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## Towards a lean digital transformation research framework: a literature review

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### ABSTRACT

Digital transformation (DT) has become a focal point within the information systems and decision support community, integrating digital technologies across various organisations. Lean Digital Transformation (LDT) is gaining traction in the academic and practitioner communities with the promise of increased DT success. However, the concept is still in an early maturity stage, with multiple conceptualisations. This study conducted a descriptive literature review of 60 articles to understand how LDT has been conceptualised and its value. The findings identify three critical perspectives in LDT research: the bridging of Lean and DT concepts, viewing DT as an enabler for Lean, and Lean as an enabler for DT. The analysis reveals a disproportionate focus on manufacturing within the LDT research landscape and LDT implementation benefits, such as improved process analysis and efficiency and output benefits, including operational excellence. The study produces an LDT Value Research Framework, highlighting the importance of LDT.

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Lean digital transformation;  
literature review; business  
value

## Introduction

Digital Transformation (DT) is a broad and relatively new topic that has garnered much interest from the Information System (IS) and decision support community (Heavin & Power, 2018). It involves the integration of digital technologies across all business domains to strengthen decision-making, operations, customer engagement, and profitability.

Following the exploration of DT within decision support (McCarthy et al., 2022; Russell et al., 2020), this study focuses on the concept of Lean Digital Transformation (LDT), which is beginning to play a significant part in influencing how DT is conducted and the value that is created post-transformation. With Lean principles at its core, LDT initially garnered attention for its potential to enhance organisational efficiency and effectiveness by eliminating waste and elevating process efficiency. However, this study highlights that, while there is limited research on the topic, there is a strong

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case for implementing LDT to reduce the risk of DT failures, regardless of their value targets. This is essentially achieved as it encompasses a holistic approach to business management that integrates all facets of the organisation, encompassing people, processes, and technology (Lima et al., 2023). As a result, it has been touted that embracing LDT, positions organisations for success in undergoing Digital Transformation. However, notwithstanding the potential of LDT, it is still only starting to emerge as a concept (Alsadi et al., 2023).

As the name suggests, Digital Transformation is a key component of LDT, which has resulted in a wide-ranging research scope and definitions that have been subject to numerous interpretations, leading to confusion and ambiguity. Indeed, researchers have pointed out the need for a more precise definition to avoid misinterpretation and enhance clarity in published literature. One of the major issues that arises is DT's frequent conflation with other organisational initiatives like digital innovation or digitalisation, which are, in fact, critical components of a broader Digital Transformation framework but not equivalent to it (Osmundsen et al., 2018). Nonetheless, two key concepts consistently emerge when Digital Transformation is examined. These include (i) the utilisation of digital technologies to change a company's business model, (ii) the modification/automation of products, organisational structures, or processes. As such, DT is not just focused on adopting digital technologies but also involves a fundamental change in how businesses operate. This implies that Digital Transformation is not just a once-off initiative but an ongoing process that requires continuous evaluation and adaptation to meet evolving business needs (Hess et al., 2020). In addition, this highlights the role of digital technologies as a means to an end, not an end in itself.

The other key component of LDT is Lean. Like the multifaceted nature of Digital Transformation, the literature provides numerous interpretations for Lean, encompassing Lean Production, Lean Manufacturing, and Lean Digital, along with the associated Lean standards, processes, and tools. Despite this diversity, a prevailing consensus denotes Lean as a set of standards, processes, tools, and managerial practices that are designed to elevate operational efficiency, ensure quality, and cultivate customer satisfaction, all while minimising waste and unnecessary costs (Womack & Jones, 1997). The roots of Lean trace back to the Toyota Production System (TPS), conceived in the 1940s to optimise manufacturing processes by systematically reducing waste (Liker, 2004). Over the years, the term 'Lean' has undergone evolution, expanding its application beyond manufacturing. Its reach now extends into various sectors, including healthcare, logistics, and the services industry.

