

Assessing the role of knowledge management to enhance or prevent digital transformation in SMEs: critical knowledge factors required.

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Abstract—The 4th industrial revolution or Knowledge Age enhances the transition to knowledge-driven organizations that rely on data, technologies and learn how to manage all the variables involved in their digital transformation (DT). How should firms manage their knowledge during their DT is an underdeveloped research issue, especially in the SMEs' context. Employing a mixed inductive-deductive approach, this multiple case-study of 35 SMEs tries to shed light on which are the critical knowledge factors required to support and hinder DT in SMEs' context.

Keywords—Digital Transformation; SME; Knowledge Management; Critical Knowledge Factors; multiple case study

I. INTRODUCTION

The evolution from the “Information Age” to the “Knowledge Age” relies on knowledge-intensive organizations, breeding knowledge workers [4 – 8], and growing a knowledge-based culture. To follow these attempts, information technologies represent a core factor enabling knowledge management innovation [6] and possibly allow a broader IT-enabled transformation.

Nowadays the debate switched from this IT-enabled transformation to the so-called digital-enabled transformation. DT is a more holistic and comprehensive concept that involves not only technologies and business models, but also organizational changes in terms of leadership, strategy, structures, processes, and culture [20].

The knowledge management function has been revamped in the digital era, through the proliferation of the Internet and information technology in all aspects of doing business [4].

Furthermore, considering the past literature, KM has been the subject of extensive theoretical and empirical researches, primarily focused on the study of large corporations. Thus, the extensive body of KM research neglected the study of smaller sized enterprises [4].

To provide insights on KM in the context of a digital organizational transformation, this research focuses on the role of KM in SMEs' DT. We try to shed light on the critical knowledge factors required to encourage or retard DT in small firms using a multiple case study of 35 Italian SMEs.

The paper is structured as follows. We begin section 2, by reviewing some of the literature on DT and KM. In section 3, we present the methodology and the empirical setting by

providing rich information on the cases involved in this study and their digitalization paths. In section 4, we present the results of our analysis and the critical knowledge factors that emerged in DT projects. Eventually, in section 5, the discussion of the cases leads to our conclusions and future research opportunities.

II. THEORETICAL FRAMEWORK

Thanks to the growing importance of knowledge in the business environment of the digital era, the topic of KM increasingly became a subject of interest to scholars and managers [17]. Indeed, technological innovations represented an accelerator for KM issues, since firms are progressively required to develop new knowledge bases or recombine their existent knowledge in different ways [6].

Although technology can boost KM, [19, p. 3] acknowledge that “technology alone should not be the primary driver for any KM projects/initiatives, and an appropriate balance of *technology, process, people* and *content* is instrumental to the continued success of any KM deployment”. Thus, in the digital era, knowledge-driven organizations cannot simply rely on their technologies to reach an appropriate KM, as far as several different aspects involved in digital transformations can represent a driver too.

First, the literature on KM underlines the increasing importance of *process*-based knowledge management [19]. Hence, knowledge that flows within organizational processes can be formalized thanks to business process mapping to foster efficiency and give insights to improve organizational processes. This contributes to knowledge management activities because process formalization provides a baseline for measuring signs of progress, helps to find critical information quickly, and enhances organizational learning [18]. Additionally, the literature on DT underlines that business process formalization and optimization can be strongly enhanced by digitalization [10 – 20].

Furthermore, in the new economy, the achievement of a long term competitive advantage relies on a firm's capacity to develop its *human capital* or “people-embodied know-how” because people's knowledge and skills are central to digitalization [17 – 15]. To this extent, technologies are pivotal in mapping know-how and operating knowledge

management by organizing and distributing information to and from employees.

Digital solutions can also boost socialization, knowledge sharing, and stimulate innovative thinking [18]. Indeed, a solid organizational knowledge infrastructure needs to be supported by a *knowledge-sharing culture* combined with IT-based KM Systems and other ICTs, to build an organizational memory [6] which can foster a DT.

Moreover, in the digital era, knowledge affects and is also influenced by the *competitive environment*, since inter-firm networks can decrease the informative asymmetry towards DT, allowing knowledge sharing and circulation [16 – 5].

