of digital transformation and advanced technologies on operational efficiency in FMCG companies. The process was designed to ensure transparency, reproducibility and methodological rigor throughout all stages of identification, screening, eligibility assessment and final inclusion of studies [25, 26].

The search was carried out in the Scopus database, selected

for its comprehensive coverage of scientific publications in the fields of business, management and technology. To operationalize the search, a Boolean equation was constructed to reflect the core concepts of the review: TITLE-ABS-KEY ("digital transformation" OR "Industry 4.0" OR "automation" OR "artificial intelligence" OR "robotic process automation" OR "computer vision") AND ("FMCG" OR "fast moving consumer goods" OR "consumer goods") AND ("operational efficiency" OR "performance" OR "productivity"). This formula made it possible to capture studies situated at the intersection of emerging technologies and operational performance.

The initial search generated 1,572 records. To ensure relevance and recency, filters were applied to include only articles published between 2019 and 2024, written in English, classified under the Business, Management and Accounting subject area, available in open access and published as final-version scientific articles. After automatic filtering, 427 records remained. Duplicates and studies lacking thematic relevance were removed through a title and abstract review, resulting in 41 articles selected for full-text assessment. Sixteen of these were excluded for not meeting the methodological or thematic criteria, resulting in a final sample of 25 empirical studies. Figure 1 presents the PRISMA 2020 flow diagram summarizing the complete selection process, and Table 2 details the inclusion and exclusion criteria applied at each stage.
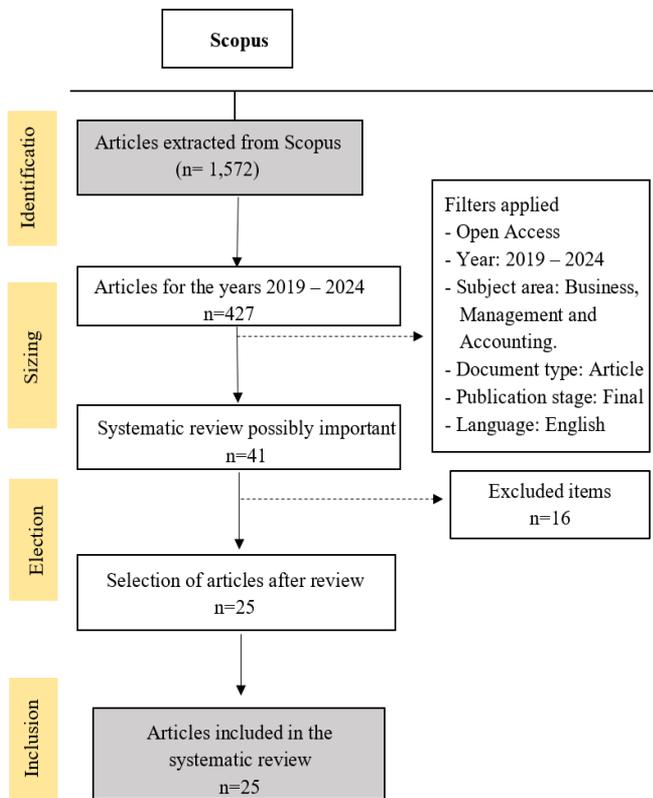

Figure 1. PRISMA 2020 flowchart of the study selection process
Note: The total number of studies to be analyzed is the total frequency of the included articles (n = 25).

The methodological quality of the included studies was appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist, which provides structured criteria for evaluating both qualitative and quantitative designs. This assessment considered the clarity of the research objectives, the appropriateness of the study design, the adequacy of sampling procedures, the validity of data collection instruments, the transparency of analytical methods and the consistency between the evidence presented and the conclusions reported. All selected studies met the minimum quality thresholds established by the JBI criteria.

