



Lean digital transformation of integrated management systems towards sustainability

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Abstract

Purpose of the paper: This study examines quality and lean management concepts and theories and their relationship to the sustainability of organizations transitioning from conventional to digitalized operations. The role of people is recognized and discussed in light of the lean-digital interplay and its implications for integrated management systems (IMSs). The sustainability objective is merged with lean principles and employee engagement in digital transformation. In this way, the beliefs and norms, behaviours and attitudes relevant to lean and intertwined with digitalization and sustainability mindsets, reflect a new form of organizational culture.

Methodology: A conceptual approach is used that draws on organizational behaviour theorists and the sociotechnical foundation of lean principles. Management system standards, regulations and norms converge with lean normalization and standardization methodologies. The conceptual framework analysis names and synthesizes concepts, such as lean-digital-sustainability culture and lean-digital IMS. A review of relevant literature leads to the development of a scale that can later be used to collect data and validate the model.

Findings: The synthesized constructs are linked in a pathway model where organizational culture assimilates the influence of lean practices, digital technologies, and sustainability principles. According to this conceptualization, the integrated management system can be transformed into an advanced enabler of sustainability. Employees who share this instilled culture become more engaged in their integrated management system, more efficient and productive, and less prone to errors and waste generation.

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Research limitations/implications: The findings of this study combined the technical (hard) perspective of digital transformation with non-technical - cultural and behavioral – (soft) factors focusing on the human perspective of the digitalization.

Future research could explore the validity of the identified relationships in real business contexts. In addition, case study analysis would deepen the proposed relationships and uncover any contingencies.

Originality/Value: The proposed model underscores the importance of culture in the successful implementation of new technologies and the mediating role of IMSs in improving sustainability performance.

Keywords: integrated management system; culture; lean; digital transformation; Quality 4.0; sustainability performance

Type of paper: Research paper

1. Introduction

Digital transformation of organisations is ongoing and highly demanding. Existing processes, procedures, standards and methods need to assimilate those demands in a constructive and adaptive way in order to remain relevant. Concepts and approaches such as Quality 4.0 and Lean 4.0 have emerged in both literature and practice to address current challenges and embrace change. In this framework, the role that management system standards can play in the digital transformation needs to be understood. The forthcoming revision of the ISO standards considers including this perspective. However, there is criticism on the effectiveness of this inclusion. Furthermore, the lagging in quality management systems to adapt to the digital needs has been strongly emphasised (Maganga and Taifa, 2023).

The velocity of transformation has increased dramatically. It seems such a long time since the mere integration of requirements, i.e. written/stated procedures and the like, were enough to justify compliance and advancement. The potential of Industry 4.0 technologies has placed data at the forefront as more than just a means to an end but rather a predictor and key factor in decision-making (Antony et al., 2023). The revolutionary digital possibilities cannot leave standards and management systems unaffected. However, the extent of the impact remains unexplored and even underestimated.

The first signs of adaptation are limited to some hints on the ‘hard’ total quality management (TQM) aspects leaving the ‘soft’, people-related aspects aside. This narrow perspective entails the risk of self-annulment of standards in the digital era. Following this path of misinterpretation, management systems’ replacement by software and platforms could make quality management seem obsolete. Therefore, it is eminent to revisit the management systems and their standards and reconsider their implications in a rational and substantive way providing clear and convincing argumentation on the significance of the ‘old’ methods and tools in the ‘new’ era.

The integration of multiple management systems can be used as an opportunity to revisit the individual management systems in a holistic manner. Furthermore, this research emphasises organizational culture as a key success factor to address the ‘soft’ TQM gap. Particular dimensions of culture are considered most significant and are conceptualised as digital, lean and sustainability elements. The resulting framework aims to highlight the impact of integrated management systems on the sustainable development of organisations that undergo digital transformation.

2. Methodology

In an effort to understand the current challenges facing management standards and systems, this study reviews the literature on digital transformation and management systems. Keywords such as Quality 4.0, Lean 4.0, Industry 4.0 and ISO standards are considered relevant to the research purpose. Lean was selected as one of the most relevant quality approaches due to its focus on people. The existing body of knowledge on organisational culture is also reviewed, focusing on the findings that relate to the digital context.

