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How to use Digitalization and Lean Management for a Sustainable Strategy?

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ABSTRACT

The purpose of this paper is to study the integration of *digitalization* and *lean management* for improving the processes and developing a sustainable strategy. The paper uses both primary and secondary data. The research identifies the main analogies and differences, and critical success factors based on the application of *digitalization* and lean methodologies. The results show how the methodology of digitalization, business process improvement, and *lean management* permits of improving the speed and efficiency of the processes and the develop a sustainable strategy.

L'obiettivo di questa ricerca è quello di studiare l'integrazione del processo *digitalizzazione* e del *lean management* per il miglioramento dei processi e lo sviluppo della strategia sostenibile. Lo studio utilizza sia dati primari che secondari. Essa individua le principali analogie, differenze e fattori critici di successo basandosi su l'applicazione di processi di *digitalizzazione* e lean methodologies. I risultati mostrano come la *digitalizzazione* integrata con strumenti di *lean management* consenta di migliorare la velocità, l'efficienza dei processi e di sviluppare una strategia sostenibile.

Keywords: digitalization, lean management, sustainable strategy operation management, business process improvement, industry 4.0

1 – Introduction

This research explores the challenges and opportunities of digitalization and lean management in the contest of industry 4.0 (Porter and Happelmann, 2014,2015; Liker, 2008, 2022; Delgado *et al.*, 2010; Akkermans *et al.*, 1999, Riva and Pilotti, 2021a; Folpmers *et al.*, 2004; Majorana *et al.*, 2011, Kovacs, 2016; BCE, 2016; Comana *et al.*, 2016; Mottura, 2011, Holweg, 2007; Hines *et al.*, 2004; Camuffo, 2017; Riva, 2008; Pilotti, 2017).

There are few studies on the application of integration of digitalization and lean management and new technologies as IOT (Internet of Things), Big Data, Artificial intelligence, ERP (enterprise resource planning), EAM (Enterprise Asset Management); BPM (Business Process Management); BIM

(Building Information Modelling) and this research intends to fill this gap. The study analyses two international excellent cases: UniCredit Bank and General Electric.

The outline of the paper is as follows: the second section describes the theoretical review and the third section the methodological aspects; in the fourth section there is the description of case of UniCredit and the fifth section of the case of General Electric; after there is the discussion and the last section concludes.

2 – Theoretical background and research questions

2.1 – *Theoretical background*

The literary review (see Table 1) shows the importance of digitalization for the strategy, based on some important strategic decisions. This paper analyses how to improve operation management by using the digital transformation (Porter and Heppelmann, 2014, 2015; Marigonda, 2022) and lean management (Liker, 2008, 2022) by comparing two leader organizations.

Tab. 1 – A literary review on digital transformation (source elaboration from Bazyar, 2021)

AUTHOR(S)	Focus
Marigonda, 2022	Industry and digital twin
Fafioli, 2022	Dossier Green Logistic
Mapingire *et al.*, 2021	Components Of A Digital Transformation Strategy: A South African Perspective
Hess *et al.*, 2020	Options for Formulating a Digital Transformation Strategy
Schumacher *et al.*, 2020	The impact of Digital Transformation on lean production system
MIT Sloan Management Review, 2019	How to Develop a Great Digital Strategy
Schallmo *et al.*, 2019	Digital Strategy: Integrated Approach and Generic Options
Korachi and Bounabat, 2019	Integrated Methodological Framework for Digital Transformation Strategy Building (IMFDS)
Chanias *et al.*, 2019	Digital transformation strategy making in pre-digital organizations: the case of a financial services provider
Dang and Vartiainen, 2019	Digital strategy patterns in information systems research
Nadeem *et al.*, 2018	Editorial: Digital Transformation & Digital Business Strategy in Electronic Commerce - The Role of Organizational Capabilities
Schallmo *et al.*, 2018	Clarifying Digital Strategy – Detailed Literature Review of Existing Approaches
Gobble, 2018	Digital Strategy and Digital Transformation

Catlin *et al.*, 2018	Digital strategy: The four fights you have to win
Westerman, 2018	Your Company Doesn't Need a Digital Strategy
Ismail *et al.*, 2017	Digital Business Transformation and Strategy: What Do We Know So Far?
Holotiuk and Beimborn, 2017	Critical Success Factors of Digital Business Strategy
Paiola, 2017	Digitalization and servitization: opportunities and challenger for Italian SM
Sebastian *et al.*, 2017	How Big Old Companies Navigate Digital Transformation
Chanias and Hess, 2016	Understanding Digital Transformation Strategy Formation: Insights from Europe's Automotive Industry
D'Cruz *et al.*, 2016	Strategy in a Digital World
Matt *et al.*, 2015	Digital Transformation Strategies
Porter and Heppelmann, 2015	How smart connected product are transforming companies

Digital transformation is important for a global approach to the correct implementation of using new digital technologies such as networking, social media, mobile technology, analytics, or embedded devices to enable major business improvements (reduction of wastes, improve customer experiences, streamlined operations, etc.). The model of *Business Canvas* (Krugen *et al.,* 2018) permits to model the process of digitalization (see Figure 1).

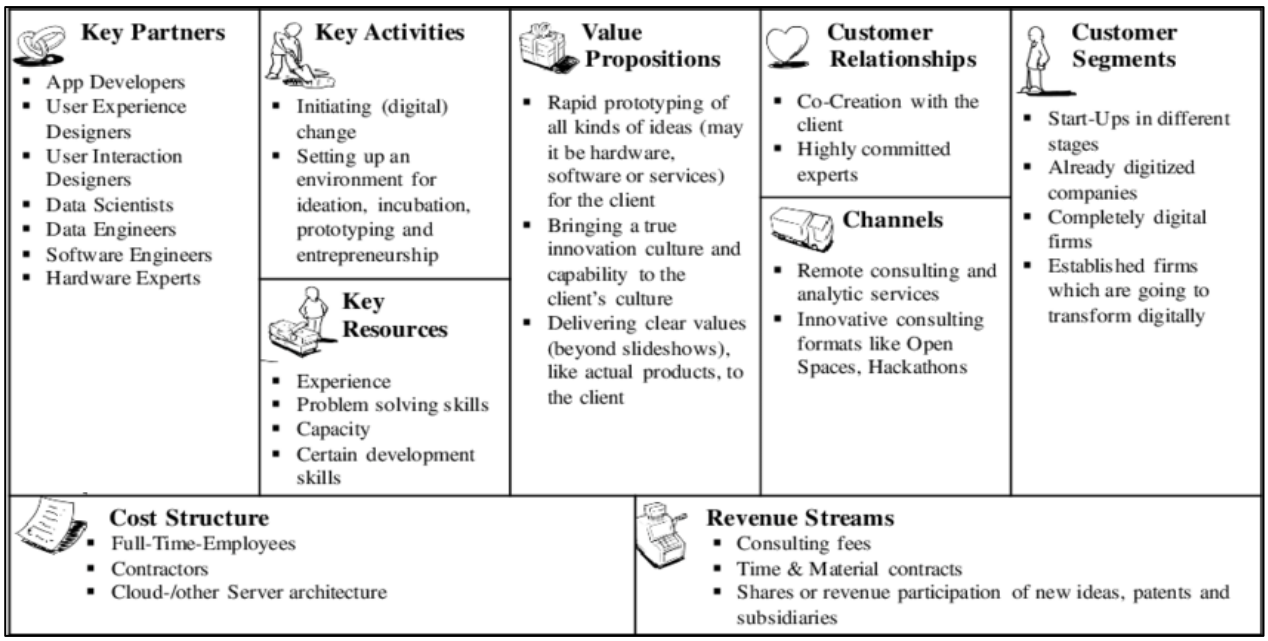

Fig.1– Integration of digital transformation and model of Business Canvas (source: elaboration from Krugen *et. al.,* 2018)

The definition of digital transformation (see Table 2) permits us to understand the importance of the global process of using new technologies.

Tab.2 – Digital Transformation Definitions (our elaboration from Gong and Ribiere, 2021)

AUTHOR(S)	Definition
Bondar *et al.*, 2017	Digital transformation is consistent networking of all economic sectors and an adaption of actors to new circumstances of the digital economy.
Fitzgerald *et al.*, 2014	Digital transformation is the use of new digital technologies such as social media, mobile technology, analytics, or embedded devices to enable major business improvements including enhanced customer experiences, streamlined operations, or new business models.
Hinings *et al.*, 2018	Digital transformation is the combined effects of several digital innovations bringing about novel actors (and actor constellations), structures, practices, values, and beliefs that change, threaten, replace, or complement existing rules of the game within organizations, ecosystems, industries, or fields.
Kem, 2019	The adoption of technologies, and their capabilities to digitize organizational assets and strategy
Liu *et al.*, 2011	Digital transformation is an organizational transformation that integrates digital technologies and business processes in a digital economy.
Martin, 2008	Digital transformation is the use of information and communication technology, not when trivial automation is performed, but in the case where fundamentally new capabilities are created in business, public government, and in the lives of people and society.
MCMC, 2020	Digital transformation is the integration of digitalized processes to achieve enterprise-wide automation, modernization, and previously unattainable outcomes
Paiola, 2018	Digital transformation is based on technology-driven (digital) that transform the firm's business model toward service supporting the product and the customers
Solis *et al.*, 2014	Digital transformation is the realignment of, or new investment in, technology and business models to more effectively engage digital customers at every touch point in the customer experience lifecycle.
Stolterman *et al.*, 2004	Digital transformation comprises the changes associated with the application of digital technology in all aspects of human society.
Westerman *et al.*, 2011	Digital transformation is the use of technology to radically improve the performance or reach of enterprises.

