Change management in the context of the 4th Industrial Revolution: exploratory research using qualitative methods

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Abstract: For manufacturing companies especially, the arrival of the 4th Industrial Revolution or Industry 4.0 has meant a leap forward and a considerable influx of innovation while new technologies are combined with increasing human knowledge and technological skills to automatize manufacturing processes and move towards a customized production culture. The aim of this exploratory research paper is to evaluate Industry 4.0 technology adoption and define the leading agents that contribute or hinder such an implementation in the scope of change management. The investigation of the adoption challenges will be made using two methodologies. Firstly, with a literature review and secondly with a statistical review using qualitative research methodologies of transcripts of readily available interviews with four Canadian manufacturers.

Keywords: Change management, Industry 4.0, Digital transformation, Qualitative research

1 INTRODUCTION

Historically, manufacturing companies focused on mass production. However, in recent years the trend is to move to a more customized approach. As an example, flexible manufacturing systems (FMS) are improving the flexibility of general-purpose facilities by connecting them via computer networks and allowing them to respond rapidly to changes in customer requirements (Lee & Ha, 2019). This has increased the complexity and industry 4.0 is shaping the new manufacturing environment that improves the productivity and quality in a factory.

Germany, with a large history of manufacturing industries, is an industrial powerhouse and its government was the first to introduce a national Industry 4.0 strategic policy initiative in 2011. The German government identified the potential of industry 4.0 as a catalyst to increase manufacturing and the country's GDP. The main aim of this initiative was to increase digitalization and the interconnection of products, value chains and business models (Klitou, Conrads, Rasmussen, Probst, & Pedersen, 2017). Other countries have promptly followed and set up national initiatives and funding too. Some examples are Austria's "Plattform Industrie 4.0," France´s "Industrie du Futur "in Europe and Brazil´s "National IoT Strategy" in South America.

According to a global survey conducted by PwC, manufacturing companies that invest in

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technology expect a revenue gain of 17,2% in the next five years compared to a 9,5% gain observed by companies that neglect the technology race. Furthermore, the first group of companies can expect a 16,2% improvement in efficiency gains and cost reduction from technology adoption, compared with 10,5% from the second group (Geissbauer, Lübben, Schrauf, & Pillsbury, 2018).

Canada has been identified by the World Economic Forum as one of the 25 economies that will benefit from changes in production that are being powered by the 4th Industrial Revolution (Martin, et al., 2018). Additionally, countries are partnering up in order to benchmark themselves against the top performers and to gain valuable expertise and know-how. Notably, there was a Canada-Germany Industry 4.0 Partnering mission that took place in Berlin at the beginning of 2018.

It is, therefore, to be expected that Industry 4.0 will shape the next generation of factories as well as give a market advantage to those companies that adopt it in a quick and effective way. However, there are many factors that can affect a successful adoption. In the following text several practices that need to be put in place for a smooth adoption will be investigated. A set of future lines of work will be outlined at the end of the paper.

The main aim of this exploratory research paper is to identify what change management practices succeed and have an influence on the adoption of industry 4.0 by comparing the adoption maturity in four Canadian manufacturing companies. The paper ends with a series of research limitations followed by a conclusion. To address this aim, the following specific objectives have been defined:

I. To identify different change management models aimed at technological and organizational changes within a company,

II. To focus on the perceived challenge of change management within the scope of Industry 4.0 adoption in Canadian manufacturing companies.

2 LITERATURE REVIEW

2.1 INDUSTRY 4.0

This new industrial revolution is being driven by the following ten disruptive technological advances: Cyber-Physical Systems, Internet of Things, Cloud Computing, Big Data, Cybersecurity, Autonomous Robots, Augmented Reality, Simulation, Machine-to-Machine technologies and Artificial Intelligence as defined by CEFRIO (Beaudoin et al., 2016). One of the main advantages is that data can be shared between the different machines and agents, hence enabling a continuous improvement process that allows for a more flexible, automated and optimized production flow (Rüßmann, et al., 2015). After extensive case studies in German manufacturing companies, three characteristics were identified as being a top priority in the effective implementation of Industry 4.0: Horizontal integration via value creation networks, Digital consistency of the engineering via the entire value chain and Vertical integration and networked production systems (Kagermann, Wahlster, & Helbig, 2013).

These are only true if matched with manufacturing and logistics systems in the form of Cyber-Physical Systems (CPS), by using the information and communications networks

globally available through the internet, hence obtaining an exchange of information while fostering self-learning (Vaidya, Ambad, & Bhosle, 2018). These CPS are at the core of Industry 4.0 since they integrate cyber and physical components using some of the technological advances that have given rise to the 4th Industrial Revolution (Alguliyev, Imamverdiyev, & Sukhostat, 2018). Through embedded sensors, CPS systems are also capable of interacting with other systems and agents of the shop floor, giving birth to the concept of a smart factory (Mourtzis, Vlachou, Dimitrakopoulos, & Zogopoulos, 2018). This is achieved by systems working in the background. When a system is context-aware, it can take into consideration context information like the position and status of an object. These systems accomplish their tasks based on information coming from physical and cyber components (Hermann, Pentek, & Otto, 2015).

Far from being a purely technological revolution, adopting Industry 4.0 does not only affect individuals and their way of working but has an impact on the entire organization that can shift the social structure of a production system (Leineweber, Wienbruch, Lins, Kreimeier, & Kuhlenkötter, 2018). Industry 4.0 is especially important in manufacturing companies and the current industrial landscape, this is where it is presently having the biggest impact (Pereira & Romero, 2017). With the help of Smart Factories that make use of the interconnectivity and communication between machines linked with human interaction companies are improving their operational effectiveness and increasing the value provided through products and services (Colli, et al., 2018) as well as improving their customer experience (Rüßmann, et al., 2015).