Having briefly outlined the concepts of Digital Transformation and Lean, which make up LDT, it is possible to see the potential of combining both but also the foundational conceptualisation challenges that exist within the domain. Hence, it is the objective of this study *to analyse existing research on Lean Digital Transformation* through a descriptive literature review, which answers a call for research to build a consensus of the interconnected relationship between Digital Transformation and Lean (Schumacher et al., 2020). More specifically, the aim of the literature review is to address two research questions:

**RQ 1:** How has current research conceptualised Lean Digital Transformation?

**RQ 2:** What are the benefits of Lean Digital Transformation?

## Methodology

This section describes the methodology used to conduct a descriptive literature review that focuses on investigating the research landscape of Lean Digital Transformation. A descriptive literature review is a specific type of review that aims to ‘*identify any interpretable trends and patterns or draw overall conclusions about the merits of existing conceptualizations, propositions, methods or findings. In doing so, a descriptive review may claim its findings to represent the state of the art in a research domain*’ (Paré et al., 2015).

The literature review approach outlined in Table 1, used the Scopus database (<https://www.scopus.com>) as its main source for articles. Initially, Web of Science and Scopus were used, but on examination of the search results, Scopus returned everything in Web of Science plus additional relevant articles, using the search terms ‘Lean’ and ‘Digital Transformation’.

The first result set included 222 papers, which were initially reviewed by examining the title, keywords, and abstract. This provided the basis for excluding non-relevant papers. However, if this initial review did not provide certainty on the content of the paper, a deeper examination of the paper was undertaken. This reduced the result set to 78 papers. However, 22 of these papers were not immediately accessible and while every effort was made to gain access to these papers through institutional licencing agreements, only 4 of these papers were retrieved. Finally, a coding schema was produced to provide a robust mechanism to analyse each paper. The schema was developed by taking a sample of 5 papers that were initially coded by two members of the research team. The results of this exercise created two separate coding schemes, which were consolidated and later tested and refined in two further iterations. The result is summarised in Table 2, which outlines the relevant concepts being examined and the examples used as a guide on how to identify these concepts. *Note for reviewers: if successful, we plan to make our concept-centric matrix publicly accessible through an open science platform.*

## Analysis

### RQ1 - How has current research conceptualised LDT?

**Table 1.** Literature review approach.

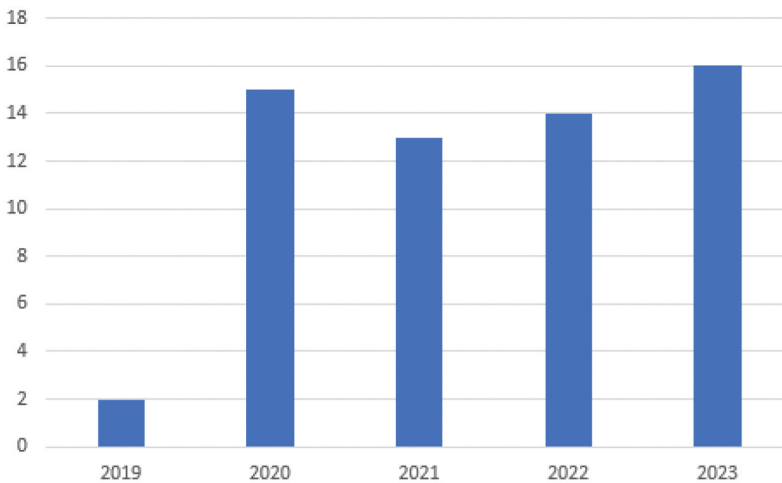
Phase	Action Taken	Outcome
1. Selecting the Sources	Specified the domain of interest.	Lean Digital Transformation (LDT)
2. Search Strategy	Identified relevant sources for the specified domain.	Scopus Database
	Identified key search terms.	<b>Lean, Digital Transformation</b>
	Iteration 1: Searched Scopus with a query of the key search terms Iteration 2: Reviewed each returned article, identifying ones that contain any of the keywords in their “title”, “abstract”, or “keywords”. Removed articles that were not relevant to the key search terms. Iteration 3: Excluded articles that were inaccessible through institutional licenses.	No. of Articles: <b>222</b> No. of Articles: <b>78</b> No. of Articles: <b>60</b>
3. Coding Schemes/ Concept analysis	Developed a coding scheme over three iterations to achieve maximum (1) accuracy in describing different types of LDT and (2) consistency in coding across the instances.	See Table 2.
4. Review Articles	As articles were reviewed, the results were documented in a concept centric matrix.	Created an extensive Concept Centric Matrix.