There is a good integration between the digital and lean management tools (Marigonda, 2022, Mella, 2021ab; Romeo, 2019) for the possibility to analyze the value stream map for modeling the different processes in the company and improving the quality, the speed, the economy, and the green sustainability factors (Slack *et al.,* 2004; Ohmae, 1982; Daily and Huang, 2001; Lee *et al.,* 2014; Delgado *et al.,* 2010; Stater, 1999, Welch and Byrne, 2003; Koning *et al.,* 2008; Gazzola and Colombo, 2014; Gazzola and Mella, 2003, 2006, 2017; Gazzola *et al.,* 2020; Mella,

1997, 2012, 2015, 2018, 2021b; Pilotti, 2011, 2017, 2019; Riva, 2007a,b; Preite, 2000, 2007, 2011, 2011b 2014; Riva and Pilotti, 2019a,b).

The digital transformation is based on some important phases, outlined in Figure 2.

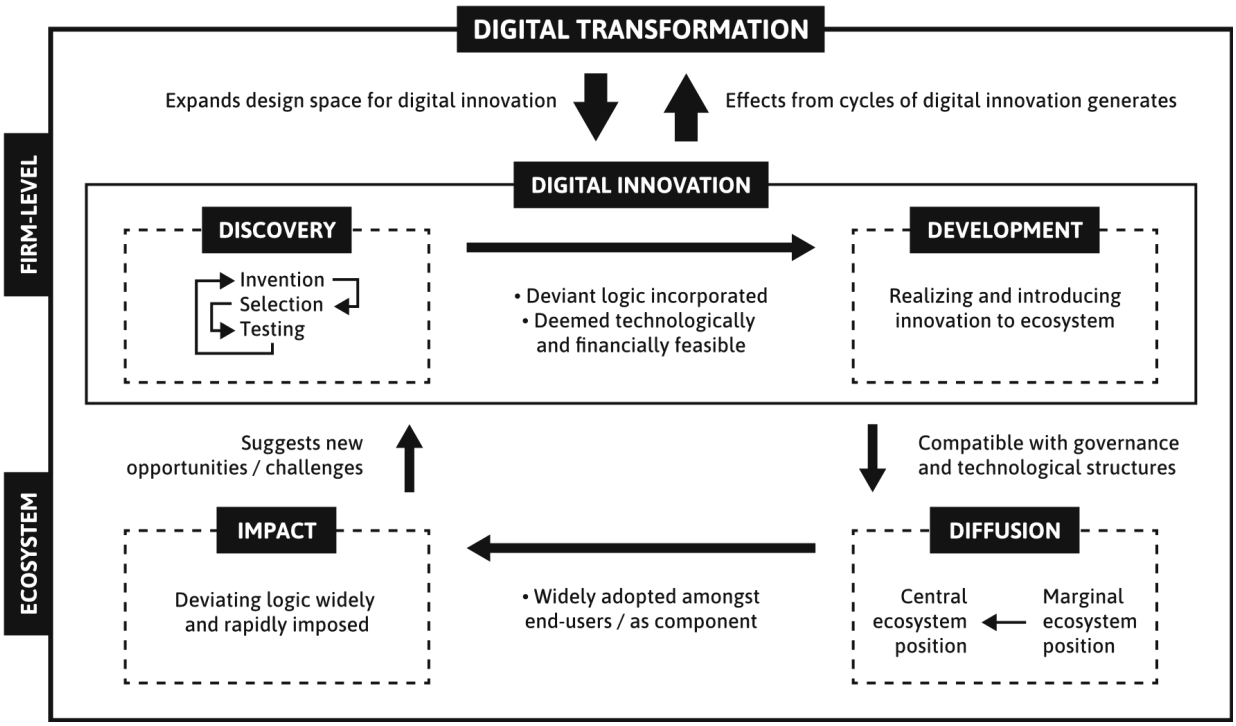

Fig. 2 – Digital Transformation (source: Skog, 2018)

There are main paradigms (Van Donk, 2008; Cousins *et al.*, 2006; De Koning *et al.*, 2008; George, 2003; Osservarorio processi bancari, 2010; Skinner, 2014, Hitt *et al.*, 2014,Nonaka, 1995; Stack *et al.*, 2004; Grant, 1997; Riva and Pilotti, 2017, 2018, 2019a,b, 2020, 2021a,b; Riva, 2006, 2007a,b, 2012; Tonchia, *et al.*, 2011; Basnet, 2000; Pilotti and Rinolfi, 2022a,b) about the management and improvement of the process of an organization based on some different theories (see Table 3).

Tab. 3 – Important paradigm about management and improvement of the process (source our elaboration from Liker, 2008, 2022; Riva, 2006, 2021a)

THEORY	Important Contributions
Digitalization	Verhoef *et al.*, 2021; Mapingire *et al.*, 2021; Hess *et al.*, 2020; Schallmo *et al.*, 2019; Korachi and Bounabat, 2019
Lean management and sigma six	Delgado *et al.*, 2010; Ohno, 1986; Womack *et al.*, 1996; Liket, 1994; Camuffo, 2017; Tonchia *et al.*, 2011; Majorana and Morelli, 2011; George, 2003 Folpmers *et al.*, 2004, Kovacs, 201; De Koning *et al.*, 2008
Quality management	Deming, 2000; Imai, 1986
Benchmarking	Camp, 1989; Zairi, 1996; Cook, 1995; Bocchino, 1995; Spendolini, 1992; Kathleeen, *et al.*, 2002; Bogan, 1994; Dembowski, 2013

Reengineering, Process management, Scientific management	Hammer and Champy, 1993, Holweg, 2007; Hall *et al.,* 1993; Weske, 2012; Taylor, 1911; Ford and Crowther, 1922
Knowledge management, Change management	Nonaka and Takeuchi, 1995; Laudon, 2004; Quintas *et al.,* 1997; Itami, 1987: Lewin, 1951, Kotter, 1996, 2008; Scott and Jaffe, 1990; Senge,1990
Theory of constraint System dynamics	Goldratt, 1984; Senge, 1990
Risk management Balanced scorecards	Norton, 2004; Eccles 1991; Simon, 1995; Kaplan and Norton, 1996, 2001; Al-Najjar *et al.,* 2012; Smullen, 2000

It is important to have a global digital transformation planning (Liker, 2008, 2022; Romeo, 2019) based on the vision, strategy, and action (see Figure 3).

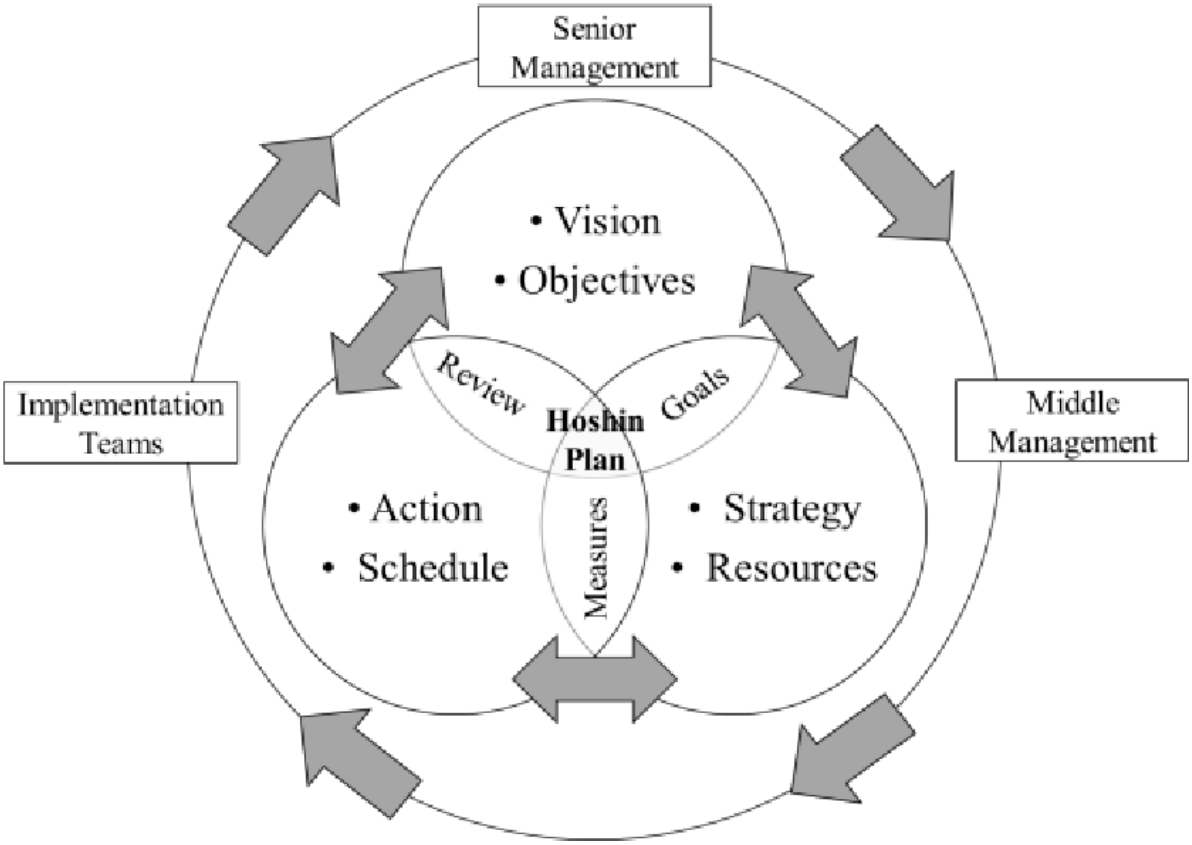

Fig. 3 – The digital transformation framework (source: elaboration from Liker, 1994; Romeo *et al.,* 2019)

Many authors (Slack *et al.,* 2004; Lee *et al.,* 2014; Delgado *et al.,* 2010; Stater, 1999; Welch and Byrne, 2003; Koning *et al.,* 2008; Maiorana and Morelli, 2011; Penna and Guerzi, 2014; UniCredit Bilancio Integrato, 2015; Crespi, 2006; Chiaramonte, 2008; De Koning *et al.,* 2008a, b; Elewaut *et al.,* 2003; Salaheldin *et al.,* 2009) present evidence of the importance of using combined Lean Thinking with Six Sigma (Wanga and Chenb, 2010; Wu and Hung-Yi, 2012; Sunder, 2013).

