

**A Critical Assessment of the Readiness of the Project  
Management Profession to Industrial Revolution 4.0 in the  
United Arab Emirates**

تقييم نقدي لاستعداد مهنة إدارة المشاريع للثورة الصناعية 4.0 في دولة  
الإمارات العربية المتحدة

by

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## Abstract

In the history of economic advancements, industrial revolutions have been identified as key factors steering the development and technological leaps. Consequently, they affect many businesses and sectors in varied ways. At the centre of this impact are project managers who are often tasked with the role of adapting businesses and delivering these changes. However, one may question the ability of project management professionals to adjust to the changes arising from the introduction of industry 4.0. In this context, this dissertation seeks to use the case study of UAE project managers to examine their readiness to not only handle the changes but also mitigate risks and seize opportunities that come with the entry of the fourth revolution. Notably, extensive literature perusal was conducted to review concepts and topics related to industry 4.0 and project management. Further, a questionnaire was administered to a selected sample of project managers to evaluate their readiness to embrace the latest revolution; the results will be used to generate the state of project management professional in the United Arab Emirates. Through the survey and a review of literature, the researcher finds that industry 4.0 and project management are highly correlated and that project managers play a huge role in the adoption of this revolution. Besides, it was revealed that the opportunities, challenges, and risks that project managers are facing when adjusting to the new industrial revolution will lead to the development of new processes, strategies, and approaches of coping with the revolution. However, the research has found that most project managers in the United Arab Emirates are barely ready for industry 4.0; most of them are not aware of what the term “industry 4.0” means. Additionally, they lack the skills needed to become successful project managers in the new revolution. Consequently, a set of recommendations are presented in this research, they include the adoption of enterprise risks management models such as ISO’s “31000 – Risk Management” standard and COSO's “Enterprise Risk Management (ERM)” framework, which are the tools being used by international organizations to mitigate the risks of industry 4.0. Incorporating them in project management will help professionals to identify not only the risks but also the challenges and opportunities arising from the introduction of industry 4.0, hence increasing their chances of surviving in the modern era.

*Keywords:* Industry 4.0, project management, project manager, risk management, ERM framework, project manager competencies.

## نبذة مختصرة

في تاريخ التقدم الاقتصادي، تم تحديد الثورات الصناعية كعوامل رئيسية تقود التنمية والقفزات التكنولوجية. وبالتالي، فإنها تؤثر على العديد من الأعمال والقطاعات بطرق متنوعة. في قلب هذا التأثير يوجد مديرو المشاريع الذين غالبًا ما يتم تكليفهم بدور التكيف على هذه التغييرات. ولذلك، يتساءل المرء عن قدرة متخصصي إدارة المشاريع على التكيف مع هذه التغييرات الناشئة من الصناعة 4.0 والصناعات الأخرى.

في هذا السياق، تسعى هذه الرسالة إلى استخدام دراسة الحالة لمديري المشاريع الإماراتيين للتأكد من استعدادهم ليس فقط للتعامل مع التغييرات ولكن أيضًا للتخفيف من المخاطر واغتنام الفرص التي تأتي مع دخول الثورة الرابعة، وتم إجراء مراجعة واسعة للأدبيات لمراجعة المفاهيم والموضوعات المتعلقة بالصناعة 4.0 وإدارة المشاريع.

علاوة على ذلك، تم إرسال استبيان إلى عينة مختارة من مديري المشاريع لتقييم استعدادهم للتكيف بالثورة الصناعية الحديثة؛ سيتم استخدام النتائج لتقييم حالة استعداد مديرو المشاريع في الإمارات العربية المتحدة. من خلال المسح ومراجعة الأدبيات، وجد الباحث أن الصناعة 4.0 وإدارة المشاريع مرتبطان ارتباطًا وثيقًا وأن مديري المشاريع يلعبون دورًا كبيرًا في تبني هذه الثورة. إلى جانب ذلك، تم الكشف عن أن الفرص والتحديات والمخاطر التي يواجهها مديرو المشاريع عند التكيف مع الثورة الصناعية الجديدة ستؤدي إلى تطوير عمليات واستراتيجيات ومناهج جديدة للتعامل مع الثورة. ومع ذلك، فقد وجد البحث أن معظم مديري المشاريع في الإمارات العربية المتحدة بالكاد جاهزين للصناعة 4.0؛ معظمهم ليسوا على علم بما يعنيه مصطلح "الصناعة 4.0". بالإضافة إلى ذلك، يفتقرون إلى المهارات اللازمة ليصبحوا مديري مشاريع ناجحين في الثورة الجديدة.

بالتالي، تم تقديم مجموعة من التوصيات في هذا البحث، وهي تشمل اعتماد نماذج إدارة مخاطر المؤسسة مثل المعيار الدولي لإدارة المخاطر أيزو 31000 وإطار كوسو "إدارة مخاطر المؤسسة" وهي الأدوات المستخدمة من قبل المنظمات الدولية للتخفيف من مخاطر الصناعة 4.0. استخدام هذه النماذج في المؤسسات سيساعد إدارة المشاريع المهنية على تحديد المخاطر، التحديات والفرص الناشئة عن إدخال الصناعة 4.0، وبالتالي زيادة فرصهم في بقاء وتطور المؤسسة في العصر الحديث.

**الكلمات المفتاحية:** الصناعة 4.0، إدارة المشروع، مدير المشروع، إدارة المخاطر، إطار عمل إدارة المخاطر المؤسسية، كفاءات مدير المشروع.

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## **1.0 Introduction**

### **1.1 Introduction**

This chapter serves as the preliminary section for this dissertation because it introduces the context of the topic. Firstly, it presents a detailed background study that lays the foundation for subsequent sections. Most significantly, the research problem is briefly discussed in an effort to highlight the reasons for studying this phenomenon. Additionally, the specific objectives, aim, research questions, scope, hypothesis and study significance are included, all of which ensure that the audiences have understood the context and relevance of this thesis.

### **1.2 Background**

The world is constantly and rapidly changing in different aspects and dimensions. Notably, industrialization has been a key measure of this noteworthy progress. Specifically, this revolution has gone through four phases, at least by the time of conducting this research. According to the World Economic Forum, the first industrial revolution started around 1784 and was characterized by a shift from the reliance on animals, biomass, and human effort “as primary sources of energy to the use of fossil fuels and the mechanical power” (Davis 2018). As a result, it ushered in new manufacturing processes that could be driven by these sources of energy. The second phase of industrialization started in the late 19th century and lasted for a few years, with its major inventions being the introduction of electricity and communication networks, among others (Davis 2018). At this point, computerization and automation were on the horizon and it was just a matter of time. In the 20th century, the next revolution was ushered by developments such as digitization and computerization, which served as a new force behind information handling (Davis 2018). This phase has been felt in the current era since most of these inventions remain highly relevant.