**Table 2.** Coding schema applied to each paper in the result set.

Code	Guidance
LDT	How LDT was conceptualised in the paper reviewed.
Conceptualisation	
Research Context	Context in which the research was conducted (e.g. geographical, industry, function)
Type of DT	Type of DT examined in the research article (e.g. IoT, Industry 4.0)
Type of Lean	Type of Lean examined in the research article (e.g. Six Sigma, Lean production)
Technology	Type of technology examined in the research article (e.g. ERP, AI)
Lean Tool/Aspect	Specific type of Lean tool or aspect examined in the research article (e.g. Kaizen, VSM)
Paper Type	Empirical (Papers that centre on direct observation or experimentation to uncover evidence that either validates or challenges theories) Conceptual (research papers that centre on abstract concepts, theories, and ideas) Both
LDT Benefits	Benefits of LDT mentioned in the research article

The emergence of LDT as a recent phenomenon is highlighted by the range of years from which the topic is mentioned in research (see [Figure 1](#)). The first mention of LDT is in 2019 with a significant rise in the following four years. From the articles analysed, 38 explicitly mention a focus on Industry 4.0 as the type of digital transformation being explored. Industry 4.0 refers to the integration of intelligent technologies like the Internet of Things (IoT) and AI to digitise manufacturing operations and enhance efficiency. According to Schneider et al. (2020), Industry 4.0 denotes the fourth industrial revolution, characterised by the union of the tangible world of manufacturing and the intangible virtual world, facilitated by the internet’s impact.

The remaining papers did not mention a specific digital transformation focus or high-light digital transformation in general. This would suggest that while LDT is applicable to all types of digital transformation (Rossini et al., 2020), research on the topic is primarily focused on traditional Lean functions. This is further supported by the types of industries and sectors that are examined as part of the research studies in our analysis. Our review indicates a predominant emphasis on manufacturing sectors and industries, with several articles *explicitly mentioning manufacturing in the titles* Torres et al. (2020); Rossini et al.



**Figure 1.** Distribution of articles by year.

(2021); Sartal et al. (2022); Narula et al. (2023); Trubetskaya et al. (2023). Again, while this outcome aligns with the historical widespread application of Lean principles in manufacturing (Julião & Gaspar, 2021), the focus of this research inaccurately portrays the belief that Lean principles have a broader relevance across various sectors, extending to non-manufacturing domains such as healthcare (Rossini et al., 2020). This, again, maybe down to the maturity of the domain, which concentrates on a traditional focus before expanding to other areas (Alsadi et al., 2023).

As part of our examination of LDT papers, we have discovered that six distinct Lean conceptualisations are employed in the research, as outlined in Table 3. Aligned with the traditional focus of the LDT domain on manufacturing, it is not surprising to see a large proportion of articles (27 in total) examining Lean manufacturing or Lean production. Lean production/manufacturing typically involves a standardised approach for industrial production systems, utilising Lean tools such as value stream mapping to identify areas for improvement (Wagner et al., 2018). The second most popular type of Lean examined is Lean thinking or Lean management. This characterises Lean as a broader and more universal concept applicable beyond manufacturing, rooted in customer-focused value, streamlined process, and continuous improvement (Dinis-Carvalho et al., 2022). The remaining types of Lean examined in the review include Six Sigma, Lean startup/innovation, Lean 4.0/digital Lean, and Lean training. In particular, Lean Training is centred on providing individuals with the expertise and competencies required to proficiently apply Lean principles within an organisation (McDermott et al., 2021).