Leyer and Moormann, (2014) study the implementation of lean methodology. Masoud (2014), Ndaita *et al.,* (2015), dos Santos and Cabrita (2016), Balkovskaya and Fineva (2016), and Kovacs (2016) investigate the leading application of lean management tools.

In this time the innovation has changed the condition of innovation with the presence of the 4° industrial revolution (see Table 4).

Tab. 4 – Types of industrial revolutions (source: adapted from Lee et al., 2014)

Period	Type of Revolution	Technology	Innovation
Late 18TH	**1° Industrial Revolution**	Historical loom	Introduction of mechanical production plants
Early 20TH Century	**2° Industrial Revolution**	Mass production and Assembly line	Introduction of work-division mass production using electrical energy
The early 1970S	**3° Industrial Revolution**	Automated Industrial Robot in Manufacturing	Use of electronics and to further automate production Lean management
Today and Near	**4° Digitalization** **Industrial Revolution** **Focus Sustainability**	The connection between Physical and Digital Systems, Complex Analyses of Big Data, and Real-time settings	Digital twin Artificial intelligence Big Data Use of smart machines, interconnected and connected to the internet

The definition of a vision and long-range strategy permits to implementation of a road map for the long-run strategy (Mariconda, 2022) and for the implementation of the integration of digitalization (artificial intelligence, big data) and lean management tools.

2.2 – *The research questions*

The integration of digital transformation and lean management is an important research stream and few research has been carried out, at the best of our knowledge, with specific attention to the impact on integration of digitalization and lean management for a the sustainable strategy. The stream of research is still partial with certain limitations, as a result, the following research questions are investigated in this paper:

RQ1: *What are the analogy and differences between the two strategies of digitalization, business process improvement, and lean management of UniCredit and General Electric?*

RQ2: *Why are the critical success for digitalization, business process improvement, and lean management?*

3 – Methodology

3.1 – *The motivation of choice of the case of UniCredit and General Electric*

We based our sample (Glaser and Strauss, 1967, Eisenhardt, 1989) on two leader companies: UniCredit and General Electric. We have chosen these two leader organizations for some reasons:

a) UniCredit has its headquarters in Milan, Italy, and is the world's 34th largest asset (Zamina, 2020) for international importance; General Electric (GE) has its headquarter in Boston, Massachusetts in United State and is ranked among the 500 as the 33rd largest firm in the United State by gross revenue;

b) the two companies selected are successful firms and present in many international markets all over the world.

3.2 – *The triangulation methodology*

We use mainly three different sources of data collection:

a) public balance sheet and other reports as secondary data;

b) qualitative analysis based on an interview protocol;

c) quantitative analysis using Likert's scale.

The method of *case study* is used because it permits to underline of the main innovations and the strategy during the time (Glaser and Strauss, 1967, Mella, 2012; Eisenhardt, 1989).

3.3 – *Secondary data*

Regarding secondary data (see Tables 5a and 5b), we study the public balance sheet and other documents.

Tab. 5a – Secondary data used in this research for UniCredit (source: our elaboration)

UNICREDIT - Main Secondary Data	Focus
Integrate Report 2020 (*source: UniCredit)*	Focus on integrated strategy
Comunicazione di Impresa in Gruppo Bancario. Il caso UNICREDIT group (source: Centtro Studio Tocqueville-Acton 2010)	Focus on organization and management
Investor Relations Unicredit (source: *UniCredit*)	Focus on financial strategy
Annual Reports 2015-2020 UNICREDIT (*Source: UniCredit*)	Focus on strategy and economy
Sustainability Strategy (*source: www.unicredit group.eu)*	Focus on a sustainable strategy

Tab. 5b – Secondary data used in this research for General Electric (source: our elaboration)

G.E. - Main Secondary Data	Focus
Annual Reports 2015-2021, GE (*Source: General Electric*)	Focus on strategy and economy
Integrated Summary Report 2015, GE (*Source: General Electric*)	Focus on digital strategy
Scorecard 2020, GE (*source: General Electric*)	Focus on strategy
Diversity Report 2020, GE (*source: General Electric)*	Focus on strategy
Ceo Letter G.E. 2021 (source: *General Electric*)	Focus on organization and management
Investor Relations G.E. 2021 (source: *General Electric*)	Focus on strategy

Regarding primary data, we collect data and information by contact and interviewees with the experts about the areas of research (see Table 6).

Tab. 6 – Interviewees (source: our elaboration)

Expert	9 interviews
Economic journalist	1 interview

The method of case study is used because it permits to underline of the strategy during the time. There are main issues covered during the interviews (see Table 7),

Tab. 7 – The protocol of the interviews (source: our elaboration)

RQ1: *What are the analogy and differences between the two strategies of digitalization, business process improvement, and lean management of UniCredit and General Electric?*	- digitalization - lean management and operation strategy - main tools and methodologies - process management - innovation strategy

RQ2: *Why are the critical success for digitalization, business process improvement, and lean management?*	- framework and tools - main differences and analogies - the best practices - history and innovation - general framework

3.4 – *Quantitative analysis*

For quantitative analysis, we use a questionary based on 5 points Likert scale. The first part of the questionaries (see Table 8a) is focused to analyze the main difference in the application of a set of tools in the two companies.

Tab. 8a – Part A Questionnaire (5 points Likert scale) (Source: our elaboration)

Application of Tools	[1] Unac-ceptable	[2] Almost Acceptable	[3] Acceptable	[4] Good	[5] Excellent
1) DIGITALIZATION TOOLS (Replacement of traditional workflow with the digital process)					
2) LEAN MANAGEMENT TOOLS (Increase workflow efficiency and minimize technical errors)					
3) BENCHMARKING (Learning from the best)					
4) KNOWLEDGE MANAGEMENT **(**Big data and artificial intelligence)					
5) RE-ENGINEERING (re-thinking the processes)					
6) CHANGE MANAGEMENT **(**Application of new technologies and Processes)					
7) THEORY OF CONSTRAINTS **(**Understanding the main limit and how to improve					
8) WORK-OUT (Increase labor productivity and speed of the processes)					
9) SIX SIGMA (Improve work quality and performance)					

Digital transformation needs an important change in the strategy and structure of the organization, and there is a need for a new skill and a comprehension of the main technologies' trends (big data, internet of things, artificial intelligence, blockchain).

The second part of the questionary (see Table 8b) is mostly focused on the different critical success factors based on some areas: I) digital vision, II) culture, III) target, IV) drivers, V) control.

Tab. 8b – Part B Questionnaire (5 points Likert scale) (Source: our elaboration)

	[1] Unacceptable	[2] Almost Acceptable	[3] Acceptable	[4] Good	[5] Excellent
I) DIGITAL STRATEGIC VISION					
Q1 - Evaluate Digital Awareness					
Q2 - Planning Digital Future					
Q3 - Develop Digital Strategy					
II) DIGITAL CULTURE					
Q4 - Culture of Digital Transformation					
Q5 - Exhibit Organizational Structure					
Q6 - Adopt Good Practices					
III) DIGITAL TARGET					
Q7 - Determine Transformation Opportunities					
Q8 - Identify Transforming Areas					
Q9 - Building KPIs					
IV) DETERMINE DIGITAL DRIVERS					
Q10 - Determine Digital Technologies to Leverage					
Q11 - Determine Skills & Capabilities Required and resource					
Q12 - Determine Other Resources Impacting Required					

V) CONTROL AND ESTABLISH DIGITAL ORGANIZATION AND MAIN KPIs					
Q13 - Define Expected Customer					
Q14 - Determine Realized Customer					
Q15 - Measures of Impacts					

For analyzing the data based on triangulation methodology, some elements are analyzed: a) *concept validity* (multiple sources of data); b) *internal and external validity* (interview methodology); c) *reliability* to verify that these investigations are valid and dependable (by using a database to collect data).

4 – The strategy of UniCredit

4.1 – *History*

UniCredit Group is an Italian global banking and financial service company with a strong position in Western and Eastern Europe, based on the merger of several Italian banks. The Group is present in 50 markets in 17 countries with more than 3263 branches (Figure 4) and about 76761 employees (UniCredit Annual Report, 2021; Crespi, 2006; Chiaramonte, 2008).

Fig. 4 –Service line - UniCredit (source: UniCredit)

4.2. – *The philosophy and the culture of UniCredit*

UniCredit underlines the importance of the cultural aspects of lean banking and the importance of some principles of strategy: a) put the customer first; b) improve the process of the organization; c) cooperate and connect with supplier and partners; d) manage the risk; e) focus on execution (UniCredit, 2020, Bilancio integrato). At the base of the lean in Unicredit, there are two fundamental and complementary concepts, described by two Japanese terms: *Monozukuri* (the ability to do things well, with constant attention to cost, time, and quality) and *Hitozukuri* (the ability to grow and shape the company's people).

4.3 – *Digitalization and Lean banking process improvement initiatives*

The process management involves a series of phases and a definition of the relative KPI tree (Majorana *et al.,* 2011; Wu and Hung-Yi, 2005). The use of a process flowchart in UniCredit permits describing a graphical representation of all activities performed in a sequence. The main phases are:

1) *process mapping*: there is a description of the process;

2) *process diagnosis*: the problem in the process is identified;

3) *process design*: develop an alternative to the process;

4) *process implementation:* validation of the process and the control;

5) *process maintenance*: monitoring the process and trying to improve.