Table 2. Inclusion and exclusion criteria applied in the review

Criteria	Inclusion	Exclusion
Document type	Original scientific articles	Reviews, editorials, conferences, book chapters
Timeframe & language Access	2019–2024; English Open access	Outside timeframe; other languages Restricted access
Thematic scope	Business, Management and Accounting (Scopus); studies analyzing digital technologies and operational efficiency in FMCG companies	Studies unrelated to digital technologies, operational efficiency, or FMCG contexts
Methodology	Empirical studies with explicit design and sufficient methodological rigor	Studies without empirical basis or with major methodological limitations

Once the eligible studies were confirmed, a structured data extraction process was implemented. A coding sheet was developed to ensure systematic extraction and organization of key analytical variables. The coding categories included: (a) the type of digital technology analyzed, such as AI, automation or computer vision; (b) the country in which the study was conducted; (c) the size of the firms examined; (d) the methodological approach adopted (quantitative, qualitative or mixed); and (e) operational efficiency indicators, including error reduction, cycle time, forecasting accuracy or resource optimization. Table 3 outlines the variables and coding rules applied during this stage. This structured approach facilitated a consistent comparative analysis of heterogeneous evidence and supported the synthesis presented in the Results section.

Overall, the methodological design ensured a rigorous and transparent review process, enabling the identification of dominant technological trends, recurring operational impacts and contextual determinants that shape the effectiveness of digital transformation initiatives within FMCG companies. Although the selected studies vary in their specific topics, all of them met the predefined eligibility criteria by providing empirical or systematized evidence relevant to digital transformation processes, operational performance or organizational efficiency. Their inclusion is justified because each contributes conceptually or empirically to understanding how technological innovation influences efficiency outcomes within FMCG environments or comparable production settings.

Following the recommendations of PRISMA 2020, a structured data extraction process was carried out. For each included study, key analytical variables were coded to ensure consistency and transparency in the synthesis. The variables were selected according to the objectives of the review and the

dimensions most frequently used in studies evaluating digital transformation and operational efficiency.

Table 3. Coding sheet used for data extraction (variables and coding rules)

Variable	Description	Coding Options	Example
Technology type	Main digital technology analyzed	AI / Automation / CV / IoT / Mixed	AI
Company size	Size of firm in study	SME / Medium / Large	Large
Country	Country of data collection	17 countries	China
Method	Research design	Quantitative / Qualitative / Mixed	Quantitative
OE Indicators	Indicators of operational efficiency	Cycle time / Error rate / Forecast accuracy / Waste reduction	Defect detection rate
Main finding	Core coded outcome	Efficiency improves / Neutral / Mixed	Efficiency improves

Note: CV = Computer Vision; OE = Operational Efficiency; IoT = Internet of Things.

Table 3 presents the coding scheme used, including the variables extracted, their definitions, coding options, and an illustrative example. This coding sheet provided the basis for organizing the evidence and conducting the subsequent analysis.

3. RESULTS

3.1 Characteristics of the studies

Table 4 shows a selection of 25 key articles, ordered by date of publication from the most recent. The articles are classified according to the following criteria: title, journal and year of publication.

A temporal overview of the selected studies revealed a progressive increase in publications over the review period. The year 2023 registered the highest number of contributions, with six studies examining the relationship between digital technologies and operational efficiency in FMCG companies. In 2020 and 2022, three publications were identified in each year, while 2019 and 2021 reported two studies respectively. This pattern suggests a growing academic interest in understanding how digital transformation supports efficiency improvements within the FMCG sector, particularly in recent years.

Table 4. Summary of selected articles included in the systematic review (n = 25)

