FATORES CRÍTICOS DE SUCESSO DA JORNADA DE TRANSFORMAÇÃO DIGITAL NA CADEIA DE SUPRIMENTOS: UM ESTUDO DE CASO ÚNICO

CRITICAL SUCCESS FACTORS IN THE DIGITAL TRANSFORMATION JOURNEY IN THE SUPPLY CHAIN: A CASE STUDY

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Objetivo do estudo
Identificar e categorizar os fatores críticos de sucesso na transformação digital da cadeia de suprimentos de uma empresa química multinacional, analisando como são gerenciados e influenciam a jornada digital em contextos organizacionais complexos.

Relevância/originalidade
O estudo preenche lacuna ao integrar dimensões tecnológicas, organizacionais e culturais na análise da transformação digital em supply chain, oferecendo uma visão prática e teórica inédita no setor químico.

Metodologia/abordagem
Pesquisa qualitativa com estudo de caso único, baseada em entrevistas semiestruturadas com gestores globais. Utilizou análise de conteúdo temática e apoio de inteligência artificial para codificação e categorização dos dados

Principais resultados
Foram identificados oito fatores críticos de sucesso interdependentes. Liderança engajada, governança estruturada, integração de sistemas e gestão da mudança cultural foram os mais recorrentes e decisivos para o sucesso da transformação digital.

Contribuições teóricas/metodológicas
Propõe modelo conceitual integrando dimensões tecnológicas, organizacionais e culturais. Oferece estrutura analítica para estudos futuros e contribui metodologicamente ao aplicar IA na análise qualitativa de entrevistas.

Contribuições sociais/para a gestão
Oferece checklist gerencial para diagnóstico e planejamento da transformação digital em supply chain. Apoia líderes na tomada de decisão, promovendo eficiência, inovação e sustentabilidade organizacional.

Palavras-chave: Transformação Digital, Gestão de Cadeia de Suprimento, Fatores Criticos de Sucesso, Estudo de Caso, Industria Quimica

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Study purpose
To identify and categorize the critical success factors influencing digital transformation in the supply chain of a multinational chemical company, analyzing how they are managed and how they shape the digital journey in complex organizational contexts.

Relevance / originality
This study addresses a gap by integrating technological, organizational, and cultural dimensions in the analysis of digital transformation in supply chains, offering a novel practical and theoretical perspective in the chemical industry.

Methodology / approach
A qualitative research using a single case study, based on semi-structured interviews with global managers. Thematic content analysis was applied, supported by artificial intelligence for data coding and categorization.

Main results
Eight interdependent critical success factors were identified. Engaged leadership, structured governance, systems integration, and cultural change management emerged as the most recurrent and decisive for successful digital transformation.

Theoretical / methodological contributions
Proposes a conceptual model integrating technological, organizational, and cultural dimensions. Offers an analytical framework for future studies and contributes methodologically by applying AI in qualitative interview analysis.

Social / management contributions
Provides a managerial checklist to support diagnosis and planning of digital transformation in supply chains. Assists leaders in decision-making, promoting efficiency, innovation, and organizational sustainability.

Keywords: Digital Transformation, Supply Chain Management, Critical Success Factors, Case Study, Chemical Industry

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1 Introduction

The acceleration of digital transformation has redefined how organizations operate and compete. More than simply adopting new tools, digital transformation requires structural changes in the business model, promoting strategic innovations and organizational reconfigurations to create sustainable value (Pisano, 2015; Vial, 2019). It is a multifaceted process that demands not only the introduction of digital technologies but also a reorientation of corporate culture, structures, and processes (Sambamurthy & Zmud, 2017; Saarikko et al., 2020).

In supply chains, digital transformation has driven significant gains in efficiency, traceability, and operational resilience. Technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Big Data Analytics, and Blockchain have been catalysts for new operational models, promoting system integration and process automation (Bag, Tiwari & Chan, 2019; Gartner, 2023). These advances have redefined supply chain management practices, especially in sectors operating under high safety and compliance requirements, such as the chemical industry (Centobelli, Cerchione & Ertz, 2020). Furthermore, it contributes to sustainability by reducing resource consumption and improving energy efficiency and transformation (World Economic Forum, 2023).

In this context, Supply Chain Management (SCM) becomes a strategic field under digital transformation. SCM encompasses the planning, coordination, and execution of all activities involved from raw material acquisition to final product delivery to the consumer, aiming at cost optimization, agility, quality, and sustainability (Mentzer et al., 2001; Christopher, 2022; ASCM, 2023). However, the current environment imposes new demands, making digital transformation a priority to ensure competitiveness and resilience in the face of global disruptions (Shih, 2020; Accenture, 2022; World Economic Forum, 2023).

Despite consensus on the benefits, evidence shows that most digital transformation initiatives fail to achieve their goals. It is estimated that between 64% and 90% of these initiatives are unsuccessful, resulting in losses of up to US$1.3 trillion per year in digital transformation programs (Ramesh & Delen, 2021; Schäfer et al., 2021). Although resistance to change is often cited as a cause of failure, interviews in this case study revealed that implementation management failures—such as lack of governance, unclear strategy, and ineffective communication—are equally or more decisive factors for the failure of digital transformation initiatives. A digital supply chain trends survey by PwC (2023) and McKinsey (2023) reports that many challenges persist, and companies have room to improve their supply chains in the digital era.

Particularly in large corporations with traditional business models, additional barriers are faced in transforming operations. Stakeholder inertia, fear of failure, and lack of alignment between leadership and technology represent significant obstacles (Sebastian et al., 2020; Hess, 2022). Only a small portion of executives report satisfactory returns on technology investments in the supply chain, highlighting the need for a more strategic view of the factors that condition transformation success (Saénz, Revilla & Borrella, 2022).