This has also shifted the need for more skilled employees in factories. Factory jobs would consist of monotone tasks that did not attract skilled workers, industry 4.0 has now transformed the profile of a factory worker and demands a skilled and technological background and experience. Due to the gradual adoption of automation in factories, employees will have the time needed to gain the skillset and knowledge to stay competitive professionally (Kovacs, 2018). Industry 4.0 fosters the interconnectivity of all the agents involved, including human interaction (Vaidya, Ambad, & Bhosle, 2018). Hermann et al (2015) came up with six design principles of Industry 4.0 that act as enablers in its adoption: Interoperability, Virtualization, Decentralization, Real-time Capability, Service Orientation and Modularity.

i) Interoperability refers to the communication between CPS inside a smart factory.

ii) Virtualization is the principle of CPS being able to monitor physical processes.

iii) Due to a shift toward customization in manufacturing, CPS takes decisions on which working steps are necessary, hence decentralizing the controlling process.

iv) Data inside a factory is constantly collected and analyzed in real-time, supporting the decision-making process and mitigating risks and issues.

v) Service Orientation refers to CPS and products being able to perceive and interact autonomously with their physical environment over their lifecycle (Pereira & Romero, 2017).

vi) Modularity allows to be more flexible with customized production processes.

Like many other methodologies, Industry 4.0 has the potential to drive down costs and increase the efficiency of production inside a company. However, over time, these gains will reach an equilibrium level. The real advantage of adopting Industry 4.0 is the increased

competitiveness and flexibility in a fast-paced environment. Laggards in adopting Industry 4.0 will end up falling back to the early adopters (Davies, Coole, & Smith, 2017).

Since Industry 4.0 is still a relatively new concept, a lot of uncertainty exists around it. This novelty can pose many problems, particularly for companies that have fewer resources available. Especially small and medium-sized enterprises (SME) are not fully aware of the scope of Industry 4.0 (Leineweber, Wienbruch, Lins, Kreimeier, & Kuhlenkötter, 2018). Another challenge faced mainly by SME's is the need to educate current workers. Due to the gradual adoption of Industry 4.0 principles in manufacturing companies, the use of CPS linked with a new environment for knowledge sharing and training has resulted in changes in the production processes. Industry 4.0 has given rise to the development of the Education 4.0 concept, where technologies like virtual reality are exploited along the teaching process, as well as giving students a more hands-on experience in so-called teaching factories. Here a more practical approach will be followed, that will enable young engineers to have the necessary knowledge and skills to work and succeed in an Industry 4.0 environment (Mourtzis, Vlachou, Dimitrakopoulos, & Zogopoulos, 2018).

The implementation maturity of Industry 4.0 is divided into four phases (Benešová & Tupa, 2017).

i) Digital representation of factories in real-time. Here the company will introduce ERP information system.

ii) Horizontal integration. The use of automated machinery will be introduced in the company.

iii) Data analysis and vertical integration. Data processing methods will be installed, using the information for the first two phases. This can be outsourced in the case of SME´s.

iv) Self-controlling manufacture and logistics. It corresponds to a completely automated manufacturing plant.

Industry 4.0 is not exclusive and can be supported by other methodologies inside the same factory. In a research paper by Davies et al. (2017) the relationship between lean/six sigma methodologies is shown to be supportive of Industry 4.0 and vice versa. Similarly, quality management has also been found to be compatible with Industry 4.0 since it needs human involvement and commitment to a micro-level (Gunasekaran, Subramanian, & Wai Ting, 2018).

2.2 CHANGE MANAGEMENT

Change management is the area of economic sciences that incorporates a set of abilities, techniques, and disciplines through which complexity and specialization are transformed in actions and results, in the context of a vision (Pisla, Irimias, & Muntean, 2010). An organizational change is defined as the movement of an organization away from its present state and towards some desired future state to increase effectiveness (Lunenburg, 2010). Every organization operates in an environment that is made up of many factors like but not limited to competitors, client needs or governmental policies. This environment is made up of the external factors that oblige an organization to perform a change. Some of these, the organization can influence by setting up different strategies. However, others cannot, and the organization needs to adapt or change in order to stay competitive in the marketplace. In change management, a

transformation describes a strategic change, whereas according to realignment it changes its paradigms of doing things (Goerzig & Bauernhansl, 2018). According to this paper, change management will be used in the Industry 4.0 technology implementation context, along with the practices, techniques, methods and tools that will support the higher management in adopting the change and the desired outcome while accompanying the employees through this transition. Change is an ever-present element, especially in recent years with the continuously evolving business environment, and this is why change management is a highly demanded skill for leaders (By, 2005).

In order to change this work culture, employees need to be empowered. Practices, like integrating a new mission statement, updating the employee handbook or enhancing the recruitment policy solely, will not be sufficient for an organizational change to be successful (Telukdarie, Buhulaiga, Bag, Gupta, & Luo, 2018).

There are many models that have been developed to aid the management of organizational and technological change in companies. While some follow a more social approach and focus on the people that are living the change or the interaction between all the actors involved (Bareil, 2004) (Collerette, Delisle, & Perron, 1997), others offer a guide to follow with set stages to allow for a successful transition (Rondeau, Transformer l'organisation - Vers un modèle de mise en oeuvre, 1999). This strong social focus on many models shows the need to mitigate the change resistance coming from employees. A change is a disruption from familiarity into the uncertain. A change cannot succeed without the employees being on board and feeling ownership of the project.