No.	Title	Journal / Year	Technology Focus	Outcome Measures	Key Outcomes
1	Barriers and the potential for changes and benefits from the implementation of Industry 4.0 solutions in enterprises	Production Engineering Archives, 2024	Industry 4.0, automation	Identification of barriers, perceived benefits	Analyses organizational and technological barriers and the expected benefits of implementing Industry 4.0 solutions
2	How manufacturing companies can improve their competitiveness: Research on service transformation and product innovation based on computer vision	Journal of Global Information Management, 2024	Computer vision, service transformation	Competitiveness, product innovation	Examines how computer vision applications support product innovation and competitiveness
3	The impact of innovation on exports of Vietnamese manufacturing and processing enterprises: the moderating role of environmental uncertainty	Cogent Business & Management, 2024	Innovation activities	Export performance, environmental uncertainty	Analyses how innovation influences export performance under varying environmental conditions
4	Scaling sustainable technologies by creating innovation demand-pull: Strategic actions by food producers	Technological Forecasting and Social Change, 2024	Sustainable technologies, innovation	Adoption and scaling processes	Identifies strategic actions that promote the adoption and scaling of sustainable technologies
5	Explaining sustainability performance and maturity in SMEs – Learnings from a 100-participant sustainability innovation project	Journal of Cleaner Production, 2023	Digital and sustainability-oriented innovation	Sustainability maturity, performance levels	Evaluates factors influencing sustainability performance in SMEs
6	Creating an innovative culture in agribusiness of micro, small and medium-sized enterprises	ARE Journal, 2023	Innovation culture	Innovation capability	Identifies how innovation-oriented culture strengthens innovation capability in agribusiness MSMEs
7	Application of quality management in the production of glucans in the food and pharmaceutical industry in Slovakia	Quality – Access to Success, 2023	Quality management tools	Quality indicators, production performance	Describes use of quality management practices to strengthen production processes
8	Frugal innovation in the expansion of a multinational subsidiary in an emerging market	Gestão & Produção, 2023	Frugal innovation	Expansion strategies, resource efficiency	Explores how frugal innovation supports market expansion in resource-limited contexts

