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Managing change towards Industry 4.0: How organizations design and implement Industry 4.0 projects

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Abstract

The paper aims to examine how best or new practices of Change Management ("CM") influence the implementation of Industry 4.0 paradigm. Due to the novelty of the phenomenon and to the deep investigation required to grasp the relationship between Change Management in industrial contexts, a multiple case study analysis has been performed: Industry 4.0 ("I4.0") projects of five different companies operating in the North of Italy have been considered. In addition, an expert consultant has been interviewed and insights have been integrated to validate assumptions and results coming from the case studies. The authors provide detailed empirical evidence on the connection and use of some CM practices throughout the implementation of I4.0. Moreover, the study finds out some managerial implications that could facilitate adoption of this paradigm such as project governance, role of Human Resources ("HR") function, enabling factors and resistances management. This study puts light on how CM practices can influence the outcome of I4.0 implementation bringing real-world observations with a clear framework connecting the two fields, as few studies have done before.

Keywords: Change management, Industry 4.0, Industry 4.0 implementation case studies, Industrial systemic innovation, Smart Manufacturing change management

1. Introduction

The world of factories is undergoing a profound transformation determined by a paradigm shift that sees the fusion of the real world of productive resources and the digital world. It is a moment of discontinuity, often associated with a fourth industrial revolution, capable of substantially modifying the methods of design, organization and management of production sites. This industrial revolution, or Industry 4.0, envisages the digital transformation of the industrial system, thanks to a combination of technologies that make it possible to create an ecosystem of factories, machines and intelligent objects capable of dialoguing not only with each other, but also with the surrounding environment.

Innovation 4.0 is based on the development of awareness of the prospects that the company intends to achieve in its process of digital transformation, which cannot overlook the importance of a crosscutting approach that takes into account the impacts of change within the organizational processes of the company. For this reason, the topic of this dissertation is focused on how firms deal with change management during Industry 4.0 implementation, a new subject not yet formalized in detail. Starting from the literature state of the art, that still lacks contributions over many Industry 4.0 change management aspects, this research paper intends to make a step further towards a systematic review of the good practices that come from real-world cases. The aim is helping firms and practitioners, to better design and address the organizational change entailed in Industry 4.0 implementation.

2. Literature Review

In order to grasp the peculiarities of the two subjects and the ones at their intersection, a deep analysis of the literature (both academic and grey) has been carried out, trying to portray the state of the art of Industry 4.0 Change Management ("I4.0 CM") approach.

2.1 Industry 4.0

The term Industry 4.0 has been used for the first time at the Hannover industrial fair in 2011, in which the German government decided to start a funding campaign in favor to the private sector and the university hubs in order to exploit the new emerging technologies, particularly their applications into the manufacturing field (Stary & Neubauer, 2016). Industry 4.0 goes far beyond the simple digitalization or digitization of factories;

it builds upon those concepts which may be simply interpreted as technological prerequisites of the new manufacturing paradigm.

In recent years, Researchers and practitioners proposed several frameworks describing enabling technologies for the implementation of the Industry 4.0 paradigm. For instance, the Italian government, within the "Piano Industria 4.0" governmental initiative, has identified 9 enabling technologies to launch a smart manufacturing initiative (MISE, 2016), or more recently, some authors managed to create a more complete framework containing 13 different technologies and technological trends as enablers (Ghobakhloo, 2018). Another type of classification largely adopted in Italy is the one provided by Politecnico of Milano (Osservatori Digital Innovation, 2016). This model identifies 6 smart technologies that can be grouped together in two distinctive groups: on one side, there are three technologies nearer to the Information Technology side (Industrial Internet of Things ("IoT"), Industrial Analytics & Cloud Manufacturing); on the other, there are three technologies with a higher proximity to the Operation Technology (Advanced Human-Machine Interface, Advanced Automation & Additive Manufacturing). Most importantly, the common trait is that adopting one or more innovative technologies is not enough to implement Industry 4.0 paradigm: a systemic perspective is required, meaning that companies need to pursue a larger and larger interconnection that enables better planning, monitoring and decision-making, increasing the general competitive level and the value added by the firm. In other words, firms should undergo through a pervasive change process.

2.2 Change Management

Nowadays, we hear more and more talks about organizational change. By surfing the Internet, it is possible to see how many texts, projects and training courses are on organizational change topics. However, what is organizational change? We can define the organizational change as "the process through which an organization modifies its present condition by identifying new arrangements for its value creation system, in order to increase its effectiveness" (Bartezzaghi, 2010). In an ever-evolving environment like today, organizations must be able to adapt, change and govern changes that affect their architecture, procedures, systems, roles and behaviors. There are many pressures coming from the surrounding environment that force companies to change. Those forces can be market globalization, competition, technological innovation, mergers and acquisitions, and so forth. In order to be able to anticipate proactively the changes required by the external context, companies must develop and empower change management practices. Bartezzaghi defines the change management as "a systematic approach to deal with change in an organization as a whole and in the individuals, who make it up. It consists of a set of processes, tools and techniques aimed at preparing the company for change, planning and controlling change, and making change effective in the organizational context" (Bartezzaghi, 2010).