Digitalization and Lean banking in UniCredit are the application of the philosophy of lean thinking to the banking world (see Figure 5)

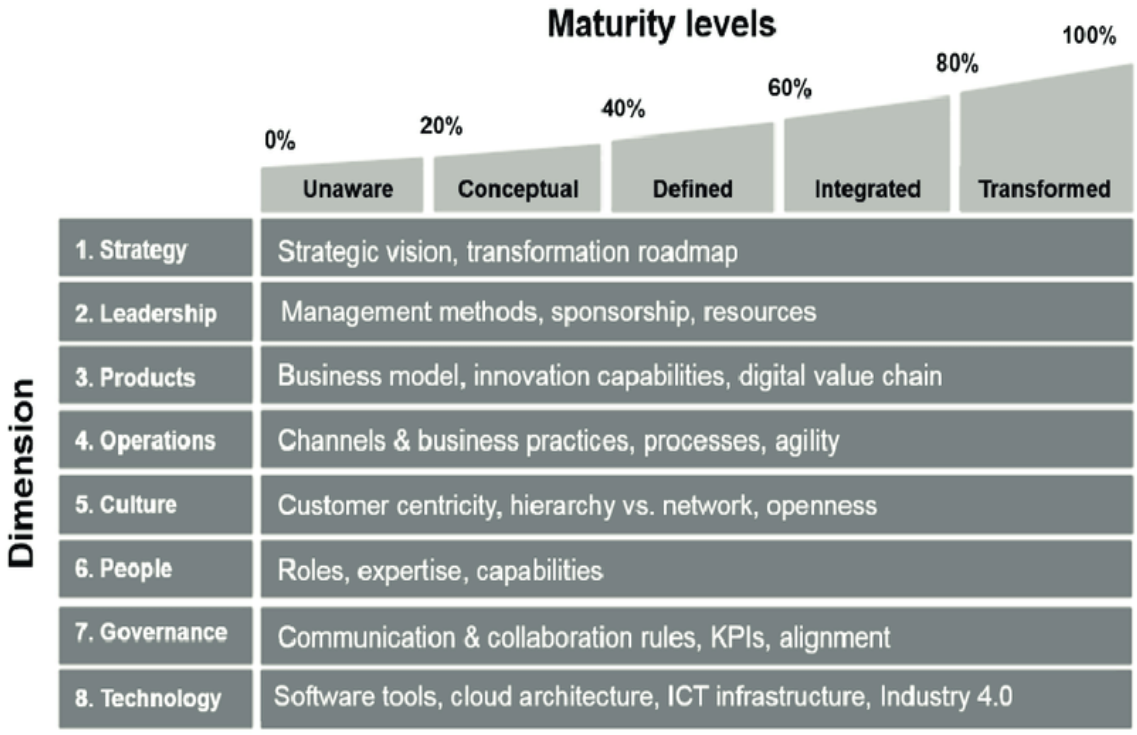

Fig. 5–Dimension and maturity of digitalization (source: Azhari *et al.,* 2014)

High levels of costs for financial services are a result of wasteful activities that provide no added value to the customer. The innovation and improvement of the process can be important for the future of the bank. A process can be defined as a series of actions that transform. The flowchart use symbol connected by arrows to describe processes.

4.4 – *Improvement and cost reduction and process management*

Lean banking in UniCredit (Majorana *et al.,* 2011) refers to improvement projects that redesign the internal processes of the bank, focusing on customer satisfaction and reducing waste using many tools (see Table 9). The focus is to improve both the upper part of the income statement (revenues) by increasing customer retention rate and in the lower (costs) through the containment and reduction of unnecessary costs and wastes.

Tab. 9 – Lean and digital tools and techniques grid for service process in UniCredit (source: adapted from Majorana and Morelli 2011; George, 2003)

1.	Process Mapping (TOOL)
2.	Brainstorming (TOOL)
3.	Root Cause Analysis (TOOL)
4.	Quality Costing (TECHNIQUE)
5.	Hypothesis Testing (TOOL)
6.	SPC (TECHNIQUE)
7.	SIPOC (TOOL)
8.	Servqual (TOOL)
9.	Gantt Charts (TOOL)
10.	Process Capability Analysis (TECHNIQUE)
11.	Regression + Correlation Analysis (TOOL)
12.	Benchmarking (TECHNIQUE)
13.	Control Charts (TOOL)
14.	Pareto Analysis (TOOL)
15.	Cost-Benefit Analysis (TOOL)
16.	Histograms (TOOL)
17.	Service Fmeca (TECHNIQUE)
18.	QFD (TECHNIQUE)

For UniCredit improvement should not focus solely on overhead cost reduction (elimination of the wastes and the not value-added activities) but also to improve the revenues (focus on critical quality factors). Processes and operational efficiency lead to reduced costs and released capacity, meaning lean banking process improvement contributes significantly to

improving performance. Lean banking does not require significant capital investment. Lean middle-market banking concepts and tools are relatively easy to learn and apply.

4.5 – *Focus on avoiding categories of wastes*

The utilization of a set of digital and lean management tools permits the improvement of the performance in simplification of the main processes (see Table 10).

Tab. 10 – Digital and lean tools (source adapted from Masoud, 2014; Ndaita et al., 2015; dos Santos and Cabrita, 2016; Liket, 1994; Womack et al., 1990; Camuffo, 2017)

DIGITAL TOOL	LEAN TOOL BASIC	ADVANCED	INTERMEDIATE
Artificial Intelligence Big Data Machine learning Simulation Digital Twin Social Intranet platform, CRMs tools, CMS (content management system), Cloud storage, Project Management tool, A recruitment management tool, communication tools	Value stream mapping (analyze information flows, Material flow and lead time ladder) 5S, Lean Wastes, Spaghetti Diagrams, 5 Whys	Flow, Pull, Kanban, One-Piece Flow, Cellular Design, System Thinking, Theory of Constraints, Total Productive Maintenance	Mistake proofing, Kaizen, SMED/changeover, Standard work, Visual management/scorecards, Process/value analysis

Making a parallel with the manufacturing world and adapting it to reality as the bank emerges seven main categories of waste (Maiorana *et al.,* 2011):

a) *over processing*: add more value for a service that costs more than what the customer is willing to pay;

b) *transport:* send paper and disclosure documents from one office to another;

c) *handling:* moving from one office to another (or from one division) by staff;

d) *shares:* practical storage waiting to be screened;

e) *expectations*: time during which the service must be delivered to the customer waits until the resource that it must occupy proves free;

f) *defects and reworking*: any wrong operation that needs to be carried out a second time to be compliant;

g) *overproduction:* document production/practices in greater numbers to the requests coming from the customer.

UniCredit analyzes the processing time and tries of avoiding the source of waste as well as dissatisfaction with the customer.

5 – The strategy of General Electric

5.1 – *Introduction and history*

Thomas Edison founded General Electrics and in 1896 the company was listed on the Dow index. The area of business is lending and leasing in support also GE's industrial business units. The business main divisions are aviation finance, energy finance, and industrial finance (see Figure 6).

Fig. 6 – Line-production G.E. (source: Intoscana)

The main principles and practices of G.E. are:

a - implant corporate culture into talent management processes such as hiring methods and leadership development;

b - all managers must get involved in the strategic vision;

c - establish the best balance of the company's global and local needs;

d - discovering new ways to distinguish the company from all competitors.

GE's growth strategy is based on some: a) technological leadership; b) services acceleration; c) enduring customer relationships; d) resource allocation; e) globalization.

5.2 – *Work-out methodology*

In 1989-90 CEO Jack Welch launched "work-out" a group-based problem-solving and employee empowerment program based on the Japanese quality circles model. Welch realized that G.E. was entering an era of constant change (Stater, 1999), so he decides to introduce Six Sigma in 1995; his vision was to reach the goal to be a Six Sigma company by 2000. Modifying the process and system appropriately (Stack *et al.,* 1992) is possible by using a workout methodology with many benefits:

1. *leading change:* leadership to manage the process is essential with a commitment to the initiative;

2. *creating a shared need*: the need and understanding for change must outweigh the resistance – the inertia in the organization to maintain the status quo;

3. *shaping a vision*: a clear and legitimate vision of the world after the change initiative by observable and measurable terms; the end-state must be described; this might be the single most critical factor in a successful change initiative;

4. *mobilizing commitment* to execute the strategy;

5. *creating a knowledge-based organization* and transferring the best practices;

6. *monitoring process* by using benchmarks.

It is important to analyze the customer journey by the map template for analyzing the creation of value (Figure 7).