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9	Evaluation of the Impact of firm level competition on Russian innovation	Economy of Regions, 2023	Innovation systems	Innovation indicators	Analyses how firm-level competition influences innovative activity
10	Leveraging on intra- and inter-organizational collaboration in Industry 4.0 adoption for knowledge creation and innovation	European Journal of Innovation Management, 2023	Industry 4.0, collaborative innovation	Knowledge creation, innovation performance	Examines how collaboration enhances Industry 4.0 adoption and knowledge creation
11	How does technology enable competitive advantage? Reviewing state of the art and outlining future directions	Journal of Competitiveness, 2022	Digital technologies	Competitive advantage dimensions	Reviews how digital technologies contribute to competitive advantage
12	Generation and prevention of food waste in the German food service sector in the COVID-19 pandemic – Digital approaches to encounter the pandemic related crisis	Socio-Economic Planning Sciences, 2022	Digital tools in food service	Food waste levels	Analyses digital approaches to reduce food waste during the pandemic
13	A technological innovation system framework to formulate niche introduction strategies for companies prior to large-scale diffusion	Technological Forecasting and Social Change, 2022	Technological innovation systems	Niche strategy development	Proposes a framework for technology introduction before large-scale diffusion
14	Internal factors that determine the success of Peruvian exports of ginger to the United States in the period 2006 – 2020	Acta Logística, 2021	Innovation and managerial capabilities	Export success factors	Identifies internal organizational factors that contribute to export success
15	Long-term research on technology innovation in the form of new technology patents	International Journal of Innovation Studies, 2021	Technological innovation, patents	Patent output	Presents trends in technology innovation through analysis of patents
16	The role of innovation in the growth of the company: A case of the emerging country	Journal of Governance and Regulation, 2021	Organizational innovation	Growth indicators	Examines how innovation contributes to company growth
17	Additive manufacturing: Currently a Disruptive Supply Chain Innovation?	Operations and Supply Chain Management, 2021	Additive manufacturing	Supply chain configurations	Discusses the disruptive potential of additive manufacturing in supply chains
18	Digitalization of business processes of enterprises of the ecosystem of Industry 4.0: Virtual-real aspect of economic growth reserves	WSEAS Transactions on Business and Economics, 2021	Digitalization, Industry 4.0	Business process performance	Evaluates effects of digitalizing business processes within Industry 4.0 environments
19	Are smart service manufacturing providers different in cooperation and innovation flexibility, in innovation performance and business performance from non-smart service manufacturing providers?	Engineering Management in Production and Services, 2020	Smart manufacturing	Innovation flexibility, business performance	Compares smart vs. non-smart providers in innovation performance
20	The Impact of the Organizational Innovativeness on the Performance of Indonesian SMEs	Polish Journal of Management Studies, 2020	Organizational innovativeness	SME performance	Analyses how innovativeness relates to SME performance
21	Digital innovation: Creating competitive advantages	International Journal of Technology, 2020	Digital innovation, Industry 4.0 tools	Competitive advantage, performance metrics	Examines the role of digital innovation in creating competitive advantages
22	Sustainable bulk-packaging system for sugar shipping: Case study of the enterprise leader in Europe	Administrative Sciences, 2019	Sustainable packaging, logistics innovation	Resource efficiency, logistics performance	Presents a sustainable packaging solution to improve resource efficiency
23	Study of sector-specific innovation efforts: The case from the Russian economy	Entrepreneurship and Sustainability Issues, 2019	Sector-specific innovation	Innovation efforts	Analyses differences in innovation efforts across sectors
24	The mediating effect of intellectual capital, management accounting information systems, internal process performance, and customer performance	International Journal of Productivity and Performance Management, 2019	Intellectual capital, information systems	Internal and customer performance	Describes how intellectual capital and systems relate to performance
25	Forecasting the main indicators of food security of Russia	IJRTE, 2019	Data analytics and forecasting	Food security indicators	Uses forecasting models to predict food security trends
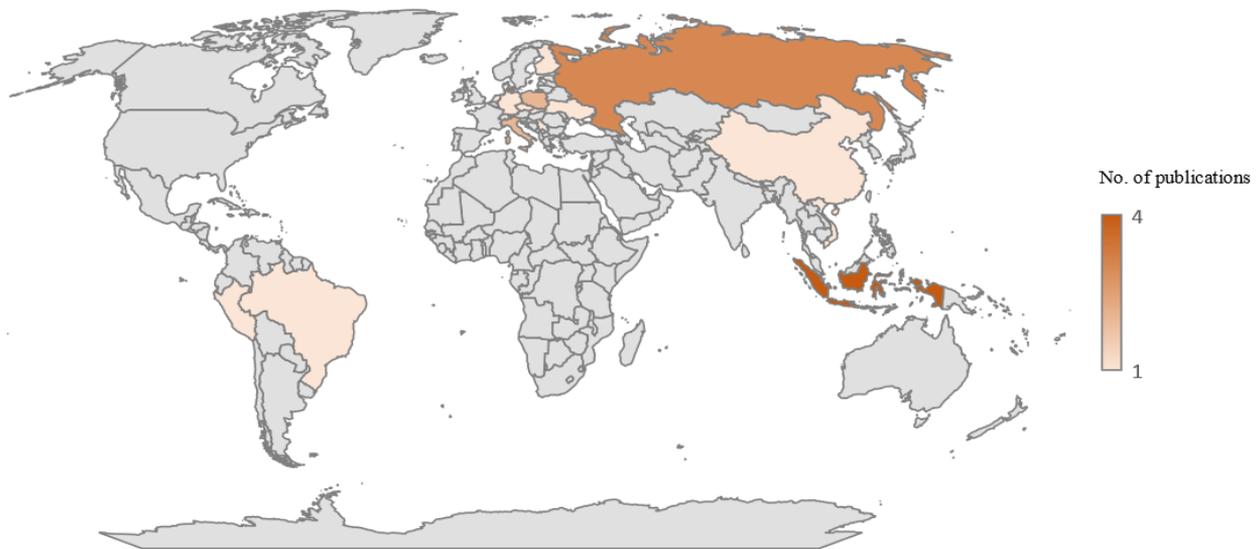
Figure 2. Geographical distribution of studies by country of data collection

Figure 2 graphically depicts the distribution of research according to the countries in which data were collected, irrespective of the place of publication. In total, 17 countries were identified. Indonesia tops the list with 4 publications, followed by Russia and the Czech Republic with 3 studies, and Italy and Poland with 2 studies each. The remaining countries, such as Brazil, China, Denmark, Finland, Germany, the Netherlands, Peru, Serbia, Slovakia, Ukraine and Vietnam, have 1 publication each.