This research postulate that the world has already ushered in the fourth industrial revolution, hence calling for the need to explore it in terms of the changes, risks, and opportunities it will bring forth with time. Notably, this assertion is based on existing reports and research whose findings are inclined toward a similar direction. Particularly, the World Economic Forum – a Switzerland-based independent international body dealing with world affairs – agrees that “industry 4.0” is the latest revolution, which represents the start of “cyber-physical systems” and that introduces entirely new capabilities for machines and people (Davis 2018). Notably, these new competencies are not only reliant on the technologies and infrastructure of the previous revolution but also dependent on new

technologies that are being embedded within societies and human bodies, such as genome editing, machine intelligence, and cryptographic methods (Davis 2018). What is more, not witnessing the effects of past revolutions in some parts is not an indication that advanced industrializations have not arrived since new technologies can leapfrog older ones depending on factors such as availability of resources and acceptance rate. A 2013 research by the United Nations has shown that 6 of the 7 billion people in the world had mobile phones, which translates to 85.7% of the total; however, at the same time, fewer people (4.5 billion, 64.3%) could not access basic sanitation such as pit latrines, which is a basic necessity in most parts of the world (United Nations 2013). Thus, it is highly likely that the world is already moving to the fifth revolution even though the effects of its precursor is yet to be evenly distributed.

In this regard, it is imperative to consider the impact of industry 4.0 in specific fields such as project management. Notably, the revolution has created working environments that are automatized and interoperated. For instance, factories have been made “smart” by the use of cyber-physical systems, Internet of Things (IoT), and real-time processing of big data using cloud computing (Win, Saing, & Kham 2018). As a result, careers have been transformed and businesses changed, and more is still to come since the revolution is still unfolding. Specifically, careers like project management are expected to obtain another dimension as traditional strategies become obsolete and new ones are introduced by industry 4.0; the new skills and responsibilities mean that project managers are likely to experience difficulties in meeting modern project requirements using their conventional approaches. Some of the transformations include automating and digitizing of manufacturing operations, the interconnection of departments and platforms within the production environment, collection and analysis of big data, sharing of data with stakeholders, and implementation of virtual and augmented reality technologies (Win et al. 2018). Subsequently, such changes will have a direct impact on project managers and their roles, mainly because they are the ones in charge of individuals and machinery tasked with achieving organizational objectives in various projects.

### **1.3 Research Problem**

As evidenced by history, an industrial revolution is largely inevitable. The fourth industrial revolution may be seen as a powerful force that will disrupt the world as it is now. However, it is arguably a reflection of the desires and actions of the majority since it is about human-driven inventions and collective choice by people to experiment and adopt the

resultant technologies and advancements into their lives. However, this perspective does not hide the fact that the emergent nature of industry 4.0 threatens many due to the many grey areas. In the case of project management, particularly in the United Arab Emirates, the ability to adjust to these changes, mitigate the risks, and seize opportunities need to be studied. Particularly, research should assess whether project managers are ready to shift to new frameworks, adopt new strategies and work processes, and obtain the necessary competencies in a bid to embrace the new revolution and survive professionally.

#### **1.4 Aim**

This research aims to examine the readiness of UAE project managers to embrace industry 4.0, particularly their preparedness to adjust their organizational setups to handle the changes that will be witnessed as the revolution unfolds. The hypothesized mechanism is that industry 4.0 will introduce new and complex methods, approaches, frameworks, and infrastructures of managing project processes, which are likely to bring new types of risks. After all, modern connections between people and systems are much more complex than in previous decades as they call for new requirements of technologies, infrastructure, management, and so forth. Thus, it is important to identify the risks, challenges, and opportunities that will be brought forth by industry 4.0, all of which will determine the situations that project managers are likely to find themselves. The ultimate goal is to use their input to propose a model of project management that can adapt to the dynamics of industry 4.0.

#### **1.5 Objectives**

##### ***1.5.1 Primary objective***

1. The primary objective of this research is to critically assess the readiness of the UAE's project management profession to the impact of the industrial revolution 4.0.

##### ***1.5.2 Specific objectives***

1. To review the literature concerning industry 4.0 and its integration to project management
2. Identify the different risks and opportunities arising from the introduction of industry 4.0 in project management
3. Review the literature on project management readiness with a focus on the project management profession
4. Examine the extent to which industry 4.0 has an impact on project management profession readiness

5. Review the current state of UAE project management practices in relation to industry 4.0
6. Propose an integrated framework that will improve project managers' readiness for the introduction of industry 4.0.

### **1.6 Research Questions**

1. What is the impact of industry 4.0 on the project management profession?
2. What is the relationship between project management and industry 4.0?
3. What are the expected risks and opportunities arising from the introduction of industry 4.0?
4. What challenges contribute to project managers' readiness?
5. How does the introduction of industry 4.0 impact the readiness of project managers?
6. What are the key practices and strategies that can improve project managers' readiness in relation to industry 4.0?

### **1.7 Significance of the Study**

Project managers work in different fields that are expected to be affected by industry 4.0, either positively or negatively. As a result, at a time when the world is experiencing the early stages of the revolution, project management professionals, who are at the sharp end of delivering change, are likely to benefit from a study that examines the risks, challenges, and possibilities of industry 4.0. In most sectors, project managers are tasked with the duty of delivering the future and realizing projected benefits; they play a critical role, whether it is constructing new infrastructure, digitizing a government agency, or implementing a digital transformation program. In its part, on the basis of its scope, complexity, and scale, industry 4.0 will have an unprecedented transformation since it is a revolution. However, though it is not clear how it will unfold in the end, one surety is that the affected entities need to have a comprehensive and integrated response. Notably, such technological revolutions may happen so quickly that adapting to the changes will come after a significant delay. In this regard, this study is useful to project managers who are keen to survive the wave of the new revolution and the upcoming revolutions, and continue leading organizational project teams to success.

### **1.8 Scope**

As noted earlier, the fourth industrial revolution is wide-reaching in terms of not only complexity and scale but also scope. The World Economic Forum notes that industry 4.0 is bridging the gap between the physical, digital, and biological domains and that it is disrupting almost all sectors across the globe, an indication that the changes will have extensive breadth

and depth, which will herald the transformation of production, management, and governance processes (Schwab 2016). As a result, due to the constraints of resources and time, this dissertation examines the impact of industry 4.0 on project management only. Moreover, to reduce the scope even further, the research will use the UAE's case study, where a representative sample of project managers will participate in a quantitative survey. Though the findings will be generalized to the target population (UAE project management professionals), it will be a valuable addition to the existing literature since the revolution is being witnessed globally.

### 1.9 Hypothesis

To assess the readiness of the project management profession in the industry 4.0 in the United Arab Emirates, through evaluating the readiness of the project manager in terms of knowledge, competencies and acknowledging risks and opportunities. Besides, presenting framework and recommendation to increase project managers readiness for the upcoming industrial revolutions.