Estudos indicam a necessidade de compreender de forma mais aprofundada quais são os fatores críticos de sucesso (FCS) que influenciam o êxito das transformações digitais e, principalmente, como esses fatores devem ser gerenciados dentro do ambiente organizacional (Cichosz, Wallenburg & Knemeyer, 2020; Dwivedi, Ganguly & Paul, 2024). Studies indicate the need for a deeper understanding of the critical success factors (CSFs) that influence the success of digital transformations and, especially, how these factors should be managed within

the organizational environment (Cichosz, Wallenburg & Knemeyer, 2020; Dwivedi, Ganguly & Paul, 2024). There is a lack of investigations that articulate these CSFs with cultural, technological, and structural dimensions, especially in complex industrial contexts such as the chemical sector.

Faced with these challenges, this research seeks to answer the following question: "How does a chemical sector company perceive the critical success factors in the digital transformation journey of the supply chain?"

To this end, the general objective is to identify and categorize the critical success factors that impact the digital transformation of the supply chain of a multinational chemical company. Additionally, it aims to understand how these factors are managed, considering aspects such as decision criteria, implemented activities, internal policies, people involvement, and organizational structures. This study is structured around three specific objectives:

1. Identify and Categorize the Critical Success Factors: Group the CSFs into categories to enable a comprehensive understanding of the phenomenon.

2. Assess the perception of CSFs: Explore how these factors are operationalized in practice through actions, policies, stakeholders, and governance structures.

The research adopts a single case study method, focusing on a multinational company currently undergoing a digital transformation journey. The organization was selected due to its representative role in the chemical sector and the challenges faced within its supply chain (Creswell & Creswell, 2021).

By addressing this topic, the present study aims to contribute to both academic literature and managerial practice, offering an integrated view of the elements that enable or hinder the success of digital transformation in supply chains. The specificity of the chemical sector adds value to the research, considering its regulatory requirements, complex operational structure, and the critical nature of its logistical flows.

2 Theoretical Framework

The theoretical framework aims to understand digital transformation and the critical success factors (CSFs) in the supply chain, analyzing how these dynamics influence operational efficiency, innovation, and sustainability. Furthermore, it examines the correlations between these factors and the management practices required for the effective adoption of emerging technologies in the chemical sector.

2.1 Digital Transformation

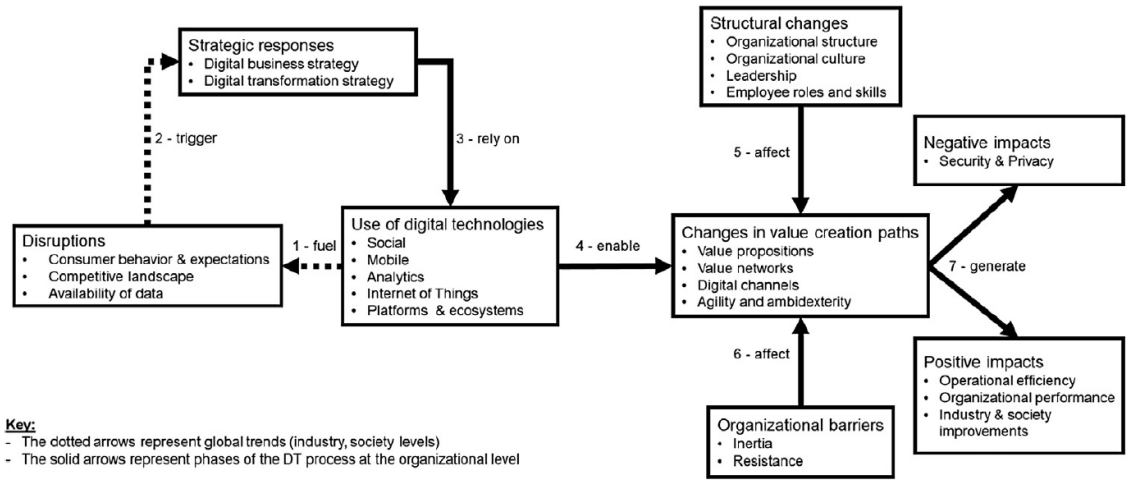
Digital transformation is a comprehensive process that integrates digital technology into all areas of a company, resulting in fundamental changes in operations and value delivery to customers. Vial (2019) and Kraus et al. (2021) define digital transformation as a process aimed at improving an entity by triggering significant changes in its properties through combinations of information, computing, communication, and connectivity technologies. This concept goes beyond the mere adoption of technologies, involving the redefinition of processes, business models, and organizational culture. The restructuring of organizational processes, from the digitization of manual tasks to the implementation of automation systems and data analytics, is essential to optimize operations and decision-making (Westerman, Bonnet & McAfee, 2014; Hess, 2015; Tabrizi et al., 2019).

Innovation strategies may have objectives that yield results over different timeframes. Activities focused on less structural changes tend to produce short-term results, while more disruptive changes typically deliver long-term outcomes (Andreini et al., 2022; Agazu & Kero, 2024). A simple example would be the digitization of a previously manual process now handled by a system—this represents a minor shift in execution capacity without altering the perceived

customer value. In contrast, a disruptive model would seek to redesign the entire value chain, process, and value proposition, introducing greater complexity and longer implementation timelines due to the need to build from scratch. These scenarios—ranging from simpler changes to full-scale transformation—are directly influenced by corporate mindset and leadership, closely tied to organizational culture (Pisano, 2015; Sambamurthy & Zmud, 2017).

This digital transformation strategy involves not only the adoption of new technologies but also other aspects that must be addressed within the organization. These include the organizational model and culture, as illustrated in Figure 1.

Figure 1: Transformation Blocks in Digital Transformation



Source: Adapted from Vial (2019).

The integration of emerging technologies plays a vital role in driving innovation and enhancing operational efficiency. A notable example is the incorporation of blockchain into supply chain management. Queiroz, Telles, and Bonilla (2020) highlight that blockchain has the potential to revolutionize SCM by enabling secure transactions and recording each stage of a product in an immutable manner. This transparent and tamper-proof record is particularly critical in sectors where product origin reliability is essential, such as food and pharmaceuticals. Efficiency and agility improvements are significant benefits, allowing organizations to become more responsive and effective (Wang, Chan & Tiwari, 2016; Mairesse et al., 2025). Data analysis, especially through big data solutions, enables informed decision-making and market trend forecasting (Pappas et al., 2018; Boussioux et al., 2024).