These data reflect a higher concentration of studies in certain countries, such as Indonesia and Russia, while others have a more limited participation. This is evidence of a diverse geographical distribution of research in different parts of the world, with scientific output more prominent in some places.

3.2 Results of the individual studies

The 25 selected studies reveal consistent patterns in three key areas: (1) impact of advanced technologies on operational processes, (2) organizational transformation associated with digitization, and (3) structural barriers to technology adoption. First, approximately 72% of the articles report significant improvements in operational efficiency, error reduction and resource optimization following the implementation of technologies such as AI, RPA and computer vision (see Table 5).

Table 5. Frequency distribution of technologies and reported impacts on operational efficiency (n = 25)

Category	Frequency	Percentage
AI	15	60%
Automation / robotic process automation (RPA)	10	40%
Computer Vision	6	24%
Studies reporting improvements in operational efficiency	**18**	**72%**
– Error reduction	12	48%
– Faster production cycles	10	40%
– Better inventory accuracy	8	32%
– Improved forecasting	7	28%
Studies reporting limited or no significant improvements	**7**	**28%**

Several studies highlight the transformative effect of these technologies on organizational culture. They identify changes in hierarchical structure, redefinition of roles, and a growing demand for digital skills at all levels of the organization. This transformation process, although positive, has generated internal tensions related to resistance to change, fear of job replacement and the need for strategic human talent management. The review shows that these tensions require institutional interventions aimed at continuous learning, the promotion of well-being at work and the generation of collaborative environments that favor technological appropriation.

In terms of barriers, obstacles linked to lack of technological infrastructure, shortage of skilled personnel, high initial investment costs and low integration between functional areas are frequently reported. These constraints are particularly critical in developing economies, where structural conditions restrict access to and exploitation of advanced technologies. In addition, some research warns that the absence of strategic planning and fragmentation of digitization processes can negatively affect the sustainability of operational improvements, leading to organizational setbacks or excessive dependence on external suppliers.

Overall, the reviewed studies show that while digital technologies offer a high potential to improve operational efficiency, their actual impact depends on how they are integrated with the human, organizational and social factors that shape the business environment. For example, Zhang et al. [18] indicated how computer vision enabled a Chinese company to optimize its product innovation processes, while Kusnandar et al. [20] highlighted the role of an innovative organizational culture in the successful adoption of digital technologies in agribusiness SMEs in Indonesia.

In the Latin American context, Arana-Nicanor et al. [27] showed how internal factors, such as training and knowledge management, were determinant for the export success of Peruvian firms, highlighting the importance of integrating technology with pre-existing organizational capabilities. This evidence confirms that the use of advanced technologies cannot be separated from the social and structural processes in which they are implemented.

4. DISCUSSION

The evidence synthesized in this review shows that digital transformation is a fundamental element in strengthening operational efficiency in FMCG companies, although its contribution is not uniform and depends on technical, organizational and contextual factors that determine the magnitude of its effects. The selected studies agree that technologies such as AI, advanced automation, computer vision and big data analytics have enabled the optimization of essential processes in areas such as planning, production, quality inspection and logistics management. However, the results also reveal significant variations between companies and countries, suggesting that digital transformation, although necessary, is not sufficient on its own to guarantee consistent improvements in efficiency [28, 29].

A central aspect of the discussion concerns understanding how the operational nature of the FMCG sector influences the effects of digitalization. Various studies indicate that this sector presents high levels of turnover, short product life cycles and volatile demand, which force companies to manage processes with greater precision and speed than those observed in other industrial environments [1, 18]. For example, AI systems applied to demand forecasting allow real-time adjustments to production volumes to prevent both stockouts and overproduction, a particularly critical task for perishable or seasonal products. The literature presents cases in which predictive models based on machine learning have reduced forecasting errors by up to 20%, improving coordination between procurement, storage and distribution. These benefits are not trivial in a sector where small variations in planning can generate significant losses due to product expiration, returns or additional logistics costs [30, 31].