Since the organizational change is a complex issue concerning procedures, processes, structures, individuals and groups, planning and its implementation can lead to many different directions, paths and typologies. In particular, two main classification dimensions affecting change characteristics are present in the literature and are summarized in the Table 1 below:

Table 1. Relationship betweenintensity and magnitude of change (Bartezzaghi, 2010)

	Incremental change	***Radical change***
Holistic change	Adjustment of the organizational and management solutions adopted	Introduction of new organizational and management models throughout the organization
Limited (or focused) change	Improvement of management methods, techniques and tools	Introduction of new organizational and management models as part of a business process

Over the years, literature developed many theories that lead to more or less effective models to deal with change management, but Lewin and Kotter models have been the most acknowledged. The former identified three steps (unfreezing, changing and freezing) that a firm needs to undertake when facing a change (Lewin, 1951). The latter, starting from the observation of typical errors of change projects, has pinpointed actions and strategies to undertake to best deal with each of the 8 phases of the identified change. Those phases are: establish a sense of urgency, form a strong guiding coalition, create a vision, communicate the vision, provide the necessary empower to implement the vision, plan and create short-term achievements, consolidate the improvements and produce more change, institutionalize the change (Kotter, 1996).

In a historical period as complex as today, in which competitiveness is increasingly high and technological change proceeds so quickly, working towards change as

a cultural and business phenomenon is essential to ensure the competitiveness of companies' ecosystems. However, even if change management discipline is quite old, its diffusion is not capillary yet.

2.3 Industry 4.0 and Change Management

What emerges from the real world is a clear trend: firms are more and more implementing projects related to a pervasive digitalization (Assochange, 2018). Research defines Digitalization as the most diffused driver for change and, at the same time, impacts over many different areas. When digitalization relates to manufacturing and operational area of a firm, the organization is dealing with an Industry 4.0 change. This kind of change process has many peculiarities: usually, it is a large-scale technological transformation, thus requesting the involvement of many different functions of the company as the impact is diffused (McKinsey, 2018). This kind of projects often relies on some kind of external collaborations within the business environment of the firm or may disruptively influence it (BCG, 2019): new jobs and new roles are created, while others are changed or no longer exist. For these reasons, the type of culture and the role of people are two factors with a peculiar high relevance in this context, much more than in others (BCG, 2018). All those points, identified inside the grey literature, highlights the need of managing this type of change with a new approach, different from the traditional one.

Since no practitioner has already proposed a specific Industry 4.0 implementations change management methodology, the purpose of this research paper will be precisely to highlight the particularities of change management in this context. In recent years, academicians have identified some gaps, trying to fill them by conducting researches over this topic. In particular, the actual state of the art regarding both new practices of change management and its relationship with the Industry 4.0 reality is grouped under nine macro-themes in the following Table 2:

Table 2. Literature review main findings

Macro theme	*Main findings*	*References*
Project Management ("PM")	PM and CM are becoming more and more integrated since PM is bringing new type of tools and is fostering agility inside CM. This trend is relevant in projects like I4.0, where radical innovations aim at introducing technologies, requiring a change in the way of working.	(Hornstein,2015), (Macke et al., 2016), (Kurdve et al., 2016), (Sjorgen et al., 2018)
Digitalization	Digitalization is changing three main aspects of CM: training, communication and monitoring. This is mainly true in I4.0 where it is plenty of data and technology is mature.	(Chryssolouris et al., 2013), (Niess & Duhamel, 2018), (Da Veiga, 2018), (Akarsu et al., 2018)
Communication	Verbal and non-verbal communication during the three phases (preparation, implementation and consolidation) has changed thanks to new digital tools. Since many I4.0 projects launches are followed by introduction of digital tools on the shop floor, they enable new practices also in the change management.	(Merriam - Webster, 2019), (Hermann et al., 2016), (Will & Pies, 2018), (Akarsu et al., 2018), (Hemme et al., 2018), (Niess & Duhamel, 2018)
Strategy and Management	The strategy definition needs to be systemic to reach financial and other type of goals; top management needs to act proactively and as a role model during the process, particularly in case of smart manufacturing radical changes.	(Agostini & Filippini, 2019), (Ghobakhloo, 2018), (Schneider, 2018), (Qin et al., 2016), (Stary & Neubauer, 2016)

Lead Team	The lead team composition and governance can have a high impact on results for I4.0 projects due to their extension and complexity (where many different parts of the processes are addressed).	(Shams et al., 2017), (Macke, et al., 2016), (McKinsey, 2018), (Koch et al., 2016)
Competences and Skills	Several types of new competences needed in these processes and firms, to fill possible gaps in order to exploit fully the technologies offered by I4.0 paradigm and to be ready for the change, should define an accurate strategy.	(Cagliano et al., 2019), (Secchi & Rossi, 2018), (Hecklau et al., 2016), (Ghobakhloo, 2018), (Liboni et al., 2019)
Culture and Resources	Organizational culture has a great effect over I4.0 changes with new introduced ways of working; the actual and perceived workload could have a strong impact over results of the processes because of the efforts required.	(Sony & Naik, 2019), (Toytari et al., 2018), (Mohelska & Sokolova, 2018), (O'Connor et al., 2018)
Peers and bottom-up Impact	Different identified effects driven by bottom-level workers involvement: correlations with resistances, generation of use cases and possibility of timely adjustments. In case of projects that introduces new ways of working, this becomes fundamental to smooth any obstacles and reach quick wins.	(Akarsu et al., 2018), (Goltz, 2018), (Niess & Duhamel, 2018), (Schneider, 2018), (Agostini & Filippini, 2019)
Maturity	The importance and the spreading of the new tools to assess technological maturity and general competences of firms is increasing in I4.0 projects due to their high-level technological knowledge requirements.	(Rajnai & Kocsis, 2018), (Sheen & Yang, 2018), (Schumacher et al., 2016) (Mittal et al., 2018),

