

Designing a Strategic Model for the Sustainable Development of Manufacturing Businesses in the Heating and Pressure Equipment Industry with an Emphasis on Technological Innovations

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Abstract

With the advancement of technology and the growing need for organizations to ensure transparency and speed in financial reporting, manufacturing businesses in the heating and pressure equipment industry face significant challenges in implementing digital accounting and leveraging technological innovations. The absence of a coherent strategic framework leads to inefficiency and reduced competitiveness. The purpose of this study is to design a strategic model for the sustainable development of manufacturing businesses in the heating and pressure equipment industry, emphasizing technological innovations and digital accounting. Using a grounded theory approach and by identifying key factors—including causal conditions, contextual conditions, intervening conditions, strategies, and outcomes—this research presents a comprehensive framework for the successful implementation of digital accounting. The findings show that success in digital accounting requires the convergence of external pressures and internal organizational requirements, technological and human capacities, effective management of obstacles, and the adoption of comprehensive technological and human strategies. The outcomes of this model include enhanced transparency and quality of financial reporting, cost reduction, improved decision-making speed, and strengthened organizational competitiveness. The results of this research can serve as a practical guide for managers of manufacturing organizations and industrial policymakers in planning and implementing digitalization projects and technological innovations.

Keywords: sustainable business development, technological innovation, digital accounting, strategic model, organizational change management, financial transparency.

Introduction

In recent decades, sustainability has emerged as one of the fundamental principles of global business development, and manufacturing industries across various sectors—particularly the heating and pressure equipment industry—are facing serious challenges in aligning their strategies with the requirements of sustainable development. These industries, which play a crucial role in providing thermal energy, industrial safety, and social well-being, must respond to the increasing market demand while simultaneously confronting environmental, economic, and social pressures (Xiao & Jinxia, 2022).

Research has shown that sustainable development in this field is achievable only through the integration of technological innovations throughout the value chain, as such innovations not only enhance productivity and financial performance but also help mitigate harmful environmental impacts (Zhang & Envi, 2021). Accordingly, designing strategic models of sustainable development for this industry has become an undeniable necessity.

Despite the significance of the issue, many companies operating in Iran's heating and pressure equipment sector still lack well-defined strategic frameworks to incorporate technological innovation into their sustainable development pathway. This weakness has reduced their competitiveness both domestically and internationally (Hamzehei & Pourkiani, 2018). Moreover, technological innovation in these industries requires strong organizational learning capabilities and targeted investment in technological capacities (Aghajani & Rahmani, 2015; Tseng et al., 2020).

Under these circumstances, the absence of a clear model for integrating strategic, environmental, and technological factors has created a gap between high-level sustainable development policies and the actual performance of companies. This challenge appears even more critical as international pressures to comply with environmental and industrial safety standards continue to rise (Svona & Paolo, 2020).

From a managerial perspective, numerous studies have demonstrated that strategic model design can guide organizations through complex conditions and turbulent environments (Jalili et al., 2019). In fact, linking technological innovation with sustainable development strategies requires a comprehensive framework that considers environmental factors, organizational capabilities, and technological trends (Zhang & Versrach, 2022). In other words, strategic models not only serve as decision-making tools for managers but also create the foundation for building sustainable competitive advantage in sensitive industries such as heating and pressure equipment.

Nevertheless, the domestic literature has so far paid limited attention to the development of a model specifically focused on integrating technological innovation with sustainable development in this sector (Aghazadeh et al., 2016). In addition, the social and economic dimensions of sustainable development are of particular importance in this industry. Manufacturing businesses must not only aim to improve efficiency and reduce costs but also manage the social and cultural impacts of their products (Haghighi Kafash et al., 2016).

This issue becomes even more significant considering that the heating and pressure equipment industry interacts directly with energy policy, environmental security, and public health. Therefore, presenting a strategic model of sustainable development capable of creating a systematic link between technological innovation, environmental requirements, market needs, and social expectations is a vital necessity for enhancing this industry's competitive position at both national and international levels (Taslimi et al., 2018). Such a model can provide a scientific and practical roadmap for managers and policymakers to transition toward a more sustainable and technologically advanced industry.

