

Employee skills and digital transformation: preliminary insights from a case study

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Abstract

Recent technological innovations are reshaping the work-life and the workplace. Advances in automation and information and communication technology (ICT) drove scholars to identify the skills required for a competitive workforce. We analysed empirical data, collected from a multinational firm, through the lenses of the situational awareness approach, with the aim of investigating managers' awareness about the relevance of digital skills to undertake a digitalization processes and whether this awareness differs across departments within the same organization. This study leads to three main contributions: (i) managers consider it essential to have a clear digital strategy in order to undertake digital transformation initiatives; (ii) managers consider it quite relevant to implement proper training initiatives both for acquiring and maintaining DS inside the organization and for fostering informal learning among senior experts and new employees; (iii) regardless of the business department, managers are often not properly aware of the DS required for a digital transformation process.

Keywords: digital skills, digitalization, digital transformation, managers' awareness, situational awareness

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1. Introduction

Recent technological innovations are reshaping the work-life and the workplace (Carillo et al., 2017; Soulé and Warrick, 2015; van Laar et al., 2018). Advances in automation and information and communication technology (ICT) pushed scholars to identify the skills required for a global, competitive workforce (van Laar et al., 2019a). The European Commission and the Organisation for Economic Co-operation and Development (OECD) (2017) highlight the importance to: (i) identify and develop the right skills to get the most from the individual markets and digital economy (Ferrari, 2012); (ii) “equip workers with the right type of skills to successfully navigate through an ever-changing, technology-rich work environment, and give all workers the opportunity to continuously maintain their skills, upskill and/or reskill throughout their working lives” (Grundke et al., 2018).

Competitiveness and innovation lie in the skills and capabilities of the workforce (Coff and Kryscynski, 2011). Indeed, the ability of a firm to remain competitive also during uncertain time is largely due to the capacity of its employees to update previous skills and acquire new ones (Araújo and Pestana, 2017; Bhattacharya et al., 2005; Carleton, 2011; Marchiori, 2009). Therefore, organizations are looking for highly skilled workers who are able to deal with increasingly interactive and complex tasks and to quickly adapt to the changing environment (Karimi and Walter, 2015). This means that employees need to have excellent technical preparation and skills enabling them to face changes (Ahmad et al., 2013; Carnevale and Smith, 2013). To carry out an appropriate digital transformation process, in particular, employees need to have or acquire the adequate Digital Skills (DS) (Curtarelli et al., 2016) and the organizations should support them in learning or improving their competences (Kamisah, Osman et al., 2009). For this purpose, it becomes quite relevant to recognize a suitable set of DS. Van Laar et al. (2017) identify a list of DS required by the current competitive environment, making them a benchmark for the competitiveness of workers and organizations. The selection of DS that are really needed by the organization for developing a digital transformation process becomes crucial at both operations and managerial level (Benaroch and Chernobai, 2017). This selection process is affected by managers’ awareness concerning both the digital transformation key issues (Fitzgerald et al., 2013) and the resources and competences needed for undertaking the digital changes (Karim and Hussein, 2008; Mcarthur et al., 2012; Moeini and Rivard, 2019). In order to explore managers’ perception and awareness, we used the conceptual lens of the Situational Awareness (Molla et al., 2015), defined as “the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future” (Endsley, 1995) and often adopted to explore the dynamics of the decision-making process (Endsley, 2015).

The aim of this work is to investigate how managers deal with the need for DS required by the digital transformation process, considering their awareness of DS, their perception about the existence of a global digital strategy as well as the need for an appropriate employee training. We examine these issues by analysing a multinational firm operating in the manufacturing sector across 18 states, collecting

evidences in three different countries: Italy, Switzerland, and Germany. The paper is structured as follows: the next section analyses the most important literature contributions in the field. The research method used to collect and analyse empirical evidence is explained in section 3. Data analysis is summarized in section 4. In the last section we report discussion, conclusions, limitations of the study and suggestions for future research analysis.

2. Literature review

In order to explore the concept of managers' awareness concerning digital skills, we will briefly review the main scholarly contributions on DS, providing a description of the taxonomy adopted for the case study analysis. In the second part of this section, we will describe the concept of awareness, the relationship between DS and managers' awareness, as well as how DS are also needed to take the appropriate decision in evaluating the specific competences required for a digital transformation process. An analytical model will be then provided.

2.1. Digital Skills

The recent developments in ICT called for the development of specific skills related to digital technologies. However, a recent study has shown that managers often do not seem to take the development of suitable DS into account and expect individual workers to develop their own skills by themselves (van Laar, E. 2019). Managers and senior executives involved in skills development do not seem to have a clear view of the importance of measuring employees' skill levels. Furthermore, they do not recognize the importance of a training program focused on DS (van Laar et al., 2019b). In such situation, rising awareness about DS within an organization should be a priority for the management (van Laar, E. 2019).