Computer vision is another example of a technology whose operational impact has been documented in concrete terms. Studies such as those by Tang et al. [17] and Majerník et al. [32] show that automated inspection of production lines makes it possible to detect microdefects in packaging, incorrect printing, deformities or adhesions that previously required manual inspection. These findings illustrate in a tangible way how digitalization can affect specific functions of the FMCG sector that require high levels of precision [32, 33].

RPA is another key element for understanding differences in reported outcomes. The literature indicates that automation systems such as collaborative robots or RPA solutions have replaced repetitive tasks traditionally carried out by operators, ranging from labelling to inventory verification [21, 29]. For example, some companies use autonomous mobile robots to transport inputs between production zones, reducing manual movements and downtime. There are also documented cases of automation in order preparation, where intelligent algorithms assign optimal routes and priorities perishable products. However, not all companies experience similar improvements, as automation also introduces challenges related to staff training, role reassignment and cultural resistance to interacting with intelligent systems [7, 34].

When analyzing the factors that limit the effectiveness of digital transformation, the literature shows that the lack of internal digital capabilities is one of the most relevant obstacles. Studies such as those by North et al. [12] and Kusnandar et al. [20] indicate that many companies do not have personnel with competencies in data analysis, programming, digital systems design or advanced technology maintenance. This is observed more markedly in small and medium-sized enterprises, which cannot afford high investments or hire specialists in emerging technologies. In these cases, advanced systems are often implemented partially or superficially, reducing their potential benefits. For example, some studies show companies that acquire AI systems but lack sufficiently robust data infrastructure, which prevents the models from being fed with accurate and up-to-date information. As a result, the systems fail to generate reliable predictions and end up being underutilized [3, 35].

Differences between geographical contexts also generate important variations. Research conducted in developed countries tends to report substantial improvements in efficiency, especially when traceability technologies, IoT sensors and intelligent storage systems are integrated [18]. In these settings, companies use integrated automation networks to control inventories in real time and coordinate logistics routes using predictive data, reducing delivery times and waste. In contrast, studies carried out in emerging economies, such as those by Annarelli et al. [36] and Okrah [37], indicate that many companies lack stable connectivity, digital infrastructure and financial capital to acquire or maintain advanced technology. Cases are documented in which production lines continue operating with manual or semiautomated processes, considerably limiting the effects of digital transformation on operational efficiency. This confirms that the impact of emerging technologies is strongly conditioned by the socioeconomic environment and not solely by the technical characteristics of the tools [2, 4].

The literature also shows that the effects of digitalization on internal labor dynamics should not be underestimated. The transition towards more automated production models often generates tensions related to job security, the redefinition of roles and the need to acquire new competencies [38]. In some cases, the incorporation of digital systems has created uncertainty among line workers, who perceive that their functions could be replaced by algorithms or robots. These tensions affect the acceptance of technology and can slow its implementation. Studies agree that when organizations invest in training and clearly communicate the objectives of digital transformation, these forms of resistance decrease and operational benefits increase [9].

Another relevant aspect identified in this discussion concerns the role of explainability in AI systems. Although various studies highlight the potential of AI to optimize processes, none of the selected research analyses the use of explainable models or mechanisms of algorithmic transparency [39, 40]. In sectors where errors may have significant consequences, such as the food or hygiene products industry, the lack of interpretability limits trust in automated systems. For example, when a classification algorithm detects a defect in a production line but does not explain its reasoning, supervisors may be reluctant to make decisions based on results that they do not fully understand. This gap reveals a relevant opportunity for future research aimed at developing explainable AI systems adapted to mass manufacturing environments, where transparency could increase the effectiveness and adoption of these technologies [41].

It is important to note that this gap is not anecdotal but systematic. Among all the studies included in this review, none explicitly reported the implementation of explainable AI techniques, nor did they include any methodological component related to model transparency. This absence across the entire sample of reviewed studies reinforces the claim that explainable artificial intelligence (XAI) remains largely

unexplored within the FMCG-focused digital transformation literature [28].