Both consulting firms and ERP solution providers agree that several factors are key for the successful implementation of such a technological solution inside a company. These are the presence of a steering committee, the reengineering of business processes, training the new users in the new systems and processes and change management (Bernier, Bareil, & Rondeau, 2002). Therefore, a bad change management strategy can hinder the correct adoption of IoT systems and their benefits.

Before a company can start thinking about how to implement a change and which change management practices they want to set in place, the company´s ability to change needs to be analyzed. This is important in order to have a clear picture of the current state of the company and how changes affect actors. Three models that achieve that are analyzed and compared in **Table 1**.

Looking at the different models in table 1 it becomes clear that one of the main points that allow a change to succeed in a company is to what extent the employees back and take ownership of the change. The organizational structure or context is also a factor that fosters or hinders a smooth transition. Before anything else, the change needs to be legitimized to mitigate the probability of resistance.

This paper will focus on any issues related to change management that can occur before, during or after the implementation of Industry 4.0 in manufacturing companies.

Model	**Description**	**Characteristics**
Autissier & Vandangeon-Derumez (2010)	Three variables are defined: Context, content, and process. The context is the conditions that foster the development of the change. The content is the domain that will be affected by the change. The processes are the ability of the actors to learn and to make their way of changing evolve. After the questionnaire is filled out, the weakest variables can be identified as well as the global ability to change possessed by the company.	It is the most basic model out of the three since it only uses one questionnaire for the collection of data.
Johnson & Rondeau (2008)	Evaluates the strengths and weaknesses of an organization. Three obstacles occur when a change wants to be implemented: Legitimize, perform and take ownership of the change. Nine dimensions are identified and three are categorized into each of the main issues.	It gives you a full diagnosis of the current situation. It can serve as a maturity model. It highlights the change abilities that need to be improved.
Hafsi & Demers (1997)	With the help of a detailed interview, the five key components that the ability to change depends on are analyzed. These are: Complexity of the organization, dynamics of the environment, characteristics of the leaders, organizational structure (organic vs. mechanic) and potential of employees.	It is the most detailed model out of the three. It gives the company a snapshot of reality. Very specific data is obtained.

Table 1:Comparison of changeability models

3 METHODOLOGY

To investigate the impact of Industry 4.0 under the perspective of change management, we structured a research project that starts with a literature review to help provide an overview of the state-of-the-art of Industry 4.0 in terms of change management and to identify future research opportunities.

Next, a qualitative analysis of four readily available transcripts has been undergone, two of which were in French and the other two in English. Gorman et al. (2005), define qualitative research as “a process of inquiry that draws data from the context in which events occur, in an attempt to describe these occurrences, as a means of determining the process in which events are embedded and the perspectives of those participating in the event, using induction to derive possible explanations based on observed phenomena”.

Qualitative research is used to get a complex and detailed understanding of a problem or phenomenon without eliminating the people from the context. This enables the researcher to discover new variables and relationships, to understand processes and complex surroundings in order to illustrate the influence of the social context. It has a holistic vision and allows for a flexible design of the research methodology. Three major methodologies are most frequently and often viewed as foundational: phenomenology, ethnography and grounded theory (Kahlke, 2014).

The interviews used as data had a primary goal of assessing a company's maturity level in the adoption of Industry 4.0. The research team's perception was that change management played an important role in this adoption and therefore analyzed the transcripts to evaluate the emergence of change management issues. The findings of these two methods were compared to identify any gaps and opportunities in how companies adopt Industry 4.0.

3.1 LITERATURE REVIEW METHODOLOGY

Research papers were accessed from the Scopus platform. Since the term Industry 4.0 was first mentioned in Germany, the main searching terms were "digital transformation," "implementation challenges," "adoption issues," "Industrie 4.0" and "Industry 4.0" in order to widen the pool of research papers. The suffix "i.e." was more common in papers written in German, whereas English articles used the "y" suffix. A total of 13 research papers were consulted to conduct the literature review. For the change management literature review, the same databases were used, and the main searching terms were "change management in industry," "ability to change models," "change management models" and "technological change management." In total 11 papers were accessed in the writing of this review. Hence the total number of articles used to write the above full literature review ascends to 24.

Furthermore, articles that described challenges and pitfalls in the adoption of IoT systems of Industry 4.0 were summarized in the Results section of this paper to aid to compare the results obtained by the interview transcripts. They have also been used to show the state-of-the-art and to identify issues that appear more commonly, compared to other issues that might be more company- or perhaps also country-related. For this purpose, the same scientific paper platforms as mentioned above were used, introducing search terms such as "digital transformation in industry AND case study," "Industry 4.0 adoption challenges AND case study" or "technological change in industry AND issues AND case study". A total of 10 research papers were deemed pertinent.

3.2 QUALITATIVE RESEARCH METHODOLOGY

In this case, we conduct case-oriented research since the desired outcome is to focus on four case studies and later compare them with the literature review. It is also to be noted that this research does not count with a high number of datasets, which makes the results true for Canadian manufacturing companies. However, one limitation of our methodology is that the results are difficult to generalize, even though the final insights could inspire future research in other countries and industrial sectors.