### 1.10 Research Structure

The research structure shows the chapter outline of this dissertation, known that it is structured into six chapters, starting from the introduction to the conclusion. However, each chapter has sub-sections addressing the specifics. The chapters are divided as following:

**Chapter 1:** it includes an introduction of the dissertation, background, research aim and objectives, research question, significant study and scope.

**Chapter 2:** The second chapter is the literature review which focused on readiness term, Industry 4.0 revolution and its risks and opportunities, besides, the interaction between humans and machines. Also, it defines project and project management, the process of project management, project management knowledge areas, and competencies of project manager. As well as, risk management, enterprise risk management and framework and process.

**Chapter 3:** This chapter discussed the methodology of the dissertation, which explains the research design. Specifically, the data collection techniques, research strategy, data analysis methods, and such aspects are explained.

**Chapter 4:** This chapter presents the finding of the surveys, to allow the reader to assess the results of the dissertation.

**Chapter 5:** The chapter is the SPSS data analysis.

**Chapter 6:** This chapter provide a discussion based on the findings represented in the dissertation.

**Chapter 7:** It includes the conclusion and recommendations of the thesis.

## 2.0 Literature Review

### 2.1 Introduction

This chapter is solely focused on reviewing and synthesizing existing scholarly and other peer-reviewed literature materials. Among the primary goals is to contextualize the topic by studying what other authors have said about the phenomenon. Notably, some of the research objectives involve reviewing past work, and this chapter will help to achieve them, hence answering several research questions. Further, it is arranged thematically on the basis of the key concepts and issues that are related to the topic.

### 2.2 Theoretical Underpinning

#### *2.2.1 Modernization theory*

This theory sees modernization as a phased process of transforming from a traditional and underdeveloped state into a more flourished society. According to Reyes (2001), this model is based on the assertion that modern societies are more productive, people can have a better education, and the less privileged can receive more welfare. Thus, it is the perfect theory to explain the industrial revolution, where the world witness improved solutions as it progresses from one phase to the other. However, it should be noted that although the structures in modern organizations and societies have increased functional capacity, they also increase the problem of integration and the challenge of coordination activities (Reyes 2001). As a result, it is important for the relevant personnel, including project managers, to enhance their skills and competencies if they are to survive in the modern era or match their demands.

#### *2.2.2 Scientific management theory*

Efficient management is critical in the adaptation of changes introduced by industry 4.0. This theory highlights issues of synthesizing workflow to improve the organization's efficiency by improving task completion efficiency. According to Nadrifar, Bandani, and Shahryari (2015), the model “delivers a proper solution for problems and challenges of industrialists [and it] is the solution to business problems” (p. 84). Frederick Taylor – the theorist – conducted several experiments to test and verify his theory. In some of these explorations, he revolutionized the art of metal works by doubling the speed of cutting; he increased efficiency at the workplace by eliminating excess movements and transfers; he increased shovellers’ efficiency from 16 to 59 tons per day, hence reducing manual workers from 500 to 140 (Nadrifar et al. 2015). He proposes that scientific methods can be used to increase economic efficiency such as labour productivity. Regarding industry 4.0, this theory

suggests that project management professionals can match the new demands by considering scientific approaches such as computerization and mechanization of processes.

### 2.3 Readiness

The term readiness means preparedness of an organization, people, or system to encounter the situation with planned action; throughout training personnel, enhance supplies, provide supporting systems within the organization (businessdictionary 2020).

The Deloitte Global has mentioned that readiness concentrates on four major areas which are: social impact, strategy, talent and the workforce, and technology.

- Social impact considered influencing the society in an industrial era, such as education, sustainability and social mobility.
- Strategies; which is a set of plans and approaches that organization utilize during the industrial revolutions; some organizations or project managers may not be ready with the changes caused by the industrial revolutions.
- Talent and workforce; that is consist of the building a confidence and skilled workforce to be ready for the new era.
- The investment on Technology; which supports new businesses models and will have great impact on organizations as it mentioned in the article (Deloitte Development 2018).

However, this shows that in order for project managers, businesses, and organizations to be ready for the industrial revolutions it has to consider its social impact, in means that how their role affect those around them in Industry 4.0 and future industrial revolutions. In addition, shifting mindset to create new values and strategies is needed to keep up with new era.

Moreover, developing the workforce's skills and capabilities will grantee the readiness of the organization for the new revolutions, which will limit the risks of moving from one industrial revolution to another (Deloitte Development 2018).

Furthermore, nowadays organizations tend to use the Readiness Assessment Tool to assess its readiness for the developing industrial revolutions, which measures an organization's ability to develop or transfer processes and strategies. As well as, identifying opportunities and challenges that might occur in implementing new processes, strategies, procedures, etc. to cope with the industrial revolution changes.

Agca et al. (2017) has mentioned that in order to use the readiness assessment tool organization must consider 6 core dimensions, which are as follow:

1. Products and services
2. Manufacturing and operations
3. Strategy and organisation
4. Supply chain
5. Business model
6. Legal considerations

The purpose of readiness assessment is to help identifying the readiness level of industrial revolution, which evaluate the level of an organization's readiness, the four levels are: level 1 – Beginner, level 2 – Intermediate, level 3 – Experienced and level 4 – Expert (Agca et al. 2017).

## **2.4 Industry 4.0**

### ***2.4.1 Chronology of industrial revolutions***

An economy is comprised of various industries that produce goods and provide services, which, in turn, generates economic activities. Notably, since the start of industrialization, technological leaps have led to a series of paradigm shifts that are now known as “industrial revolutions.” As noted earlier, at least four industrial revolutions have taken place since the 1780s (Davis 2018). According to Xu, David, & Kim (2018), the first industrial revolution started in the 1760s when the steam engine was invented. This mechanized tool ushered in new manufacturing processes, which were different from the methods used in feudal societies. Notably, the transition involved the use of coal as the primary source of energy at a time when trains were the main modes of transport. Furthermore, steel and textile industries were the most dominant in that era, particularly regarding issues such as capital investment, returns, and employment. In the 1900s, the second industrial revolution had started being witnessed, especially after the invention of the internal combustion engines, which was the start of rapid industrialization due to the mass production that was triggered by the use of electricity and oil to power various machinery (Xu et al. 2018). In the mid-20<sup>th</sup> century, the third industrial revolution came into force, and it was evidenced by electronics and information technology inventions that were used to automate production, as well as advanced communication and computing tools that acted as enablers of new ways of information generation, processing, and sharing (Davis 2018; Xu et

al. 2018). Notably, in earlier years, people screwed and welded. The current industrial revolution, which is the fourth one, involves computer-aided processes such as three dimensional (3D) printing and contemporary technologies such as cyber-physical systems, Internet of Things (IoT), big data, and cloud computing (Win et al. 2018; Xu et al. 2018). Table 1 below summarizes these revolutions in terms of transition periods, energy resources, key innovations, main achievements, affected industries, and primary modes of transport.