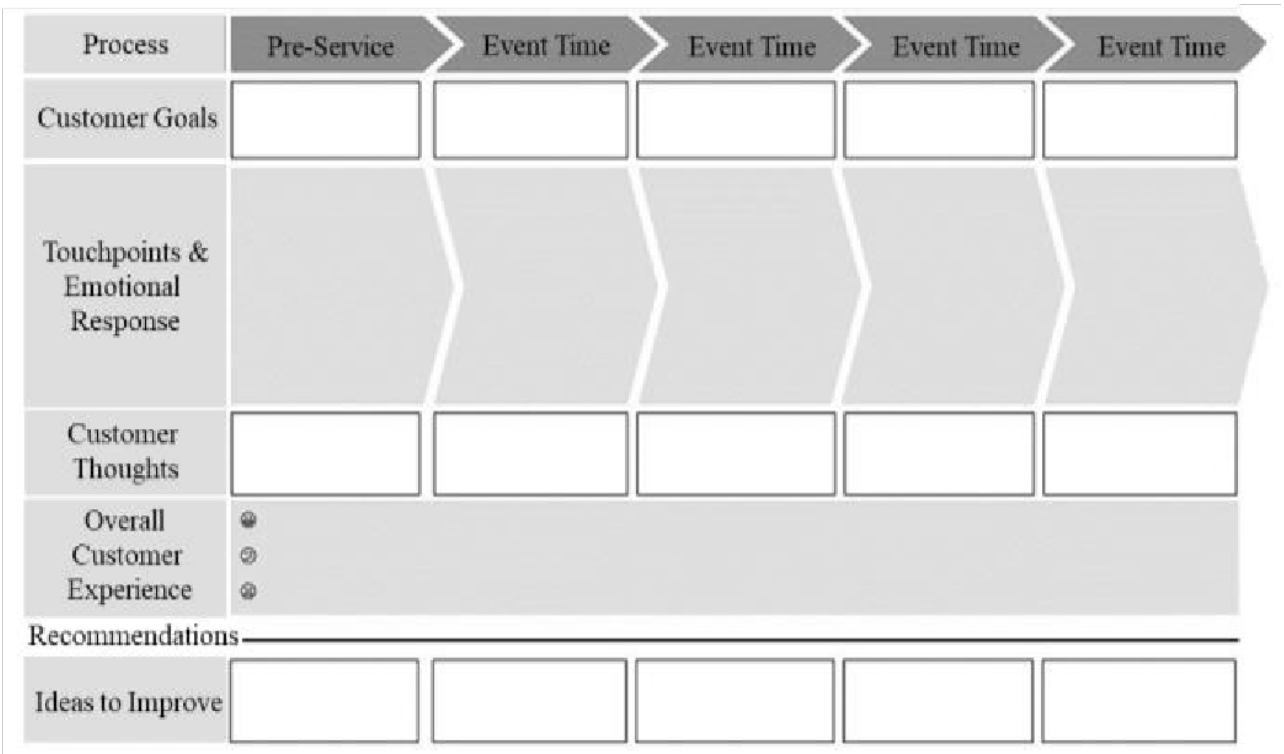

Fig. 7 – Customer journey Map Template (elaboration from Liker, 2004; Romeo *et al.,* 2018)

5.3 – *G.E. uses the lean system based on some important integrated set of processes*

There is some key process (Delgado *et al.,* 2010; Welch and Byrne, 2003) used in the implementation of *lean six sigma* methodology in GE:

a) to determine the attributes most important to the customer (critical to quality); to achieve six sigma quality targets, a process must produce no more than 3.4 defects per million opportunities (about 1/250000); the SIMP (structured idea management program) permits to innovate based on the implementation of a lean production line (see Figure 8);

b) to measure of failing to deliver (defect: anything that doesn't meet customer expectations or customer specifications) what the customer wants-;

c) to determine what the process can deliver (process capability: the ability of the procedure to reach the same result during the time);

d) to analyze what the customer sees and feels; study the variation as the difference that the customer notices from one item to the next, as well as the differences within processes; six sigma aims to reduce variation as much as possible for a repeatable result;

e) To ensure consistent, predictable processes to improve what the customer sees and feels (accuracy and repeatability are essential so you can predict what an operation will do in the future).

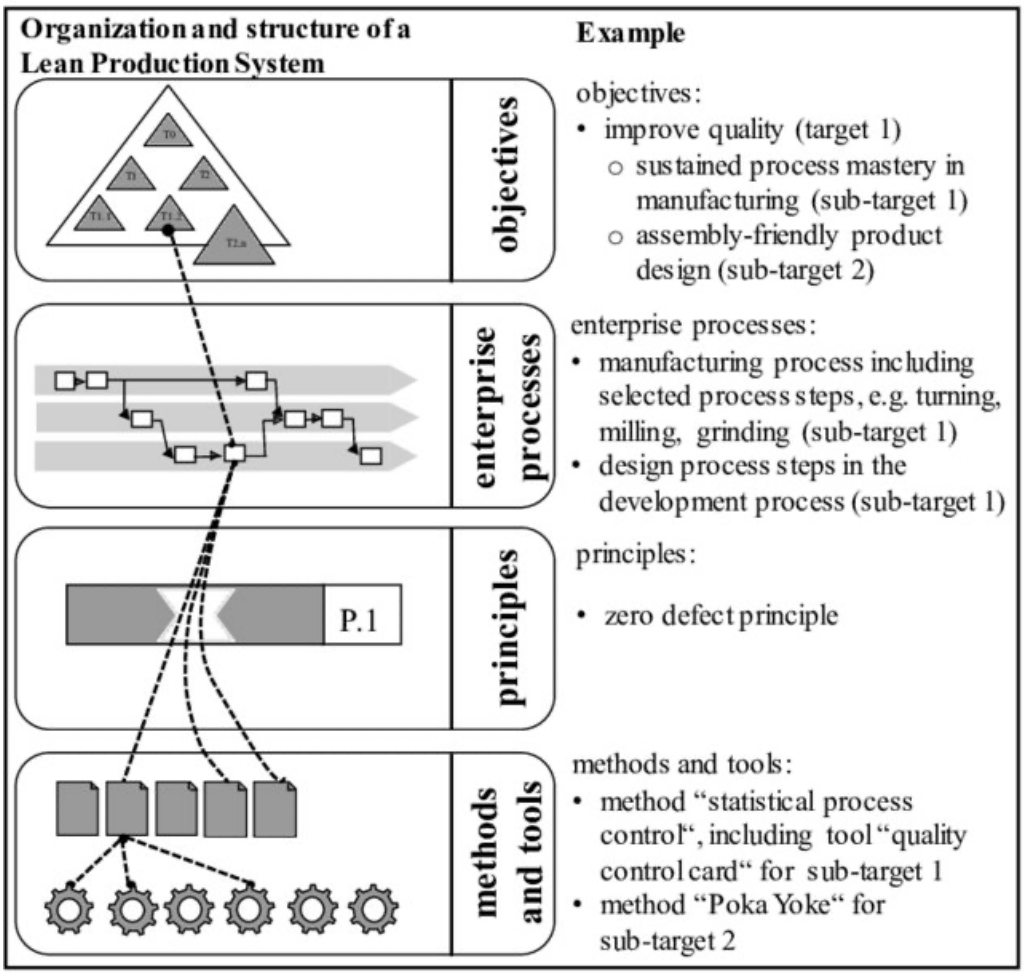

Fig. 8 Lean Production line (*Source*: Rowbotham and Bohlin, 2003)

5.4 – *The change acceleration process (CAP) model in G.E. and SIMP*

The team for improvement of a process creates the change effectiveness equation (QxA=E): the effectiveness (E) of any initiative is equal to the product of the quality (Q) of the technical strategy and the acceptance (A) of that strategy. It is important to define the value stream map and the risk management (see Figure 9).

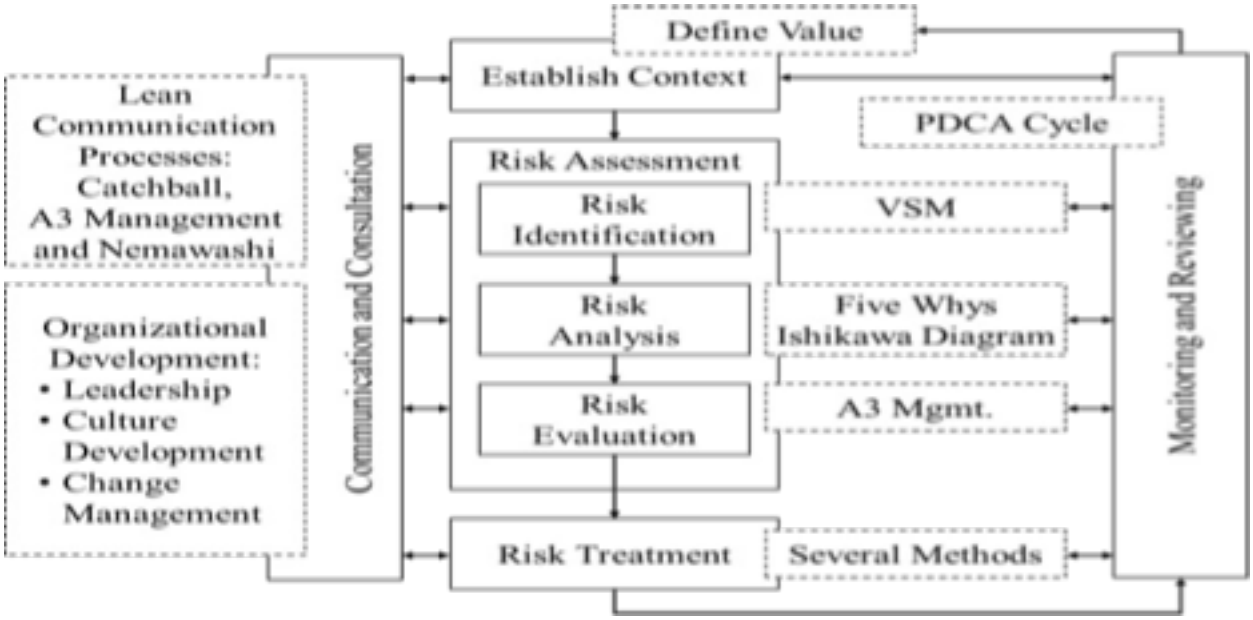

Fig. 9 – Value stream map and risk assessment and treatment (*Source*: elaboration form Hines, 2004)

5.5 – *Quality control and Lean Week in GE*

The quality of the suppliers is a valuable role in the quality strategy which constitutes an advantage for end customers. Suppliers provide essential products and services for end-customer satisfaction. The process is the essence of each organizational unit and is the priority for the unit. The lean week is a five-day brainstorming week to improve (Imai, 1986).

The lean week in G.E. is based on these lean principles:

a) determine the value desired by the customer;

b) design the value stream for each product providing that value (eliminate waste); make the product flow continuously;

c) use pull strategy;

d) research perfection reducing the number of steps and the amount of time and information needed to serve the customer continually falls. The first two days are based on value stream mapping to identify the added and non-added value of an action and future target. In the third and fourth days, there is the development of an "action workout".