This research was conducted using readily available interview transcripts produced by Scremin et al. (2018). The researchers conducted interviews with the aim of developing a maturity assessment framework. A set of indicators was used to determine that the required information was acquired from the interviewees. These indicators do not align with the aim of these research papers. However, there is valuable information in the transcripts that could be used for this exploratory research. These transcripts were analyzed by highlighting the areas where the interviewees talked about what strategies they had used to make the digital transformation in their company. These could be strategies that proved to be successful or issues that arose during the implementation process. As mentioned above, two interviews were conducted in French and two in English. In order to perform a consistent analysis in both languages and avoid translation problems, the help of French native speakers was sought to

insure a correct translation. In this way pitfalls involving idioms or expressions were avoided.

After the pertinent information was extracted from the interview transcripts, a text summarizing all the information was produced. These texts vary in length and some are more information heavily than others. The researchers aim to compare the results found from these analyses. Additionally, a second analysis of the transcripts allowed us to identify a common focus point that impacted the implementation of Industry 4.0. A first review allowed for a selection of the labels that according to our opinion covered the majority of the content. Seven main aspects were identified that repeatedly appeared in the four analyzed transcripts. These were "Change management", "Employee education and knowledge", "Technology issues", "Why Industry 4.0 was implemented", "Results and current uses of I4.0 technologies", "Recommendation for government and funding" and "ERP/technology limitation and problems". Using this legend, the transcripts were carefully read a second time and the quote that talked about any of the aspects outlined in the legend was highlighted in a specific colour. "Change management" was mentioned across all transcript and therefore provided a wide range of information to be analyzed. It was a highly interesting topic to the researchers who favoured its choice to investigate further.

These results and the literature review results were cross-examined. The outcomes are discussed and a set of future lines of study is outlined.

4 RESULTS

The four companies that are being analyzed are all Canadian and operate in the manufacturing industry, making Industry 4.0 adoption imperative for them if they would like to be competitive to a global level. The reason why these companies were selected is due to their efforts in implementing Industry 4.0 and their willingness to participate in the past research, meant that they had a person that took ownership of the transformation project and felt strongly about it.

Furthermore, three of the companies are small and medium-sized enterprises, whereas another is a bigger company. Since SME's have a lower revenue, it is important for them that investments are returning money in the short term. The implementation of Industry 4.0 technologies comes along with a high dispense of money and an initial influx of capital and paybacks might only arise after one or two years. Many companies might not own a high amount of active money that they can invest on Industry 4.0 technologies. This can cause a big issue in the adoption of new technologies since high management will keep an eye on financials and might not see the benefits of implementing said technologies in the factories. Companies will have to rely on private or public grants that can include very extensive applications.

Out of the four cases analyzed, companies C1, C2 and C3 bought a system from an external provider to later customize, whereas company C4 decided to develop an in-house system. The reason for this was because every company and especially SME´s operate in a different manner and no system can accommodate these diverse needs. External systems offer generic functionalities that are compatible with every company. However, most companies with an external IoT system, only use a reduced percentage of the systems functionalities. This might be because some of these are not applicable, the system was just introduced to solve an issue and nothing else is further explored, or that employees are not sufficiently trained nor willing

to make more use of the tool. The development of an in-house IoT system comes with its own issues. The man power to develop this solution is required and SME´s might have the need to employ software developers for this matter. Furthermore, a higher initial capital investment is needed to develop the tool. However, this investment will be gained back since operations will run smoother and the company's competitiveness in the market will increase. Since these benefits are only visible in the long-run, we fall back to the same root problem that many SME´s are facing: a lack of human and financial resources.

4.1 LITERATURE REVIEW RESULTS

According to the literature review, a big issue in implementing Industry 4.0 systems would be that it is usually implemented in silos with the help of consultants. Furthermore, the company's strategy needs to be aligned with the change that wants to be implemented. This is imperative for the company to move forward along with its changing ecosystem. (Telukdarie, Buhulaiga, Bag, Gupta, & Luo, 2018). Incremental innovation in value creation and value delivery accounts for the improvement of the traditional Business Models in companies (Ibarra, Ganzarain, & Igartua, 2018). Since a digital transformation is responsible for this increase in innovation, if such a change wants to be carried out, the business model needs to be modified. Furthermore, higher management needs to recognize digital transformation as the fundamental, strategic paradigm shift that it is and that it is necessary to stay competitively globally. Similarly, in order to see a change being adopted, a digital transformation requires installing a culture that supports the change while enabling the company's overarching strategy. This digital culture empowers people to deliver results faster. The Boston Consulting Group defines three steps of embedding a digital culture (Hemerling, Kilmann, Danoesastro, Stutts, & Ahern, 2018): (i) Articulating the change required; (ii) activating leadership characteristics and engaging employees and, (iii) aligning the organization to embed the new culture.

Arnold et al., (2018) conducted a quantitative study where they sent a questionnaire to German manufacturing companies analyzing relevant Industry 4.0 adoption factors (Arnold, Veile, & Voigt, 2018). Perceived challenges can deter this adoption since manufacturing companies need to invest in training employees, ensure IT security, adjust their business model, adapt internal and external communication, and deal with the uncertainty of legal frameworks and missing standards. However, their research indicated that these challenges had no impact when adopting Industry 4.0 in German manufacturing companies. This can be accounted for the strong support by the German government (Kagermann, Wahlster, & Helbig, 2013) and the early appearance of this term in said country. Not the same can be said in the Canadian context, and we have to expect that these perceived challenged will still be problematic in the companies analyzed in this paper.

Implementing Industry 4.0 inside a company comes along with greater transparency, since everything is stored in a cloud and is accessible in real team to any allowed member. This increases the risk of cyberattacks and industrial spying, as well as the emerged challenge of securing data rights and access (Müller, Kiel, & Voigt, 2018). The thought of this happening can be an issue on senior management minds, that can cause resistance and reticence to implement said technology.