Lecture review

Technological innovation and sustainable development, as two key concepts in contemporary management, play a fundamental role in improving the performance of organizations and industries. In fact, technological innovation not only enables the enhancement of processes and products but also serves as a strategic tool to respond to environmental, social, and economic pressures (Anadon & Gabriel, 2016). According to Khaki (2019), grounded theory in management can provide a framework for identifying and

explaining emerging patterns in the field of innovation and sustainable development. On this basis, attention to technological innovations in various industries—particularly in highly complex manufacturing sectors—has become an even more urgent necessity.

Studies indicate that empowering organizations to create, absorb, and transfer technology directly affects their innovative performance and competitive position (Rasouli et al., 2023; Canuto et al., 2016).

From an organizational perspective, innovation encompasses diverse dimensions such as product, process, organizational, and marketing innovation, each of which can differently influence the sustainability of supply chains and business performance (Rezvani & Gerailinejad, 2013; Chiffi & White, 2022). In manufacturing industries—especially in complex supply chains—technological innovation is regarded as a determinant of sustainability and productivity (Rostami et al., 2017; Lee et al., 2014). Moreover, investment in research and development (R&D) can play an accelerating role in enhancing the innovation capacity of organizations (Akcali & Sismanoglu, 2015).

From this perspective, technological innovation is not merely a technical process but a strategic concept that requires alignment with an organization's overall policies and strategies (Alizadeh et al., 2022).

The human and knowledge dimensions also play a fundamental role in the theoretical foundations of technological innovation. The transfer of technology and the enhancement of an organization's absorptive capacity depend on human capital, organizational knowledge, and technological learning ability (Rasouli et al., 2023; Ince et al., 2016). Consequently, knowledge management maturity is one of the key prerequisites for transforming potential technological capacities into actual innovation (Ghasemi & Valmohammadi, 2018). Furthermore, strategic innovation and open innovation, as two complementary approaches, help organizations create value by leveraging both internal and external resources (Ghasemi et al., 2017; Madsen et al., 2019).

In this regard, grounded theory-based approaches can effectively explain the dimensions of organizational commitment and talent management in fostering innovation (Aref et al., 2018; Gholipour & Eftekhar, 2016).

Moreover, technology and innovation management is directly linked to the macro-level policies of industrial and economic development. The successful implementation of technological strategies requires designing models that simultaneously consider environmental, competitive, and technological dimensions (Mazloumi & Motavalli, 2012; Kalko & Obsa, 2022). Among the key enablers of technological innovation are technological infrastructures, inter-organizational collaborations, and government support (Karimi Zarchi et al., 2019; Ghaseminejad & Salami, 2012).

Some studies also emphasize that technological innovation, when integrated into green supply chain management, can create sustainable competitive advantage (Lee et al., 2014; Rodger & George, 2017).

Thus, technological innovation is not merely a tool for improving the economic performance of organizations but plays a foundational role in promoting sustainable development (Fayomi et al., 2019).

In modern management approaches, technological innovation is considered a key driver in shaping sustainable competitive advantage and achieving economic and social development. Many studies stress that technological innovations not only increase productivity but also play a crucial role in improving product quality, reducing costs, and responding to changing customer needs (An & Ahn, 2016; Fayomi et al., 2019). This is particularly significant in high-tech manufacturing industries, such as heating and pressure equipment, which face dynamic and highly uncertain environments (Chiffi & White, 2022).

From this perspective, technological innovation is recognized as the connecting link between environmental requirements, organizational capacities, and the overarching strategies of sustainable development (Anadon & Gabriel, 2016).

Furthermore, scholars argue that the success of technological innovation in organizations depends on multiple factors, including technological learning capacity, knowledge management, and the ability to absorb external knowledge (Canuto et al., 2016; Ince et al., 2016). In other words, organizations that have

a stronger capability to identify, absorb, and leverage emerging technologies can advance along the innovation path faster and more effectively (Rasouli et al., 2023).

Accordingly, designing knowledge management maturity models and investing in R&D are proposed as fundamental strategies for creating and sustaining technological innovation capacity (Ghasemi & Valmohammadi, 2018; Akcali & Sismanoglu, 2015). The importance of technological collaborations between organizations and research institutions has also been repeatedly highlighted as a strategic approach for technology transfer and innovation enhancement (Ghaseminejad & Salami, 2012; Lee et al., 2014).