|            | <b>Period</b> | <b>Transition Period</b> | <b>Energy Resource</b>        | <b>Main Technical Achievement</b>         | <b>Main Developed Industries</b>    | <b>Transport Means</b>         |
|------------|---------------|--------------------------|-------------------------------|---|-------------------------------------|--------------------------------|
| <b>I</b>   | 1670-1900     | 1860-1900                | Coal                          | Steam Engine                              | Textile, Steel                      | Train                          |
| <b>II</b>  | 1900-1960     | 1940-1960                | Oil, Electricity              | Internal Combustion Engine                | Metallurgy, Auto, Machine, Building | Train, Car                     |
| <b>III</b> | 1960-2000     | 1980-2000                | Nuclear Energy<br>Natural Gas | Computers, Robots                         | Auto, Chemistry                     | Car, Plane                     |
| <b>IV</b>  | 2000 -        | 2000 - 2010              | Green Energies                | Internet, 3D Printer, Genetic Engineering | High Tech Industries                | Electric Car, Ultra-Fast Train |

*Table 1 - Primary Characteristics of Industrial Revolutions*

*Note.* Reprinted from “The Fourth Industrial Revolution: Opportunities and Challenges,” by M. Xu, J. M. David and S. H. Kim, 2018, *International Journal of Financial Research*, 9(2), p. 91.

#### **2.4.2 Defining industry 4.0**

Various scholars have made attempts to define industry 4.0, and a notable theme is an assertion that it is the second technology revolution. The postulation is that the previous industrializations were based on a similar technological framework and that the latest one introduces a new paradigm. According to Lee et al. (2018), industry 4.0 entails the use of artificial and machine learning and ubiquitous and mobile computing technologies that are inexpensive, smaller, and stronger. These diverse technologies are highly differentiated from the traditional ones, which suggest that industry 4.0 is revolutionary. What is more, this era came with other technologies such as cyber-physical systems (CPSs), the Internet of Things (IoT), big data, and cloud computing (Win et al. 2018). It also includes others such as “smart factories, cyber-physical systems, self-organization, new systems in distribution and

procurement, new systems in the development of products and services, adaptation to human needs, and corporate social responsibility” (Lee et al. 2018). These inventions are unique due to their ability to create connections between various technologies and markets in different industries. Thus, this contemporary approach makes industry 4.0 a whole new technology revolution.

Another perspective is that industry 4.0 is the revolution that allows entities to achieve the highest basic needs. Notably, Lee et al. (2018) industrial revolution as the “co-evolution between human desire and technological innovation,” that is, “esteem needs and intelligence technology,” as mirrored by Maslow’s hierarchy of needs (see *Figure 2*). The argument is that it has introduced a form of self-organization for human beings, particularly between real and virtual aspects. For instance, through technologies such as augmented reality (AR) and virtual reality (VR), self-organization is achieved by digitally transforming reality into the virtual world. Similarly, analog transformation can change an optimized virtual or digitized project (e.g. dimensional designs) into a real infrastructure.

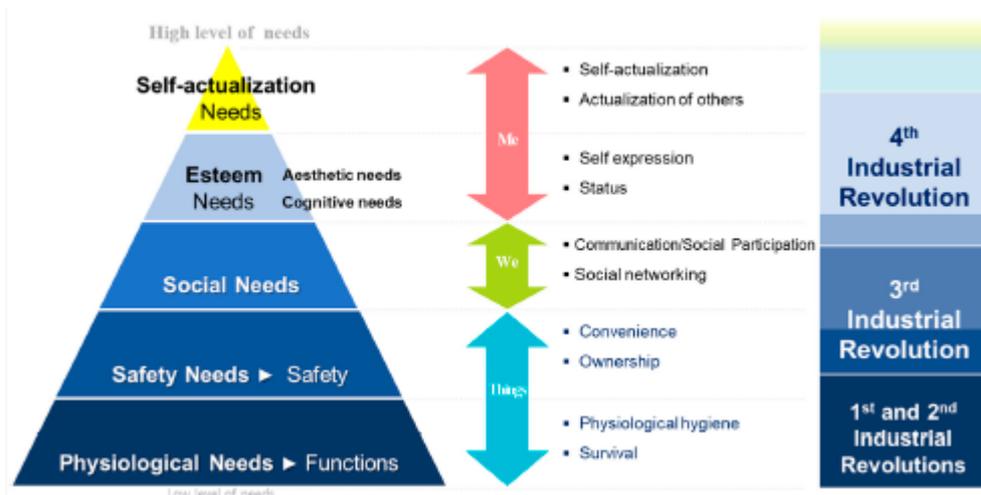


Figure 1 - Esteem Needs and Intelligence Technology

Reprinted from “How to Respond to the Fourth Industrial Revolution, or the Second Information Technology Revolution? Dynamic New Combinations between Technology, Market, and Society through Open Innovation,” by M. Lee et al., 2018, *Journal of Open Innovation: Technology, Market, and Complexity*, 4(21), p. 5.

Most significantly, industry 4.0 can be seen and defined as a super-disruptive innovation. Lee et al. (2018) say that such innovations come to fulfil “the needs of new customers with differentiated elements, which is different from the previous main market, enabling a new market or niche market to emerge.” As a result, it is expected to introduce varying changes to human functions, especially for those delivering the said needs as they will have newer and enhanced skills. For instance, as shown in Table 1, industry 4.0 is

characterized by green sources of energies, and clients are likely to request construction engineers and project managers to install technologies such as solar power and ensure that the structures are allowing sufficient natural light. Arguably, such requirements require different approaches than the ones used in traditional projects, which is a challenge for the involved professionals to match these demands.

### 2.4.3 The risks of industry 4.0

Though industry 4.0 is expected to be beneficial to the various fields and industries, it introduces different risks within organizations. Particularly, this revolution will lead to changes in strategies, business models, values, supply chain, processes, skills, and stakeholder relationships (Büchi, Cugno, & Castagnoli 2020). In research meant to culminate into a risk framework for industry 4.0, Birkel, Veile, Mülle, Hartmann and Voigt (2019) find that implementation of industry 4.0 creates 6 risk dimensions, which has 27 sub-dimensions that affect individuals, businesses, and national economies. Table 2 summarizes these risks as revealed by this particular study.