Management commitment – To implement any operational, functional, strategical, organizational or technical change inside a company, it is imperative to have the highest management commitment. Since the implementation of a new ERP system and the adoption of other Industry 4.0 technologies is a strategical change at the heart it needs a 100% backing from the CEO to be fruitful. This support is critical to achieve long-term success, adding to the fact that leadership was ranked the number one facilitator of large transformation efforts (Aladwani, 2013).

Employee education & knowledge – It is evident that the demanded profiles in the manufacturing industry are shifting and more technology-savvy workers are needed. Process engineers and systems/infrastructure architects are needed to set up the software infrastructure (Benešová & Tupa, 2017). Furthermore, data engineers or individuals with programming skills are needed to analyze the data and identify opportunities, issues, etc. There is also a need for digital leadership skills so that team leaders and senior managers understand how to create business models and business processes for the digital world (Commission, 2015). It is discussed that automation will not substitute entire jobs but will automate certain tasks. Focusing on this task approach it was found that in Germany only 15% of the jobs are at risk of being substituted compared to the 47% that was initially expected.

Company size – According to the government of Canada a small enterprise (SE) has up to 99 employees, a medium enterprise (ME) between 100 and 499, while big enterprises are any company with over 500 employees (Innovation, 2016). The number of human resources is expected to have an impact in the adoption of any change inside a company. Depending on the size of the company, different grants or programs are available and offered by the government or private funds.

The first paper that was analyzed, describes the benefits and challenges of a digital workflow implementation in the aerospace industry. Two of the companies mentioned in this research paper are from the Canadian aerospace sector and the digital workflows are a technological change which falls into the Industry 4.0 spectrum. The authors identified the following issues or challenges (Rojo Abollado, Shehab, & Bamforth, 2017).

i) Defining complex processes. Business processes need to be reengineered.
ii) Worker resistance. The human factor is the most common factor of change resistance. They might see the automatization processes as a way of reducing their decision-making power. This is because team managers will have access to a centralized system where all the operations and machines are overviewed, therefore shifting the power from the employees to the plant managers.
iii) Management engagement. The right managers need to be engaged to minimize conflicts arising between the stakeholders.
iv) Overmanagement and creation of new work. An excessive amount of detail of control of the system can incur in a disproportional amount of cash influx and an increased worker resistance.
v) Loss of flexibility. There are business processes inside a factory that rely heavily on employee judgment and automatizing them will lead to a loss of flexibility.
vi) Technical implementation costs. Expenses range from the purchase of the system, customizing the product to the company's unique needs or training and employing new workers.

A case study conducted by Kaidalova et al. (2017) analyzed a Swedish manufacturing company that wanted to embrace a digital transformation by implementing new IT systems into their current architecture. Two types of IT are identified, namely enterprise-IT for lower-level information and product-IT, which includes data coming from communicating machines and systems coming from CPS and IoT. The latter type is made from IT components that are built into the product. The company ran into several challenges while implementing these two IT systems into the existing enterprise architecture (Kaidalova, Sandkuhl, & Seigerroth, 2017), namely: (i) governance and responsibility between the R&D and IT departments; (ii) increasing speed and suitable methods to support agile teams; (iii) balancing governance and support between both IT systems; (iv) lack of framework to describe IT technology stacks for IoT and digitalization and (v) handling legacy systems during the transformation into the digitalization age.

This case study focused heavily on the technological challenges that arise when adopting a digital transformation. An increased employee resistance can appear if the change encounters numerous technical faults that hinders the daily tasks of the workers.

Eikebrokk, Lind & Olsen (2018) studied a cluster of over forty small enterprises in the cultural sector in Norway, which collaborated to co-develop and implement a CRM tool for each of them to make use of internally. The authors have defined several challenges that appeared while analyzing this case study (Eikebrokk, Lind, & Olsen, 2018).

i) Lack of human and financial resources. This is due to the small size of the companies, it calls for more public and private grants and incentives regarding digital transformation in SME´s.
ii) Inadequate comprehension of required investments and needed expertise. This could be accountable to the nature of the sector that the enterprises belonged to. The culture sector is unlike the manufacturing sector not very technologically focused.
iii) Lack of government incentives. The smaller the company and the scarcer the resources, the harder it is for a company to implement a new technology without financial and consulting help.
iv) Employee resistance. In this case some employees saw the implementation and prior development of the CRM tool as causing an extra workload on top of their daily tasks.
v) Lack of leadership. The person that was appointed the leadership role, was not entirely involved and lacked presence. Other staff members showed a greater dedication to the project, and they would have been a better fit as leaders. This highlights the importance of choosing a clear leader that is involved and dedicated to the project.

In another study from researchers from HEC Montreal (Bernier, Bareil, & Rondeau, 2002), an analysis of how the implementation of an ERP system transforms a company was carried out. The authors define three types of ownership challenges during this process, presented next. These challenges appear at several levels.

Strategic level – A technological change such as the implementation of an ERP system, is categorized as a high risk and high-performance project. Challenges that can appear on the strategic level are listed as follows.

i) Lack of management commitment and engagement. It is vital for the success of this

implementation. This includes clear definitions of business objectives, open communication and the skills needed to work with the new digital tools.

ii) The need for a systematic development perspective and a shift in strategic and competitive positioning.

iii) Processes need to be reconfigured to be integrated into the ERP system. This reconfiguration leads to new roles and responsibilities.