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In the following section, a review of relevant literature explores organizational culture as a potential critical success factor for business performance in terms of quality, lean, and sustainability, conditioned by digital transformation as a supporting change mechanism. Research on management systems and standards is then reviewed from the same perspectives to highlight potential interdependencies with culture. Any benefits - in terms of performance - that organizations might derive from these interdependencies are also explored. The subsections of the literature review conclude with corresponding research hypotheses, which are then visualized in the conceptual model.

3. Literature review

3.1. *Lean-quality culture*

Culture encompasses values, norms and beliefs within organizations (Gimenez-Espin et al., 2013). Organizational culture drives employees by influencing their behaviors, performance outcomes and organization's external environment for attaining organizational goals (Sony et al., 2021). A quality culture based on continuous improvement and lean principles is considered part of the organizational culture (AME, 2009). Moreover, a lean-quality culture brings closer people and management systems. Rationality, technology and control of management can only treat the formal ('what meets the eye') processes, leaving the deep-rooted causal mechanisms of human behavior in the dark. Unfortunately, lean mindset is not internalized so far into the organizational fabric or, in other words, has not been assimilated yet by the culture of organizations that implement lean initiatives (Hines, 2022; Panayiotou and Stergiou, 2021; Paro and Gerolamo, 2017).

Lean philosophy requires profound cultural transformation instead of just a technical leaning (Ingelsson and Martensson, 2014; Gaiardelli et al., 2019). If the organizational culture does not support the necessary learning process, the culture needs to be changed for the implementation to be successful and the continuation assured (Shook, 2010). Sahoo (2022) emphasized organizational culture as a prerequisite to successfully implement lean processes within a firm.

3.2 *Digital lean-quality culture*

Duerr et al. (2018) draw on the organizational culture model by Edgar Schein (1985) and explore the Artifacts, Espoused Beliefs and Values, and Underlying Assumptions of digitalized companies and define digital organizational culture as the motivation for firms to digitalize. Digital transformation calls for positive intelligent automation behaviors paired with creative thinking, empathy and intuition (Yu and Ashton, 2022) Drawing on socio-technical system theory, industry 4.0 technologies moderate the relationship between socio-technical practices and performance in terms of workers' health, quality, and productivity (Tortorella et al., 2022). The quest for improvement and performance enhancement, manufacturing flexibility, waste elimination, process control optimization, efficient manpower utilization and competitive advantage gave emphasis to the importance of integrating lean principles into organizational culture (Sahoo, 2022).

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Digital transformation has paved the way for novel approaches of quality management aiming at quality responsibility within open system structures where “service quality and brand quality with speedy management connected to culture and personal satisfaction will have the highest value” (Park et al., 2017). The fourth generation of quality (Quality 4.0) enhances quality culture improving connectivity, collaboration, and visibility (Thekkooote, 2022).

Organizational climate and culture affect the attitude of employees toward digital transformation initiatives, such as artificial intelligence interactions, shifting focus to employees’ mindset, creativity, empathy and intuition (Yu et al., 2022). Conversely, Quality 4.0 facilitates data interchange, analytics, and quality management, yielding a culture of adaptability, transparency, connectivity, collaboration, and informed decision making (Sony et al., 2021). Nevertheless, there is limited research work on the social side of Quality 4.0 (Dias et al., 2022). According to Antony et al. (2023), the top three readiness factors of Quality 4.0 are top management commitment, leadership and organizational culture.

3.3 Sustainability culture

Businesses with a strong sustainability performance orientation own a particular organizational culture (Isensee et al., 2020). Corporate sustainability culture reflects a long-term strategic sustainability orientation, the streamlining of sustainability along the human resource value chain, covering attractiveness, employee recruitment and retention, motivation and rewards, employee separation (redundancy), and employee outcomes, i.e. in-role and extra-role behaviors (Galpin et al., 2015). However, what remains a challenge for corporations is to fully integrate sustainability principles into their strategies, business models, and operating processes and build cultures that support the necessary transformation of mindsets and behaviors (Stahl et al., 2020).