Overall, knowledge represents the main firm's *strategic resource* which drives the decision-making process [1 – 4 – 24], and particularly in the context of DT, knowledge increases when framed in a convincing (digital) strategy [12 – 2]. Indeed, in terms of digital strategies, literature refers to two novel concepts of strategy [20]: digital business strategy or DBS [2], and digital Transformation Strategy or DTS [12] that can lead also to the redefinition of a firm's *business model*.

Eventually, despite the considerable advancements in our understanding of DT phenomenon, a significant gap between digital knowledge management and SMEs' business realities persists [4] and academic efforts to explain it are met with limited success. Moreover, traditionally literature on KM tend to focus on one or a few specific aspects related to KM, and little literature efforts are available in adopting a holistic/systemic approach in trying to understand all the different aspects related to KM in the context of DT.

As a matter of fact, knowledge management plays a pivotal role in enabling or hindering DT in SMEs, therefore *the extent of this research is to study which are the critical knowledge factors that enhance SMEs' chances to develop a successful digital transformation*.

III. METHODOLOGY

A. The digital transformation in Italian SME: the National Plan for Industry 4.0 and the role of "PID"

Italy has recently developed a National Plan for Industry 4.0¹, which comprehends a wide range of measures to help Italian companies to decrease their informative asymmetry towards DT.

The National Plan provides the establishment of specific structures called "PID", i.e. "Digital Enterprise Point" located in the Chambers of Trade with the specific purpose of orientating Italian organizations in developing digital capabilities. During the past two years (2018-2019), Verona's PID and University have drawn up together a project called "Enterprise 4.0" to facilitate the DT of a hundred of SMEs of the province, which the Chambers of Trade financed for €1 million (funds from Ministry of Economic Development).

The project provided a learning path articulated into 20 focus groups on specific digital issues and the development of a tailored-project of digitalization for all the SMEs.

Among 100 tailored-projects, 35 regard issues related to digital knowledge management in SMEs' business context and focused on business process mapping through BPM formalism to improve SMEs' management of individual and collective crucial knowledge, find inefficiencies or change the business information system.

B. Research methods and empirical settings

In order to answer our research question, we employed a qualitative approach, employing multiple sources of evidence [21] like participant observations, semi-structured interviews, field notes, and so forth (see Table 1).

In terms of the empirical setting for data collection, we focused on SMEs, which represent the economic backbone of most industrialized countries contributing in terms of job creation to the economic and social growth of a nation.

To develop the above-mentioned "Enterprise 4.0" project each company have been actively supported by an academic task force for about 600 hours in order to develop its tailored digitalization project. Moreover, within a year, 20 focus groups on DT had been realized for the companies that took part in the "Enterprise 4.0" Project.

Thanks to this activities, we collected data on the organizational DT of 100 SMEs and this paper bases its findings on a subset of 35 organizations that developed a tailored digital project aimed to improve SMEs' management of individual and collective crucial knowledge regarding DT. Therefore, we develop a multiple case study research based on 35 organizations which exhibited heterogeneous experiences in term of digitalization.

The enterprises belong to various business sectors (following ILO classification) such as: agriculture, food, graphical sector, construction, leather sector, commerce, services, mechanical engineering sector, electric engineering sector (see Appendix A).

Relating to the dimension of those enterprises, according to ISTAT (Italian National Institute of Statistics) standards, the 74% of the organizations are micro-sized companies (below 2 mln/€ revenues and below 10 employees), 24% are small-sized companies (below 10 mln/€ revenues and below 50 employees), and 3% are medium-sized companies (below 43 mln/€ revenues and below 250 employees).

For the multiple case study research, we employed within-case and cross-case analysis techniques [25]. We compiled detailed descriptions of each case to look for patterns in the interviews and revisited the data multiple times, using tables to facilitate between-case comparisons [21]. We then compiled detailed descriptions of each case.

In the next phase, we conduct a preliminary unstructured analysis using a deductive theory-driven coding in which the literature review about DT was employed in order to understand which are the main "initial" categories [21] of DT-enabling and hindering factors related to KM e.g., [20]. In detail, we employed the following categories: processes, culture, technologies, structures, strategy, business models, leadership [20] and we grouped codes regarding each observed factor in several categories.

¹ The National Plan for Industry 4.0 supported a project for the digitalization of Italian SMEs by allocating specific resources to the Chambers of Trade. The relevant government decree of May 22,

2017 was published in the Official Gazette and is available at <https://www.gazzettaufficiale.it/eli/id/2017/06/28/17A04352/sg>

Eventually, to triangulate our findings, we reviewed available secondary data (including company websites, management reports, and other company documents) for all the companies involved in the project.