Functional level – These are challenges that are related to the project itself and are in general rooted in two different sources of problems.

i) Redundancy of old systems, ways of working, resources and skills. The challenge here is how to deal with the redundancy of systems that are not compatible with the new technology being implemented

ii) Prior decisions about who can have access to which information. Information is power and it is therefore important to be able to give access to certain information just to the people that need it. A recurrent mistake is to give access to a high number of people (Medland, 2014), resulting in some information being mishandled unintentionally.

Operational level – Operational ownership denotes the organization's ability to consider the human challenges that arise throughout the implementation of the new technology. The challenges that arise at this level are listed as follows.

i) Managing blockages by employees that could jeopardize the use and legitimization of the project

ii) Not maximizing the human potential during the change.

iii) Conveying the new business model vision to the employees.

iv) Considering the concerns of the staff.

Bernier, Bareil, & Rondeau (2002) have identified seven concerns that appear during the implementation of an ERP solution. Every phase describes the concern that goes through an employee mind and it shows how they develop as a function of time. While an employee is expected to feel indifference for the change, they will start to assess what impact it could have for them. This kind of change usually impacts the whole company, regardless of departments and seniority, impacting every employee to different degrees. The first phase starts with employee indifference and moves towards the last or seventh phase where the employee helps with the continuous improvement of the software package due to its professional impact. (Bernier, Bareil, & Rondeau, 2002)

4.2 INTERVIEW ANALYSIS RESULTS

All interviewed companies have highlighted the importance of having higher management and the CEO backing and driving the change. Company C3 has changed their company strategy and has set up a roadmap focusing Industry 4.0 technologies and digital transformation. It needs to be noted that the companies that had been previously interviewed, while company C2 opted to develop and implement an in-house software that enabled Industry 4.0 inside the company, the rest of the enterprises decided to look elsewhere and used available commercial software to be subsequently customized to meet the company’s specific needs. An internal project was set in place to automate production through system integration as well as decision-making. The production, every process and decision are standardized. This brings both its own challenges

and benefits. In order to develop an in-house IoT system, the necessary programming and IT skills need to be recruited if not already available in the company, since they will be spending the entirety of their work week dedicated to this tool. It is more time consuming and a higher initial investment is needed. However, in the long term it will save more money, since the system will be tailored to the company and can be modified along the way to cater for future requirements. The percentage of the system featured used by a company with an in-house solution will be of an increased value compared to the one of a company with a purchased solution. A company with lower capital availability would benefit from an external provider since they guide the client along the implementation process. There are technological silos, since some machines are fully automated while others still need to be operated by a human worker. These silos make it difficult to automate the factory, since some machines are not compatible with the state-of-the-art CPS put in place. The employee education is structured by training the team leaders who are in turn expected to train their team.

Table 2 shows an overview of the frequency of appearance of the seven labels that were defined, in the interview transcripts. Change management was mentioned a total of 32 times across the four analyzed transcripts. Even though other concepts showed a higher number of mentions they were highly repetitive and change management provided a higher array of information for this exploratory research.

Labels	**C1**	**C2**	**C3**	**C4**	**Total**
Change management	18	11	2	1	32
Employee education and knowledge	19	14	3	0	36
ERP/technology limitation and problems	15	15	9	3	42
Technology issues	3	4	3	0	10
Why Industry 4.0 was implemented	18	17	2	2	39
Results and current uses of I4.0 technologies	7	12	6	3	28
Recommendations for government and funding	9	7	3	1	20
Total	**89**	**80**	**28**	**10**	**207**

Table 2: Frequency of appearance of the chosen labels in the interview transcripts

4.3 COMPANY C1

This interview transcript was available in French. The company C1 is migrating their IT system to a new ERP which will be compatible with further technological improvements. In one of their factories they have started with introducing horizontal integration by connecting all the machines and computers. This company was very concerned with the concept of resistance to change coming from not only factory workers but from all levels of the organization.

In the interview transcripts the interviewee mentioned the term “résistance au changement” (resistance to change) in three different occasions and “réfractaire” (refractory) in another two. The strategy that was followed revolved around the education of higher management in order for them to understand that Industry 4.0 will transform the entire manufacturing industry as

well as changing their mid-set when it comes to business decisions. Since the results of this digital transformation are only seen in the long-term, it was difficult to convince higher management and the driver of the change in company C1 is to this day struggling to convince key players in the company about the benefits of this adoption.

Return on investment is expected to be very rapid and business people that have this engrained in their mind, struggle to see the benefit of adopting Industry 4.0. Another issue that arose was that workers needed to be trained beforehand since it was not efficient for them to be trained at the time of the implementation. This made it a requirement for a detailed plan that accommodates this training.

The workforce expertise shift was also a challenge, since the company was used to employing more manual workers. Now the human resources team needed to be familiar with recruiting programmers' profiles. This is more challenging in an SME or a company without an assigned human resources department. Furthermore, unless people inside the company don't own the competences and want to implement IoT and Industry 4.0, they will have to rely on consultants that will not understand the business as well as the employees and management, and with every change it will be like going back square one.

Another issue was the need of a transversal team that included young graduates and experienced workers to promote the change. An ecosystem needs to be created where a hybrid workforce coexists with workers that understand the traditional model but also understand the need to transition to Industry 4.0, whilst being able to make the connection between the two models.

A big challenge for management is to understand the ability to change that the company possesses, and which competences are needed before the transition can begin. This high amount of pre-planning that consumes money, it is hard to explain to top management. It is hard to keep up with the ever-changing ecosystem and the new technologies that appear constantly. The silos in this company are very problematic when implementing a change, since every department looks out for themselves, making the transition to a transversal model essential in the success of the digital transition.