3. Research Questions and Framework

Industry 4.0 Change Management is at the intersection of the two topics illustrated before. Due to the newness of the former topic and to the partial diffusion of the latter, different gaps in the literature can be found, pointing out areas in which performing future researches, as suggested by many authors. It is possible to summarize these gaps around three main topics:

•Change process: it is urgent to identify and define the key steps inside the change process (Schneider, 2018). In particular, the steps where there is the highest uncertainty and need to expand the actual knowledge are 4: lead team formation (Toytari, et al., 2018), top management approach (Sony & Naik, 2018), communication (Will & Pies, 2018) and change management advancements (Niess & Duhamel, 2018);

•Contextual and characterizing factors: there is still a lot of knowledge to develop around the correlations between outcomes and some contextual factors (inside and outside the firm) in order to understand the best conditions to implement these technological projects (Da Veiga, 2018). In particular, the unstudied internal factors concern the employees and competences management, the firm technological and organizational maturity (Ghobakhloo, 2018), the centralization level of decisional process (Hermann et al., 2016), the saturation of resources and the firm culture. On the other hand, the unstudied external factors deal with the environmental momentum, the national culture (Sheen & Yang, 2018), the industry nature and the type of approach for the implementation of the project in case this is settled outside the limits of the company (Sony & Naik, 2018);

•Industry 4.0 distinctive elements: some general high-level roadmaps have been developed, but a specific roadmap for firms with some distinctive traits is missing (for instance, SMEs which have many more constraints in comparison with the large ones) (Mittal et al., 2018). Finally, the effects over the firm structure (at both macro and micro level) are still unclear (Liboni et al., 2019).

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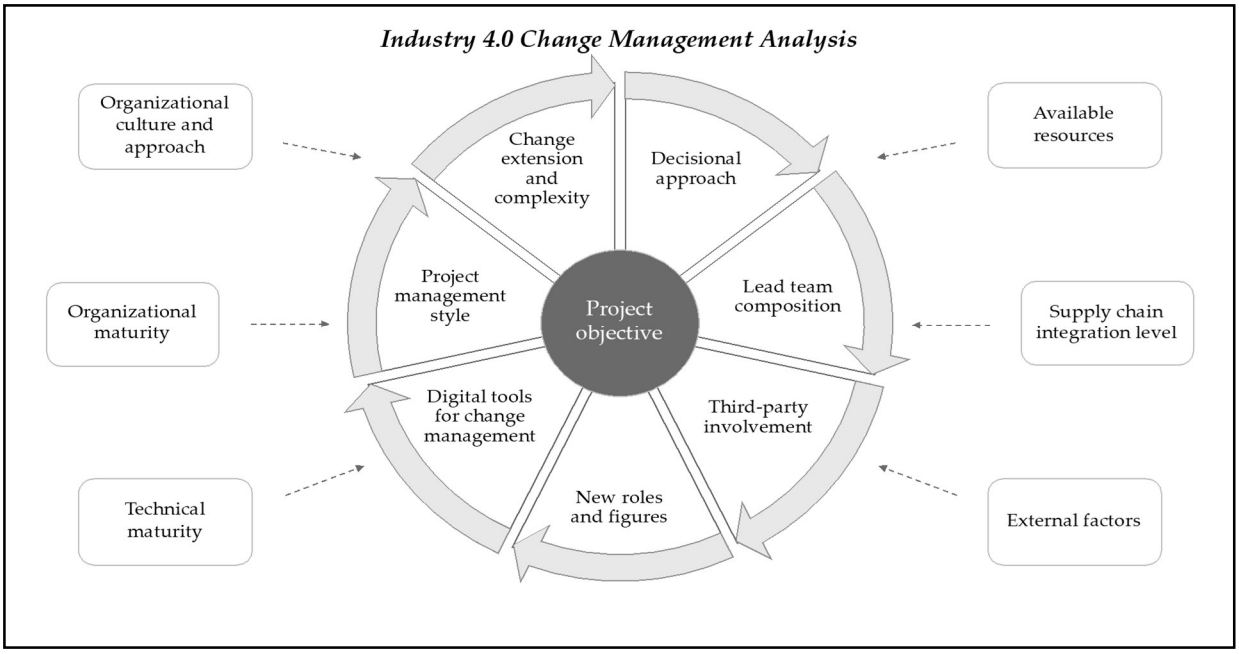

Fig. 1. Analysis framework

Defined the gaps, the research questions that this dissertation aims to answer are the following:

- RQ1: "How is the change management team composed when designing and implementing Industry 4.0 innovation inside an organization?"
- SQ1.1: "Which is the role of the HR function within the Industry 4.0 project?"
- RQ2: "How are resistances managed during the Industry 4.0 change management process?"
- RQ3: "Which are the contextual and environmental factors that affect the readiness of a firm towards the successful adoption of Industry 4.0 innovation?"

In order to answer the research questions in a reliable and coherent way, an analysis framework (Figure 1) has been developed, in which some key variables, distinguished in contextual and characterizing variables, enable the analysis of real-world case studies.