| <b>Risk dimension</b>      | <b>Sub-dimensions</b>   |
|----------------------------|---|
| <b>Economical risks</b>    | <ul style="list-style-type: none"> <li>• Financial - require large investments</li> <li>• Time and importance of investment - wrong technologies can be detrimental</li> <li>• Changing business models – enterprises can lose core competencies, amassed success, or profitability</li> <li>• Competition - geographical borders disappear and introduce new players</li> <li>• Dependencies - loss of power due to integrations with external partners</li> </ul> |
| <b>Ecological risks</b>    | <ul style="list-style-type: none"> <li>• Consumption – e.g. high energy consumption</li> <li>• Pollution – increased emissions and waste generation</li> <li>• Lot size one – reduced usability due to excessive individualization</li> </ul>   |
| <b>Social risks</b>        | <ul style="list-style-type: none"> <li>• Job losses - shift in competencies</li> <li>• Change in organizational structure/leadership – adapting to new requirements</li> <li>• Internal resistance and corporate culture</li> <li>• New requirement for training</li> <li>• Lack of qualified personnel</li> <li>• Stress and Overextension – additional tasks</li> <li>• AI concerns - distrust in decisions</li> <li>• Manufacturing relocation</li> </ul>        |
| <b>Technological risks</b> | <ul style="list-style-type: none"> <li>• Technical Integration – increase in technical complexity</li> <li>• Dependency – overreliance on technology</li> <li>• Standards – need to unify and standardize systems</li> <li>• Cyberattacks</li> </ul>  |

|                                  |  |
|----------------------------------|--|
|                                  | <ul style="list-style-type: none"> <li>• Data possession – protection and defining ownership</li> <li>• Cloud computing - security of stored data and processing capability</li> </ul> |
| <b>Legal and political risks</b> | <ul style="list-style-type: none"> <li>• Lack of infrastructure</li> <li>• Legal aspects – clarify concerns such as data protection</li> </ul>   |

*Table 2 - Risk Dimensions and Sub-Dimensions*

*Note.* Adapted from “Development of a Risk Framework for Industry 4.0 in the Context of Sustainability for Established Manufacturers,” by M H. S. Birkel, J. W. Veile, J. M. Müller, E. H. and K. Voigt, 2019, *Sustainability*, 11, p. 384.

#### **2.4.4 The Opportunities of Industry 4.0**

Firstly, contemporary technologies that will arise as a result of industry 4.0 will reduce barriers separating inventors from markets. Inventions such as 3D printing can help designers to produce prototypes, hence helping in creating real products. As a result, entrepreneurs can establish start-ups with minimal costs since they can realize the products by using 3D printing technology, which is free of constraints associated with traditional prototyping methods (Xu et al. 2018). In other words, an inventor can produce the final product using minimal resources, thereby eliminating intermediaries whom they could have needed to realize their goal.

Secondly, the extensive adoption of AI presents an opportunity for revolutionary solutions that will significantly affect the economic landscape in the long-run. Xu et al. (2018) argue that though intelligent agents are likely to replace people in forms of jobs due to their ability to rationally address complex problems, they also bring new ways of growing economies. Statistically, a study by McKinsey – a consulting firm – has found that about 50% of current work processes are likely to be automated through various technologies, thereby enabling businesses to not only save money but also create new types of jobs (Manyika et al. 2017). The impact on the bottom line is more efficient systems can drive economic growth much faster and job opportunities for those with contemporary skills.

Thirdly, as noted earlier, industry 4.0 is allowing more integrations between different types of technologies and mechanizations. According to Klaus Schwab – the founder of the World Economic Forum – the latest revolution is generating forces that will create “a fusion of technologies that is blurring the lines between physical, digital, and biological spheres” (Xu et al. 2018). However, the fusion is not a mere combination but the creation of a new facet that contain new markets and growth opportunities (Xu et al. 2018). In other words, the results of bridging the gap between real and digitized formats is the creation of new dimensions, such as 3D printing, AR, and VR, which are new opportunities.

Fourthly, robotics arising from the introduction of industry 4.0 already have an impact and are expected to continue altering the world in various ways. Generally, robots are forms of automation involving motorized tools, which are now used in doing tasks such as cooking, recording shows, playing music, operate cars, and so forth (Xu et al. 2018). Companies such as Amazon are using robots to move goods around their warehouses and delivery orders to customers, which reduces operational costs and optimize usage of floor space. However, their potential remains unexploited, especially considering the advancements that are frequently introduced. In this regard, robotics is expected to not only continue improving the quality of life but also creating new opportunities for new jobs (Nicva 2018).

Last but not least, the advanced connectivity between computerized objects is and will continue offering new ways to automate. Notably, IoT is about the internetworking of physical devices, systems, and services in an attempt to create a network of interacting objects (Xu et al. 2018). Such forms of connectivity are advancing as the technology is being exploited even further. Subsequently, it has already been applied in creating smart grids and smart cities, which highly rely on fast data transmissions via the Internet. Such applications will continue to be introduced with time.

#### ***2.4.5 Interaction of humans and machines***

A major concept related to the fourth industrial revolution is the cyber-physical system (CPS), which is regarded as a key technology. Notably, it is at the core of the establishment of smart applications and intelligent processes in the production and manufacturing industries. Due to its introduction, factories, particularly of the future, are expected to find ways to meet demands that require fastened, flexible, and complex production processes, mainly due to the use of CPS to interconnect manufacturing centres. Notably, the interconnection of information and communication technologies is aligned with the concept of IoT since it supports the integration and establishment of structures to create value. Specifically, integrations in the fourth revolution can be seen in as sides: the vertical and the horizontal one (Tupa, Simota & Steiner 2017a). The latter represents the movement of information and collaboration within different hierarchical levels, including management, functional, and operational levels of an enterprise. On the contrary, the former indicates a close collaboration between several enterprises within the same value creation network (Tupa, Simota & Steiner 2017). *Figure 2* shows these integrations between people and systems using CPS, which is seemingly a core technology of industry 4.0 (Tupa, Simota & Steiner 2017).

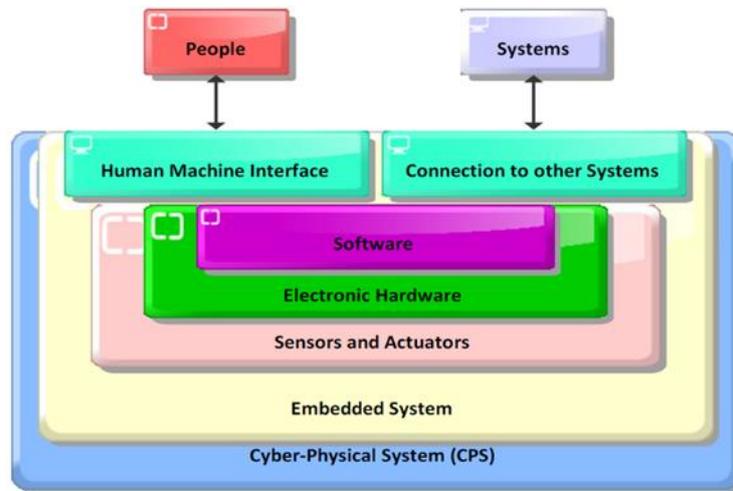


Figure 2 - Interaction of humans and machines via CPS

## 2.5 Project Management

### ***2.5.1 Defining a project and project management***

To explore the concept of project management it is important to first understand the meaning of the term project. It can be defined as a temporary and distinctive endeavor since the planners know when it will be started and ended, as well as the resources that will be used and what will be covered during this timeframe (Project Management Institute 2017). Furthermore, it is not a routine operation since its primary goal is to accomplish a set of objectives. Moreover, a project team represents the individuals that come together to work on these deliverables (Project Management Institute 2017). Examples of projects include the development of software, improving a business process, construction of buildings, and so forth. In this context, management of projects is about using relevant and available skills and procedures to realize a set of predefined goals (Project Management Institute 2017). Notably, project management is accomplished by applying and integrating the appropriate processes that are specific to the project at hand. The project management practices affect various professionals in the field, including project managers, supervisors, stakeholders, and such (Project Management Institute 2017). In other words, project management allows an organization to execute certain unique tasks effectively and efficiently.