In addition, the literature reviewed suggests that the link between digitalization and sustainability deserves greater attention. Although studies such as those by Lombardi et al. [33] and Bor et al. [42] indicate that digitalization can reduce waste, optimize resource consumption and promote cleaner processes, they also warn that the acquisition and operation of advanced technologies involve environmental costs associated with hardware production, energy consumption and electronic waste management. For example, some computer vision systems require high-resolution cameras and dedicated servers to process images, which can significantly increase energy consumption if not managed appropriately. This tension between operational benefits and environmental impacts suggests the need for digitalization strategies that integrate sustainability criteria from the design, implementation and evaluation stages [29].

The transversal integration of digital systems also emerges as a determining factor for success. Studies show that companies that implement technologies in isolation obtain limited benefits, whereas those that adopt integrated models achieve broader improvements in efficiency. For example, when companies combine AI-based demand forecasting systems with real-time inventory platforms and automation technologies in production, cycle times decrease and synchronization between areas improves noticeably [15]. However, integration requires significant investment and advanced organizational capabilities, which explains why many companies remain in the early stages of digital maturity.

In addition, the implications derived from these findings operate at two distinct levels. At the managerial level, professionals should priorities workforce reskilling, strengthen digital capabilities, promote integrated technological adoption and ensure that digital initiatives are aligned with organizational strategies. At the policy level, governments and regulatory bodies must address structural barriers by investing in digital infrastructure, fostering national training programmes and providing incentives that facilitate technology adoption. Clarifying these two layers of implications is essential for understanding how digital transformation can advance at both organizational and societal levels.

In summary, this review confirms that digital transformation in the FMCG sector must be understood as a multidimensional process in which advanced technologies, human skills, organizational structure and contextual conditions interact to determine outcomes. Technological innovations, although promising, do not automatically guarantee improvements in operational efficiency if they are not accompanied by strategic management that considers the particularities of the sector, talent development and the structural limitations of each context. Future research could explore in greater depth the application of explainable AI, the development of digital maturity models adapted to FMCG companies and the environmental impacts of digitalization, in order to promote a holistic approach that facilitates the transition towards more efficient, responsible and sustainable production systems [43-46].

5. CONCLUSIONS

The objective of this systematic review is to examine the influence of digitization and the implementation of advanced technologies on operational efficiency in FMCG companies, based on empirical studies published between 2019 and 2024. The analysis of 25 selected studies revealed that technologies such as AI, automation and computer vision are widely used to streamline operations, reduce costs and enhance competitiveness, contributing to sustainability goals in the FMCG sector.

However, technology integration is not without its challenges. Key barriers include internal resistance to technological change, high investment costs in digital infrastructure, and a shortage of personnel with specialized digital competencies. These challenges are more pronounced in developing economies, where limited access to capital and digital infrastructure restricts the effective implementation of advanced technologies.

The limitations of the study include the geographical concentration of the research, which makes it difficult to extrapolate the results to other contexts. There is also a lack of longitudinal studies analyzing the sustained effects of digitalization, as well as a lack of attention to emerging technologies such as explainable AI and their real applicability in business environments.

From an applied and societal perspective, the findings highlight the need for people-centered digital transformation strategies that consider continuous training, active staff participation and the balance between operational efficiency and organizational well-being. Similarly, from a theoretical point of view, this review provides evidence to advance towards integrative models that articulate the technological with the organizational.

As future lines, it is recommended to develop comparative studies between regions, research focused on the ethical implications of digitalization, as well as evaluations of the environmental impact associated with technological adoption. Addressing these dimensions in future research will support the transition toward more equitable, transparent, and sustainable digitalization models aligned with the SDGs, particularly in operationally intensive sectors such as FMCG. These insights can support policymakers and industry planners in designing sustainable digitalization strategies that enhance operational efficiency while aligning technological adoption with long-term development goals.

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