Methodology

The existing literature does not provide yet a structured scientific expertise on how companies deal with changes within Industry 4.0 contexts. Moreover, the topic is worth for a further investigation and requires further analysis. For these reasons, the chosen approach was an exploratory one to carry out the research and case study methodology seemed to be the most suitable.

The following were the criteria to collect the sufficient number of case studies: firms were implementing or had already implemented Industry 4.0 projects at the time of the research (April 2019 – November 2019); the location of the company was in the north of Italy, in order to guarantee a comparable national culture background; no restrictions over the company sector or the size for a greater possible generalization of the findings.

In the end, the analysis sample has been of five companies, whose summarized characteristics are in the Table 3 below:

Table 3 Case studies – Companies overview

	Pharma Firm	Automotive Firm	Elevator Firm	Utility Firm	Electronic Firm
Industrial sector	Chemical - pharmaceutical	Automotive	Metalworking	Utilities	Household appliances
Core business	Human and veterinary pharmaceuticals	Production of braking systems for motor vehicles	Production, maintenance and delivery of people flow solutions	Natural gas transport, dispatching, regasification, storage	Production of raw components for household appliances
Turnover	39,59 billion €	78,5 billion €	8,94 billion €	2,6 billion €	43 million €
Size	99.000 employees	410.000 employees	55.000 employees	3.000 employees	240 employees
Industry 4.0 project	Big data and analytics for predictive	Big data and real time analytics; Application of	Automation production line; Real time	IoT sensors to optimize the	IoT sensors; Big data analytic

	analysis; Integration with MES and ERP; IoT sensors; Augmented Reality; Tablet for monitoring;	Machine Learning techniques to predict and report critical situations; IoT sensors;	data monitoring; Introduction of a global unified MES to be integrated with the ERP;	monitoring and maintenance of infrastructures; Big data and analytics; Tablets with augmented reality applications;	s; Wearables and smartphone application within the plant; Integration with MES and ERP

In addition to the five firms reported in the Table 3, two additional companies have been indirectly analyzed by exploiting the insights shared by a consulting company, interviewed to add to the analysis a different point of view.

In order to collect information and empirical data about the reported companies, the choice was a multiple case study methodology. A structured questionnaire containing guidelines to conduct the interviews followed to have consistency among case studies. After interviews, all the audio records have been transcribed in order to analyze with an academic lens (rationalizing the contents and applying the analysis framework) what interviewees have said about the Industry 4.0 change undertaken by companies. Regarding criteria the ideal targets for interviews, the decision was to interview professionals of those companies who had been part of the smart manufacturing projects. In particular, interviewed employees covered roles not only belonging to the manufacturing area (e.g. production manager, industrial engineering manager, etc.), but also to other company functions (e.g. HR manager, Information Technology ("IT") manager, project manager): the purpose was to catch the perspective of both people perceiving the main effects in the daily manufacturing operations and people more concerned by the organizational repercussions. In the end, the total amount of words in the transcriptions has been higher than 89.000, coming from more than sixteen hours of records.

5. Results

By addressing all the variables of the analysis framework, each case study has been analyzed, so that different and similar ways of managing the change among firms can be highlighted.

5.1 Pharmaceutical Firm

This company's project, aimed at increasing the productivity of people and the efficiency of the production plan, has been focused on the implementation of technologies like augmented reality, real-time data analysis and electronic dashboards.

Briefly analyzing the environment surrounding this company with the framework of analysis, it is possible to observe a highly maturity both Organizational and Technical since they were conducting upskilling courses after having identified some gaps. In addition, a quite open decision-making context was already in place considering some bottom up processes to deliver continuous improvement. Then, it was possible to grasp that resources were not missing (neither financial or human).

The project followed the structure outlined in the Figure 2 below:

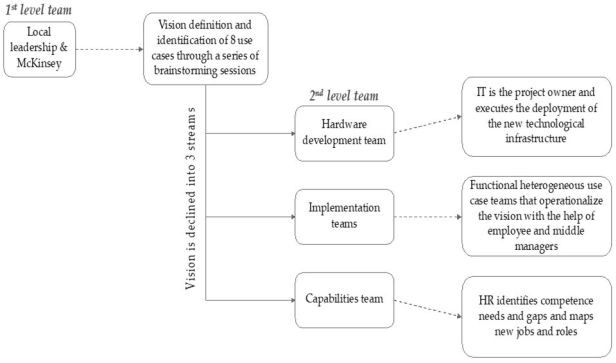

Fig. 2. Pharmaceutical firm change prooject structure

Considering the change management style, some key points most be highlighted: the decisional approach was bi-directional (top-down for the vision and bottom up for use cases identification) and inclusive of several functions and hierarchical levels; external actors has been included in the process as well as new hired workforce; project followed an iterative process to deliver value while keeping low the complexity level.

Looking at the project flow, at a higher level, top management (a heterogeneous lead team) engaged a consultancy company to co-design the vision and change roadmap to bring innovation at the lower level. This engagement came from a perception felt from the Chief Executive Officer of this company who then transferred it throughout all the hierarchical levels.

At the lower level, three work streams worked in parallel with a distributed ownership. In particular, one main enabler was put in the work conducted by HR

the Tech innovation in terms of HW deployment. In parallel, exploiting the quick wins of these work streams, some use cases flourished all around the shop floor that has been then scaled up and brought in the daily operations bringing higher efficiency (e.g.digitalization of some processes part through Tablets to monitor quality).