TABLE I. DATA SOURCES

Collected Data	Number	Note
Start event	1	The Project has been presented to all the companies during the 3-days event focused on digital transformation topics.
Interviews	119	The interviews comprised informal interviews, collected during a visit to the firm's headquarters to discuss the focus of the project, and direct observation of the firm activities.
Follow-up	57	About half of the interviews were followed by other follow-up activities (mostly for the more complex projects).
Final meeting	100	Each project had been closed and discussed with the company tutor and academic researchers.
Focus group	20	Within a year, 20 focus groups on DT had been realized for the companies that took part in the "Enterprise 4.0" Project.
Dissemination events	5	Local dissemination activities on DT in the five main areas of Verona.
Notes from the direct observation	63 pages	Several notes were taken during interviews, follow-up activities, and direct observation of the organizations.
Internal documents	35	Before the interviews, there was a chance to analyze the results of the digital-maturity assessment made by the Chamber of Trade for each organization.

IV. RESULTS

In this section, the preliminary results on the 35 cases are presented around the observed *research themes* relating to KM and DT of SMEs [20]: processes, organizational culture, technologies and infrastructures, strategy, business models and leadership.

Moreover, also direct quotes from participants are included to provide a richer interpretation of pertinent findings.

A. Processes

Nowadays, one of the main problems for the majority of the organizations is to find the best way to capture, share, retain, and reuse their knowledge [6].

The urgency of codifying organizational knowledge (particularly process-based knowledge) to foster DT [10] was generally understood by the SMEs' managers who participate to "Project Enterprise 4.0", since their firm's *business processes* were mostly still unformalized and rely on routines and practices (i.e. tacit knowledge).

Firm "AI" stated: *"the idea to formalize our knowledge is an idea towards which we have been directed from the beginning. We understand that coding the information is important also for a small organization because it allows you to grow faster since you're already structured in the processes as a larger firm"*.

Indeed, a significant gap between the desired level of organizational knowledge formalization and SME's business realities persists, therefore in several cases, organizations need to focus on process mapping through BPM formalism to improve internal awareness of individual and collective crucial knowledge, find inefficiencies and redundancies, and map the information flows.

Firms' knowledge-assessing maps can boost communication among workers, increase internal analysis,

promote internal knowledge standardization, business process simplification and progress measurement for improving the decision-making process.

Focusing on the process-enabled DT, we noticed that a boosting factor towards DT dealt with the internal analysis level: organizations with already formalized processes or with good managerial control (performance audit, business intelligence, and so forth), move faster towards the formalization of a robust digital strategy.

B. Organizational Culture

Furthermore, from workers' point of view, a positive attitude towards information sharing was registered only between some SMEs, while in others *cultural resistance to digital change* and organizational informative silos still persists, even if they were slowly decreasing.

Since knowledge is the most important resource for innovation within companies and since innovation is driven by the knowledge possessed by the firm's employees [23], with their attitude, the firm's employees can welcome DT or raise barriers that can hinder the process by affecting internal motivation towards this theme.

On this firm "AF" affirm: *"Although we try to let information circulate as much as possible within our company, we have experienced resistance to change from our employees. Some people felt the technology was not as an information driver but as a driver of control over their actions."*

We noticed that in many organizations (19 over 35), the promotion of DT was slowed down by cultural resistance to change that was found at any level of the organization, both managerial level and operational level.

Conversely, in other firms where resistance to change was not registered, DT projects run faster.

This scenario is in line with the results of [4, p. 285], stating that "non-standardized processes are likely to be strongly linked to poorly implemented technology and a culture that perhaps is still working in silos and thus the management of knowledge is not considered to be owned by the knowledge-driven workers".

C. Technologies

Technologies can help in building organizational memory, a solid organizational knowledge architecture integrating collective knowledge in a shared environment [6]. To this extent, ICTs, especially KM systems, can help by providing information standardization and transfer, and redesigned activity flows [13].

Overall, SMEs show to own these KM-enabling technologies. When these KM systems are distinct from each other and not aligned with defined business processes, users may have to operate separate systems in order to accomplish their tasks [19]. Among 35 SMEs, one of the main drivers of DT consists in the optimization of the firm's KM systems. To this extent, the above-mentioned business process mapping was used also to portray constraints, and sinks (losses or stopping points) of knowledge within the firm [18] to optimize KM systems.