Digital transformation is not merely a matter of implementing technology; it also requires clear strategic alignment. Leading a successful digital transformation demands a clear vision and strong leadership to ensure that technology is aligned with the company's business objectives. Westerman, Bonnet, and McAfee (2014) argue that leadership must mediate between technology and organizational aspects, creating an integrated strategy that fosters true transformation. The creation of digital ecosystems, exemplified by giants such as Amazon and Alibaba, is redefining relationships among suppliers, partners, and customers, driving innovation and value creation (Pappas et al., 2018; Brosnan et al., 2023).

2.2 Supply Chain Management (SCM)

Supply Chain Management (SCM) is a central concept in the business world, referring to the coordinated management of all activities involved in the flow of products, services, and information among suppliers, manufacturers, distributors, and customers. SCM integrates business processes from the point of origin to the point of consumption, aiming to better meet

the needs of the end customer (Mentzer et al., 2001; Christopher, 2022; ASCM, 2023). The essence of SCM lies in the ability to connect and optimize these flows to create sustainable value for both companies and customers.

An effective supply chain must be agile, adaptable, and aligned (Lee, 2004; Brandtner, 2024). Agility refers to the ability to respond quickly to market changes and customer demands, while adaptability is the capacity to adjust to global structural changes, such as new markets and technologies. Alignment involves coordinating strategies and objectives among all supply chain partners to reduce waste and maximize return on investment.

The integration of technology into SCM is essential to improve efficiency, increase visibility across the supply chain, and support data-driven decision-making. Information systems are crucial for integrating internal and inter-organizational business processes, enhancing both operational and strategic supply chain performance (Gunasekaran & Ngai, 2004; Tavana et al., 2022). Emerging technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain are redefining operational efficiency, improving visibility and traceability throughout the supply chain, and contributing to resource optimization and waste reduction (Blecker & Kersten, 2019; Shan, 2023).

Big data and analytics are transforming how supply chains forecast demand, manage inventory, and optimize resource allocation (Gunasekaran et al., 2016; Shan, 2023). AI and Machine Learning are redefining analytical capabilities in SCM, enabling the prediction of demand patterns, inventory optimization, and identification of potential risks, resulting in faster and more accurate responses to market changes (Blecker & Kersten, 2019; Brandtner, 2024). Blockchain technology has the potential to revolutionize transparency in supply chains by creating immutable and transparent transaction records, which enhance trust among partners and ensure data integrity (Kshetri & Voas, 2020; Almeida & Soares, 2022).

The integration of sustainable practices is another significant innovation in SCM. Sarkis et al. (2020) argue that green SCM involves implementing environmentally responsible practices throughout the supply chain, from selecting sustainable suppliers to using biodegradable packaging and optimizing transportation routes to minimize the carbon footprint. The need for agile and responsive supply chains is imperative in a rapidly changing market environment. Agility enables companies to adjust operations quickly and efficiently in response to external changes. These innovations in SCM not only provide a competitive advantage but also ensure that companies can sustain their operations responsibly and adaptively in response to market demands and environmental concerns (Shah et al., 2023).

2.3 Critical Success Factors

Critical Success Factors (CSFs) are essential for understanding which areas of an organization require special attention to achieve strategic objectives. In his seminal work from 1979, Rockart introduced the concept of CSFs as fundamental to effective management performance, emphasizing that without proper focus on these areas, an organization may fail to reach its key goals.

The methodology for identifying CSFs involves understanding executives' data needs, which reflect the organization's priorities. This requires interviews and discussions with executives to outline strategic objectives and the areas that require accurate and efficient data for monitoring.

- *Innovation:* In rapidly evolving sectors, the ability to innovate can be a critical success factor.
- *Customer Satisfaction:* In service-oriented industries, customer satisfaction is often a key CSF.
- *Operational Efficiency:* In manufacturing companies, operational efficiency can determine success in competitive markets.

Identifying CSFs is a vital practice for any organization seeking success and efficiency. Rockart's approach remains relevant, as it provides a clear framework for understanding which elements of a company's operations are essential to achieving its overall goals. Implementing a In project management, CSFs are the essential conditions or activities required to ensure project success. According to Belassi and Tukel (1996), understanding and managing these factors is crucial to avoiding failure and maximizing the likelihood of achieving project goals. They propose a systematic approach to identifying CSFs, highlighting aspects such as clearly defined objectives and scope, top management support, project team competence and composition, and effective planning. Pinto and Slevin (1988), as reviewed by Muller and Jugdev (2012), emphasize executive support as a CSF, while Turner (1999), also reviewed by Muller and Jugdev (2012), points to the project manager's competence as a determinant of project success.

Digital transformation is the process through which companies restructure their operations and strategies by integrating digital technologies. CSFs for digital transformation not only identify the essential elements for this transition but also guide organizations on where to focus their efforts to maximize the impact of digital technologies on their operations and business models. According to Besson and Rowe (2012), digital transformation requires a strategic approach that combines technology, processes, and people. CSFs in this area include committed leadership, a culture of innovation, and the integration of IT with business strategy (Soomro et al., 2020).

In fast-paced sectors such as the chemical industry, the ability to innovate is an indispensable CSF. Innovation enables companies to adapt to market changes and maintain a competitive edge. To measure innovation, companies can monitor the number of new products launched and their reception in the market (Pisano, 2015; Moreira et al., 2024). Customer satisfaction is also frequently a CSF in service-oriented industries. Monitoring customer feedback and satisfaction indices helps ensure that customer needs are being effectively met (Rockart, 1979; Muller & Jugdev, 2012).

For manufacturing companies, operational efficiency can determine market success. Developing performance indicators to monitor process efficiency and implementing continuous improvement is essential. Strong leadership is also a key factor, as it is crucial for guiding digital transformation and ensuring strategic alignment. Involving top management in the planning and execution of digital transformation initiatives is fundamental to success (Sacavém et al., 2025).