5.2 Automotive Firm

This company's project, aimed at both increasing the productivity of the assembly lines and enhancing the effectiveness of firm's products, has been focused on the implementation of technologies like IoT sensors for machine monitoring, predictive maintenance and big data analytics within the production plants.

function in the capabilities streams as well as by IT that drove

Briefly analyzing the context, high technical maturity and organizational maturity could be noticed since HR were already used to conduct surveys and find how to empower workforce. This company was extremely integrated with its suppliers following a Just in Time methodology combined with a Lean number of hierarchical levels in a matrix organizational structure could be found.

The project followed the structure outlined in the Figure 3 below:

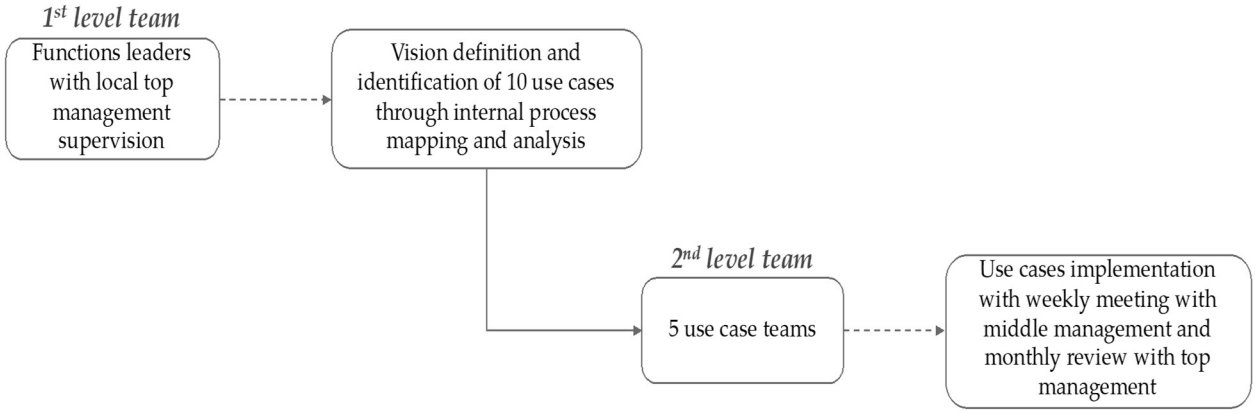

Fig. 3. Automotive firm change project structure

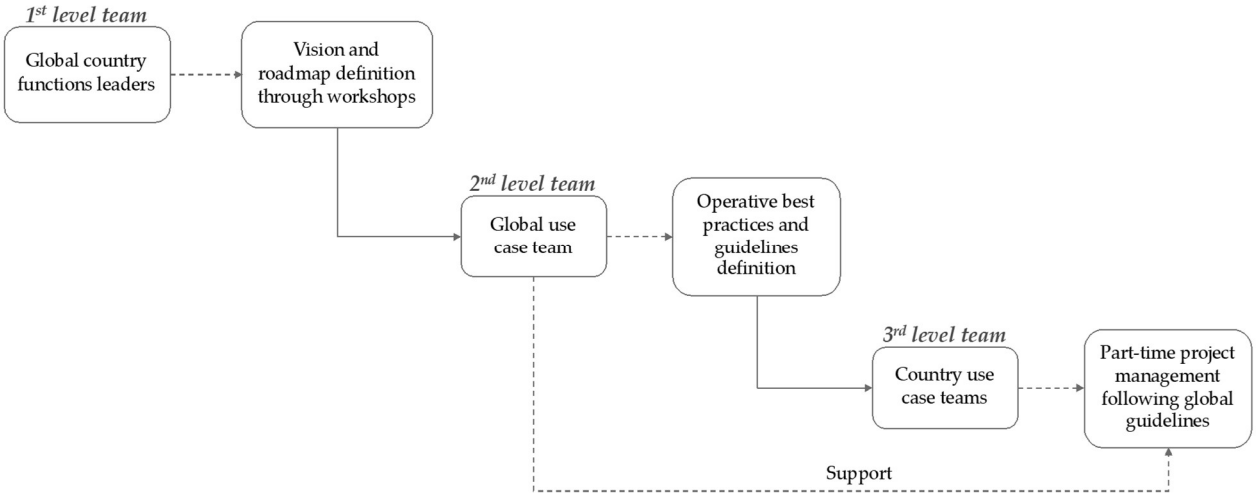

Fig. 4. Elevator firm change project structure

Manufacturing cultural approach. Finally, a low Analyzing the change management style, this is what was observed: the decisional approach had been inclusive since the beginning with all the management involved as well as some blue collars representatives. New roles have been created to face the need of new competences. The project was faced in a design thinking way with the implementation of co-creation workshops and agile sprints only over the identified areas.

After the country manager's perception of an innovation need, top management board, involving leaders of all functions, firstly focused on creating a shared vision. Then, they conducted some workshops whose output was the identification of use cases to deploy along their processes.

As a second step, five multi-disciplinary inter-functional use case teams (including also HR, IT, Operations) focused over one specific innovation area each, implementing new digital processes and tools while updating middle and top management on a regular basis. During those sprints, new best practices and new roles came into daily routines and a continuous innovation mindset spread all over the company, increasing productivity.

5.3 Elevator Firm

With the objective of increasing its production lines productivity, the firm has started the implementation of automated machines in its plants, connected and integrated with the information systems

to perform real-time data analysis.