So far, organizational cultures integrate either environmental objectives, such as resource efficiency and environmental protection, or social objectives, such as internal development or stakeholder engagement, separately (Linnenluecke and Griffiths, 2010; Isensee et al., 2020). However, a sustainability-oriented culture succeeds more than increased levels of employee performance or stakeholder engagement or resource efficiency; it rather elevates organizational performance altogether (Galpin et al., 2015). Furthermore, Maletic et al. (2015) recognized the potential contribution of a sustainability/quality-oriented culture to enhancing organizational performance. Interestingly, research has conceptually linked culture and sustainability with digitalization in light of the latest technological developments (Isensee et al., 2020).

3.4. Organizational culture and management systems

For a long time, total quality management (TQM) researchers and practitioners remained focused on the visible/tangible, rather technical aspects of TQM practices ignoring or underestimating the invisible/intangible shared values and beliefs of the people involved, failing to identify the root causes and explain the behaviors and attitudes (Dahlgaard et al., 2007). Later on, the significance of people in process improvement and business excellence was gradually acknowledged, with organizational culture being one of the key success factors. Lean philosophy was grounded on the very involvement of people and their attitudes, beliefs and values in quality management and decision making. Advanced quality management

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methodologies, such as the six sigma approach, are now integrated with lean to better understand the human involvement in traditional quality management tools and techniques. Quality management-oriented organizational culture is now recognized as an indispensable ingredient for the success of TQM initiatives and corporate sustainability (Evans & Lindsay, 2020, pp. 669-676).

The aforementioned discussion supports the conceptualization of an organizational culture integrating lean, digital and sustainability principles, norms, values, beliefs, and behaviors, that can lead to a sustainable lean-digital integrated management system (IMS). Hence, the following research hypothesis is generated:

Research hypothesis 1. A lean digital and sustainability-oriented organizational culture has a significant positive impact on an integrated management system.

Next, literature on lean and quality management systems is reviewed exploring links with digital transformation and sustainability performance.

3.5. Lean management and standards

Lean was originally a set of practices and tools that were used by manufacturing companies and represented by the well-known term 'lean manufacturing'. Lean management (LM) is a concept wider than lean manufacturing in that it integrates the systems approach and applies lean principles in a wider framework interconnecting resources, processes, and outcomes. Alongside the internal linear transformation of inputs to outputs through process bundles, systems interact with their environment, affecting and being affected by their stakeholders. Systems approach offers a holistic view (top-down or bottom-up) that identifies cause-effect relationships between processes and indicators.

Lean management (LM), as an integrated socio-technical system (Camacho-Miñano et al., 2013; Shah and Ward, 2007), requires cultural and technological aspects to be simultaneously taken into consideration. Implementing lean is as complex a task as its assessment (Scherrer-Rathjet et al., 2009; Shah and Ward, 2007). Lean implementation is associated with TQM, just-in-time, activity-based costing, high performance work systems and total productive maintenance (Camacho-Miñano et al., 2013; Narasimhan et al., 2006; Shah and Ward, 2007).

3.5.1. Lean normalization

Lean orientation focuses on efficiency and the maximization of resource usage on the one hand and the minimization of waste on the other. According to Toyota's way of thinking, it is impossible to separate standardized work processes from talent development. All work may not be repeatable and predictable, but all work involves muda (waste), and one of the primary purposes of standardized work is to analyze the work processes to track waste and to eliminate it systematically (Liker and Meier, 2007: p. 109). Lean is also considered a systems approach to high performance (Liker and Meier, 2007: p. 110).

Quality management deals with the mitigation of defects and the reduction of quality costs at the same time. Lean has evolved into a TQM strategy that often combines the benefits of both lean and Six Sigma toward improving quality, reducing waste, and satisfying customer needs

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Goupta et al., 2022; Touriki et al., 2022). Bacoup et al. (2018) proposed “Lean Normalization” as a methodology to improve the implementation of an ISO standard in synergy with Lean thinking. Fredriksson and Isaksson (2018) juxtaposed Lean to Six Sigma, ISO standards, and TQM and stressed that Six Sigma deals with process variation, while Lean aims to reduce waste, the ISO standards aim to enhance customer satisfaction, and TQM aims to increase customer satisfaction with the same or a reduced amount of resources.