Six Sigma is a powerful methodology that combines two approaches to business excellence: Lean and Six Sigma. Six Sigma aims to systematically reduce process variation, while Lean focuses on eliminating waste and promoting continuous development among personnel (Antony et al., 2017). Additionally, there are other Lean methodologies that apply Lean principles to specific activities. For instance, Lean Startup utilises Lean principles to launch new businesses or products, emphasising rapid iteration and customer feedback collection. For example, Geada (2021) provides a summary of Lean Startup, as a method for rapidly developing products with minimal processes and capital. Similarly, Lean 4.0/digital Lean extends the application of the Lean tenets into Industry 4.0, integrating technologies. It merges traditional Lean manufacturing methods with the digital innovations of Industry 4.0, aiming to enhance productivity, reduce waste, and promote sustainability across manufacturing supply chains. Beyond its original manufacturing roots, Lean practices have spread to various sectors like healthcare, construction, logistics, banking, and telecommunications. Lean 4.0 advances this trend by integrating digital technologies to boost efficiency and effectiveness (Cifone et al., 2021).

**Table 3.** Types of Lean included in the research articles.

Type of Lean	No of Papers	Examples
Lean Manufacturing/Production	27	Alieva and Powell (2023); Kong et al. (2023); Trubetskaya et al. (2023)
Lean Thinking/Lean Management	13	Pschybilla and Homann (2020); Rueb and Bahemia (2020)
Six Sigma	5	Clancy et al. (2022); Citybabu and Yamini (2023)
Lean Startup/Innovation	5	Kuula et al. (2020); Londral et al. (2022)
Lean 4.0/Digital Lean	5	Sengupta et al. (2021); Narula et al. (2023)
Lean Training	1	Singh et al. (2023)

### Key LDT research conceptualisations

Exploring Lean Digital Transformation within this descriptive literature review reveals three key research perspectives on LDT (see Table 4).

The first perspective **bridges the concepts of Lean and Digital Transformation**, without adding further theoretical value. For instance, Basulo-Ribeiro et al. (2023) outline challenges linked to digitalisation, such as being ‘time-consuming’, necessitating ‘skills in human resources’, and demanding a ‘high investment in new technologies’ – all of which are standard challenges encountered in Digital Transformation initiatives. The discussion on Lean is distinctly separate and centred around its level of advancement within the organisation and its maturity level. Additionally, as part of their study, Dalton and Stošić (2021) carried out two separate literature reviews, one concentrating on digitalisation and the other on Lean. The findings from the research are also categorised separately into Lean and Digitalisation. The lack of theoretical contributions beyond bridging the two domains could be an indicator of the emergent nature of LDT.

The second perspective highlights a research focus of **digital transformation as an enabler of Lean operations**. This focus details how digital advancements can support organisations in embracing or enhancing Lean operations. For instance, Queiroz et al. (2022) specifically investigate the role of digitalisation as a catalyst for implementing Lean in SMEs. In addition, the research conducted by Rybski and Jochem (2021) underscores the concept of Digital Transformation as an enabler for Lean by detailing a step-by-step process for incorporating digital elements into Lean Production Systems (LPS). The study also highlights the perceived utility of this approach in supporting the integration of digital elements into existing LPS.

The third research focus explores how **Lean is an enabler of digital transformation**. This focus underscores the capacity of Lean methodologies to serve as a methodical and organised approach in implementing diverse forms of DT, extending beyond just efforts aimed at waste reduction and process improvement. As Rossini et al. (2020), noted that Lean principles acting as a ‘... prerequisite for a successful digital transformation’ underscores the application of Lean principles and tools. Applying Lean principles and tools simplifies the initial process of gathering requirements and helps in effectively utilising the acquired information to ensure a successful DT.

#### RQ 2: What are the benefits of Lean Digital Transformation

Analysing the articles, there were many mentions of independent Lean benefits and independent digital transformation benefits; however, out of the total dataset, only 26

**Table 4.** Types of LDT research.

Type of Research Focus	No of Articles	Examples
Bridging the Concepts of Lean and Digital Transformation	17	Basulo-Ribeiro et al. (2023); Dalton and Stošić (2021)
Digital Transformation as an Enabler for Lean	19	Queiroz et al. (2022); Rybski and Jochem (2021)
Lean as an Enabler for Digital Transformation	24	Rossini et al. (2020); Trubetskaya et al. (2023); Romero et al. (2019)