### ***2.5.2 The Process of project management***

A project is managed procedurally, from the time it was initiated to the closing phase. The following analysis highlights the key processes characterizing the project management (*Five Phases of the Project Management Lifecycle* 2019). Notably, each of them is associated

with specific inputs and outputs that contribute to the achievement of the set project objectives.

### **Initiating**

It is the first step of the project lifecycle, and it is where the value and feasibility of the project are evaluated. Usually, project managers use various assessment tools to decide whether to start the project or not. Notably, evaluation considerations include:

- Business case document – it explains the need for the project and contains the estimation of the potential benefits, including possible financial gains.
- Feasibility study – it refers to the evaluation of project goals, timeline, and cost, all of which help to determine the ability to execute the project when various constraining factors are considered. Moreover, it collates all the requirements and accounts for available resources in an attempt to determine whether the latter is sufficient to meet the former, which would mean a completed project.

### **Planning**

Once the project manager approves of the project, a solid plan is prepared by the involved team members who are keen to maintain the set timeframe and budget. The planning phase is the actual guide on the amount of resources (money, time, materials) that should be used at every juncture. Thus, it directs the team to handle every aspect of the project, which indicates the output will be of reasonable quality milestones and risks will be controlled.

### **Executing**

This phase is the most important as it entails realizing the actual goals and delivering the various deliverables in a bid to satisfy the client. As a result, the project manager ought to apportion resources appropriately and keep the team fixated to the project. Notably, the execution phase highly relies on the planning phase since the idea is to meet each outlined milestone using the set budget and timeline, all of which are outlined in the project plan.

### **Monitoring and Controlling**

This phase overlaps several others, mainly the execution stage. Particularly, project managers and their teams ought to constantly monitor and control the project progress to ensure that it is within the schedule. The goal is to prevent scope creep and assess performance on the basis of key performance indicators.

## Closing

The final phase takes place after the project is completed and handed over to the client. Additionally, all other stakeholders are informed and the resources are made available for other endeavors. Thus, it is the time for project managers and their teams to evaluate the achievement of the goals and document their realization with a key emphasis on identifying the challenges and mishaps. The idea is to benchmark these errors when handling upcoming projects, which is likely to translate to more success.

### ***2.5.3 Project management knowledge areas***

The term “knowledge area” is used often in the field of project management. It alludes to critical technical factors that are needed for one to successfully manage a project. Such core subject matters include processes, practices, inputs, outputs, tools, and techniques (Project Management Institute 2017). In this regard, the following list highlights the nine main knowledge areas in project management as discussed by (Sarmad Hasan 2017) :

- **Integration management** – the processes and activities needed to combine, coordinate, and unify the project management process.
- **Scope management** – defining the deliverables and project problems that are required to complete the project.
- **Time management** – a set of processes required to manage project time.
- **Cost management** – it entails estimating and managing the costs incurred throughout the project.
- **Quality management** – consist of processes of planning, managing, and controlling the project or product quality vis-à-vis the stakeholders’ expectation.
- **Resource management** – it involves not only procuring resources but also managing them according to the project plan.
- **Communication management** – it is about ensuring that project information and data is flowing promptly and to the right stakeholders.
- **Risk management** – a critical factor involving the planning, identification, analysing, response planning, response implementation, and monitoring of risks related to the project.
- **Procurement management** – includes the aspects related to purchasing and acquiring products or services to complete the project effectively.

#### **2.5.4 Competencies of Project managers**

Various critical competencies determine the success of a project manager. Here, the term competency refers to an observable and measurable set of knowledge, skill, ability, and personal attribute that could develop an individual's performance, which results in implementing a successful project within the organization (Dziekoński 2017). In this regard, Integrated Project Management [IPM] (n. d.) identifies nine critical competencies, which are highlighted below:

- **Execution** – achieved through developing and managing the project's budget, schedules, and timelines. As well as, being able to employ strong skills and integrate risk management in the work processes.
- **Decision making** – the ability to collect available data and make the decision based on facts, needs, and circumstances, as well as being able to conduct scenario analysis.
- **Communications** – being able to convey information to the team, stakeholders, and the entire organization. Besides, it involves having appropriate communication tools to prepare and deliver presentations.
- **Strategy development** – the ability to understand the impact of a project on the overall organization, as well as integrating the goals of an organization to the project scope and deliverables and developing strategies that contribute to the organizational corporate targets.
- **Team management** – ability to motivate and inspire the team, and also lead by example through task delegation and proper management/resolution of conflicts within and outside the team.
- **Business acumen** – being able to understand the latest trends in the industry and quickly respond to changes that could affect the project or business.
- **Technical competence** – having the hands-on skills and tools needed to manage projects effectively
- **Critical thinking** – the ability to determine the validity of project progress and analyse the project's objective.
- **Leadership** – being able to take initiatives, guide the team, and react appropriately to situations.

## **2.6 Project Management and Industry 4.0**

At the core of industry 4.0 is the dynamic configuration of production mechanisms, which have significant differences with traditional methods. According to Win et al. (2018), such changes in the manufacturing sector have the potential to alter original designs to a significant extent. As a result, the shift will call for an integrated project management approach, hence compelling project teams to become more focused on specific objectives that stem from the adoption of various elements of Industry 4.0. For instance, business processes and tasks that currently do not require back-office support such as data analytics and designs will be gradually automated (Win et al. 2018). In this regard, it is paramount for project management professionals to adjust for them to survive.

Another notable aspect that will affect project management is the new technologies that will become mainstream with the introduction of industry 4.0, which are expected to affect it to a significant extent. Notably, technological breakthroughs such as IoT and AI will evolve a notch higher as the revolution unfolds to move from simple task automation to predictive project analytics, actions, and advice, as argued by Win et al. (2018). As a result, going into the future, they will change the way project tasks are not only managed but also delivered. Thus, despite the result benefits of these technologies, they will certainly affect project management in all ways possible, especially due to the increased expectations from customers and executive management after they realize the possibilities. In the end, project managers will be expected to deliver more in less time when compared to current practice (Win et al. 2018). In this regard, they ought to leverage the benefits of industry 4.0, particularly the technologies, to match future demand.