Elevator Firm context was characterized by a strong pressure of labor unions as well as by a risk adverse culture. Some people formed a sort of expertise center regarding IT technologies. Some constraints about financials were present.

In particular, the project followed the structure outlined in the Figure 4 below:

About Change Management, the decisions had been flowed top-down (from the group Headquarters to the single country plants). All the process has been internal with the exploitation of distributed Center of Expertise around the globe. The project management followed a classical waterfall approach and was assigned to an identified person in each country. Any new role has been introduced since they tried to adopt I4.0 innovation to the actual landscape.

This Industry 4.0 project was born at a central level within the global board of directors. All the global functions and country leaders have been involved to create a vision and a roadmap. After that, at an intermediate level, each global use case team set guidelines and developed best practices involving technical and managerial people from operations, maintenance and data analytics.

The last step to bring innovation in the shop floors was at a local level where a country use case team, with a part-time support of the corresponding global one, managed the rollout of single innovative use case along the plant floor (e.g. IoT production monitoring). In this context, HR function was involved only after the implementation to manage labor unions. The outcome of higher efficiency in the Italian plant was reached with huge efforts and in delay in comparison to the project plan (i.e. the worst case of change and project management).

5.4 Utility Firm

In order to improve operational flexibility and enhance its asset management system, the firm undertook a project focused on the implementation of technologies like augmented reality, IoT sensors and big data analytics to support its operators in day-by-day operations.

The environment surrounding the Utility Firm was characterized by a friendly working context whit HR creating commitment into workers to achieve their goals together and improving some aspects to build a mature organization. In addition, IT Technologies was under renewal, at the time of the research, to improve technological maturity. Massive financial investments were present in the budget of the company.

In particular, the project followed the structure outlined in the Figure 5 below:

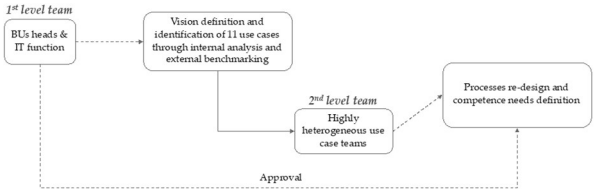

Fig. 5. Utility firm change project structure

Taking a deeper view over the change management style, this is what was observed: the decisional approach involved many different stakeholders since the

beginning; new job titles have been introduced (either hiring from the external labor market or by moving internal resources); iteration during the roll-out phase of the project were the standard approach with some co-creation moments facilitated by external actors.

This Utility firm top management perceived an innovation need driven by the higher competitive market. All Business Units general managers and IT leadership team collaborated to design a vision and identify eleven use cases coming from an internal operations analysis and an external benchmarking.

At a lower level, highly heterogeneous teams (both in terms of functions and in terms of hierarchy and with the facilitation of consultants) focused on one use case each, managed the process re-design and collaborated strictly with HR function to define the new competences needed (e.g. remote collaboration for infrastructure maintenance). The innovation was then widely adopted throughout daily operations increasing efficiency with low resistances.

5.5 Electronic Firm

This firm's project, aimed at radically changing the business of the firm by both increasing productivity and exploiting new market opportunities, was focused on the implementation of technologies like IoT sensors for machine monitoring, smart wearables and big data analytics within the production plants.

Electronic Firm moved inside an environment typical of a family firm: lots of emphasis was over the workforce welfare while trying to stay updated over the last technological trend also creating a new function (showing high level of organizational maturity). This is the only Small-Medium Enterprise and it was the one with the highest lack of Human Resources since it was not easy to attract talents, even if financials were not a problem, and actual resources were saturated. A strong integration with their suppliers and customers was observable. Finally, a continuous improvement mindset characterized the top management choices and company culture.

In particular, the project followed the structure outlined in the Figure 6 below:

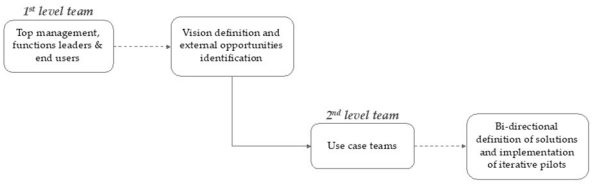

Fig. 6. Electronic firm change project structure

Taking under consideration how change was managed, this is what was observed: a real agile project management approach was adopted meaning that complexity had been kept low by rolling out a small portion of the project at a time to validate assumptions Then, a complete new business unit was formed to coordinate this change while involving all the impacted functions in the decision-making. Finally, customers have been involved to design the flow and to receive their feedbacks.

Top management was looking for new sources of competitiveness and decided to launch some workshops and call for ideas open to all functions and hierarchical levels, despite it reduced productivity for a limited period. The output from this process helped top management to define a vision and identify most relevant opportunity.

At the lower level, different use cases were addressed one at a time (starting from predictive maintenance to industrial machine big data analysis) following an iterative and bi-directional process: the innovation team involved directly internal end-user to co-design and adopted a human-centric agile approach. What happened is that the innovation came strongly into every process not only enhancing efficiency but also opening new business opportunities: a new unit of business opened just after the change even if they are struggling to hire new employees with job titles belonging to the Information and Communication Technology environment. This new Business Unit creates SW products addressing both internal manufacturing plant and other firms' factories and supply chains (which were already integrated in a lean way) going on global scale.