**Table 5.** Implementation and output benefits of LDT.

Author/Year	Improved Process Analysis	Implementation Efficiency	Collaborative Empowerment	Improved Value Identification	Improved Technical Analysis	Implementation Agility	Continuous Learning	Better Risk Management	Increased Strategy Alignment	Clear Customer Focus	Operational Excellence	Process Optimisation	Waste Reduction	Resource Optimisation	New Products/ Growth Opportunities	Environmental Sustainability	Cost reduction	Enhanced Customer Experience
Trubetskaya et al. (2023)	x											x						
Citybabu & Yamini (2023)										x								
Lima et al. (2023)			x	x							x							
Narula et al. (2023)																		
Ayoubi et al. (2023)																		
Frecassetti et al. (2023)	x	x		x														
Singh et al. (2023)																		
Citybabu & Yamini, (2023)	x		x				x											
Diniz-Carvalho et al. (2023)	x																	
Sartal et al. (2022)	x																	
Ladera-Mejia et al. (2022)																		
Londral et al. (2022)																		
Londral et al. (2022)																		
Ruggiero et al. (2021)																		
Rossini et al. (2021)																		
Sengupta et al. (2021)																		
Powell et al. (2021)	x																	
Kalinowski et al. (2020)	x																	
Rueb & Bahemia, (2020)																		
Rueb & Bahemia, (2020)																		
Santhipalai and Ramayake (2020)	x																	
Ghobakhloo & Fathi, (2020)																		
Schneider et al. (2020)																		
das Chagas Santos et al. (2020)	x																	
Szedlak et al. (2020)																		
Romero et al. (2019)	x																	
Busto Parra et al. (2022)	x																	
Fadley (2021)	11	9	8	6	5	4	3	3	2	1	12	9	9	6	3	2	2	1

articles explicitly mention LDT benefits. From our analysis of these articles, two main categories of benefits emerged: (1) LDT implementation benefits that highlight the advantage that Lean brings to the process of implementing a digital transformation, and (2) output benefits, which are the overall benefits of a Lean digital transformation.

### **Implementation benefits**

*Improved process analysis* is the top-ranked implementation benefit outlined in the literature review. Trubetskaya et al. (2023) state that a thorough process analysis empowers organisations to streamline, structure, and visually standardise work steps and their durations. Such an approach plays a crucial role in facilitating the successful implementation of Industry 4.0. (DT). Expanding upon this view, Romero et al. (2019) offer a comprehensive perspective by dedicating a significant portion of their research to the topic. They highlight the use of tools like 'Value Stream Mapping' (VSM), 'Service Blueprint', and 'Customer Journey Map' as essential components for thorough process analysis and improvement identification before the actual implementation phase.

*Implementation efficiency* is a very common benefit that is mentioned in 11 articles in total. While this directly acknowledges the impact that LDT can have on the implementation of a DT, it represents general implementation tasks such as data-driven decision making, and better team communication. In highlighting the advantages of data-driven decision-making, Frecassetti et al. (2023) underscores these benefits, 'Data-driven systems offer actionable insights, leading to time savings, error reduction, and the maximization of opportunities'. Interestingly, strategic alignment is only mentioned in two articles. As noted by Romero et al. (2019), this is one of the most important aspects of a digital transformation and one that many organisations get wrong. More specifically, many organisations pursue a technology-centric approach, which has led to a lack of efficiency gains, and or new digital products and services that do not bring true added-value for the customer (Romero et al., 2019).

### **Output Benefits**

*Operational excellence* holds significant importance in the field of Lean literature as a cornerstone of Lean initiatives (Ghobakhloo & Fathi, 2020). This is supported by our analysis, which places it as the top-ranked benefit across both categories. An example of LDT and green operational excellence depicted by Dinis-Carvalho et al. (2022) 'Overall, the adoption of these approaches can help companies achieve operational excellence while minimizing their impact on the environment, making it an essential component of sustainable business practices'. What is interesting to note is the limited focus on wider DT benefits such as new product opportunities (3 articles), environmental sustainability (2 articles), and enhanced customer experiences (1 article). This would suggest that while LDT offers multiple benefits in conducting any type of digital transformation that can fundamentally alter organisations' processes and business models, the types of benefits that are described by current research focus on very traditional efficiency benefits.