## **2.7 Risk Management**

Risk occurs in different forms and it affects an organization in varying ways. Specifically, the consequences could range from reduced economic performance to degraded reputation, environmental effects, security concerns, and societal calamities. As a result, risk management helps entities to continue with operations and perform normally in uncertain environments. Weaver (2008) defines risk as the presence of uncertain events that can lead to negative or positive impacts on projects' goals. In this context, risk management is the process of understanding and controlling these uncertainties through processes and frameworks that enable entities to meet their objectives. An example of such frameworks is the "Enterprise Risk Management" model that seeks to align risk management efforts with business strategies in an attempt to establish a risk management culture in the organization

(Ambrosone 2007). The underlying goal is to view risks as not only hazards but also opportunities since they are inevitable.

### ***2.7.1 Enterprise Risk Management***

In the last few years, the Enterprise Risk Management (ERM) has emerged, and it is a “plan-based business strategy” which aims to identify, assess and prepare for any kind of risks that may interfere with the business’s operation and objectives (Committee of Sponsoring Organizations of the Treadway Commission 2004).

There countless benefits of implementing ERM within the organization; first ERM could save the organization's resources such as time, assets, income, property and personnel, not only that but it protects the business's image and reputation. As well as, increase stability and improvements, improve stakeholder trust, enhance competitive advantage, etc. (Fadun 2013). There are different types of ERM models and frameworks, but this research will focus on two popular frameworks which are COSO ERM Framework and ISO 31000 – The principles, Framework, and Process of Risk Management.

#### ***2.7.1.1 COSO Enterprise Risk Management Framework***

The COSO ERM framework highlights the essential components and provides clear direction and guidance for Enterprise Risk Management; it defines ERM as the culture, capabilities, and practices that integrate with the organization’s strategy-setting, and it is seen as a purpose to manage risks that's through creating, preserving and realizing the value (Ambrosone 2007). There are two ERM framework, the first one that was introduced by COSO in 2004 called ERM-Integrated Framework, and it was recognized and adopted by many organizations worldwide. The constant changes in the business's environment and new risks emerged has led to a dramatic evolve in ERM thinking and practices. Therefore, the Committee of Sponsoring Organizations of the Treadway Commission (COSO) published a new framework in 2017, which known as the ERM- Integrating with Strategy and Performance (*What you need to know about the framework changes to Enterprise Risk Management 2017*).

*ERM Framework updated in 2017*



*Figure 3 - ERM Framework updated in 2017*

The 2017 ERM framework which is known as ERM- Integrating with Strategy and Performance is reflected more into the organization's culture, capabilities, and practices, as well as, corporate strategy-setting; also, manages risks is recognized in creating, protecting and realizing value within enterprises. It also it focuses on the organization's culture within its ERM practices, and the decision making in the ERM is highly important and management are aware of enhancing decision making at every stage of the value chain, and that's in strategy selection, the establishment of objective and performance targets, and resource allocation (COSO & WBCSD 2018).

It consists of five components and 20 principles; the five components influence the establishment of the organization's mission, vision, core values, strategy development, business objective formulation, and implementation and performance; which eventually leads to **enhanced value** (Cokins 2013).

Furthermore, the 2017 ERM framework breaks down the relationship between risk and strategy into three dimensions:

- Risk to the strategy; it highlights the risk that could affect the success of the selected strategy.
- Risk of the strategy; to evaluate strategies and if it is aligned with the organization's mission, vision and core values.

- The implication from the strategy; to consider the unintentional consequences of the selected strategies.

The components are as the following:

1. **Governance and culture**; this component includes 5 five of the 20 principles and it guides board oversight responsibilities, operating structures, the leadership's tone, and to attracts and develops the right individuals.
2. **Strategy and objective-setting**; this component emphasis on strategic planning and the recognition of the effect of internal and external factors on risks. This will enable an organization to analyse the business context, define risk appetite, and to formulate objectives.
3. **Performance**; after developing a strategy, the organization moves into identifying and assessing risks that could impact its ability to achieve these goals. Besides, it allows the organization to identify, assess, prioritize, and respond to these risks. Then, develops a portfolio view through developing and evaluating a portfolio view of risk.
4. **Review and revision**; after prioritizing risks and set of activities have been chosen, the organization starts on the review and the revision phase where changes are assessed, and it considers as an opportunity for the organization to understand the ERM process and how it can be improved.
5. **Information, communication, and reporting**; this last component consists of sharing information from internal and external sources of the organization. As well as, using systems to capture, process, manage, and report on the organization's risk, including culture and performance.

#### ***2.7.1.2 ISO 31000 Risk Management – Principles and Guidelines on Implementation***

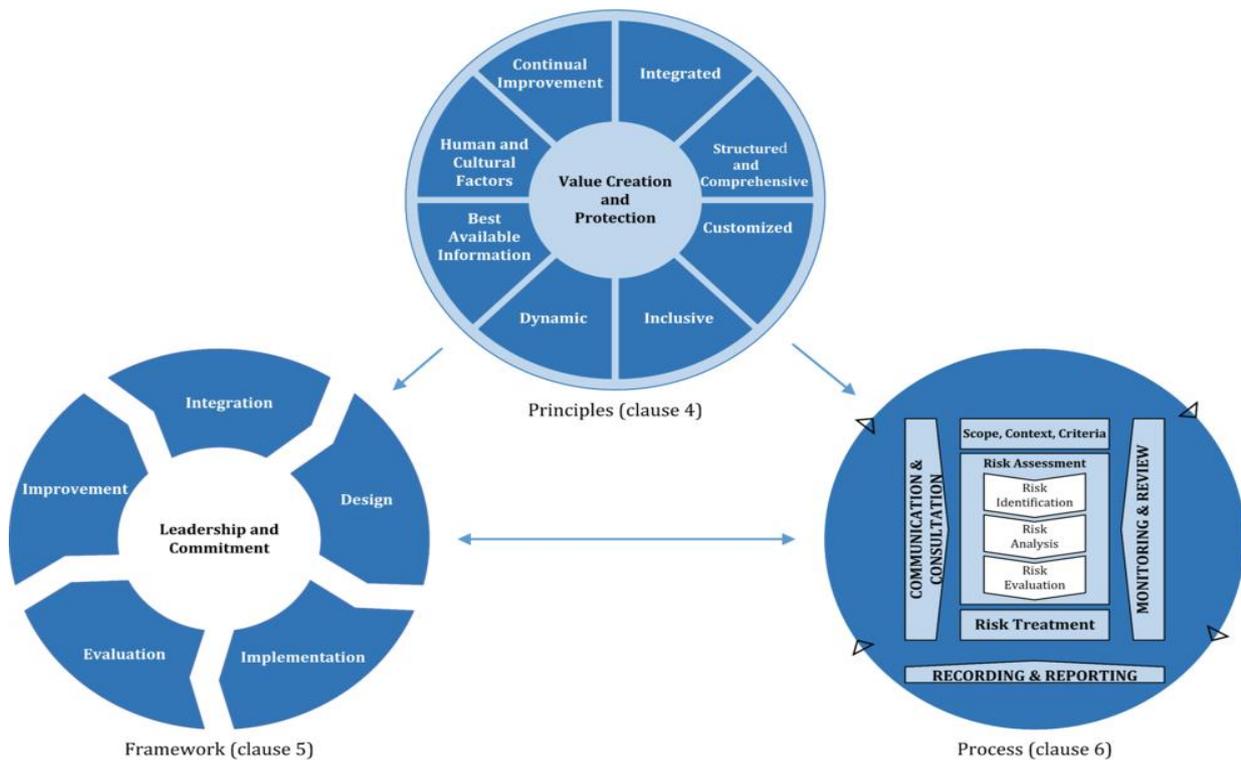
The term ISO stands for International Organization for Standardization; the ISO 31000:2018 - risk management consist of guidelines, principles, framework, and process for managing risks.