This need has been explored from different viewpoints and several taxonomies have been elaborated and tested in the last decade. Voogt and Roblin (2012) identified and explored skills that transcend the mere knowledge of specific software, and their classification include 8 different types of skills, namely: collaboration, communication, creativity, critical thinking, problem solving, digital literacy, productivity, and citizenship. Claro et alii (2012) elaborated four macro-classes of skills: ability to solve cognitive tasks through the use of ICT, skills related to higher-order thought processes, skills not related to technology (software), and cognitive abilities related to the development of employees' lifelong learning (Claro et al., 2012). Another classification is by Ferrari (2012) who identified the following digital competences: communication, collaboration, evaluation and resolution of problems and technical operations, sharing, creation of content and knowledge, ethics and responsibility in information management.

The Partnership for the 21st century (Partnership for 21st century Skills, 2008) distinguishes between three macro classes of skills, which are determined by sub-sets

of skills: (i) learning skills (communication, creativity and innovation, critical thinking and problem solving); (ii) literacy skills (literacy, media and ICT information); and (iii) life skills (adaptability and flexibility, productivity and responsibility, leadership and responsibility initiative and self-direction, social and intercultural skills).

Another classification is provided by the Assessment and Teaching of 21st Century skills (ATC21S), that, through the help of several experts, identifies four macro-classes of skills (Binkley et al., 2012): (i) ways of thinking (which includes as sub-skills: creativity and innovation, critical thinking, problem solving and decision making, learning to learn and metacognition); (ii) ways of working (which includes as sub-skills: communication, collaboration and group work); (iii) tools for working (which includes as sub-skills: computer literacy, IT and communication literacy) and (iv) living in the world (which includes as sub-skills: life and career, personal and social responsibility).

Van Laar et al. (2017) developed the most widely used classification and identified the digital aspects that should be integrated within the concept of DS. The term DS identifies the human skills that exist in the digital environment and that are essential for individual employment (van Laar et al., 2017). These skills are a combination of heuristic and technical human skill sought after in the job market. We decided to adopt van Laar et al. (van Laar et al., 2017) classification, focusing on the following 21st-century DS: information, communication, collaboration, critical thinking, creativity, problem solving, ethical awareness, cultural awareness, flexibility, self-direction, and lifelong learning.

2.2. Manager awareness and DS

Human capital is considered a source of sustainable competitive advantage, especially by combining competencies and capacity to provide solutions to managerial issues (Delery and Roumpi, 2017; Vaggelas and Leotta, 2019) and positively affecting firm performance (Crook et al., 2011). One of the managerial issues is represented by the recruitment of high-quality applicants (Coff and Kryscynski, 2011), resulting particularly crucial when organizations act in a dynamic environment or intend to undertake a digital transformation process (Karimi and Walter, 2015). In this context, an appropriate management of human capital with related digital competences could be a key to success in the digital economy (Lewis et al., 2004).

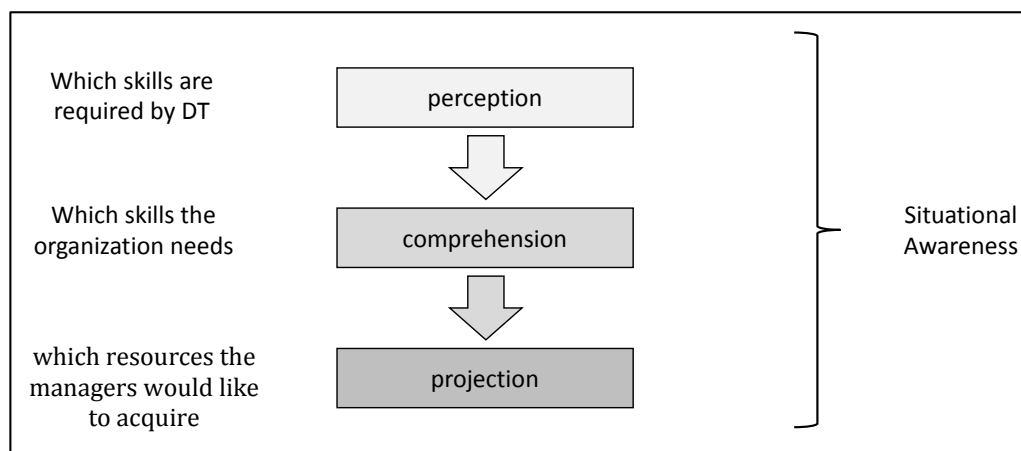
DS are strategically relevant for all employees, also for those not directly involved in IT functions (Vial, 2019). In fact, DS could be useful to improve performance at the operational level (Anthony Byrd et al., 2006) as well as for solving complex business problems (Dremel et al., 2017). DS are also crucial for managers and board members, to properly address IT governance issues (Benaroch and Chernobai, 2017).

Therefore, managers' perception about key issues concerning the digital transformation process seems to be particularly relevant (Fitzgerald et al., 2013), as well as the way managers perceive the resources and competences needed to undertake these digital changes (Karim and Hussein, 2008; McArthur et al., 2012;

Moeini and Rivard, 2019). The ability of managers to have a correct perception of digital transformation key issues is often determined by the signals they receive, either inside or outside the organization, and by the capacity to process the information they collect in the environment (Molla et al., 2015; Watson, 1990).