5.6 Consulting company's case studies

The last two case studies are the outcome of information gathered by interviewing a consulting firm involved in the 4.0 projects' implementation. Since both reported projects were still under development, it was

possible to analyze the framework variables only partially.

Looking at the project objectives, both firms aimed, in two different ways, at the same result, to directly connect their customers with their production system. Therefore, the objective was to both increase flexibility and to enhance effectiveness on the market, requiring a partial re-design of the production and of the information systems.

In these cases, innovation came into with the involvement of consultancy firms giving to the top management a broader perspective to show trends and related benefits. Of course, a driver of this request was the perception of firms' management of a technological gap in comparison to the competitive landscape.

Besides that, other common aspects were decision-making moments with involvement of different hierarchical levels together with a multitude of functions. Indeed, the change they are addressing involved many functions, not only the productive ones.

In the end, looking at the environmental aspects, a relevant supply chain integration level was sought and a culture prone to change was formed by the HR.

5.7 Expert's perspective

During the discussion with the consulting firm's expert, several focal points was touched and explained. Under his point of view, it is possible to differentiate the objective of an Industry 4.0 project into two categories that can have different effects on the outcome: Industry 4.0 can enable just efficiency or also enhance customization and effectiveness that can really disrupt the market

Then he has highlighted the need of a digital-oriented culture, besides an organizational and technical competences required during the change. He has also pointed out the need to have an agile project management style and a change lead team that should be heterogenous both horizontally and vertically, involving in some way all hierarchies during the process. In this context, HR could be a great resource, especially for issues related to corporate culture.

Looking at the exploitation of supply chain synergies, he has reported that companies should always think about the impacts on the customers and should look at the market changes to follow them, employing Industry 4.0 as a way to create higher level of integration.

In the end, he expressed his mind about labor unions: since they can be a source of problem or a resource, they need to be managed carefully.

6. Discussion

After applying the framework of analysis to describe and assess individually the case studies of each company, a cross-case analysis is provided with the objective to point out patterns, common features and clusters that emerge when all change projects are examined systemically.

From the real-world evidences, some observations come from similarities and differences analysis among the case studies. Some insights were useful to answer the research questions, some others only to be reported in the cross-case analysis. In particular, this analysis allowed studying case studies analogies, worst and best cases differences and cross-fertilization features.

Starting from certain observations, that do not address a specific research question, it is possible to report some insights related to differences and similarities between SMEs and large companies. The Electronic Firm is a positive example of Industry 4.0 implementation and it is the only SME in the sample. In fact, it is possible to point out that few differences have emerged in comparison to the other positive observed case studies. In particular, the impact of the reduced size can be observed only in three framework variables: 1) it has created difficulties in attracting and acquiring talents; 2) it has implied a higher saturation of resources, lowering the overall availability; 3) it has created a greater flexibility that allows the exploitation of "pure" agile practices in the project execution style and a higher level of heterogeneity in project teams in terms of functions and of hierarchical layers involved, thus allowing a pure bottom-up decisional approach (the only in the firm sample).

Another important observation not addressing any research questions is about the potential or actual level of integration along the supply chain. In fact, the exploitation of synergies along the supply chain with specific actors affects the project final objective: indeed, the only firms leveraging an integrated supply chain have pursued not only efficiency objectives, but also competitiveness and effectiveness on the market.

6.1 First Research Question

Looking at the first research question, case studies have reported some insights to fill the gaps on the composition of project governance (Toytari, et al., 2018).

First, the necessity to move away from the traditional approach emerges, since one lead team and change agents are no longer suitable for this type of change (Bartezzaghi, 2010). Indeed, Industry 4.0 project governance needs to be developed on more levels: a higher level in which a vision team has to define the project strategy, and a lower level in which multiple teams deal with the development of single use cases. All these teams must involve people from different corporate functions, from industrial to commercial ones, guaranteeing heterogeneity of competences. Moreover, if involved properly in project and lead teams, actors outside the company (e.g. consultants, system integrators, etc.) can have an important role in guaranteeing innovativeness.

Looking specifically at the role of the HR function, some cues emerge. What is reported from the case studies, something not considered in the literature, is that HR must participate in the governance of the project and not simply support seldom the lead team, meaning that it must be involved at least in the use case teams. This because the HR function is not only responsible for the training of employees (as said in literature) (Secchi & Rossi, 2018), but it must take charge of the innovation-oriented cultural change that the introduction of the Industry 4.0 paradigm entails, too. Moreover, this position is reinforced since HR covers a fundamental role in engaging the trade union, one of the external actors to be actively involved in the change process, as well as in setting the right level of organizational maturity to be ready for this disruption.

6.2 Second Research Question

Investigating whether traditional change management practices for reducing resistance remain valid even in Industry 4.0 contexts or whether new ones need to be developed (Sony & Naik, 2018), a first cue is that the use of digital tools is not so widespread (i.e. no real world observations), contrarily to what is reported by the literature (Niess & Duhamel, 2018).

A second observation can be made on the top management approach. In particular, the active role of the top management is one common characteristic of every successful case, meaning that it should be involved during both the launch and the execution of the project, at least for revisions at a regular basis that could facilitate support the defined decisional approach. In this way, a holistic view of the company could be beneficial to identify how innovation could serve the whole company. In addition, doing so, resistances from both the top and middle management are reduced, and indirectly, commitment is more effectively spread among informal leaders too.