Certification leads the way to operational excellence in consonance to the organizational culture enhancing competitiveness (Carvalho et al., 2022). Nevertheless, the lack of standardization of Six Sigma and Lean curricula has been an issue for both manufacturing and service companies (Antony, 2021). Furthermore, Antony et al. (2021) criticized the existing lean & six sigma standards and the ISO 18404:2015 standard, in particular, as prescriptive, lacking the necessary flexibility to fit different company sizes or industries (manufacturing-restricted view). Herrera and Van Hillegersberg (2019) discussed the requirement for standardization of continuous improvement in information technology services. Exacerbating the challenge of incompatibility, several companies have adopted bespoke training and certification standards (Antony et al., 2021).

3.5.2. Lean management performance

Lean management performance can be driven by holistic/strategic management tools, such as the balanced scorecard (Kaplan and Norton, 1996). The balanced scorecard (BSc) is a strategic tool developed by Kaplan and Norton (1996). Using BSc, lean thinking can pair with strategic objectives along four dimensions: financial, customer, internal business processes, and learning and growth (Chiarini, 2011). Recently, Kaplan and McMillan (2021) linked BSc to the three-pronged sustainability performance. Since lean philosophy draws heavily on the Japanese quality mindset, scholars and practitioners identified hoshin kanri (policy management) as an alternative lean performance assessment tool (Witcher and Butterworth, 2002). In an analogy to the BSc, hoshin kanri is applied by senior managers cross-functionally on four dimensions: quality, cost, delivery, and education or people (Kondo, 1998; Witcher and Chau, 2007).

The findings on the effects of certain lean practices on performance are rather contradictory (Belekoukias et al., 2014; Varela et al., 2019). Mitigation of quality defects has a positive impact on business performance, improving quality, speed, dependability and cost. JIT increases performance significantly while Kaizen has a moderate effect. TPM contribution was found insignificant and Value stream mapping had negative impact on organizational performance (Belekoukias et al., 2014). Other researchers have established positive contribution of industry 4.0 technologies on sustainability performance, yet the results regarding the influence of lean practices on sustainability performance were inconclusive (Varela et al., 2019).

3.6. Integrating lean with quality management

Certification to quality management standards is generally considered as the beginning of a TQM journey that can contribute to a positive climate sustaining TQM practice implementation (Wickramasinghe and Perera, 2014). Chiarini (2011) composed a guideline formalizing lean

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principles and tools, such as lean metrics, 5S, TPM, Jidoka and Kaizen events. Hoshin Kanri, lean office and Asaichi – A3 report are principles and tools that are less known and implemented. The integration of lean practices and ISO 9001 requirements raises efficiency whereas the adoption of the ISO 9001 standard alone raises effectiveness (Chiarini, 2011). Applying Lean on quality management system (QMS) documentation may decrease QMS bureaucracy (“Lean office”) affecting transactions instead of products (Keyte and Locher, 2004). Furthermore, value stream mapping, lean metrics, 5S and takt time are the mostly used lean tools while Jidoka and Total Productive Maintenance (TPM) are most often formalized into ISO 9001 documents (Chiarini, 2011). Blecken et al. (2010) proposed a model integrating quality and lean management systems to reduce production cost by establishing stable and efficient processes with methods and tools of lean management. Furthermore, the integration of Lean tools and requirements of ISO 9001:2015 was found to contribute in problem solving, waste reduction, internal communication, and productivity, while challenged by lack of time, training and employees’ commitment (Sá et al.,2020).

3.7. Integrating lean with environmental management

There is a paucity of empirical evidence of any relationships between lean and green (Souza Farias et al., 2020). Lean and green adopt different perspectives on performance, as well (Souza Farias et al., 2020). Environmental management focuses on waste reduction and includes measures addressing environmental pollution, energy conservation, legal compliance, and social responsibility. Some environmental protection measures, such as wastewater treatment, may increase costs or production time (Hallam and Contreras, 2016). Nevertheless, some energy and other resource recycling/reuse interventions may decrease costs. Scholars emphasized that lean leads to green in that it catalyzes a culture of waste mitigation and resource conservation (Hallam and Contreras, 2016). However, some Lean practices contradict these green objectives. For instance, just-in-time, with its on-demand order of materials, asks for increased transportation costs (Dieste et al., 2019).