At the same time, both domestic and international studies show that technological innovation cannot be fully effective without considering its strategic and organizational dimensions. For example, Ghasemi et al. (2017), by examining the role of open and strategic innovation in corporate performance, demonstrated that combining these two approaches significantly improves organizational outcomes. Similarly, Aref et al. (2018) highlighted the importance of managerial commitment in improving organizational performance—an aspect directly linked to supporting technological innovations.

Additionally, Gholipour and Eftekhar (2016) showed that talent management, using a grounded theory approach, can provide the human infrastructure necessary for enhancing an organization's innovation capacity.

These findings collectively indicate that technological innovation must be addressed through a comprehensive, multidimensional model that simultaneously covers human, technological, and strategic aspects.

Finally, the research literature underscores that sustainable development cannot be achieved without technological innovation. Industries today face pressing requirements such as reducing energy consumption, optimizing resources, and meeting environmental standards, which can only be addressed through the use of advanced technologies (Rodger & George, 2017; Lee et al., 2014).

For this reason, the design of strategic models for sustainable development in manufacturing industries must be grounded in technological innovation to balance economic, social, and environmental objectives (Mazloumi & Motavalli, 2012; Kalko & Obsa, 2022).

Such a model not only facilitates the enhancement of industrial competitiveness and economic growth, but also plays a key role in realizing the overarching goals of sustainable development.

Research Methods

In general, research methods in the behavioral sciences can be classified according to two main criteria: the purpose of the research and the method of data collection. This study is applied in terms of its purpose and descriptive–correlational in terms of its method. It is considered descriptive because its aim is to provide an objective, factual, and systematic description of the events, phenomena, and issues related to the research domain. A descriptive study seeks to describe the conditions or phenomena under investigation. This research is also an applied study, designed to inform national policy-making. Due to the lack of access to laboratory experimentation, it also falls within the category of descriptive research. From the perspective of its nature, it can further be classified as an evaluative study. The required information and data for this research have been collected using a library-based method, which plays a critical role in forming the theoretical framework of the study. To this end, the researcher has consulted various academic and research centers, reviewed reputable domestic and international scientific journals, examined available articles, reports, project outcomes, and analyzed the records of previous studies. In addition, relevant materials have been retrieved from the Internet and related websites. For data analysis, the techniques of content analysis and coding have been employed.

Data analysis

This qualitative study was conducted among the existing research on the dynamic capabilities of circular accounting. To analyze the data, a qualitative content analysis with a conventional approach was applied. The research method is descriptive–analytical, of the content-analysis type. Content analysis is a method

that refers to any systematic and objective technique for extracting the characteristics of a message's meaning.

Step 1: Formulating the research question.

The research questions, together with the parameters under investigation, are presented in the table below.

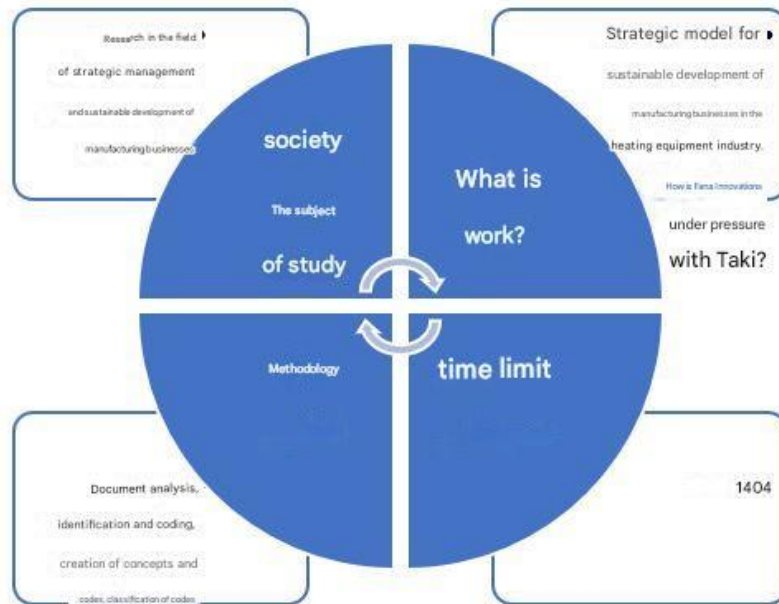


Figure 1. Parameters and research questions based on the first step of the meta-synthesis method

Step 2: Systematic review of the literature.