## Findings and discussion

### *Emergence of LDT as a research domain*

The emergence of LDT as a key research topic represents a significant progression in understanding and applying Lean within the context of broader DT activities. Nevertheless, and perhaps in contrast to prevailing perceptions, it is important to note that the current body of research around LDT maintains a strong focus on manufacturing potentially limiting the applicability and insights across diverse sectors. Likewise, there is a concentration of existing literature on Industry 4.0, essentially utilising DT to transform manufacturing processes and technologies. While Industry 4.0 is a critical component of any exploration of LDT, overemphasising this specific context may create a skewed perception that LDT is predominantly tailored for manufacturing (Alsadi et al., 2023). The overemphasis on LDT in manufacturing highlights a significant gap in research in other industries.

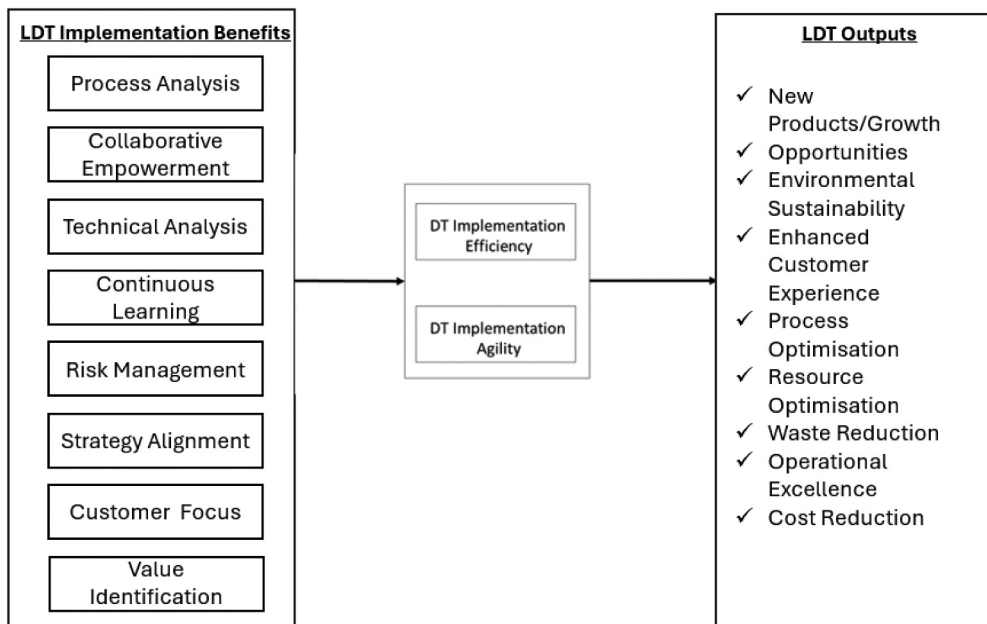
The literature around Lean and Digital Transformation presents three main perspectives. Bridging the concepts of Lean and Digital Transformation, digital transformation as an enabler of Lean operations, and Lean is an enabler of Digital Transformation. Of the three perspectives, Lean as an enabler of DT offers most value and a roadmap for future DT initiatives. Upon embarking on their DT journey, many organisations often prioritise acquiring or procuring digital solutions without thoroughly evaluating their current processes and procedures. This rush often leads to the digitisation of existing, often paper-based, processes without proper due diligence. Lean, as an enabler of DT, ensures such approaches are negated. Furthermore, the high failure rate of DT initiatives in organisations is estimated at around 70% (Weber et al., 2022). The impact is multifaceted, including financial loss, inadequate use of resources, missed opportunities, inadequate services, and reputational damage. Reputational damage is often overlooked, but it is challenging to eradicate or implement further initiatives when it occurs. Effectively addressing these challenges demands a focused effort to improve the understanding and execution of LDT implementation, providing organisations with an improved likelihood of successful and sustainable transformation initiatives. Lean can support DT based on a process improvement strategy, laying the groundwork for a successful implementation (Romero et al., 2019). Similarly, Szedlak et al. (2020) caution against digitising existing processes without proper evaluation. Implementing unnecessary processes can drain time, money and personnel.