Ongoing collaboration between departments and external partners is vital for successful digital transformation. Promoting a culture of collaboration and open communication within the organization and with external stakeholders can facilitate the integration of new technologies and processes (Ahmad et al., 2023). Additionally, robust data management is fundamental for informed decision-making and supply chain efficiency. Implementing data management systems that ensure data accuracy, security, and accessibility is essential (Omol, 2023).

3 Methodology

To investigate the critical success factors (CSFs) that can leverage digital transformation in the supply chain, this research adopts a qualitative approach through an exploratory single case study. This approach enables an in-depth analysis of the studied phenomena, fostering an understanding of the internal dynamics and challenges faced by organizations during their digital transformation journey (Barends & Rousseau, 2018).

The approach was grounded in methodological frameworks, with the case study considered appropriate for contemporary phenomena embedded in complex contexts, where there is no clear separation between phenomenon and environment (Yin, 2015). The focus was

to understand how digital transformation occurs at the organizational level and which factors contribute to its success in a real operational environment, specifically within the supply chain.

The choice of a qualitative approach is justified by the exploratory nature of the investigated phenomenon—digital transformation in supply chains—which involves multiple interdependent dimensions (technological, organizational, and cultural) that are difficult to quantify in isolation. According to Yin (2015), qualitative case studies are suitable when seeking to understand complex phenomena in real contexts, especially when the researcher has no control over events and the focus is on "how" and "why" processes occur. The qualitative approach allowed for capturing perceptions, experiences, and interpretations of the interviewees, enriching the understanding of CSFs from a contextualized and in-depth perspective.

3.1 The Case Selection and Data Collection

The case study was conducted in a multinational chemical company, globally recognized for its performance in innovation, sustainability, and digital transformation. The selected company, whose name is withheld for ethical and methodological reasons, operates in more than 160 countries, with approximately 35,900 employees and an annual net revenue of around US$45 billion. The selection was based on criteria of accessibility, sector representativeness, and digital maturity, making it relevant for understanding the transformation dynamics in the supply chain. Upon accessing the company's 2025 Proxy Statement on its official website, it was confirmed that digital transformation is explicitly highlighted as one of its strategic pillars, supported by an executive transformation committee and structural investments in value chain digitization, automation, and data analytics.

The data collection process was planned based on a literature review on digital transformation in supply chains, particularly the studies by Centobelli, Cerchione & Ertz (2020), Cichosz, Wallenburg & Knemeyer (2020), and Dwivedi, Ganguly & Paul (2024), which emphasize the importance of considering dimensions beyond technology, such as organizational culture, governance, and leadership. Based on these references, a semi-structured interview guide was developed with questions aimed at exploring perceptions about the current stage of digital transformation, enabling factors and perceived barriers, governance practices, adopted technologies, and cultural aspects. The research process, consent form, and interview guide were submitted for approval to the FGV Human Research Ethics Compliance Committee (CEPH/FGV), with approval granted under opinion no. P.630.2024 issued on 12/18/2024.

Ten professionals from different continents (Latin America, North America, Europe, Asia, and Global Operations), functional areas, and hierarchical levels were interviewed. The interviews were conducted via videoconference using Microsoft Teams, with an average duration of 50 minutes, totaling approximately 500 minutes of transcribed material. The conversations were recorded with consent, transcribed, and, when necessary, translated into Portuguese while maintaining fidelity to the content, also using MS Teams and Copilot tools.

3.3 Use of Artificial Inteligence

The use of Artificial Intelligence (AI) has proven to be a valuable tool for optimizing various stages of academic research. In this study, AI was used responsibly, ensuring transparency, integrity, and originality in the development of the work. The use of these technologies did not replace the researcher's critical analysis but served as support to enhance the efficiency and depth of the research.

AI was applied in three main areas: support for literature review, processing and analysis of interviews, and assistance in structuring the work. AI tools were used to identify, synthesize, and organize academic references relevant to the topic. The use of these technologies enabled

efficient searches for scientific articles, reports, and regulatory documents related to critical success factors in digital transformation of the supply chain. Despite the support provided by AI, all references were manually validated to ensure their relevance, timeliness, and credibility.

3.4 Data Processing and Analysis

The analysis was conducted based on thematic content analysis, following the procedures outlined by Bardin (2016), in four stages: pre-analysis, coding, categorization, and researcher annotations, which supported the interpretation of the data. The results are presented in a narrative format, using a comparative approach between the case study findings and the theoretical framework. The analysis considered dimensions encompassing market, organizational, individual, and information technology levels (Albertin & Albertin, 2012). This approach facilitates the contextualization of the findings and highlights their practical and academic contributions to the field of digital transformation in supply chains (Creswell & Creswell, 2021).

As a limitation, the study focuses on a single case, which restricts the generalizability of the results. However, given the exploratory qualitative nature of the research, analytical depth is prioritized over statistical representativeness. From an ethical standpoint, all participants were informed about the research objectives and provided consent for the use of their data. No sensitive information was collected, and anonymity was preserved in accordance with the guidelines of the American Psychological Association (APA, 2020).

4 Analysis of Results

The qualitative data analysis phase began with the organization and exploration of the empirical material collected from the interviews. To this end, the thematic content analysis technique was adopted, allowing the identification of recurring patterns and significant categories. Given the substantial volume of data, approximately 500 minutes of transcribed interviews, a natural language-based artificial intelligence tool (ChatGPT) was used as technical support for the initial screening and structuring of the data, without replacing the critical interpretation conducted by the researcher. Tables 2 and 3 present the interview questions and answers, followed by the main emerging topics from this analysis, organized according to the previously defined dimensions.