In this step, all texts related to the objectives of the research were reviewed. Eligible studies for inclusion in the meta-synthesis were selected. In meta-synthesis studies, secondary data obtained through qualitative methods in the field of the research topic are used for data collection.

Step 3: Selecting appropriate categories.

At this stage, the researcher evaluates the quality of the retrieved sources based on the research keywords.

Step 4: Extracting information from the texts.

In this stage of the qualitative meta-study (meta-synthesis), the researcher, considering the nature of the subject and the collected sources, must select one of the nine methods of this approach. In the present study, content analysis was used as the method for extracting information from the final sources.

In a qualitative thesis, the aim is to understand phenomena from the perspective of the participants and within their specific institutional and social context—an aim that is often overlooked when findings are quantified. A qualitative thesis can be positivist, interpretive, or critical. Rather than measuring and evaluating an organizational phenomenon, it is concerned with understanding its meaning.

Qualitative research processes assume that organizational realities are not fixed or self-evident, but rather the result of the projection of human perception. Advocates of qualitative research argue that discovering new knowledge requires direct engagement with organizations and the use of human senses and interpretation to understand organizational phenomena.

The coding stages used in qualitative theses include open coding, based on categories extracted from the preliminary theoretical framework; axial coding; and selective coding.

Step 5: Analyzing and synthesizing qualitative findings.

In the fifth step, after extracting the information in the previous stage through content analysis, the qualitative findings of prior studies are analyzed, interpreted, and synthesized to provide a new,

integrated, and systematic interpretation (Sandelowski & Barroso, 2007). All identified codes are grouped into categories with similar concepts.

Table (1) Codes and categories of research components of the first stage

Model dimension	Components
Causal conditions	Financial and fiscal laws and regulations push for transparency . Some organizations are quick to process financial information Information technology developments and the expansion of digital infrastructure Competitive market pressure and the globalization of financial services Increasing demand for real- time financial reporting The need to reduce operational costs and traditional accounting
Background conditions	Organizational culture and the level of acceptance of new technology Level of maturity of information technology and software / hardware infrastructure Government support policies in the digitalization of processes Level of training and skills of employees in digital technologies Economic situation and investment capacity of companies Access to cloud platforms and artificial intelligence in the financial sector
Interventional conditions	resistance to technological change Information security and financial data retention considerations Level of senior management support for digital innovation Coordination between different parts of the organization ((finance , technology , operations The existence of national and international standards for digital accounting) Investment rate in research and development R D) related to & digital accounting
Central phenomenon: digital accounting	Use of systems ERP and financial integration Applying Artificial Intelligence Technology in Accounting and Auditing Automation of accounting processes (RPA, (Automation Real- time Financial Reporting Using blockchain for transaction transparency Big Data Analytics
Strategies	Training and empowering human resources in digital skills Investing in digital infrastructure and new technologies Design and implementation of digital accounting pilot projects) Developing partnerships with financial technology FinTech (companies Reviewing financial processes and eliminating traditional methods

	Implementing International Digital Standards in Financial Reporting
Consequences and results	Increasing financial transparency and reducing human errors Reduce costs and improve operational efficiency Improving the quality and speed of financial reporting Strengthening the trust of investors and stakeholders Increased flexibility in financial decision – making Improving the organization 's competitive position in domestic and global markets

Source : Research findings

:Next, by combining the indicators, the following new codes are extracted

Table (۲) Codes and categories with a comparative approach (second stage)

Table combining metrics into two more general components

Main component	More general ↓ component	Constituent metrics	More general ↑ component	Constituent metrics
Causal conditions	External market pressures – regulatory and Demand-driven	Regulatory pressure, competitive market pressure, demand for real-time reporting	Internal efficiency and digital transformation requirements	The need for processing speed, IT developments, reducing operating costs
Background conditions	Organizational capacities and human capital	Culture and acceptance of technology, digital skills of employees, investment capacity and economic situation	Technological infrastructure and policies	IT infrastructure supportive , government policies, access to new technologies
Interventional conditions	Environmental and external factors	Cybersecurity risks, regulatory regulations, economic - political conditions	Internal organizational factors	Employee resistance, challenges of restructuring, resource constraints
Central phenomenon: digital accounting	Technological capabilities and intelligence	Process automation, use of artificial intelligence, integrated reporting systems	Transparency and reliability of information	Increasing financial transparency, improving data quality, accelerating reporting