It is important to define the global strategy of the company and use a different tool to determine the process of creation of value. The control of the risk is an important dimension for controlling the process and improving the process by using new technology and developing intelligent digital twin (Marigonda, 2022) and creating a model for simulation (what-if analysis).

6 – Discussion and managerial implication

6.1 – *Comparison and benchmarking of the organizations*

The data from the questionnaire (see Table 8a) (based on Likert's scale) allows the two organizations UniCredit and General Electric to be compared (see Figure 10).

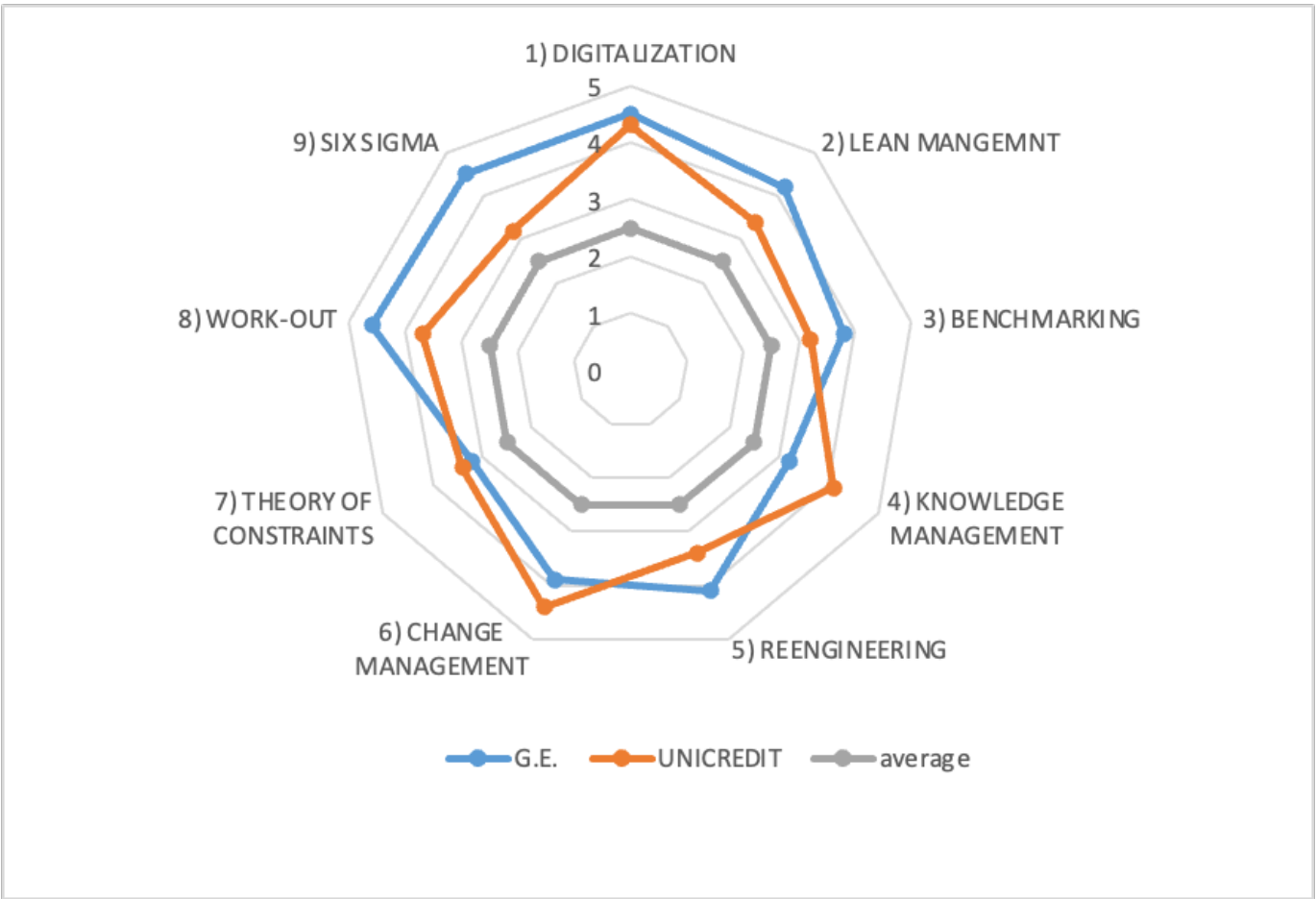

Fig. 10 – Benchmarking the result of the organization (source: our elaboration adapted from Liker et al 2008, 2022; Slack *et al.,* 2016)

The digitalization is an important strategy for both the companies. The strategy of UniCredit compared with G.E. is based on lean integrated with six sigma**.** G.E. uses a strong workout methodology; lean six sigma is a powerful business strategy for achieving operational and service excellence.

In origin, the methodology was on manufacturing but now is used also in service and transactional processes (Maiorana *et al.,* 2011).

It is important to know the internal processes and level of performance. Financial institutions are more and more competitive companies.

It is therefore essential to create a digital bank where the processes meet the new expectations on time while keeping operating costs low and there is the presence of innovation for improving speed, quality and cost-reduction based on many methodologies (see Table 11)

Tab. 11 – Important methodologies to improve the process (our elaboration from Liker, 2008, 2022; Burch, 1994, Womack et al., 1996)

	Digitali-zation	**Work out**	**Six Sigma**	**Bench-marking**	**Reengineering and Change Management**	**Theory of Constraints**
GE	****	*****	***	****	**	**
UNI CREDIT	****	*	*****	**	****	**
	Digital value chain	***Remove waste***	***Reduce variation***	***Leaning the best practice***	***Change process***	***Manage constraints***
	1. Elimina-tion of no value-adding cost 2. Software tools 3. Cloud architecture 4. ICT	1. Identify value 2. Identify value stream 3. Flow 4. Pull 5. Perfec-tion	1. Define 2. Measure 3. Improve 4.Control	1. Select the firm to compare 2. Determine the gap 3. Z Chart 4. Strategy to improve	1. The current situation 2 New vision 3 The definition of path 4 Actions to reach the new vision 5 Control and measure change with KPI	1 Identify constraint 2. Exploit the constraint 3. Subordinate processes 4. Elevate the constraint 5. Control
	Conversion of content to digital form	Variation	Flow	Learning from best	Change	Systems constraints

UniCredit application of the best methods of Six Sigma (reducing non-quality costs) and the lean methodology (waste reduction) in one approach that, with the necessary adaptations, it becomes precisely lean banking. UniCredit delivers excellent customer experience due to processes toward the customers' needs – for improving the customer satisfaction. They are important factors in defining the "best practices": industrialization of improvement, focus on processes, recognition of the efforts of the staff, quality upstream and downstream integration as quality, and visual management.

On the contrary in General Electric, the methodology Design for Six Sigma serves to determine the customer needs and process capability. G.E. implements digitalization tools, six sigma as early in the product or service life cycle as possible, especially at the design stage. The tools for DFSS (Design for Six Sigma) are: a) QFD (quality function deployment); b) VOC (voice of customer), c) FMEA (failure mode and effect analysis); d) software Cristal ball (a simulation tool).

6.2 – *Comparison of the digitalization strategies*

The results of questionnaire (see Table 8b) underline the difference on the comparison of the digitalization strategy of UniCredit and General Electric (see Figure 11). Important is the

utilization of digital model for the production and to application of improvement of the processes.

Fig. 11 – Benchmarking digital transformation critical success factors of UniCredit and General Electric (source: our elaboration adapted from Liker *at al.*, 2008, 2022; Slack *et al.*, 2016)

For long run strategy is important to plan the digital future based on a clear vision on the resources and technologies to apply for improving the results and define the needs of the customers.

Another tool used for the implementation of DFSS (Design for Six Sigma) in G.E. is the DMADIC cycle (Delgado *et al.*, 2010):

I) define,

II) measure,

III) analyze,

IV) design,

V) implement,

VI) control design to meet customer needs and process capability (Yang, 2005) based on some KPIs shown in Table 12.

Tab. 12 – KPIs for measures of performance of the process (source: adapted from Liker, 2004; Slack *et al*., 2016; Mariconda, 2022)

DIGITALIZATION	Connectivity, Digital Traffic, Artificial Intelligence Big Data Social Media Performance, Digital Technology Intelligence Digital Twin Dashboard Erp (Enterprise Resource Planning) Eam (Entreprise Asset Management) Bpm (Business Process Management) Bim (Building Information Modelling)
SUSTAINABILITY	Environmental performance Waste Economic of material (paper...) Emission CO2 Save natural resources
QUALITY	Number of defects per unit; Level of customer complaints; Scrap level; Warranty claims; Mean time between failure Customer satisfaction score
SPEED	Customer query time; Order lead time; Frequency of delivery; Actual and theoretical throughput time; Cycle time
DEPENDABILITY	Percentage of the order delivered late; Average lateness of orders; Proportion of product in stock; Mean deviation from promised arrival; Schedule adherence
FLEXIBILITY	The time needed to develop new product/service; Range of product/services; Machine change-over-time; Average batch size; Time to increase activity rate; Average capacity/maximum capacity; Time to change schedules
COST	Minimum delivery time/average delivery time; Variance against budget; Utilization of resources; Labor productivity; Added value; Efficiency

6.3 – *Lean management practices*

Lean management practices stress the concept of built core competence and eliminate waste and re-engineering (Dixon *et al.,* 1994; Hall *et al.,* 1993) by using a group of methodologies (just in time, poka-yoke, source inspection automated inspection, six sigma). The methodologies of digital transformation which permit to improve the performance are: a) Articial intelligence; b)

Big data; c) ERP (Enterprise Resource Planning), d) EAM (Enterprise Asset Management); e) BPM (Business Process Management); f) BIM (Building Information Modelling).