Table 2 – Interview with Questions and Answers

QUESTIONS		INTERVIEWEES				
		E1	E2	E3	E4	E5
Q1	*Professional Experience and Involvement*	Leader of the global supply chain risk and resilience team. His background includes education in science, finance, strategy, and marketing, equipping him to manage complex and interdisciplinary risks.	Global Director of Supply Chain Excellence. With 37 years of experience, he entered the digital transformation journey by leading the planning transformation, focusing on people, processes, data, and technology—in that order	Leader of Integrated Supply Chain for two business divisions of the company. Works with planning, customer service, and continuous improvement. Participates in the digital transformation as an internal client, connecting global solutions to local realities and leading user engagement.	North America Supply Chain Director. He began his digital journey with a project in the United Arab Emirates, progressing through APO and OMP implementations, with a focus first on demand planning and supply.	Global Director of Innovation in Supply Chain, leading the Digital Fulfillment Center. He created this role after identifying digital gaps following the implementation of ERP. For the past seven years, he has been dedicated to transforming processes and accelerating the adoption of emerging technologies
Q2	*Observed Changes / Technology Adoption*	Recognition of the ongoing technological revolution. The company has made significant investments in AI, IoT, blockchain, and cloud technologies, establishing the Digital Fulfillment Center (DFC) to apply these innovations across the supply chain.	Digital transformation is driven by corporate restructuring. Initially approached as a structured program, the transformation is now being integrated into the organization's daily operations, with a strong emphasis on efficiency and productivity.	From abstraction to tangible impact. Digital tools are now in practical use, such as order management systems. The current focus is on extracting real value from the implemented solutions.	Growing adoption of tools such as OPR and ASP. The organization has developed greater trust in data, using it to support critical decisions and planning meetings, with an increased sense of ownership and accountability for data quality.	Generative AI adoption (e.g., Copilot) has enhanced individual productivity. The focus is now shifting toward the use of agent-based AI to automate standardized processes and achieve productivity gains at the organizational level.

Q3	*Critical Success Factors (CSFs)*	1. Understanding the technological moment. 2. Operational efficiency through automation. 3. Visibility and transparency. 4. Agility and resilience through predictive models. 5. Customer focus and reliability.	1. Empowering people. 2. Harmonized processes. 3. Data quality. 4. Technology as a catalyst. 5. Engagement of middle management.	1. Change management from the beginning. 2. Data discipline and governance. Digitalization demands well-defined processes and continuous data maintenance to ensure reliable outcomes.	1. Effective change management. 2. Digital education at all levels. Promoting digital literacy throughout the organization, with a particular focus on middle management. 3. Time for user adoption.	1. Alignment with corporate strategy. 2. Leadership support. 3. Data quality and governance. 4. Process standardization. Without standardized processes, automation becomes unfeasible—as seen in the complexity of freight billing.
Q4	*Challenges and Overcoming Strategies*	Resistance to change, legacy system integration, data security, operational continuity, and difficulty in measurement. Strategies: clear communication, reskilling, investment in cybersecurity, and technological adaptation.	COVID-19 and major supply chain disruptions. The greatest challenge was maintaining digital discipline when people wanted to return to Excel. Data interdependence requires strong leadership and well-defined processes	The biggest challenge was reconciling the adoption of new technologies with ongoing operations. Effective strategies included more practical training, gamification, and instructional design adapted to maintain user engagement.	Difficulty in promoting true ownership of the tools. The suggested strategy is to create teams of subject matter experts (SMEs) with dedicated time to explore, test, and master the systems, fostering practical and in-depth learning	A culture of past success made change more difficult. The challenge was to scale models beyond the traditional "one problem, one model" approach. The solution was to create multidisciplinary teams (business, data science, IT) and invest in modern architecture (data lake, ML Ops).
Q5	*Emerging Technologies*	Example: creation of the "Supply Chain Knowledge Graph," which connects plants, products, customers, and logistics to predict geopolitical and operational risks, enabling fast and strategic responses.	System integration (OMP, SAP, manufacturing) was more critical than the adoption of emerging technologies. Attempts with DDMRP and AI had low adoption. The challenge is to operate innovations at scale with reliable data.	Technologies such as IoT, AI, and GPS-based visibility have not yet delivered their full expected value. The organization is at the beginning of a learning journey to structure processes that can effectively leverage these technologies.	AI is promising but still underutilized due to the speed of evolution and resource limitations. There are ongoing initiatives, such as using AI for freight and cost analysis, but full adoption will take time	Examples include digital assistants for customer service, advanced modeling for planning, and the use of knowledge graphs to map material flows. There are also initiatives involving blockchain and growing interest in quantum computing.
Q6	*Results and Performance Indicators*	Reliability, on-time delivery, and customer satisfaction. Automation reduced human errors and provided real-time data, improving decision-making and enhancing the customer experience	Inventory reduction and improved demand visibility and predictability. Metrics such as DSI and DDI improved. There were also gains in manufacturing and transportation costs, although these are harder to isolate	Significant increase in the use of digital channels for order placement and benefits from standardized planning through a single system. This brought greater visibility and integration across supply chain stages	The main improvement was in plan quality, which increased from 40% to nearly 80%. There were also improvements in OTD9 (on-time deliveries), with better visibility to act quickly in response to issues	Inventory and working capital reduction through better supply/demand balancing. Improved customer experience and use of data as an asset to drive continuous improvement and innovation.
Q7	*Success Cases*	The "Supply Chain Knowledge Graph" was highlighted as a success case, enabling real-time visualization of risks and impacts across different countries and operations	The transformation of planning brought visibility and standardization. Digitalization revealed process variations, allowing decisions on what to standardize or keep differentiated. Example: demand forecasting with AI and unified processes.	Digitalization forced improvements in master data quality. Data governance became essential and continuous, directly impacting operational efficiency and information reliability.	Weekly tactical planning meetings (ITP) with all functions integrated, using digital tools for fast and collaborative decision-making. There were also advances in long-term planning (4 to 24 months).	OP Cycle Next project: a production scheduling model based on linear programming, implemented globally. Results: better asset utilization, waste reduction, and margin improvement. Co-creation with the business accelerated adoption and value.
Q8	*Future Trends*	Hype automation, autonomous AI agents, blockchain for traceability, sustainability with IoT, digital twins, and "Supply Chain as a Service" as an emerging operating model	System openness and integration, strategic partnerships with platform providers (SAP, Microsoft, OMP), and adoption of AI as part of technology upgrades, with a focus on practical value rather than innovation alone.	1. Increased effective use (adoption) of already implemented tools. 2. Greater utilization of emerging technologies such as AI and big data for predictability and decision-making.	Use of AI to predict and suggest actions in supply/demand balancing and logistics. The expectation is that AI will help optimize assets and strategic decisions, although full adoption is still about 24 months away	Adoption of AI, machine learning, and knowledge graphs. However, the focus is on a culture of continuous learning, new career paths, and skill development to manage complex scenarios and sustainability.
Q9	*Strategic Advice / Recommendation*	Investing in emerging technologies, developing internal models, promoting sustainability, and exploring new operating models focused on efficiency and resilience	Focus on extracting value from already implemented technologies. Strategic partnerships with platform providers to leverage future innovations. Less investment in new projects and greater emphasis on adoption and effective use of existing solutions.	Focus on measuring the real value extracted from tools, not just superficial usage. Pursuit of greater integration between collected data and practical decision-making	The culture is evolving to embrace technology as an ally. The challenge is to ensure that employees see AI as an empowerment tool, not a threat, and are prepared to take on more strategic roles	Investing in competency mapping, skills validation, and continuous training. The goal is to elevate professionals to more strategic roles and prepare them for challenges such as circularity and resilience.
Q10	*Final Remarks / Additional Insights*	Have a clear vision of success, leadership engagement, leverage existing resources, invest in people, and ensure data quality (data hygiene) as a foundation for reliable decision-making	Be prepared for a long journey. Technology works, but success depends on adapting to the organization's culture and people. Change management must be personalized and people-centered, as they are the true differentiator.	Present solutions clearly and engagingly from the beginning. Assign technology-specific experts. Facilitate training with interactive formats. Measure effectiveness after implementation and continuously adjust to ensure sustainability.	Start with focus. Avoid "Big Bang" approaches. Invest where there is the greatest potential for value. Leverage the enthusiasm of young talent, but direct efforts to ensure return on investment	Don't be driven by technology alone. Start with the business strategy, connect it to processes and people. Avoid chasing every innovation; have a clear roadmap and focus on real results.