Strategies	Technological transformation in accounting	ERP implementation , use of blockchain, development of business intelligence systems	Developing human and organizational capabilities	Employee training, change management, cross-departmental collaboration
Consequences and results	Improving financial quality and transparency	Transparency of financial information, improvement of reporting quality, increase of stakeholder trust	Organizational efficiency and competitiveness	Reduce costs, increase decision-making speed, improve performance and innovation

Source : Research findings

The status of the content network is mentioned below:

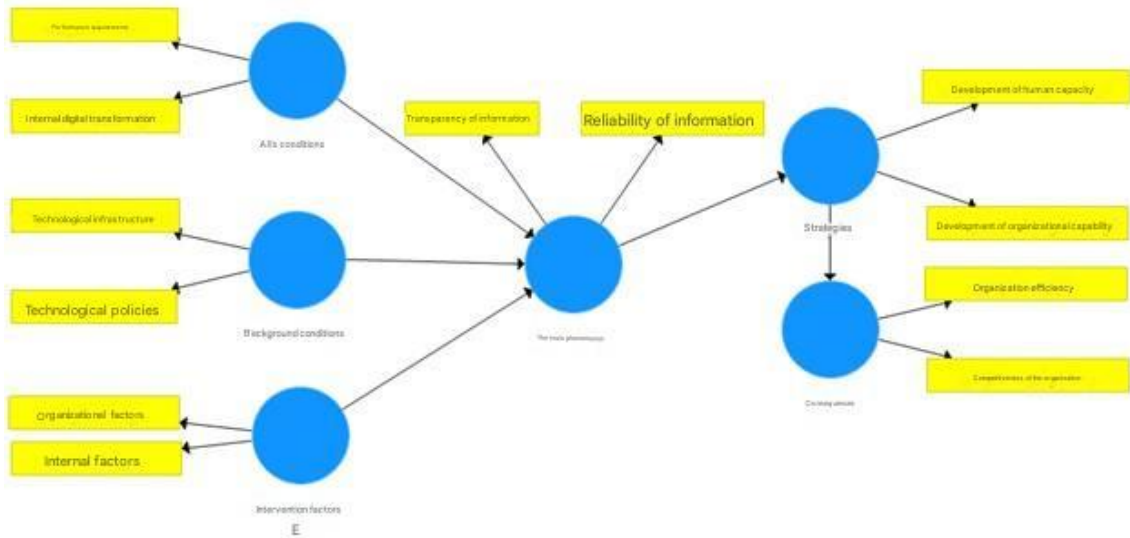


Diagram (2) Research Topics Network

Conclusions

1. The purpose of this study was to design a strategic model for the sustainable development of manufacturing businesses in the heating and pressure-equipment industry, with an emphasis on technological innovation and the implementation of digital accounting. The research sought to identify and analyze the key factors—including causal conditions, contextual conditions, intervening conditions, strategies, and consequences—in order to present a comprehensive and integrated framework for the successful adoption of digital accounting in organizations. The findings showed that:

2. Causal Conditions

The study revealed that the emergence of digital accounting is driven by a combination of external pressures and internal organizational requirements. External pressures primarily appear in the form of financial regulations, legal requirements, and the intensifying competition of the marketplace. In practice,

organizations are compelled to transition from traditional methods to digital systems in order to meet stakeholders' growing demand for faster and more transparent financial reporting. At the same time, advances in information technology and the need to reduce operational costs have further highlighted the necessity of using intelligent and digital tools. Therefore, the causal conditions stem both from institutional and external pressures and from internal needs for agility, speed, and efficiency in financial reporting. These findings align with international research on digital accounting, which shows that technological transformation is institutionalized only when external and internal forces converge toward change.

3. Contextual Conditions

Contextual conditions provide the environmental foundation that enables the realization and establishment of digital accounting. The study identified that organizational capacities—including a technology-friendly culture, the digital skills of employees, and investment capability—are fundamental. Without capable human capital, even the most advanced technologies will not perform effectively. In addition, government support policies, the maturity of IT infrastructure, and access to modern technologies play a catalytic role in accelerating digitalization. The combination of these two categories of factors—internal capacities and external policies and infrastructure—creates an environment in which digital accounting can move beyond pilot projects and become institutionalized on a sustainable basis. In other words, contextual conditions form a bridge between causal pressures and implementation strategies; without them, digital accounting strategies are likely to remain incomplete or fail.