Firm “Z” stated: *“to solve the problem of information sharing, we are now implementing a new software that is a system of storage of all business data. Now we are in the installation phase and we are working on loading historical data and updating the system”*.

In general, some firms highlighted more difficulties with the alignment of their KM systems often caused by cultural resistance to change. Conversely, other digitalization projects focused on improving this alignment to obtain fluid knowledge management (allowing generation, codification, and transfer of knowledge asset).

D. Infrastructures

Eventually, from the point of view of *public infrastructures* enabling digitalization (e.g. optic fiber), the underinvestment in infrastructures has been highlighted by 6 companies located far away from the main industrial zones.

Firm “S” explained: *“In this territory we don’t have any access to optic fiber, which would be extremely important to manage rapidly the enormous amount of data originated by our architecture Industry 4.0. For this reason we are forced to consider moving our industrial installations elsewhere to be able to manage our data and information”*.

Indeed, as far as KM is a strategic factor that refers to creating, sharing, using and managing the knowledge and information both within an organization and across organizations [5], this lack of digital infrastructures clearly negatively impacted on the use of KM-enabling technologies and on DT of firms in general.

E. Strategy and Business Models

In terms of strategic responses to DT, organizations should exploit and expand their knowledge by consolidating their digital strategy [12 – 2], in terms of DBS [2] or DTS [12]. While DBS describes “desired future opportunities and strategies”, DTS represents a blueprint supporting companies in governing transformations that arise from the integration of digital technologies, as well as in their operations after a transformation and can lead to the *business model* redefinition.

Indeed, relating to the exploitation of knowledge to develop a clear *strategy*, and to the concepts of DBS and DTS, a clear division emerges between firms’ digital transformations. Some cases highlight a clear DBS or even a more complex DTS which, in some cases led to a new *business model* adoption.

For example, the shareholder of company “Z” stated: *“In this competitive scenario, we decided to differentiate by introducing very advanced types of tools in order to adapt to digital transformation. Thanks to this choice not only our clients but also many competitors often ask us to develop difficult projects for their clients, which they couldn’t do with their standard equipment”*.

Other cases show just a proactive behavior towards digital understanding without any ability to exploit knowledge in order to shape a clear strategy. In some cases, we also spot the evidence of the absence of a digital strategy and the adoption of a mere mimetic isomorphic behavior towards DT [9]

Relating to the absence of a clear strategy company “M” stated: *“we don’t have any specific digitalization strategy, for us it is still premature to talk about digital, we are not ready.”*

F. Leadership

As technological innovation boosts organizational change and adaptation, it introduces also the redefinition of existent roles [3]. Preliminary results highlighted that the definition of a digital strategy was promoted thanks to the long-term vision of a key organizational figure, the Digital Leader (DL). Among the observed SMEs, the DL figure isn’t a new managerial and recognized position, and can be covered by managers, owners or even key-employees that foster digital knowledge and encourage digitalization paths inside organizations.

Relating to the DL figure the shareholder of firm “AF” told us: *“I’m the digital leader. I come from the IT sector and therefore I know what it means to bring digitization within the company. It is necessary to involve all employees to ensure that everyone accepts the challenge and put themselves in the conditions to learn”*.

V. DISCUSSION

The preliminary results on the 35 cases highlighted that in many firms, an important trigger that has promoted DT had been information sharing: many organizations undertook digital actions aimed at improving cross-organizational information exchange.

Integrating internal and external knowledge sharing and dissemination by formalizing existing knowledge affect positively in internal communication within the organization by removing information asymmetries and redundancies. Moreover, formalizing existing knowledge thanks to BPM formalism helped also to face generational turnover within the organization.

Therefore a critical knowledge factor promoting DT is related to higher levels of process management. This result is in line with a recent study by [10] that shows how a clear and coherent DT is underlined by firms that digitally transform their processes.

Moreover, in SMEs context, among the enabling and hindering factors towards DT we find that cultural resistance to change slows down the process of formalizing internal knowledge that is often the focus of SME’s DT projects.