3.8. Lean integrated management systems

Having established a relationship of lean with quality and environmental management systems the train of thought leads us to highlight the potential of integration of these systems and their combined beneficial effect. Jewalikar and Shelke (2017) emphasized that a lean integrated management system (IMS) enables meeting quality objectives with lesser paperwork, simpler system requirements, safer and healthier conditions and environment friendly waste disposal practices. Ho (2010a,b) and Rebelo et al. (2014) identified significant relationships between lean and management system integration and proposed their own integrated lean IMS models for sustainable development. From a practical perspective, Asif et al. (2013) discussed an example of a top-down social responsible-IMS, where value-based management is used along with lean manufacturing and Six Sigma tools to reduce costs and improve quality.

3.9. Lean IMS and sustainability performance

The belief is growing that the continuous improvement of an IMS strongly depends on the development of a lean infrastructure to meet the stakeholders’ needs (Carvalho et al., 2022).

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The main reason for integrating the systems is to meet the expectations of the customers through a lean business system by streamlining and simplifying the processes, avoiding conflicts between the systems and raising awareness among employees (Jørgensen, 2008). According to recent survey findings, the top three IMS impacts were the increase in operational performance, the reduction of costs with consequent increase in operational efficiency and lean management, and sustainable development (de Souza Barbosa et al., 2022).

Safety-health-environmental integrated management systems are linked to lean value realization, waste reduction, and risk mitigation enterprise outcomes (Kruse et al., 2019). A lean initiative of task standardization is considered one of the best practices of IMS execution that can support corporate sustainability. Such initiatives reduce errors securing corporate sustainability processes (Vieira Nunes et al., 2022). Souza and Alves (2018) composed and tested a model (LIMSSI) by “implanting” lean principles and practices to integrated management systems aiming to improve corporate sustainability performance. Legal compliance was acknowledged as a major strength of the model by employees at both strategic and tactical levels, whereas cultural shift was pointed out as a major challenge by shop-floor employees (Souza and Alves, 2018). Benefits accrued from the lean IMS implementation - as identified in literature (Jewalikar and Shelke, 2017; Souza and Alves, 2018; Souza Farias et al., 2019) - are listed in Table 1.

Table 1. Lean IMS benefits

INTERNAL BENEFITS
1. Organizational benefits
Improvement of quality of management by down-sizing three functional departments to one and reducing fuzzy management boundaries between individual systems
Simplification of systems resulting in less bureaucracy
Resource optimization
Objectives integration in the enterprise strategy
Improvement of organizational performance
Waste reduction and increased productivity
Increase in operational efficiency by harmonizing organizational structures with similar elements and sharing information across traditional organizational boundaries
Avoidance of duplication between procedures of systems
Streamlining paperwork and communication
Legal compliance pursuit
Operational risk reduction
Multiplier effect of simple improvements
Ergonomics
Reuse of materials and resources
2. Financial benefits
Cost savings by the reduction of the frequency of audits
Reduction in external certification costs over single certification audits - Increase in profit margins
Reduction of fines, embargoes and sanctions (legal compliance pursuit/operational risk reduction)
3. People benefits

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Increase in employee motivation, awareness and qualifications
Creation of a better company image among employee
EXTERNAL BENEFITS
1. Financial benefits
Competitive advantage with lean IMS
Improvement of position in the market
Gain new customers/satisfy existing ones
2. Communication benefits
Improvement of company's image by delivering what customer wants.
Improvement of relations with stakeholders
Evidence of legal compliance
3. System benefits
Improvement in quality, environmental and health and safety management
Reduction of hazardous waste generation
Reduction of equipment damage and product loss
Reduction of product loss
Holistic view of process and value stream
Use of real data instead of forecasts
Inventory reduction

Lean IMS benefits that are listed in Table 1 are financial, social and environmental and influence stakeholders, both external and internal, including employees, customers, suppliers, auditors, the authorities, and the environment. In other words, lean IMS can positively and significantly affect all dimensions of corporate sustainability performance, as measured in the extant literature (Gianni et al., 2017; Vieira Nunes et al., 2022).

Based on the aforementioned discourse the following research hypothesis is generated:

Research hypothesis 2. A lean IMS has a significant positive impact on corporate sustainability performance.