Communication maintains its fundamental role as seen in traditional change management (Bartezzaghi, 2010), but with a greater focus on reverse reporting (i.e. from bottom to top) that is becoming more and more important, reducing the risk of not-acceptancy of the new technology and increasing the commitment around the project even in the bottom levels of the pyramid. In this way, it is also possible to exploit indirectly the influential network of employees in order to lower the resistances around them and spreading innovative ways of working more quickly.

Looking at the relationship between barriers lowering and time constraints or other complexity characteristics of the context, no evidence of impact can be found, meaning that managerial style of change does not depend upon the project time objective, extension or environmental complexity. It is of little importance if there is a short-term perspective or a long-term one: resistances and, in general, the project, must be managed always in the same way (Jing & Van de Ven, 2018) following the best practices.

Finally, the last important aspect useful to lower barriers is the creation of new professional figures (e.g. data scientists), finalized to make the change fixed (Hecklau et al., 2016). New roles and figures not only create the right conditions for a successful change by adding new necessary competences if the technical maturity is not so high, but also play a fundamental role as change stimulators, accompanying quick wins by bringing their knowledge and expertise related to innovation beneficial for the whole change team.

6.3 Third Research Question

The last research question investigates the absence or presence of enablers that a company must have to implement more easily an I4.0 project. Firstly, some considerations can be made on the enabling competences. As reported in the answer to the first research question, having HR expertise is necessary to drive the cultural change. Similarly, IT skills are required, even if firms can access them through third-parties involvement. What turns out to be important is that the IT function evolves with the aim of becoming a business support function, able to guide the choices on the technologies that are at the basis of the information generation, processing, storing and sharing. Contrarily to what is reported by literature (Hecklau, et al., 2016), Industry 4.0 related skills are not necessary at the beginning of the change process, since they can be

developed along the way, meaning that it is essential to develop an on-going accompanying plan to build them during the course undertaken by the company (Liboni et al., 2019).

Besides skills, organizational maturity and culture are other two fundamental enabling factors. On one hand, the firm needs to be able to map, analyze and manage internal process and competences to find gaps and plan improvement measures, and on the other hand, corporate culture needs to be prone to a continuous improvement mindset together with an inclination to internal and external collaboration, fundamental to commit all hierarchical levels and external actors. Moreover, a particular mention must be done to the importance of having a distributed leadership within the company, not dictated by the hierarchy, to be exploited during change implementation for commitment creation, innovation spread and enhancement of the decisional process (Hermann et al., 2016).

Finally, no evidence has been found on the impact of the sector type over the project results, meaning that it cannot be considered as a fundamental enabling factor (Sony & Naik, 2018).

7. Conclusions

Looking at the answers to the research questions, it is possible to resume some managerial implications that could be exploited by practitioners when dealing with this type of change:

- Managers should prepare the change by shaping the culture in the suggested way leveraging on traditional practices and tools;
- Management should build strategic partnerships in order to be ready to collaborate with third parties to have different perspectives and all the needed competences at the table to grasp innovative trends;
- A cultural enabler trait that managers should develop is the internal collaboration by creating ad hoc collaborative moments and acting as role models in this sense sharing best innovative practices;
- HR function should be directly involved within the different project teams, so that cultural changes, plans to fill the skills gaps in an innovative context and relationships with trade union can be addressed properly;
- Management should focus on building organizational competences ex-ante while the technical ones can be developed during the implementation of the change, following precise training plans;
- Managers should set up the change governance in a heterogeneous way (both functional and hierarchical) and over two levels: in the higher one, a vision team which design the innovation roadmap, while in the lower one, different use case teams which would roll-out innovative projects;
- Top management should be involved from the formation of the vision and it should be updated constantly throughout revision meetings in order to be aligned, to share thoughts and to show commitment;
- New professional figures or roles should be introduced by insourcing them from external market or by developing competences internally;
- Managers should collect feedbacks and enable co-creation moments with informal leaders.

The research has been conducted in a structured way, but some limitations need to be acknowledged and some directions for future research should be indicated.

Firstly, a limitation can be identified looking at the geographical constraints applied to the company selection that could have influenced some variables due to the same national culture. This limitation could be overtaken by applying the same research protocol and framework to a new set of companies in other areas of Italy, Europe or the World.

Secondly, the application of the framework only to already implemented cases presents a limit. A possible option to obviate this limit could be to apply the framework during the implementation of an Industry 4.0 project instead of analyzing finished projects, so that different phases' peculiarities can be deepened.

Then, the number of case studies is not statistically relevant, even if it is possible to observe a convergence of the results. It would be important to test the findings among a new and larger set of case study in the same conditions in order to find some significant statistical inferences.

Finally, there are other areas to conduct further research. For instance, it would be important to apply this framework to a significant number of SMEs to understand if the single-case observations reported in this dissertation are confirmed or not.

In general, the adoption of the Industry 4.0 paradigm and the digitalization of manufacturing processes represent a great opportunity for the world's production systems, but it is still a niche topic among practitioners and academicians. Going some steps ahead with the study of this new mega-trend is fundamental in

order to allow an always greater audience to grasp the benefits coming from it. Since the fourth industrial revolution is not only the introduction of new technologies and software, but it is firstly a redefinition of processes, balances and dynamics, it cannot exist without a well-structured change management strategy able to involve the entire company. Therefore, without a corporate organizational change and a technological project execution, Industry 4.0 remains just a chimera.

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