In order to explore managers' perception issues, based on the contribution by Molla et al. (2015), we adopted the concept of Situational Awareness (SA), defined as "the *perception* of the elements in the environment within a volume of time and space, the *comprehension* of their meaning, and the *projection* of their status in the near future" (Endsley, 1995). This concept is often used to explore the dynamics of the decision-making process, where perception, comprehension, and projection are considered as three hierarchical phases of SA (Endsley, 2015). In the SA scenario, at the beginning there is the *perception* of the status, attributes, and dynamics of relevant elements in the environment; then there is a *comprehension* of those elements and their connections, recognizing patterns, resulting in a holistic picture of the environment; as a third step there is the *projection*, consisting in the ability to project the future states of the environment, comparing them with the desired goals, useful to support the decision-making process (Endsley, 1995).

Fig.1 - Analytical Model



Source: our elaboration

Based on these premises, managers should have (i) the right competences to elaborate the information in each SA phase, in order to properly lead the digital transformation process, and (ii) a clear idea about the resources and competences they need in their team for undertaking these changes (Amidei, 2009). Indeed, prior research reveals how digital skill insufficiencies negatively affect task performance, especially in a context where digital-related training is underestimated, with a greater focus on spending in IT infrastructure than on human factors (e.g. promoting digital competence acquisition and training employees) (van Deursen and van Dijk, 2014). Assessing and recognizing the existing digital competences, identifying those that are

missing, is strategically crucial for properly planning and leading the digital transformation process (Hess et al., 2016).

However, we still know very little about how the SA process takes place when applied to digital activities and skills. In order to further understand digital transformation, we developed the analytical model set forth in Figure 1. On the right-hand side, we reported the three phases of the SA and on the left-hand side of the diagram we applied such phases to the digitalization process. Specifically, through the analysis of empirical data, we wanted to explore the implications for strategic choices in terms of training and recruitment in a multinational firm.

3. Empirical context and method

3.1. Methodological approach and empirical context

Our research question aims to explore how managers deal with the need of DS required by the digital transformation process, paying specific attention to their awareness about DS, their perception about the existence of a global digital strategy as well as the need for an appropriate employee training. We decided to explore this issue through a case study since case studies prove to be particularly appropriate for investigating how a phenomenon emerges. A case study methodology enables the identification and understanding of the various dimensions that characterize a phenomenon (Eisenhardt, 1989; Eisenhardt et al., 2007; Leonard-Barton, 1990; Van Maanen, 1998) and it is the preferred approach when the boundaries between context and phenomenon are blurred, as in our case (Van Raak and Paulus, 2001; Yin, 2009). A recent development in the methodological literature demonstrates how case studies generate contextualized explanations; the present work is part of this stream of studies (Piekkari et al., 2010; Welch et al., 2011).

This research analyses a company that has made significant investments in digitalization, robotics, automation and training. We call this organization “MNL” because we are not allowed to disclose the name. MNL developed a fully automated warehouse where people and robots work together. Thanks to these investments, the firm has become a market leader and has achieved surprising production results: in a single day it produces exactly what was produced 30 years ago over the course of a year. MNL is present in 18 countries all over the world: Argentina, Brazil, China, Colombia, Czech Republic, France, Germany, India, Indonesia, Ireland, Italy, Mexico, Russia, Spain, Thailand, United Kingdom, United States and Switzerland. MNL is divided into 12 different departments with different objective, tasks, and roles. MNL invests 7% (Company’s Annual Report, 2018) of its profits in R&D every year. The investments of the last three years in R&D amount to \$75.3 million in 2018, \$68.2 million in 2017 and \$66.2 million in 2016 (Company’s Annual Report, 2018).

3.2. Data collection strategy

Data collection strategy is articulated in three steps: i) we collected information from journal articles, databases, firm official websites, firm annual reports and firm internal documents; ii) we gathered firm's job descriptions; iii) we carried out open-ended interviews. Job descriptions are internal documents containing the analytical description of each organizational position: position in the organization chart, name of the position, roles, required skills, purposes, relationships in terms of collaboration and cooperation with other organizational positions and tasks assigned. The job description is used for different purposes: it offers a clear image of the person who covers that position and it is used in the recruiting process and during the job interview.

Our main source of data is represented by open-ended interviews conducted with different typology of high skilled workers. A detailed list is reported in Appendix A. Interviews have been conducted in 5 different production sites, 2 in Italy, 2 in Germany and 1 in Switzerland. In total, we carried out 57 interviews, 37 in Italy, 18 in Germany and 2 in Switzerland. Specifically, 53 interviews were face-to-face while 4 through Skype call. The interviews followed a semi-structured protocol, reported in Appendix B. The protocol consists of three parts: the first part asks generical question about educational background and previous work. The second part asks specific questions about the firm's digitalization strategies, the need to improve certain skills and the relationship between digitalization and employee skills. In the third part we ask to identify the most important DS needed in the interviewee's department. The answers obtained during the interviews reflect the specific point of view of the respondents (Albuam and Oppenheim, 2006). Interviews were conducted between October 2018 and September 2019. The duration of the interviews was between 30 and 75 minutes and the questions were related to specific topics for the employees' DS.