These methodologies are also coherent with the theory of synchronous manufacturing and the theory of constraints. The quest is to look at the problem of value creation with a global view. We can analyze the evolution during the time (see Table 13) of digital and lean transformation importance of integration of different methodologies both in G.E. and UniCredit (digitalization, lean management, sigma six, theory of constraints,). The resolutions of many problems come from rethinking how the process is organized (Goldratt, 1992; Chase and Jacobs, 1992).

Tab. 13 – The evolution of lean in UniCredit and G.E. (source: elaboration from G.E. and UniCredit repositories, 2005-2022; Majorana and Morelli, 2011; Hines *et al.*, 2004; Liker, 2008, 2022)

PHASES	I) 1950-1980 AWARENESS	II) 1980-MID 1990 QUALITY
Literature theme	Dissemination of shop-floor practices	Best practice movement benchmarking leading to emulation
Focus	JIT techniques, cost	Cost, training and promotion, TQM, process reengineering
Key business process	Manufacturing shop-floor only	Manufacturing and Materials management
Industry sector	Automotive – vehicle assembly	Automotive – vehicle and component assembly
Scholars	Shingo (1981, 1988) Schonberger (1999)	Womack *et al*. (1990); Hammer (1990); Stalk and Hout (1990); Harrison (1992)

PHASES	III) MID 1990-2000 QUALITY, COST AND DELIVERY	IV) AFTER 2000 DIGITALIZATION, VALUE SYS-TEM; TIME-BASED COMPETITION, DIGITAL TRANSFORMATION, VIRTUAL FIRMS
Literature theme	Value stream thinking, lean enterprise, collaboration in the supply chain	Digital transformation, Artificial intelligence, Big Data Virtual organiza-tion, Capability at the system level
Focus	Cost, process-based to support flow	Value and cost, tactical to strategic, integrated to supply chain
Key business process	Order fulfillment	Integrated processes, such as order fulfillment, and new product development
Industry sector	Manufacturing in general – is often focused on repetitive manufacturing	High and low volume manufacturing, extension into the service sector
Scholars	Lamming (1993) MacBeth and Ferguson (1994) Womack *et al.*, (1994,1996) Rother and Shook (1998)	Mariconda (2022); (Brown N. and Brown I. (2019); Hines *et al.* (2002); Mapingire *et al.* (2021); Hess *et al.* (2020); MIT Sloan Management Review (2019)

In UniCredit and General Electric there is the application of an integration of digital and lean management tool for improving the quality and reduce the cost and the time of the processes.

7 – Conclusions

In this paper, we investigate how to use digitalization and lean methodology for improving the results. Lean thinking philosophy is the main guiding tool for a digital transformation process. The cases show the benefits of digitalization and lean sigma six implementations for lowering the operational cost, improving process and product quality, and efficiency with an increase in productivity.

7.1 – *The differences between the organizations*

Concerning the first research question: "***RQ1:*** *What are the analogies and differences between the two strategies of digitalization, business process improvement, and lean management of UniCredit and General Electric ?", w*e discover:

A - FIRST - UniCredit and General Electric have a similar evolution of the implementation of methodology based on a longitudinal evolution of the methodology applied (see Table 13). Both G.E. stress the importance of an integrated set of tools for process improvement, digitalization, and lean management.

There are some general differences in the application and importance of some important methodologies and tools (see Table 14).

Tab. 14 – The comparison of implementation of tools

	TOOL BENCHMARKING FACTORS FCS	UNICREDIT	GENERAL ELECTRIC
1	DIGITALIZATION	****	****
2	LEAN	***	****
3	SIX SIGMA	***	*****
4	BENCHMARKING	***	****
5	KNOWLEDGE MANAGEMENT	****	***
6	REENGINEERING	***	****
7	CHANGE MANAGEMENT	****	*****
8	THEORY OF CONSTRAINTS	***	***
9	WORK-OUT	***	*****
	Likert scale (1-5) – Levels : ***** **HIGH,** *** **AVERAGE** ***LOW**		

Our findings show how G.E. and UniCredit have some differences in strategy and management tools to improve process performance by application of digital and lean tools. In

G.E. there is a strong use of work-out methodology with integration with lean six sigma strategy and the quality control; data analysis permits to improve efficiency and data quality, and the elimination of waste. On the contrary, UniCredit uses universal expertise in Lean and Six Sigma to provide the latest and most effective tools, materials, and information, and build strong relationships with our customers by continuously improving practices and skills.

On the contrary, the main strategy elements of lean management in UniCredit are: a) culture based on a set of principles (customer first, improve the processes, cooperate, and connect, managing risk, focus on execution); b) importance on both cost reductions and customers satisfaction; c) the use of process management; d) avoid waste in the bank and financial service; e) strong integration between lean and six sigma.

B - SECOND - For G.E. the lean strategy is based on *digital value stream* analysis (see Figure 12). The main strategic actions are: a) the implementation of a set integrated of processes (CTQ, analysis of the defects, process capacity, control of variation); b) the use of CAP (change acceleration process); c) the quality control of processes and lean week, d) use of Design for sigma six (DMAIC). GE's lean strategy is based on classic phases of sigma six lean management based on standard Motorola lean strategy.

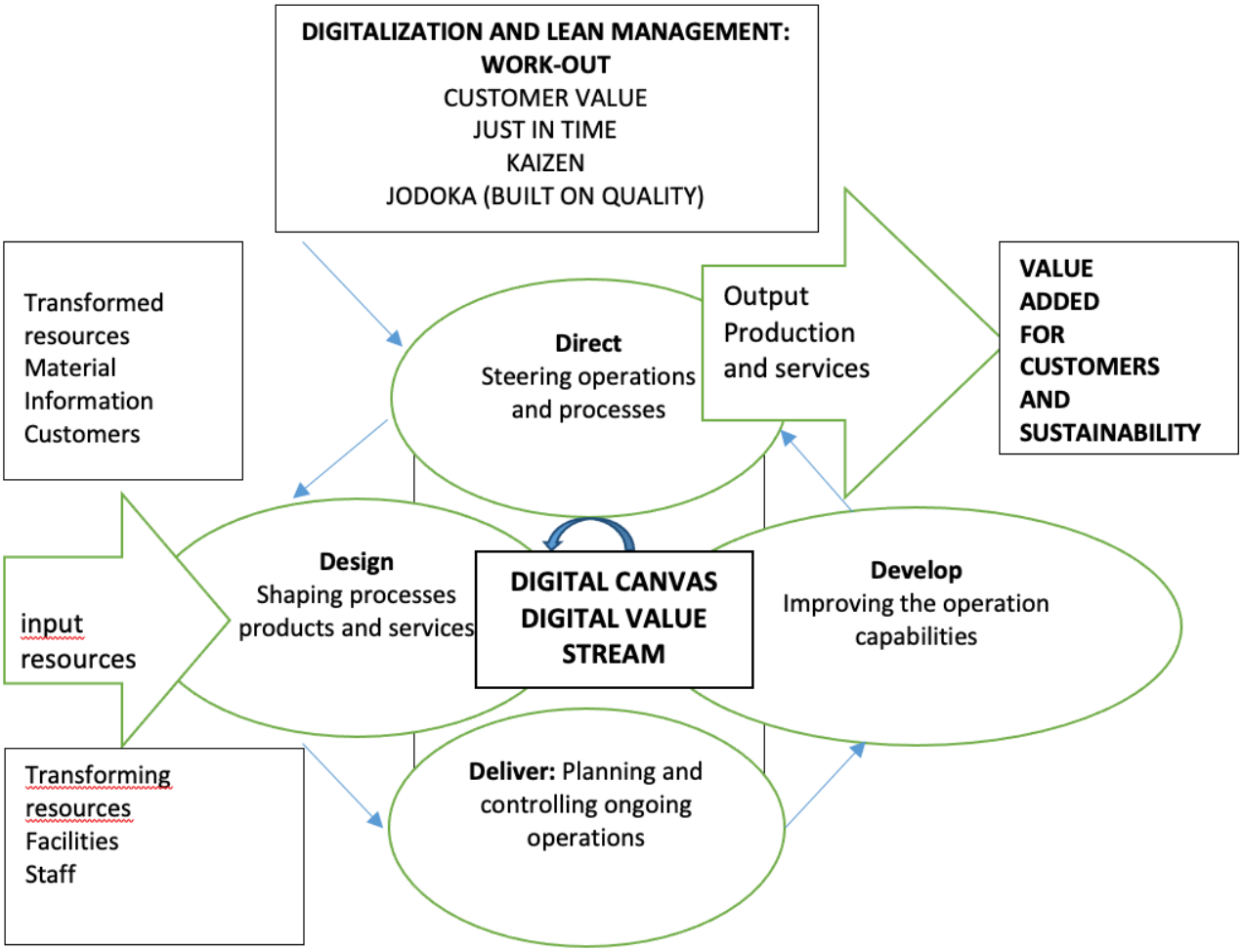

Fig. 12 – Digitalization and Lean operation strategy general framework (source: adapted from Liker 2008, 2022; Slack *et al.*, 2016).

C - THIRD - The answers to the first question are consistent with past studies (Porter and Heppelmann, 2014, 2015; Ohno, 1988; Womack *et al.*, 1996, Ramarapu *et al.*, 1995; Prater *et al.*, 2001; Pilotti and Riva, 2018, 2019, 2021; Pilotti and Rinolfi, 2022; Mella, 2021a,b; 2005; 2012; Senge, 1999; Kaplan and Norton, 1996, 2001, 2004a, 2004b; Deming, 2000) and underline the benefits of a strategy for using the new technologies and integration of digital and lean methodologies: IOT (Internet of Things), Artificial intelligence, Big Data, ERP (enterprise resource planning), EAM (enterprise asset management); BPM (business process management); BIM (building information modelling).