Table 3 – Interview with Questions and Answers

QUESTIONS		INTERVIEWEES				
		E6	E7	E8	E9	E10
Q1	*Professional Experience and Involvement*	Logistics Leader for Asia-Pacific for about 5–6 years. Involved in digital transformation due to the belief that information is the most asset in the supply chain and that intelligent data analysis is essential to generate value.	Global Supply Chain Director for the Packaging and Specialty Plastics business. Leads planning, logistics, productivity, and customer service. Involved in digital transformation to manage global complexity and increase efficiency.	Supply Chain Director for Packaging and Specialty Plastics) in Asia-Pacific. Involved in digital transformation for over 10 years, focusing on planning, logistics, and digital initiatives such as OMP, .com, and logistics visibility	Supply Chain Leader for Hydrocarbons in Europe. Works on planning digitalization (with OMP) and customer service transformation with a focus on productivity and visibility.	Global Logistics Operations Leader. Became involved in digital transformation upon recognizing the need for efficiency and real-time visibility to manage freight and complex supply chains.
Q2	*Observed Changes / Technology Adoption*	Growing adoption of simple automations, use of analytical tools, and application of AI for sales forecasting. Young teams have engaged enthusiastically, developing their own solutions and delivering results superior to traditional methods.	Massive adoption of digital channels for orders (from 10% to nearly 60%) and global integration of planning, replacing manual and isolated processes with digitally connected systems	Significant increase in order digitalization (from 3% to 60%) using .com and integration with contracts. Internal processes were also digitalized using the GO App, improving visibility and collaboration across functions	Greater clarity of roles and responsibilities, elevation of the supply chain team's role, and visibility of previously hidden issues. Digitalization brought discipline and revealed improvement opportunities that were previously invisible.	Shift from a focus on tools to a focus on processes and data-driven actions. Transformation became integrated into work processes, with greater emphasis on insights and decision-making.
Q3	*Critical Success Factors (CSFs)*	1. Understand what is critical to the business. 2. Identify relevant data and drivers. 3. Structure data logically. 4. Choose technologies that support these goals. The focus should be on generating value, not just applying technology.	Having a solid foundation of master data and reliable systems. Master data quality is essential to avoid errors and ensure that digital processes function correctly.	1. Adaptation to business needs. 2. Stakeholder involvement during the design phase. 3. Process simplification before digitalization. 4. Effective change management to ensure alignment and engagement.	1. Alignment at all levels of the organization. 2. Leadership support (top-down). 3. Clarity on the objectives and benefits of the transformation. Lack of alignment delayed implementation in some cases.	1. Focus on work processes, not just the tool. 2. Recognition that digital transformation is also change management. 3. Preparing the organization for changes in roles and ways of working.
Q4	*Challenges and Overcoming Strategies*	1. Prioritizing resources and time for digital initiatives. 2. Connecting with experts and keeping up with industry trends. The strategy is to balance short- and long-term goals and seek collaboration with technology and data partners.	1. Difficulty in perceiving immediate value during the construction of the digital foundation. 2. Resistance to change, both internal and from customers. Overcome through education, persistence, and demonstrating practical benefits.	1. Disconnect between technical teams and business needs. 2. Tools not always suited to the business model (e.g., OMP). 3. Lack of integration between systems. Strategies: continuous feedback, testing, and pursuit of connectivity between platforms	Initial resistance from teams and adjacent functions. Effective strategies included clear communication of the value of change, stakeholder involvement, and the use of profiles with organizational and transformation skills to lead the change.	Attempts to do too many things at once and excessive focus on tools. Effective strategy: prioritize initiatives, align with processes, and ensure clarity on how tools change the work.
Q5	*Emerging Technologies*	An example of AI used to predict delivery delays based on visibility data. Although not all implementations were successful, valuable lessons were learned about what truly adds value to the business.	AI still in the early stages, with great potential. The Internet of Things (IoT) has already delivered concrete gains, such as automating the production confirmation process, eliminating manual errors, and speeding up deliveries	Use of RPA, Power Automate, and Copilot for automating repetitive tasks. AI is still in the early stages but shows potential for customer service, planning, and logistics visibility. Example: integration with customers via EDI/API	Initial adoption of AI and Copilot is still incipient. Current use is more focused on individual productivity (emails, files, presentations). The organization is still exploring how to apply these technologies more strategically.	AI and machine learning are still in early stages. There is potential, but the value has not yet been fully realized. Emerging technologies generate enthusiasm but also distractions and prioritization challenges.
Q6	*Results and Performance Indicators*	Shift from a total cost focus to LCE (cost, service, and carbon). Analytical tools helped identify cost-saving opportunities and service improvements, with significant financial impact and result predictability	Forecast accuracy improved significantly through statistical models and large-scale data, positively impacting the entire supply chain.	Forecast accuracy, reduction of inefficient inventory, and increased productivity. Digitalization enabled better planning and efficient resource use, even with headcount constraints.	Reduction of rework and increased productivity. Improved inventory management and visibility over customer response time. Digitalization helped identify bottlenecks and improvement opportunities in the process	Improved customer experience (CX score), logistics visibility, and working capital. Digitalization enabled better communication with customers and more informed decisions regarding inventory and costs
Q7	*Success Cases*	Partnerships with LSPs such as DHL and PSA resulted in improvements in sustainability, reliability, and efficiency. Visits to innovation centers revealed how digital technologies are being applied to generate value across the entire logistics chain.	20% reduction in inefficient inventory (products over 6 months old) thanks to improved demand forecasting and better alignment between planning and actual orders. This increased turnover and service levels	Adoption of .com for digital orders, with a positive impact on customer experience and freeing up resources to focus on strategic customers. There were also gains from report automation and internal process improvements.	Increased visibility and discipline in customer service processes. Reduction in response time and use of data to support decisions and improve dialogue with stakeholders. Results are still maturing but already show a positive impact.	The logistics excellence program generated $84 million in value in 2024 and projects $100 million in 2025. This was only possible due to the visibility and operational discipline enabled by digital transformation.
Q8	*Future Trends*	Belief that the future lies in generating insights from data across the value chain. Technologies like	Growth in the use of AI and machine learning. Shift in professional profiles: fewer transactional tasks, more	Increasing adoption of AI for data analysis, planning, and customer service. Connectivity among value chain partners (customers,	Integration of sustainability as a critical variable in supply chain processes. The organization is	The speed of technological change is the main trend. Preparation requires a growth mindset,