3.3. Data Analysis

Data analysis was conducted to explore how managers address the need for DS and the role played by the firm's strategic choices about training and digitalization. We adopted an inductive approach, integrating sensitizing concepts with empirical evidence. Sensitizing concepts are defined as "those background ideas that inform the overall research problem" (Charmaz et al., 2003: p.259) and are used as points of departure for data analysis (Bowen, 2006; Charmaz et al., 2003). The sensitizing concepts identified in the literature are reported in the analytical model (Fig.1) and guided the coding process. We coded and analyzed the data obtained through the interviews and identified the general themes emerging from them. To identify the general themes, as illustrated in sections 4.1 and 4.2, we triangulated interviews data with documental analysis. To examine differences and similarities as regards the awareness between different departments, as discussed in section 4.3, we integrated

data from the interviews with the job description contents. In section 5 we report an extension of the analytical model including the evidences emerged from data analysis.

4. Results

Results arising from the interviews are discussed as follows: we will first review the general themes that emerge from the interviews: relevance of a global strategy and relevance of training. Such general themes identify challenges and difficulties that MNL is facing while digitalizing its business. Then, we will delve deeply into the awareness and comprehension of DS for managers. We will examine the differences and similarities as for the awareness between different departments thus identifying general and specific challenges.

4.1. Relevance of a digital global strategy

One of the key issues that has emerged during the interviews is the importance of a clear and structured global digital strategy while implementing the digitization of processes. In fact, several interviews pointed out the importance of a clear guidance coming from the top management. For instance, one interviewee said: *"I think that, before talking about skills, the organization should first understand what the best digitization strategy is, communicate it in the right way, so that everyone understands the direction they are going in. We don't have a clear idea where we are going. We need a clear vision"* (Interview n. 52, K.O.). Similarly, another interviewee said: *"We need a conscious management that has a long-term vision because the digitization of the firm is a long-term process that must be planned taking into account facilitating the interaction between people and digitization, providing for the systematic availability of capital for the research and purchase of digital systems."* (Interview n. 5, B.L.). It appears necessary for the interviewee to understand concretely how to take advantage from the digital transformation and what are the best technologies and implementable solutions. This will allow the development of a clear and feasible strategy.

Employees are aware that a lack of a strategy makes it difficult to acquire the right information for ad hoc strategic planning. According to some interviewees, the roadmap for digitization is not clear and the strategy is not well communicated by the top management. Employees admit that, without a clear strategy, they are confused and have no idea of what will happen in the future within the firm. The managers interviewed state that a lack of long-term vision does not allow them to make informed decisions. Some interviewees ask for greater interaction between people and more communication about digital strategy. This would facilitate the development of new skills through specific training plans or the acquisition of new human capital through recruitment. One interviewee pointed out that *"The organizational aspect, however, is not to be underestimated, because it is the starting point"* (Interview n. 3, A.R.)

4.2. Relevance of training

The second issue that has emerged from the analysis of the interviews is the importance of training activities. Training activities help develop skills that are missing in the organization but essential to address the change that is taking place. In fact, one interviewee stated: *"I don't feel like my staff in the department is ready to cope with this change. We need to implement and develop our skills through specific training in order to have a better understanding of what digitalization is and which benefits it would bring to the firm"* (Interview n. 39, T.F.). The importance of training for the acquisition of DS is underlined by all the interviewees. Training is essential to acquire agility, flexibility, ability to make informed decisions and to respond promptly to change. Almost all respondents are aware that the organization has digitisation and digital culture gaps. Appropriate training is, according to them, the solution. *"All the skills for industry 4.0 are missing. I feel like we are 40 years behind, we should accelerate the process as soon as possible. It's vital to me that the firm makes a careful selection of personnel, along with field training"* (Interview n. 3, A.R.)

The need for training is often combined with the need to acquire specific professional figures externally. In fact, figures such as data scientists and data analysts are required by the organization not only for their capabilities in data processing and analysis but also for the possibility to include them in training programs with the aim of transferring their skills to other workers. With their help it is possible to create internal programs to increase internal capabilities. For instance, one interviewee said: *"To spread these skills, we need to map talents and train them. There are people who have strong statistical skills. Therefore, through skill mapping, it is possible to identify the more suitable people and make them work with experts. Working side by side will allow a transfer of skills"* (Interview n. 2, A.E.)

Additionally, respondents identify the need of training for the acquisition of DS not only for specific categories of employees but also for all the employees in the organization to use new tools. In fact, if new digital tools are deployed without a training, there is a risk that users will consider these tools as inefficient or ineffective due to their inability or impossibility to use them. One interviewee reported: *"For example, they launched Teams, distributed it and shared a link to learn how to use it, but it's difficult for 13.000 people to learn how to use it and to know all the features of the program. This happens not only for software but also for tools of a certain importance. Support for users is missing. To date, we have several tools that are being launched, even quite powerful ones, but in reality, the problem is that behind it there is no staff training"*. (Interview n. 50, B.D.).