3.10. Digital transformation, lean and management systems

Digital tools collaborate for Lean implementation in SMEs by visualizing data, supporting collaborative supplier relationships, and using technologies such as simulation software that allow deeper understanding of processes to reduce project risks (Rossi et al., 2022). Furthermore, lean-green digital integration promotes sustainable development using resource efficiency advanced technologies (Rossi et al., 2022). Lean manufacturing on the shop floor aims at eliminating idle activities, reducing downtime, improving profitability, enhancing work efficiency, and improving product quality (Tripathi et al., 2022). Tripathi et al. (2022) composed and tested an innovative shop floor management model using hybrid integrated lean and smart manufacturing. It was found that productivity and operational performance increased by deploying online monitoring, embedded system, smart sensors, storage devices, and smart control systems (Tripathi et al., 2022).

3.11. Quality 4.0

Quality 4.0 refers to the digitalization of quality management and aligns quality management practices with I4.0 technologies (Salimova et al., 2020). It has been claimed that, within “the

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scope of digital transformation, there has been limited innovation in the field of quality” (Sampaio et al., 2022). Furthermore, Asif (2020) emphasized that traditional management models are not aligned with Industry 4.0. The researcher argues that “mindful” quality management focuses on the repetition of processes as boring, never changing routines. The implementation of I4.0 technologies, e.g. artificial intelligence, exploits people forcing them to mimic machines and not the other way around. This technology-oriented adaptation is inconsistent with the socio-technical system perspective of human-machine interaction that is the very core of digital transformation. Indeed, quality management systems in their current, outdated, mechanistic form have become obsolete. Lean structures seem more adjusted to the platform-based value chain operations of the digital era (Asif, 2020). In this context, management systems need to mature and embrace the change pointing at their strengths, including traceability requirements, the stakeholder view of business operations, and the internalization of knowledge (intellectual capital of organizations).

Focus on results and motivations are the most valued skills for Quality 4.0 managers (Santos et al., 2021). The skills most valued by people who work in companies that do not have certifications other than quality are communication, teamwork, motivation, and openness for change (Santos et al., 2021). The skills most valued by people who work in companies that have multiple certifications are leadership, critical thinking, and decision making (Tripathi et al., 2022). Quality 4.0 managers need to adapt to change both efficiently and effectively. It is thus understandable why top employees’ soft skills required in an Industry 4.0 are creativity, emotional intelligence, and proactive thinking (Cotet et al., 2017; Santos et al., 2021). Proactive thinking, when applied to new technologies, assesses how human resources can best connect with technological developments to speed up and sustain change (Cotet et al., 2017).

3.12. Lean 4.0

Lean 4.0 is a novel approach to digital technologies aiming to improve waste detection and reduction in virtual and physical processes (Rossi et al., 2022). Lean 4.0 can enhance employees’ well-being, fostering a new way of thinking and training employees in favor of the lean digital culture (Rossi et al., 2022). Interestingly, there is an ongoing debate on whether Industry 4.0 and lean objectives are conflicting in that industry 4.0 technologies are cost-intensive, whereas lean initiatives aim at cost mitigation (Tortorella et al., 2022). Furthermore, Sanders et al. (2016) stressed that, on the one hand, lean initiatives simplify processes while, on the other hand, Industry 4.0 technologies may increase operational complexity.

3.13. Digital IMS and sustainability

Digital archiving is one step toward automation of integrated management systems (Darabont et al., 2019). However, digital transformation implies the creation of an “intelligent” IMS that will adapt IoT or Artificial intelligence applications in line with an automation mindset. In the intelligent IMS “the level of data collection should be comprehensive, automated and digital” (Sony and Naik, 2020). In other words, big data will support and advance quality improvements, green initiatives, risk management, energy savings in an integrated, autonomous, performance-oriented manner (Ajmi et al., 2022; Mahmood et al., 2022; Tupa et al., 2017). Recently, scholars emphasized that with “an institutional environment conducive to

improving operation efficiency and stimulating innovation, a higher sustainability premium can be gained from digital transformation” (Ji et al., 2023).