4.4 COMPANY C2

This interview was also conducted in French. The company had to employ four software programmers working full time to develop the in-house IoT system and had a master student and a doctorate candidate doing their respective theses at the company. The strategy that was followed by C2 is strongly linked to the human resources within. Employees are thoroughly trained, and gain skills needed in the digital era. The SME invest in people that share company values, do not necessarily own strong digital or programming skills but are open to learn and be trained in this field. Additionally, they employ young graduates for the IT department.

In the project definition, the desired expertise was put in place beforehand. A map of the different decisions to be made was established, so that a decision-making system could be used. As well as an employee profile shift, employees become more polyvalent as they need to possess the required skills to operate the machine, analyze its data or do maintenance. In other words, this SME wants its employees to be all-rounders. Is it hard to find compatible times for training programs for people from different departments, which is why some of the training

happens during lunch time. In these training sessions, only team managers are invited, who later have the job of training their own team. The company realizes that people will show resistance, however, unlike company C3, they do not try to figure out the employee's concerns, but rather dive right into the change and acknowledge that this does not smoothen the transition.

Another challenge defined by this company was the redefinition of tools and processes, since the instructions were not well constructed, and employees would not follow them. A new set of standards is therefore being developed using the PDCA (Plan-Do-Check-Act) cycle to design and map the processes within the company. Since this company is an SME, they encountered the issue of missing resources to maintain and support the change after its implementation.

4.5 COMPANIES C3 AND C4

These two interviews were held in English. Company C3 has implemented a new ERP software and are using hard data provided by this system to get real-time information that enables them to increase their performance. However, they haven't reached a vertical integration, where machines communicate between each other and adjust when recurrent issues appear. The company made a strong effort to cushion their employees and question them to record their reservations and concerns about the upcoming change. The company set up a rewards system to recompense those workers that increased their efficiency to a certain level. According to the company this human approach that focused on the workers' concerns and rewarded them accordingly, had a very positive effect on the implementation mitigating possible risks and issues. People lost their job in the company due to this digital transformation, but it took over a year before the first person was fired.

Concerning company C4, their change management strategy revolved around having everyone from all levels of the company fully committed and taking ownership of the success of the project. They also invested in a strong internal communication strategy to achieve the above mentioned. Since an external service was purchased, the full support of the system integrator during and after the installation was needed.

5 DISCUSSION

Table 3 shows the challenges that appeared in each of the analyzed companies and compares them. Since C4 only offered a computer-generated transcript it was a bit scarce in information and no issues as such during the implementation of their IoT system were specified in the transcript. C1 did the most extensive interview and its transcript provided the researcher with the greatest pool of information related to the topic. Since several companies were analyzed, different issues appeared before, during and after the implementation of industry 4.0 technologies. There can be different factors that make some challenges more prone to appear than others, depending on each company.

Challenge	C1	C2	C3	C4
Resistance to change	✓			
Convince higher management	✓			
Employee training	✓			
Department silos	✓			
Loss of employees		✓	✓	
No suitable times to train people in different departments		✓		
Redefinition of tools and processes		✓		
Missing resources to support the change after its implementation		✓		
Lacking digital competences	✓			

Table 3:Challenge comparison

The challenge that refers to the loss of employees appears in both C2 and C3. However, they are due to different reasons. In the case of C3, a person had to be fired because the new IoT system had taken over their tasks and there was no work available for that person inside the company. On the other hand, some workers in C2 left the company voluntarily because a higher automation simplified their jobs and made their daily tasks boring and not challenging and did not match their experience anymore.

A deeply rooted technological change inside a company is a high risk and high-performance project (Bernier, Bareil, & Rondeau, 2002). Companies of smaller sizes have leaders that act more on the conservative side (Eikebrokk, Lind, & Olsen, 2018) and are therefore not so willing to go forward with such a risky transformation. Even though many SME managers want to make a change and move closer towards automatization and Industry 4.0, they do not know how or do not know where to start with a limited set of human and financial resources. This is an issue that C1 encountered, since the driver of the change felt at points that they constantly needed to convince higher management that the change was needed and beneficial for the company. This can pose a high stress on the initiator and like stated in the literature review a leader of such a project needs to be present and dedicated (Eikebrokk, Lind, & Olsen, 2018). This lack of confidence can jeopardize the motivation of the project leader by having to prove their actions to management. In contrast, C2 did not encounter this challenge since the driver of the transformation was the company owner. The task to oversee the change was then delegated to someone else inside the company, still having the backing from higher management. This constellation promotes the legitimization of the change and can help mitigate the multiple issues arising from employee resistance. On a similar line both the literature review and C3 said that government incentives were needed to achieve a successful implementation which also links with the challenge that C2 encountered with respect to missing resources to support the change after its implementation. A change needs to be monitored and evaluated after its adoption, in order to be able to analyze its performance and assess whether the initial objectives have been achieved (Collerette, Delisle, & Perron, 1997). Added financial and human resources are needed to provide this support and monitoring aspect in the evaluation phase of the change.

The redefinition of tools and processes is a challenge that was found in C2 and is also described in three of the case studies in the literature review. When introducing automation and

IoT systems, the traditional processes might not be compatible with the digitalized way of working. There is a need to reengineer these processes in conjunction with the process owners in a manner that allows for a swift transition between the technical components and workers. The processes need to be adapted and fully operable. However, a standardization effort needs to be made in order to allow employees to understand the new structure and to speed up the internal training process. Additionally, this will benefit new workers that join the company.