Furthermore, balancing the various aspects of a multinational firm in different countries is something that requires attention, awareness, the right tools, and the right people in the right place. This can be guaranteed by the appropriate mix of skills. One interviewee pointed out: *"In my opinion, having a balanced mix of the various ICT skills would be perfect. In general, I can say that, as far as my department is concerned, the skills I would focus on the most are: Critical Thinking, Communication and Information Management. But, aiming for perfection, we would need a good mix of all digital skills"* (Interview n. 50, B.D.).

On a final note, respondents highlight that people are reluctant to change when they do not understand why change is necessary and what it will bring, as can be read in the following: *“In my opinion, employees should be motivated to acquire new information and to generate new ideas. One strategy could be job rotation, which could give them the opportunity to play different roles”* (Interview n. 23, M.K.). This problem is more relevant for senior workers who need more time to adapt to change (Lazazzara and Za, 2016, 2019). In this case the management is faced with the dilemma between training a more experienced resource or acquiring a young resource. In particular, one interviewee from the R&D department underlined that: *“First of all, we need to evaluate the willingness and readiness to approach the change. Another weakness is age: there are many senior employees and it takes time to change their mindset. It is necessary to understand if it is convenient to train them or to acquire new, younger employees. Management plays an important role in this subject by supporting and supervising its staff, providing an adequate training, and illustrating all the benefits this industry could introduce into the firm. This is crucial to motivate employees. The management must be supportive by showing the right example.”* (Interview n. 38, A.Y.)

4.3. Focus on awareness and digital skills

Finally, the third issue that emerged from the analysis of the interviews concerns the level of managers' awareness of DS. As mentioned in the literature review, recognizing the existing digital competences, identifying which ones are missing, is strategically crucial for properly planning and leading the digital transformation process (Hess et al., 2016). For this reason, it is interesting to investigate the perception of the manager concerning the DS needed by the firm for properly addressing digital transformation issues (question n. 3), if they are already there (question n. 4), which ones are missing in the organization (question n. 5), and which ones should be acquired (question n. 7). Specifically, in Appendix C, we reported a table for each point, summarizing the answers provided by the managers.

As a first contribution, we note that approximately the 90% of the managers stated that the staff does not have the DS required for dealing with the digital transformation process (table C2). Based on these results, it seems that the organization is not ready to properly deal with digital changes, since the majority of the employees does not have the necessary digital competences.

Considering table C1 and table C3, it is possible to compare managers' opinions concerning the set of DS needed for managing a digital transformation process with the ones missing in the organization. Comparing the two tables, although the skills identified by the interviewees are almost the same, “Technical”, “Flexibility”, and “Lifelong learning” are the main skills required for handling a digital change among others, but “Technical”, “Flexibility”, and “Communication” are perceived as the DS missing in their organization. Moreover, there are few cases where a DS not required for the digital transformation is still perceived as missing (e.g. *critical thinking*) or vice versa (e.g. *self-direction*).

The most relevant result arises comparing table C1 and C3 with table C4, the skills on which the manager focuses, when she or he can recruit a new resource. In table C4, beyond the corroboration of the skills “Technical”, “Communication”, “Flexibility”, and “Lifelong learning”, the majority of the managers include all the 12 DS, emphasizing quite often the focus on “Information management”, “Collaboration”, “Creativity”, “Critical thinking”, and “Problem solving” skills. Adopting a Situational Awareness perspective, these discrepancy or misalignment between what is described in table C1 and C3 and what is set forth in table C4, could be interpreted as a lack of consistency between the perception (which skills are required by DT), comprehension (which skills the organization needs), and projection (which resources the managers would like to acquire) phases.

This aspect is particularly evident also in some interviews, where the respondents identify a few skills required by the digital transformation process (question n. 3) and a long list of competences they intend to acquire. The answers provided by two interviewees, considering question n. 3 (table C1) and n. 7 (table C4) are as follows:

- Q.3: “These are all skills related to software skills and communication and social relationship skills. Skills must go hand in hand with technology” [...] Q.7: “Surely, having excellent interpersonal relationships, Knowledge of new technologies, Communication (languages), Collaboration, Flexibility, Creativity, Problem solving, critical thinking. Respect for other cultures, being able to understand the attitudes of others also and especially when they belong to different cultures” (Interview n. 1, A.T.)
- Q.3: “The key to change lies in the data, more and more data is available, for me the key thing is to have the technical capabilities to select the data and make it operational. I would look for a data scientist” Q.7: “For me they are the following: technical, because he/she must understand what he/she does; communication, collaboration, creativity is also very important, critical thinking, problem solving is also important, as flexibility and finally the continuous learning is fundamental”. (Interview n. 57, T.E.)

The results seem to confirm that there is a not clear and well defined managers' perception about which resources and competences they need in their team for undertaking digital changes (van Deursen and van Dijk, 2014). Moreover, analysing tables C1 and C4, the misalignment on DS is not affected by the department where the manager works nor by the country, but it is commonly distributed across all the firm sectors considered during the case study.