7.2 – *The importance of integration of methodologies*

Concerning the second research question: "*Why are the critical success for digitalization, business process improvement, and lean management?", w*e discover:

A - FIRST - G.E. and UniCredit company tend to adopt the original Toyota production system and manufacturing philosophy pioneered by the Japanese engineers Ohno and Shinto. In lean management, there is a systematic approach to a problem, and it underlines the importance of learning activity and a smart control system based on innovation and *kaizen actions* of improvement based on long-term commitment. It is important the integration of many methodologies (see Table 15). *J*ust-in-time production methods are a key element of lean production. Also, the lean methodologies can be applied in many sectors (world-class benchmarking) (Porter *et al.*, 2014, 2015; Riva and Pilotti, 2017, 2019a, 2021b).

Tab. 15 –The integration of a mix of methodologies (source: our elaboration adapted from Porter *et al.*, 2014, 2015; Goldratt, 1984; Slack *et al.*, 2016)

	DIGITALIZA-TION	**THEORY OF CONSTRAINTS**	**SIX SIGMA**	**LEAN MANAGEMENT**
Objectives	Digital transformation	To increase profit by increasing the throughput of processor operation	Identify who the customers are; determine the needs of those customers;	To increase profit by adding value from the customer's perspective
Measure and target	1) Conversion of the contest into digital form 2) Cloud architecture 3) Change in process and services	1) Throughput 2) Inventory 3) Operating expense	1) Translate those needs into our language (the language or organization); 2) Optimize the product features to meet customer needs	1) Cost 2) Throughput time 3) Value-added 4) Efficiency
Strategy to improve	Focus on how value can be created and	Focusing on the constraints the	Quality control develop a process	Eliminating waste ad adding value

	exploited using digital technologies	'weakest link' in the process	that can produce the product	by considering the entire process
Method	Creation of a digital data platform Employ artificial intelligence Digital revision of the firm's operation and business model	A five-step, continuous process Emphasizing acting locally	Improvement prove that the process can Produce the product under operating conditions. transfer the process to operations.	Continuous improvement emphasizing the Whole supply network

B - SECOND - Lean methodology integrated with digital strategy improve the strategy and the control of business process. The important result is that *Lean Thinking Philosophy* can be the main guiding tool for a *Digital Transformation process* (see Figure 13).

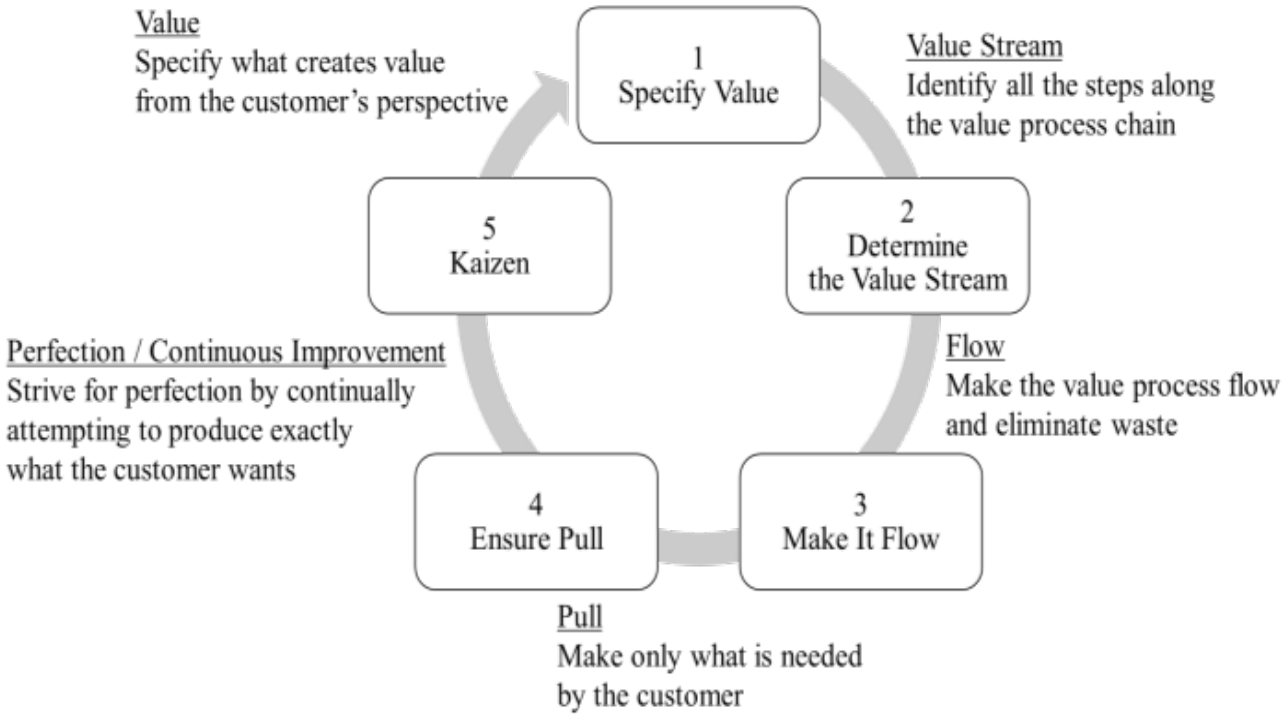

Fig. 13 – Lean management philosophy as strategy general framework for digital transformation (source elaboration from adapted from Liket, 2004; Romeo *et al.,* 2019; Slack *et al.*, 2016)

It is important to have a strategy that is based on breakthrough and continuous improvement (see Table 16) for permitting a continuous creation of innovative ideas (Deming, 2000; Drucker, 1998; Gazzola *et. al.*, 2020).

Tab. 16 – Features of breakthrough and continuous improvement (Elaboration from Imai, 1986; Deming, 2000)

DIMENSIONS	BREAKTHROUGH IMPROVEMENT	CONTINUOUS IMPROVEMENT
Effect	Short-term but dramatic	Long-term and lost-lasting
Pace	Big steps	Small steps
Time-frame	Intermittent and non-incremental	Continuos and incremental
Change	Abrupt and volatile	Gradual e constant
Involvement	Select a few 'champion'	Everybody
Approach	Individualism, individual ideas, and effort	Colletivism, group effort, system approach
Stimulus	Technological breakthroughs, new inventions new theories	Conventional know-how and state of art
Risk	Concentred- 'All eggs in one Basket'	Spread- many projects simultaneously
Practical requirements	Requires large investment but Little effort to maintain it	Requires little investment but great the effort to maintain it
Effort orientation	Technology	People
Evaluation criteria	Result for profit	Process and efforts for better results

C - *THIRD* - The use of a system of control (obeja room) (see Figure 14) permits to analyze of the performance and the control of the results (Ohno, 1988; Womack *et al.*, 1990; Mella, 2014, 2020, 2021a,b; George, 2003; Deming 2000; Riva and Pilotti 2021a,b; Gazzola *et al.*, 2020; Preite, 2000; Mariconda, 2022).

Fig. 14 – Obeya Room for control the change strategy for Digitalization and Lean transformation framework (source: adapted from Deming, 2000; Liket, 2004; Romeo *et al.*, 2019)

A Six Sigma can also help to control the level of quality of the processes; this methodology started in the manufacturing industry and was developed by Motorola in the 1980s and after Jack Welch Ceo of General Electric has used to improve the strategy. Also, the culture for continuous improvement and respect for the persons and the main dimension of improvement (Liker, 2008, 2022) (see Figure 15).

Fig. 15 – The importance of continuous improvement and respect for the people (source: Liker, 2008, 2022)

D - FOURTH, The answers to the second question are consistent with past studies (Ohno, 1988; Porter and Heppelmann, 2015, 2015; Womack and Jones, 1996; Karlsson and Åhlström, 1996; Delgado *et al.*, 2010; Pilotti and Riva, 2018, 2019, 2021; Mella, 2012 ,2015a,b, 2021b; Gazzola and Mella, 2003, 2006, 2017; Pilotti e Ridolfi, 2022; Simon,1995; Kaplan and Norton, 1996, 2001, 2004a, 2004b; Riva, 2006, 2007a,b; Paiola, 2018; Deming, 2000) and underline the importance of integration of many tools.

The case of G.E. and UniCredit shows the importance of digital transformation and lean as a methodology of change and as tools for the reduction of costs. It is important to combine digital and lean operations by the transfer best practices for delivering continuous excellent customer service.

7.3 – *The potential area of application of digitalization and lean management*

The original contribution of this paper (*highlights*) and the production of new knowledge in the field are:

I) *the original description and comparison of two leaders' companies;*

II) *to give a new practical framework for strategic implementation for analyzing the methodologies for digitalization, process improvement, and lean management with many applications* (see Table 17);

III) *a comparison of the difference and analogies in strategic implementation of process improvement by digitalization and lean management.*

Future research can study the relationship between digitalization and process improvement using artificial intelligence and big data.

In summary, the application of digitalization and lean strategy in UniCredit and G.E. can be a model of positive implementation of processes improvement also for other companies.

Tab. 17 – Applications of digitalization and lean management in many processes (source our elaboration)

	Potential Areas where Integration of Digitalization and Lean Management has been developed
BANKING	Virtual banking, control of number of processing errors, number of customer complaints received per month, number of ATM breakdowns, duration of ATM breakdowns, etc.
HEALTHCARE	The proportion of medical errors, time to be admitted to an emergency room; number of successful surgical operations for a week, number of wrong diagnoses, waiting time to be served at the reception in a hospital, etc.
ACCOUNTING E FINANCE	Payment errors, invoicing errors, errors in inventory, inaccurate report of income, inaccurate report of cash flow, etc.
PUBLIC UTILITIES	Late delivery of service, number of billing errors, waiting time to restore them after a fault has been reported, the call center of the utility company, etc.
SHIPPING AND TRANSPORTATION	Wrong shipment of items, wrong shipment address; late shipment, wrong customer order, etc.
AIRLINE INDUSTRY	Baggage handling, the number of mistakes in the reservation; waiting time at the check-in counter, etc.

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