Moreover, SMEs seem to own all the KM-enabling technologies needed to collect and manage their organizational memory but their integration still represents a critical factor which, when controlled, can enhance organizational KM and foster SMEs’ digitalization. Conversely, the institution’s underinvestment in infrastructures negatively impacts both on KM-enabling technologies and in SMEs’ digital transformation. Furthermore, results highlight also how the institution’s regulatory impositions, programs, or incentives can boost digital knowledge.

Knowledge represents the primary firm’s *strategic* resource driving the decision-making process [1 – 4 – 24], and the preliminary results evidenced that a digital

transformation projects that isn't supported by a SME's convincing digital strategy (DBS or DTS) hardly and rarely starts and is shared and supported by workers.

Indeed, our preliminary results shows that, a new role such as the Digital Leader emerged among SMEs, and contributes in the development of the digital strategy and in fostering digital knowledge.

VI. CONCLUSION

The knowledge stock owned by a firm depends on several factors that can enhance its chances to develop a successful digital transformation.

Our preliminary results suggest that in SME's digital projects the KM affects and is affected by the digital strategy and is deeply linked with long-term digital leadership.

Moreover, a solid organizational knowledge infrastructure needs to be supported by a knowledge-sharing culture, relies on formalized processes, requires integrated KM-enabling technologies and up-to-date and extended infrastructures.

Since the extensive body of KM research has primarily focused on the study of large enterprises, this study contributes in understanding the way in which micro, small and medium-size enterprises conduct knowledge management while developing a digital transformation. In particular, the research underlines some critical factors related to a successful KM which SMEs that are dealing with DT, have to oversee.

From an empirical standpoint, this study encourages institutions to invest in infrastructures and to provide resources or programs for removing information asymmetries on digitalization. Besides, the research enhance the debate proposing SMEs the implementation of management practices aimed to pursue digitalization by raising their knowledge around the above mentioned factors.

VII. LIMITATIONS AND FURTHER RESEARCH OPPORTUNITIES

Due to its exploratory nature, this study has limitations that can open several avenues for further research. Firstly, within different national or regional contexts, a similar explorative analysis can highlight other critical knowledge factors required in digital transformations. Then, further research can also focus on specific sectors or company size.

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APPENDIX A: CASE STUDIES. SOURCE: OUR ELABORATION

Case	Dimension	Industrial activity (ILO Classification)	Date of establishment	Annual turnover	n° employees
A	micro	Services	1987	€ 1.800.000	19
B	micro	Commerce	2009	€ 1.000.000	1
C	micro	Services	2017	€ 141.000	1
D	small	Services	1920	€ 2.043.371	46
E	micro	Mechanical Engineering Sector	1974	€ 2.700.000	9
F	small	Commerce	2001	€ 12.000.000	37
G	small	Commerce	1950	€ 3.000.000	11
H	micro	Services	1997	€ 550.000	5
I	micro	Mechanical Engineering Sector	1990	€ 925.160	13
J	micro	Commerce	1990	€ 2.600.000	5
K	micro	Food	2003	€ 5.000.000	7
L	micro	Food	2000	€ 500.000	10
M	micro	Graphical	1970	€ 200.000	3
N	micro	Services	1999	€ 60.000	0
O	small	Agriculture	1983	€ 10.000.000	21
P	micro	Agriculture	2016	€ 30.000	0
Q	micro	Agriculture	2016	€ 1.000.000	5
R	small	Commerce	2002	€ 6.000.000	14
S	small	Commerce	1966	€ 20.000.000	20
T	micro	Construction	1987	€ 1.800.000	16
U	micro	Graphical	1995	€ 2.000.000	11
V	micro	Services	2018	€ 34.000	0
W	micro	Electric Engineering Sector	1984	€ 500.000	5
X	micro	Mechanical Engineering Sector	1974	€ 1.457.078	8
Y	micro	Commerce	1960	€ 433.000	3
Z	micro	Services	1989	€ 700.000	7
AA	micro	Services	2017	€ 100.000	0
AB	micro	Services	2017	€ 100.000	2
AC	small	Commerce	1987	€ 4.296.600	13
AD	micro	Mechanical Engineering Sector	1990	€ 930.000	9
AE	micro	Mechanical Engineering Sector	1970	€ 600.000	4
AF	micro	Service	2000	€ 3.900.000	8
AG	small	Textile, Clothing, Leather, Footwear (TCLF Sector)	1998	€ 9.800.000	26
AH	medium	Commerce	1945	€ 65.000.000	130
AI	micro	Food	2014	€ 550.000	15