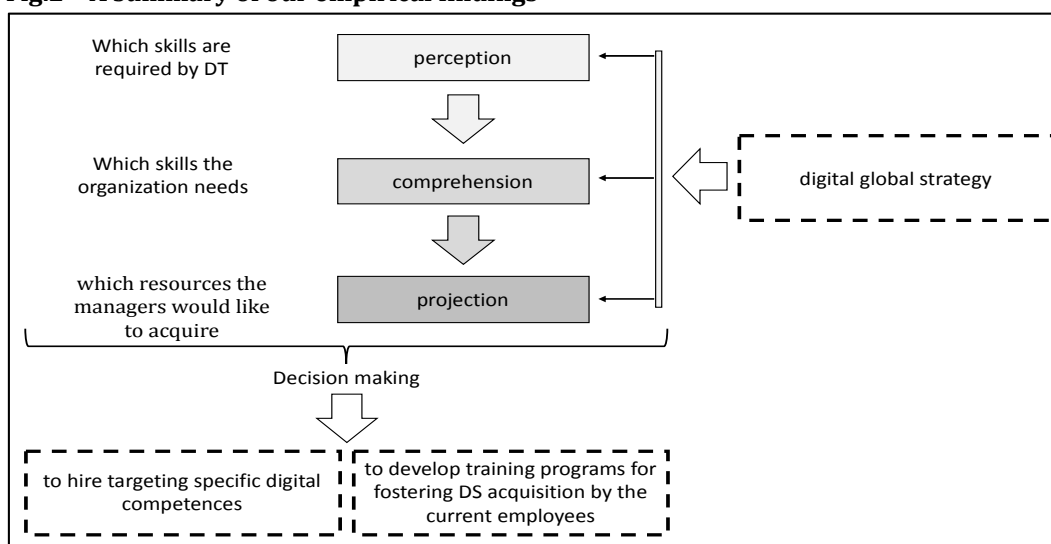
5. Discussion and Conclusions

Human capital is considered a source of sustainable competitive advantage, positively affecting firm performance (Coff and Kryscynski, 2011; Crook et al., 2011), resulting particularly crucial when organizations intend to undertake a digital transformation process (Karimi and Walter, 2015), where digital competences are considered a key factor (Lewis et al., 2004). This paper, through the use of a case study, investigates whether managers are really aware of the need of specific DS to

initiate a digitalization processes, and whether this awareness differs across departments within the same organization.

This study contributes to the research stream related to the strategic relevance of DS for digital transformation, shedding new light on the importance of managers' awareness. Summarizing the results it is possible to identify three main contributions: (i) managers consider it essential to have a clear digital strategy in order to undertake digital transformation initiatives; (ii) managers consider it quite relevant to implement proper training initiatives both for acquiring and maintaining DS inside the organization as well as for fostering informal learning among senior experts and new employees; (iii) regardless of the business department, managers are often not properly aware of the DS required for a digital transformation process.

Fig.2 - A summary of our empirical findings



Source: our elaboration

Fig.2 reports a summary of the contributions of the paper, integrating and enlarging the analytical model reported in Fig.1. In this model managers' digital awareness is viewed as composed of three sequential phases: perception, comprehension, and projection. Each phase could be affected not only by the skills owned by the manager (useful for understanding digital phenomena) but also by the existence of a clear digital global strategy (useful for properly interpreting what happens in the environment and what is the direction to follow). For this reason, based on our analysis, the digital global strategy can influence the phases managers go through for building their digital awareness. Moreover, based on their digital awareness, managers will take decisions in order to increase and/or improve the DS needed by the firm for implementing the digital transformation process. These decisions are mainly related to (i) the development of training programs for fostering DS acquisition by the current employees, and/or (ii) acquiring digital competences by hiring people having specific DS from the job market. As a consequence, if managers

have some difficulties identifying the DS they already have in the firm and which ones they really need to adequately support the digital transformation, this misalignment can negatively affect their decision process.

As a practical contribution, our preliminary results underlying the importance of having a clear digital global strategy to share among managers, providing them with a direction to follow to implement a digital transformation process. At the same time, it is also crucial for the manager to have an adequate DS set in order to interpret all the relevant information they receive concerning digital phenomena, thereby improving their decision-making process. As a theoretical contribution, we have adopted the framework of situational awareness (SA) as a useful tool to investigate managers' awareness of DS. This approach could be further adopted also for exploring the awareness related to other topic strategically relevant to the digital transformation. The results of this research would benefit from further investigation in order to explore the dynamics affecting managers' awareness, identifying which elements could be used to mitigate the misalignment between the SA phases of perception, comprehension, and projection.