### *LDT research framework*

As highlighted in the analysis, LDT research has outlined its potential to provide added value during the implementation of DT initiatives, which also impacts the output success of the initiative to derive maximum value from their digital investments. The significance of LDT becomes evident in this context, which is only now being discussed in the literature. Building upon these insights, the developed LDT value research framework outlines key benefits and components for understanding and implementing LDT initiatives See Table 5. This framework provides organisations with a structured approach to leverage Lean principles in their digital transformation journey, facilitating improved efficiency, agility, and value creation. See Figure 2.

The framework identifies the essential benefits of LDT as identified in the existing literature. Moreover, it expounds on how these benefits can enhance the efficiency and agility of implementing DT initiatives, ultimately fostering new product growth and uncovering valuable opportunities for organisations. Additionally, the framework integrates traditional Lean outcomes, such as waste reduction, while illustrating how incorporating Lean principles during requirements gathering and implementation can yield numerous benefits, including facilitating enhanced process analysis and value identification. Furthermore, from an output perspective, the framework outlines the conventional benefits of Lean initiatives, such as waste reduction and process optimisation, and delves into the broader outputs of DT initiatives that often transcend traditional Lean objectives.

Looking ahead, the framework provides a basis for future research, which is necessary to establish a thorough structure for assessing and improving Lean’s contribution in all phases of DT deployment. This necessitates closely examining the Lean elements that are most impactful at each stage and an exploration of its effects on various DT undertakings. Analysing instances of successful integration of Lean in DT initiatives can offer practical illustrations and benchmarks for businesses. The objective is to optimise the efficiency of LDT in practical settings. As an illustration, the LDT implementation benefit of *Strategy Alignment* highlights the coherence and integration between an organisation’s digital ventures and its broader business strategy, incorporating Lean principles. Moreover, *Continuous Learning* within the LDT framework accentuates the perpetual acquisition of knowledge and skills to continually refine and adapt LDT practices, ultimately assisting with ongoing DT efforts and future endeavours.



**Figure 2.** Towards an LDT value research framework.

Furthermore, incorporating *Value Identification* into the LDT Value Research Framework enables organisations to efficiently prioritise initiatives, allocate resources, and ensure alignment with strategic objectives. This aspect also streamlines the measurement of return on investment (ROI) and the overall success of LDT initiatives, empowering organisations to assess their effectiveness and make informed decisions regarding future initiatives and resource allocation, as demonstrated by Ghobakhloo and Fathi (2020).

## Conclusion

In conclusion, the broad exploration conducted in this descriptive literature review sheds light on various perspectives and methodologies regarding Lean and Digital Transformation. The diversity emphasised within this section underscores the considerable variations in research focus, revealing a discernible lack of maturity across numerous perspectives and approaches. The identified disparities highlight the urgent need for a more cohesive and mature understanding of Lean and Digital Transformation within the existing body of literature.

Due to the varied interpretations of what constitutes LDT in the literature, one thing is clear: more detailed practitioner research is required. In-depth research conducted by practitioners can offer valuable insights for organisations, aiding in developing informed and strategic approaches. With this knowledge, organisations can navigate the ever-changing landscape of LDT and uncover effective strategies, frameworks, and best practices for successful integration. This will give organisations a more comprehensive understanding of how LDT can be incorporated, enabling them to optimise their DT implementation and reduce the high failure rate. Several papers emphasise the importance of practitioner-oriented research. For instance, Cifone et al. (2021) have suggested that empirical investigations on practical applications can provide important insights into the effectiveness and feasibility of these approaches in real-world settings. Similarly, Schumacher et al. (2021) advocate prioritising practitioners' research in future research.

Also, the developed LDT Value Research Framework offers a structured approach for organisations to leverage Lean in their digital transformation journey, fostering improved efficiency, agility, and value creation. By outlining key benefits and components gleaned from existing literature, the framework provides practical insights into how LDT can enhance the implementation of DT initiatives, ultimately driving new product growth and uncovering valuable opportunities. Additionally, integrating traditional Lean outcomes, such as waste reduction, and the emphasis on *Strategy Alignment* and *Continuous Learning*, underscores the framework's adaptability and relevance in evolving business landscapes.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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