One of the companies and a case study in the literature review commented the problematic of legacy systems and machinery and how they will be integrated into the digital age. Before any change can be started, these systems and equipment need to be identified, so that mitigation actions can be set in place. A solution of how old and new equipment can co-exist needs to be reached that does not impact the daily operations of the company. However, this has to be done in conjunction with the process owners since it will mainly impact them. During a brainstorming session they will be more effective at identifying potential issues and can come up with more innovative ways of how this technical challenge can be tackled.

Since Industry 4.0 is such an innovative concept, there are not many experts or professionals with experience in the area. Similarly to what C2 is proposing as a talent concept is moving away from the traditional human resources way of working of employing the "perfect" person for the job and instead is looking for individuals with the necessary soft skills and a high passion and motivation to learn. The latter is a better fit since the traditional approach can be compared to looking for a needle in a haystack whereas the new talent concept provides more training opportunities and career development. This is linked with change management since a digital transformation will require new IT profiles inside the company and this shift in the recruitment culture that C2 already follows is compatible with the 4th Industrial Revolution. Adding to this, there exists the problematic regarding training the human resources team to be able to recruit more technical and programming profiles. Furthermore, it could be discussed to externalize the human resources department for these positions. Many recruitment consultancies offer their services to companies that are struggling to find certain profiles or that don't have an assigned human resources department within the company. Many of these consultancies have specialized IT departments with consultants that have a wide range of experience recruiting these types of profiles, able to focus on the technical skills demanded in the marketplace and needed by a client company.

Since the literature review only found an implementation of technologies like CRM and ERP, the issues that occur when more advanced Industry 4.0 technologies like Artificial Intelligence (AI) is adopted, are expected to be of a more challenging nature.

6 CONCLUSION

This exploratory research paper shows that change management is a vital part of adopting Industry 4.0 in our dynamic society. Even though Industry 4.0 would be thought to be solely a technological change, its deep restructuring of the company, as we know it, and shift in business models and objectives, make it additionally an organizational change. When adopting such innovative technologies, both the technical and the human aspect needs to be acknowledged. In the same line, a strong detail needs to be given to the planning of the change management strategies. Many factors need to be taken into account and it is imperative to make use of

existing change management practices by empowering the employees and letting them take ownership of the change project. The concerns of the employees following up to the change need to be anticipated and mitigated before they occur (Bareil, 2004).

Since the case studies that have been included in the literature review mainly talk about CRM or ERP system implementation, there is still a long way to go in terms of adopting Industry 4.0 in the industry especially in SME's. As mentioned in the literature review Industry 4.0 includes several technologies such as Augmented Reality, Autonomous Robots in or Additive Manufacturing amongst others and solely introducing CRM or ERP systems is a good entry point. However, there is still a large pool of disruptive Industry 4.0 technologies available. Furthermore, the companies analyzed are still at the beginning stages of achieving a total integration of IoT systems. There are diverse challenges that can occur during the implementation of strategic and technological change. However, these challenges can be mitigated with good planning and change management strategy.

Even though the decision process that the researcher used for each categorization was described, it is still in the eye of the beholder and could have differed depending on the researcher. Qualitative methodology recognizes that the subjectivity of the researcher is closely involved in scientific research. Subjectivity can bias a researcher (Ratner, 2002).

This research as various research limitations. Firstly, the data available was limited and it is therefore needed to perform this analysis with a wider pool of enterprises of different countries and in varying phases on the Industry maturity adoption scale. These results would then be used to support or refute the above-outlined issues. Adding to this, the interview transcripts that have been analyzed and mentioned throughout the exploratory paper were undertaken for a different research project that aimed at assessing the maturity of Industry 4.0 adoption in the interviewed companies. A set of indicators were defined, and the questions were constructed to obtained information on these indicators. Since the questions made were not aimed at obtaining information about change management, but rather included them as the interview took its normal course, some important data might have been lost.

As suggestions for future studies on this topic, there are several lines of future research that can be raised from this exploratory paper. A case study could be conducted that focuses on analyzing the change management successes and pitfalls in their implementation of an Industry 4.0 related technology, in different countries. This would lead to uncovering to what extent the government has an influence of digital transformation within a country. The finding could show which governments are currently putting the biggest efforts on fostering Industry 4.0 in their country and which ones need to foster the concept further. Following the same line of thought, one could analyze if there is a valid claim in the need to pressure the government into giving more grants and marketing the currently available government grants, so they reach more companies. C3 used such a government grant which resulted in the government matching their investment in the acquisition of an industry 4.0 enabling software and its implementation and set-up. However, even though these aids and grants are available, the interviewee at C3 stated that many SME´s did not know about these and are therefore missing out on cash influx. A separate platform could be set in a place where these governments or private grants are offered to make them more accessible and visible. As stated in the Norwegian case study, small companies rely on these grants and have even become dependent on public backing (Eikebrokk, Lind, & Olsen, 2018).

The training programs that have to be set in place in order to fill the knowledge gaps inside the companies might need a restructuration since employees should see these as an opportunity for self-development. A research paper that comes up with a strategy and a structure of such programs in the context of a company that is implementing Industry 4.0, could cover this need.

It could be further investigated if this change in the human resources approach is a smart choice. In this paper, it was discussed whether to adopt a talent concept where the perfect person for the job is no longer looked for but rather a capable individual with high motivation and passion to learn new skills. Is this the right approach in our new digitalized industry? To what extent are companies including this new recruiting culture in their human resources department?

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