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Appendix A. Interviews details

N.	Interviewee	Position	Site	Department	Date	Length
1	A.T.	Assembly Supervisor, Production Planning	Italy	Manufacturing	22/01/2019	50'
2	A.E.	Business Process Management Analyst	Italy	Operations	21/01/2019	35'
3	A.R.	Manufacturing director	Italy	Manufacturing	24/01/2019	45'
4	A.D.G.	Director, talent management EMEA	Italy	Human Resources	28/01/2019	35'
5	B.L.	Vice president operation excellence	Italy	Operations	17/01/2019	45'
6	B.S.	Master data	Italy	Engineering/Industrialization	21/01/2019	40'
7	D.P.	Assembly Production Manager	Italy	Manufacturing	28/01/2019	50'
8	D.M.	Engineering manager	Italy	Engineering/Industrialization	16/01/2019	35'
9	E.R.	Quality & Environmental manager	Italy	Quality and Sustainability	23/01/2019	33'
10	F.D.M.	Vice president, IS delivery management	Italy	Information System	13/02/2019	50'
11	F.C.	Innovation Manager Expert Center	Italy	Research and Development	13/02/2019	45'
12	F.G.	Delivery manager, IS innovation	Italy	Information System	21/01/2019	35'
13	F.D.	Master data	Italy	Engineering/Industrialization	21/01/2019	35'
14	F.G.	Product Line Manager, Marketing	Italy	Marketing	12/02/2019	45'
15	F.M.	Human resources generalist	Italy	Human Resources	14/01/2019	40'
16	F.S.	Director, corporate human capital management process	Italy	Human capital management system	16/01/2019	20'
17	G.D.	Director, sales controlling EMEA	Italy	Finance	28/01/2019	30'
18	G.M.	Head accounting Chieti & Pescara	Italy	Finance	24/01/2019	30'
19	L.D.V.	Automation manager	Italy	Engineering/Industrialization	17/01/2019	75'
20	L.P.	Product/Process Qualification manager	Italy	Research and Development	21/01/2019	30'
21	M.D.F.	Assembly engineering manager,	Italy	Engineering/Industrialization	16/01/2019	45'
22	M.F.	HR director south Europe	Italy	Human Resources	23/01/2019	23'
23	M.K.	Credit manager Europe	Italy	Finance	23/01/2019	50'
24	M.B.	Supply chain director	Italy	Supply chain	17/01/2019	50'
25	M.G.	Environmental, Health, Safety Leader	Italy	Quality and Sustainability	21/01/2019	30'
26	M.P.	Senior Manufacturing Manager	Italy	Manufacturing	11/01/2019	40'
27	M.F.	Personnel Administration	Italy	Human Resources	28/01/2019	25'
28	M.B.	Product Designer Expert Center	Italy	Research and Development	21/01/2019	45'
29	M.P.	Designer engineering	Italy	Engineering/Industrialization	15/01/2019	40'
30	N.C.	Quality assurance director	Italy	Quality and Sustainability	22/01/2019	40'
31	Q.D.C.	Prototype Shop Manager	Italy	Research and Development	12/02/2019	50'
32	R.D.L.	Senior manager, delivery management	Italy	Information System	29/01/2019	40'
33	R.P.	Manager, mould engineering	Italy	Engineering/Industrialization	15/01/2019	50'

34	R.F.	Accounting and tax manager	Italy	Finance	24/01/2019	45'
35	S.F.	Treasury Dpt. Accounting	Italy	Finance	28/01/2019	35'
36	S.F.	Project manager	Italy	Engineering/Industrialization	15/01/2019	35'
37	V.D.	HR manager	Italy	Human Resources	12/02/2019	30'
38	A.Y.	Junior Project Manager Production	Germany	Research and Development	27/09/2019	25'
39	T.F.	Director Quality Management EMEA	Germany	Quality and Sustainability	24/06/2019	30'
40	R.F.	Director Operations	Germany	Operations	09/07/2019	45'
41	F.H.	Continuous Improvement Manager	Germany	Research and Development	14/06/2019	32'
42	J.J.	Senior Manager Germany & Head of HR	Germany	Human Resources	19/06/2019	30'
43	H.K.	Director Product & Project Management	Germany	Marketing	25/06/2019	30'
44	D.K.	Head of Human Resources	Germany	Human Resources	19/06/2019	30'
45	S.R.	President Global Market Development	Germany	Marketing	19/06/2019	35'
46	T.S.	Head of Supply Chain	Germany	Supply chain	25/06/2019	19'
47	S.S.	Director Quality Management	Germany	Quality and Sustainability	25/07/2019	25'
48	A.S.	Purchasing Manager	Germany	Operations	26/08/2019	17'
49	R.V.	Supply chain director	Germany	Supply chain	22/07/2019	18'
50	D.B.	Vice President General Manager EMEA	Switzerland	Finance	24/07/2019	30'
51	K.I.	Senior HR Manager	Switzerland	Human Resources	18/06/2019	58'
52	K.O.	Manufacturing Manager	Germany	Manufacturing	26/07/19	20'
53	P.K.	Operations Manager	Germany	Operations	01/08/2019	27'
54	I.K.	Operations Manager	Germany	Operations	29/07/2019	26'
55	G.S.	Quality Senior Manager	Germany	Quality and Sustainability	08/07/2019	13'
56	R.F.	Operations Senior Manager	Germany	Operations	22/08/2019	48'
57	T.E.	Vice President Corporate University	Germany	Corporate University	13/09/2019	23'

Appendix B

Semi-structured protocol used for the collection of interviews

- 1 How many years have you been working for the firm?
- 2 What's your educational and professional background?
- 3 Many firms today, thanks to the new industrial revolution, are aiming at corporate digitization. What are, in your opinion, the skills required by the transformation in progress?
- 4 Do you currently think that staff have all the skills to deal with this type of change?
- 5 If you think there are missing skills, what do you think they are?
- 6 What strategy do you think the firm should adopt to improve or implement the missing skills?
- 7 If your boss decided to place a new resource alongside you, what are the only skills you would like to focus on? - If you decide to acquire a new resource, which are the only Skills you would like to focus on? (this is to be answered in case he/she is the head of the department)
- 8 What, in your opinion, could be the right strategies to undertake so that, in the future, there are no shortages in the skills of employees?
- 9 If you could choose to implement skills you lack, which one would you choose?
- 10 If you could choose skills to improve, which one would you choose?