4. Intervening Condition

Intervening conditions are the barriers and facilitators that influence the process of implementing digital accounting. The findings showed that environmental factors such as cybersecurity risks, international sanctions, economic–political circumstances, and restrictive regulations can all affect the speed and quality of digital accounting implementation. In addition, internal organizational factors such as employee resistance to change, financial resource limitations, and the difficulty of structural transformation were identified as key obstacles. These results indicate that even when favorable causal and contextual conditions exist, digitalization projects in accounting will fail if intervening conditions are not properly managed. Thus, a key conclusion of the study is the necessity of change management and reducing employee resistance, alongside investment in cybersecurity and organizational flexibility, because these elements can be decisive for the success or failure of digital strategies.

5. Core Phenomenon

The core phenomenon of this research is digital accounting, which serves as the focal point of all causal, contextual, and intervening factors. The findings showed that digital accounting can be analyzed in two main dimensions:

1. Technological and intelligent capabilities, including process automation, the use of artificial intelligence, and the integration of reporting systems.
2. Transparency and reliability of information, including improved data quality, financial transparency, and faster reporting.

6. Together, these two dimensions indicate that digital accounting represents not merely a simple technological change but a fundamental transformation in the nature and function of accounting. This finding is consistent with recent research in the field of “smart accounting,” which shows that technology elevates accounting from a purely reporting process to an analytical and decision-support tool. Therefore, the core phenomenon in this study is effectively a redefinition of the role of accounting in the digital age.

7. Strategies

The strategies organizations use to address causal, contextual, and intervening conditions are a combination of technological actions and human–organizational measures. The technological dimension includes the implementation of ERP systems, the use of blockchain to increase transparency and security, and the development of business intelligence (BI) systems. These tools help organizations increase the

speed and accuracy of financial reporting through automation and data integration. Alongside these, human and organizational strategies include employee training, change management, and strengthening cross-departmental collaboration. The findings showed that even the most advanced technologies will fail without complementary human and organizational strategies. In other words, successful strategies for digital accounting must be integrated and holistic, considering both technology and people. This conclusion is consistent with change management theories that emphasize the importance of “technology–human combined management” in the success of digital projects.

8. Consequences

The consequences of digital accounting identified in this study fall into two main categories:

1. Enhancing financial quality and transparency, and
2. Improving organizational efficiency and competitiveness.

9. First, organizations benefit from improved financial reporting quality, increased stakeholder trust, and greater transparency in financial information, which in the long run lead to better positioning in capital markets and stronger public confidence. Second, digitalization of accounting contributes to reducing operational costs, speeding up managerial decision-making, and ultimately boosting innovation and competitiveness. The findings indicate that the positive outcomes of digital accounting extend beyond the accounting department to the entire organization and even to its interactions with the external environment. This shows that digital accounting is not merely a technical tool but should be considered a strategic managerial approach.

Practical Managerial Recommendations

- Targeted investment in new technologies: Direct financial and human resources toward intelligent financial technologies and digital accounting tools—such as ERP, RPA, blockchain, and artificial intelligence—to improve the speed, accuracy, and transparency of financial reporting.
- Human resource empowerment: Managers should design continuous training programs to enhance employees’ digital skills and embed a culture of technological acceptance in the organization to reduce resistance to change.
- Process integration and change management: Create coordination among financial, operational, and IT units through change management so that digitalization projects are implemented in a synchronized manner and avoid potential failures.
- Development of standards and compliance: Implement national and international digital accounting standards within organizational processes and, while ensuring legal compliance, use best practices for risk control and data security.
- Encouragement of innovation and collaboration with the technology ecosystem: Establish partnerships with technology companies and research and development centers so that digital innovations can be adopted more rapidly and productivity can increase.
- Continuous monitoring and performance evaluation: Define key performance indicators (KPIs) for digitalization and continually measure the impact of digital accounting and technological innovations on transparency, cost reduction, and decision-making to ensure timely improvements.

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