		blockchain have potential but depend on industry maturity and trust to scale.	focus on analysis, exceptions, and support for predictive models	suppliers, government). Exploration of virtual assistants and integration via EDI/API.	adapting systems and processes to incorporate environmental metrics without increasing operational complexity.	curiosity, and a willingness to learn and adapt continuously.
Q9	*Strategic Advice / Recommendation*	Focus on standardization and use of single platforms. The organization seeks to understand which digital capabilities are needed and how to connect with external trends to maintain competitive advantage.	Investing in upskills and shifting professional profiles. The focus is on technical and analytical skills to navigate the new digital environment and support continuous evolution.	Investing in system connectivity (e.g., OMP, ECC, GO App), exploring AI for sales assistants, and promoting integration with customers via EDI/API. The goal is to build a more connected and efficient digital ecosystem	Pragmatic evaluation of sustainability integration into existing systems. Using past digitalization experiences to adapt processes and avoid excessive complexity.	Adopting a mindset of continuous learning and growth. The organization recognizes that change is constant and that readiness to adapt is essential.
Q10	*Final Remarks / Additional Insights*	1. Use a single platform. 2. Standardize whenever it makes sense. 3. Restructure processes before automating. 4. Involve the industry and partners to maximize value. Digital transformation must be collective and strategic.	1. Build a solid foundation of data and systems. 2. Stay committed to the transformation, even when facing obstacles. Digitalization is essential to remain competitive in today's landscape.	Choose solutions aligned with the business, involve stakeholders from the beginning, ensure leadership support, and align with the strategic vision. Transformation must be planned with a focus on value and adaptability.	Start as early as possible. Be clear about the value of transformation and prepare the organization for the challenges. Change management and stakeholder engagement are key to success.	1. Define a long-term vision with annual priorities. 2. Link transformation to work processes. 3. Ensure stakeholder engagement and understanding of the transformation's value.

In the pre-analysis stage, a floating reading of the transcripts was conducted to identify central ideas, keywords, and recurring language patterns. AI was used to generate automatic summaries of each interview, highlighting the main themes mentioned by the participants. This provided an initial overview of the content and facilitated the identification of relevant excerpts for in-depth analysis.

Coding was carried out in two phases. In the open coding phase, the data were broken down into units of meaning and labeled with representative codes (e.g., "resistance to change," "system integration," "leadership sponsorship"). AI assisted in suggesting initial codes based on term frequency and occurrence, but the validation and refinement of the codes were performed manually by the researcher. Next, axial coding was conducted, where the codes were grouped into thematic categories based on semantic and conceptual relationships. AI was used to map relationships between codes, suggesting groupings that were subsequently reviewed by the researcher.

In the categorization stage, the goal was to group the codes into thematic categories that represent central dimensions of digital transformation in the supply chain. For this case study, the following procedure was adopted: grouping similar or complementary codes; defining categories by naming and describing each based on the groupings; and internal validation by verifying the internal coherence of each category and the distinction between them. As a result, the thematic categories were organized into three main analytical dimensions: technological, organizational, and cultural. AI contributed to the visualization of these categories, facilitating the identification of interdependencies among the factors.

In the stage of associating with analytical dimensions, the objective was to relate the thematic categories to the analytical dimensions defined in the theoretical framework of the research. This involved reviewing the theoretical framework to identify analytical dimensions (e.g., critical success factors, barriers, impacts, trends) and mapping the categories by associating each with one or more dimensions. The final step consisted of interpreting the data considering the theoretical references, including interviews, literature, and observations.