Appendix C.

Table C1

Number of interviews where every specific DS was mentioned by the managers answering to question number 3: Many firms today, thanks to the new industrial revolution, are aiming at corporate digitization. What are, in your opinion, the skills required by the transformation in progress?

Departments (n. of interviews)	Skills											
	Technical	Information management	Communication	Collaboration	Creativity	Critical thinking	Problem solving	Ethical awareness	Cultural awareness	Flexibility	Self-direction	Lifelong learning
Manufacturing (n. 5)	XX	X	XXX	XX	X							
Operations (n. 7)	X	X									X	
HR (n. 8)	XX									XXXXX		XX
Finance (n. 6)	X									XX		X
Engineering (n. 8)	XXXX											
Supply chain (n. 3)	XX											X
Marketing (n. 3)	X		X									X
Quality Sustainability (n. 6)	XX				X				X			
IS (n. 3)							X					
R&D (n. 6)	XX		X	XX						XX		X
HCMS (n. 1)	X											
Corporate University (n. 1)		X							X			

Table C2

Summary of the answers provided by the managers to question number 4: Do you currently think that staff have all the skills to deal with this type of change?

Departments (n. of interviews)	SI	NO	NEUTRAL
Manufacturing (n. 5)		XXXXX	
Operations (n. 7)		XXXXXX	X
HR (n. 8)	X	XXXXXXXX	
Finance (n. 6)		XXXXXX	
Engineering (n. 8)	X	XXXXXXXX	
Supply chain (n. 3)		XXX	
Marketing (n. 3)		XXX	
Quality and Sustainability (n. 6)	X	XXXXX	
IS (n. 3)	X	X	X
R&D (n. 6)		XXXXXX	
HCMS (n. 1)		X	
Corporate University (n. 1)		X	

Table C3

Number of interviews where every specific DS was mentioned by the managers answering to question number 5: *If you think there are missing skills, what do you think they are?*

Departments (n. of interviews)	Skills											
	Technical	Information management	Communication	Collaboration	Creativity	Critical thinking	Problem solving	Ethical awareness	Cultural awareness	Flexibility	Self-direction	Lifelong learning
Manufacturing (n. 5)	XXX		XX							X		X
Operations (n. 7)	XX	X	XX							X		X
HR (n. 8)	XXX											
Finance (n. 6)	X	X	XX							XX		
Engineering (n. 8)	XXXX	X	X		X	X	X					
Supply chain (n. 3)	X									X		
Marketing (n. 3)	X											
Quality Sustainability (n. 6)	XXXX											X
IS (n. 3)	X			X								
R&D (n. 6)	XX		X				X			X		
HCMS (n. 1)												
Corporate University (n. 1)	X	X										

Table C4

Number of interviews where every specific DS was mentioned by the managers answering to question number 7: If your boss decided to place a new resource alongside you, what are the only skills you would like to focus on? If you decide to acquire a new resource, which are the only Skills you would like to focus on? (this is to be asked in case he/she is the head of the department)

Departments (n. of interviews)	Skills											
	Technical	Information management	Communication	Collaboration	Creativity	Critical thinking	Problem solving	Ethical awareness	Cultural awareness	Flexibility	Self-direction	Lifelong learning
Manufacturing (n. 5)	XXXXX	X	XXXX	XXX	XXX	XX	XXXXX X	X	X	XXX	X	XXX
Operations (n. 7)	XXXX		XXXX	XXX	X	XX	XXX	XX	XX	XX	X	X
HR (n. 8)	XX	X	XXXXX	XXXXX			XXXX		XX	XXXX	X	XXXX
Finance (n. 6)	XXXX	X	XXXXX	XXXXX	XXXX	XX	XXXXX	X	XXX	XXXX	X	XXXXX
Engineering (n. 8)	XXXXXX XX	XXXX	XXXXX XXX	XXXXX X	XXXXX	XXXX	XXXXX XXX		X	XXXXX	X	XXXXX
Supply chain (n. 3)	XXX		XX		XX		X			X	X	XX
Marketing (n. 3)	XX		XX	XX		X	XX			XX		X
Quality Sustainability (n. 6)	XXXX	XXX	XXXXX	XXXXX	XX	X	XXX		X	XXX	X	X
IS (n. 3)	X		XXX	XX	X		XX		X	XX	X	XX
R&D (n. 6)	XXXX	XXX	XXXXX X	XXX	XXX	XX	XXX			XXXX	X	XX
HCMS (n. 1)	X		X	X								
Corporate University (n. 1)	X		X	X	X	X	X			X		X