Based on the aforementioned discourse the following research hypothesis is generated:

Research hypothesis 3. A **digital IMS** has a significant positive impact on corporate sustainability performance.

4. Conceptual model

The preceding discussion leads to a conceptual model (Fig. 1) where organizational culture assimilates the influence of lean practices, digital technologies, and sustainability principles. According to this conceptualization, the integrated management system can provide the foundation to adopt a composite form of organizational culture that embodies the particularities of lean, digital and sustainable orientation. Employees that share this instilled culture become more engaged in their integrated management system, more efficient and productive, and less prone to errors and waste creation.

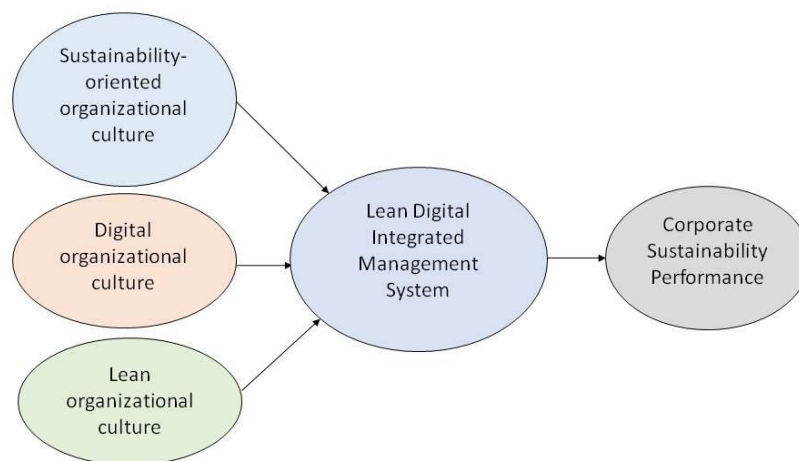


Figure 1. Conceptual model

To date, there are two research streams: one that understands LM fostering sustainability in all three dimensions (economic, environmental, and social) and another that stresses the counteracting effects of LM on sustainability performance in terms of a cost-benefit analysis (Henaio et al., 2019). The identified ambivalence calls for further investigation. This model addresses the raised question on the lean-sustainable complementary relationship and identifies organizational culture as a potential catalyst, with I4.0 technologies boosting the socio-technical system in a positive direction.

The empirical validity of this model needs to be tested by future research. Lean digital integrated management systems can be measured in terms of internalization or maturity

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(Domingues et al., 2016; Gianni and Gotzamani, 2023; 2024). Corporate sustainability performance can be measured in terms of stakeholder or triple bottom line results adapted to the digital context (Gianni and Gotzamani, 2024; Siltori et al., 2021). Lean IMS benefits can be used in addition to the already identified measurement scales of IMS corporate sustainability performance (Gianni and Gotzamani, 2024; Poltronieri et al., 2018).

5. Conclusion

The findings of this study unveiled a path connecting culture with lean-quality initiatives under the digital transformation ‘umbrella’ yielding corporate sustainability performance. On the sidelines of this path, it also became evident that, in the current times, where industry 4.0 technologies and capabilities are imposing new “rules” in operations management, lean-quality fusion is an opportunity for the quality movement to regain impetus. To the best of the authors’ knowledge, this research addresses - for the first time - management systems and standards in combination with a kind of organizational culture permeated by lean, quality, and sustainability principles. The integration of management systems acts hypothetically as an enabler of intertwining the digital effect in this composite culture and creating a novel form of IMS that can influence corporate sustainability performance.

Furthermore, this study emphasized that digital transformation depends on people as much as technologies. Digital transformation is usually considered synonymous to the technological advancement within organizations. Yet, in the particular model, the role of employees is vital in all three steps of the culture-driven path. In other words, people in the model need to be ‘carriers’ of culture, components of the socio-technical IMS, and stakeholders - either satisfied or dissatisfied with the sustainability-oriented outcome of their organizations. In this people-centered view, the lean digital IMS can be the mechanism of digital transformation. So far, academics and practitioners have established that quality, environmental, and social responsibility management systems - when integrated - foster corporate sustainability performance. Springboarding on this strength of integration, the proposed model goes one step further and highlights the potential of IMS to incorporate the cultural change that the fourth industrial revolution brings about.

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