4.1 Discussion of Results

The findings of this research revealed eight Critical Success Factors (CSFs) for digital transformation in the supply chain, grouped into three interdependent dimensions: technological, organizational, and cultural. The CSFs are presented below in order of perceived relevance, based on the frequency and qualitative emphasis of the interviews:

1. Engaged Leadership

2. Structured Governance
3. Strategic Communication
4. Systems and Process Integration
5. Change Management and Engagement
6. Digital Mindset and Capability Building
7. Strategic Alignment and Prioritization
8. Technological Infrastructure and Data Reliability

In addition to their frequency, interviewees emphasized that the engagement of middle management was a key differentiator in sustaining digital transformation on a daily basis. As reported by E2, "middle management engagement was overlooked, but it is essential to sustain the change." These factors do not operate in isolation but rather in systemic synergy. Engaged leadership directly influences governance and change management, while systems integration depends on both technological infrastructure and strategic alignment across departments.

Furthermore, the creation of multidisciplinary committees was highlighted by E5 as an effective practice to ensure cross-functional alignment and accelerate decision-making. E3 added that "data governance has become essential and continuous, directly impacting operational efficiency." The literature indicates that system interoperability and real-time visibility are essential conditions for supply chain efficiency (Gunasekaran & Ngai, 2004; Wang et al., 2016; Queiroz et al., 2020). This premise was widely validated in the case study. Interviewees emphasized the integration of platforms such as OMP, SAP ECC, and .com as fundamental for process synchronization, improved forecast accuracy, and increased productivity. One interviewee stated: "Digitalization forced an improvement in master data quality. Data governance became essential and continuous, directly impacting operational efficiency and information reliability" (E3). Data governance and information security were also mentioned as prerequisites for operational reliability.

Authors such as Kane et al. (2015) and Sacavém et al. (2025) emphasize that engaged leadership is a determining factor for the success of digital transformation. The empirical data support this view: senior leadership engagement, the role of multidisciplinary committees, and strategic clarity were decisive elements in advancing initiatives. Companies that prioritized high-impact projects and promoted autonomy in cross-functional teams reported greater adoption and sustainable results.

The literature highlights that digital transformation requires a profound cultural shift, with a focus on continuous learning, collaboration, and openness to innovation (Sambamurthy & Zmud, 2017; Cameron & Green, 2019). Several interviewees emphasized the importance of cultivating a digital mindset within teams, especially in contexts of rapid technological evolution. One leader stated: "Technology changes very quickly and requires a mindset of continuous learning," reinforcing that digital transformation demands more than tools—it requires a new way of thinking and acting.

In the case of study, resistance to change was one of the challenges reported. Strategies such as clear communication, digital training, and recognition of small wins were effective in mitigating resistance and promoting team engagement. E9 reported that "initial resistance was overcome through clear communication and stakeholder involvement from other functions," while E1 noted that "ongoing communication about the purpose of the transformation helped reduce fear and increase engagement".

Centobelli et al. (2020) and Dwivedi et al. (2024) argue that CSFs should not be treated in isolation but rather in an integrated manner. This approach was confirmed in the study, where CSFs were grouped into three interdependent dimensions—technological, organizational, and cultural—that reinforce one another.

The literature suggests that successful digital transformation requires strategic focus and disciplined execution (Besson & Rowe, 2012; Pisano, 2015). Interviewees reinforced this idea

by reporting that attempts to implement multiple initiatives simultaneously led to frustration and low adoption. In contrast, projects with well-defined scope, aligned with process realities, and supported by dedicated teams showed greater effectiveness. As E10 stated: "We tried to do too many things at once, with too many tools and no focus. We overcame this with prioritization and focusing on processes rather than tools".

This study addresses a gap in literature by proposing an integrated approach to analyzing Critical Success Factors (CSFs) in digital transformation of the supply chain. Unlike studies that treat technological, organizational, and cultural aspects separately (Centobelli et al., 2020; Cichosz et al., 2020), this research presents a conceptual model that highlights the interdependence among these dimensions.

The categorization of CSFs into three axes—technological, organizational, and cultural—enables an understanding of how human, technical, and structural factors mutually influence one another. The model and the relationship map among the CSFs offer a new lens through which to interpret the complexity of digital transformation in challenging industrial environments, such as the chemical sector.

From a practical standpoint, the findings help organizations diagnose their digital maturity, prioritize strategic actions, overcome cultural barriers, and structure digital governance with engaged leadership. The identified CSFs serve as managerial checklists to support decision-making, investments, and internal policy development. Finally, the study suggests that the results may serve as a foundation for more robust frameworks, combining qualitative and quantitative methods, applicable across different sectors. The sustainability of digital transformation depends on the organization's ability to learn, adapt, and evolve continuously.

5 Conclusion

This study aimed to identify and understand the critical success factors (CSFs) that influence the digital transformation journey in the supply chain of a multinational company in the chemical sector. Based on a qualitative approach, using a single case study and interviews with managers from different regions and hierarchical levels, it was possible to map eight CSFs organized into three interdependent dimensions: technological, organizational, and cultural. The results revealed that the success of digital transformation does not rely solely on the adoption of emerging technologies, but rather on the simultaneous orchestration of human, technical, and structural factors. Engaged leadership, structured governance, systems integration, and cultural change management were identified as key conditions for enabling transformation and generating sustainable value.

From a practical perspective, the identification and categorization of CSFs provide a useful tool for business leaders to assess the digital maturity of their supply chains, prioritize strategic actions, and structure transformation initiatives more effectively. However, the study presents limitations. The main one relates to the qualitative nature and the focus on a single case, which restricts the generalizability of the findings. Additionally, data interpretation is subject to researcher subjectivity, although mitigated by cross-analysis and validation.

For future research, it is recommended to: (i) replicate the study in different sectors and organizational contexts; (ii) use quantitative methods to measure the impact of CSFs on performance indicators; (iii) deepen the analysis of the interaction between cultural and technological factors; and (iv) conduct longitudinal studies on the evolution of CSFs over time. The empirical evidence reinforces these conclusions. For instance, interviewees reported that leadership engagement is essential to sustaining change, that data governance impacts operational efficiency, and that clear communication and stakeholder involvement are highly relevant to overcoming resistance. These accounts confirm that the identified CSFs are not

merely theoretical but are experienced in practice by professionals within the studied organization.

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