The ISO 31000 can be used by different types of organizations regarding their sizes, activities, and sector, as it helps organizations to increase the probability of success by achieving objectives while improving the way of identifying the opportunities and threats of risk, besides, to effectively allocate and use resources for risk treatment. However, ISO 31000 will guide organizations and allow them to compare their risk management practices

with an internationally recognized benchmark, which will provide the right principles for effective management and corporate governance (*ISO 31000 RISK MANAGEMENT 2018*).

### **The Principles, Framework, and Process of Risk Management**

This research will focus more on the ISO 31000 – The principles, Framework, and Process of Risk Management, as it will assist the project manager to focus on certain areas to increase the readiness for Industry 4.0. *Figure 4* demonstrates the ISO 31000: 2018 Risk Management Guidelines (ISO 2018).



*Figure 4 - ISO 31000: 2018 Risk Management Guidelines*

For further explanation, the research will focus on each area in ISO 31000. First of all, the **principles** which include eight effective risk management elements such as:

1. **Integrated**; which shows that risk management is an integral part of the entire organizational activities.
2. **Structured** and comprehensive; it contributes to reliable and comparable results.
3. **Customized**; it is customized and consistent with the organization's internal and external context to its objectives.
4. **Inclusive**; to include the involvement of stakeholders by allowing their participation, which enhance the risk awareness and risk management.

5. **Dynamic**; risk is the unexpected event it can occur, change or disappear as the organization's internal and external context changes; therefore, risk management will help to detect, acknowledge, and responds to the changes in inappropriate time.
6. **Best available information**; risk management inputs are based on historical and current data, as well as on future expectations. That is why it takes limitations and uncertainties into account with the association of data and expectation. Knowing that it has to be timely, clear and available to relevant stakeholders.
7. **Human and cultural factors**; those factors have a high influence on all aspects of risk management at each level and stage.
8. **Continual improvement**; risk management is improving continually by learning and gaining experience.

The risk management principles will assist the project manager in linking the framework and practices of risk management into the organization's goals and strategies, as well as, aligning risk management to the organizational activities. That is because principles include values which support a comprehensive and coordinated view of risk that applies to the entire organization.

The **framework** of risk management is to help in integrating risk management into the organization's activities and functions; the framework consists of:

1. **Integrating**; to integrate risk management in the organizational activities, project managers and top management will need to understand the organization's context and structure, with purpose and goals that is to enable everyone to manage risk in every part of the organizational structure.
2. **Designing**; when designing the framework of risk management, it is important to fully understand the internal and external context of the organization. The internal include the organization's vision, mission, and values, organizational structure and culture, strategies, objectives, and policies, etc.

While the external context includes: social, cultural, political, technological factors and more, key drivers of trends, and external stakeholders.

Moreover, designing is about assigning an organization's roles, authorities, and responsibilities, allocating resources and establishing communication and consultation.

3. **Implementing**; this is through developing a plan and decision making. To implement the framework successfully, it needs the engagement and awareness of stakeholders, as this will ensure addressing uncertainty in decision making.
4. **Evaluating**; for effective evaluation, organizations should be able to measure risk management framework performance and comparing it to its purpose and to determine if it is appropriate to support achieving the organizational objective.
5. **Improving**; the continuous monitoring and adapting the risk management framework to identify external and internal changes will allow organizations to improving their value.

Finally, the risk management **process** which consists of systematic application of policies, procedures, and practices with other activities such as communication, consulting, assessing, treating, monitoring, reviewing, recording and reporting risks. Besides, it is an essential part of management and decision making that is integrated into all organizational levels. It consists of:

1. **Communication and consulting**

It is to allow internal and external stakeholders to understand the risks, why certain decisions are made, and actions required. This will increase awareness and obtain feedback and information that support decision making.

2. **Scope, context, and criteria**

The purpose of this is to customize the risk management process, to allow effective risk assessment, and to select the suitable risk treatment. The scope refers to the organization's activities such as objectives, decisions, expected outcomes, time, resources, stakeholder, etc. The context is the internal and external environment of the organizations. While risk criteria should include the amount and type of risk, that is to evaluate the risk and enable it to make the right decision.

3. **Risk assessment**

It is the process of identifying, analysing, and evaluating risks; the risk assessment must be conducted collaboratively as this will allow the integration of the organization and its stakeholders for the best outcome. Then, using the best available information.

#### **4. Risk treatment**

To address risk, it is important to select and implement possible options that is through formulating options, planning and implementing, assess the effectiveness, and decide if it is acceptable or not (if not take further treatment).

#### **5. Monitoring and review**

This step will assure and improve the quality of process design, implementation, and outcomes. That is because it takes a place at each stage of the process, however, it should incorporate with the organizational performance management, measurement and reporting activities.

#### **6. Recording and reporting**

It is essential to document the outcome of the risk management process and it should be reported through proper mechanisms. This particular step aims to communicate the outcome across the organization, provide the necessary information, improve risk management activities, and interaction with stakeholders.

While leadership and commitment refer to top management or project managers to ensure that risk management is integrated to the organizational activities; for example: allocating resources to manage risks and to issue a policy that establishes a risk management approach (BS ISO 31000 : 2018 BSI Standards Publication Risk management — Guidelines 2018).

### **2.8 The relations between readiness, project management, industry 4.0, and risk management**

As it mentioned above, that readiness is to prepare businesses, people, or systems with planned action, through training, enhancing supplies and etc. (businessdictionary 2020). The project manager's readiness depends on identifying the project management process and how does it work, to identify the knowledge area to manage project successfully, and to project manager's competencies in terms of knowledge, skills, and personal attribute to enhance individual's performance (Project Management Institute 2017).

Nowadays, project manager readiness is essential in organizations and industries such as manufacturing, construction, healthcare, and education. The changes that are caused by the industrial revolution increases the importance of project manager's readiness in organization. Since industrial revolutions create new opportunities and risks, besides it causes the emerge

of new systems and processes; therefore, it is important for project manager to be prepared to such changes and that is through forecasting or identifying risk and opportunities by utilizing the risk management framework and process within the organizations.

Hence, this dissertation is to assess the readiness of the project management profession to Industry 4.0, and it helps to accommodate the amount of preparation needed for the current or the upcoming industrial revolutions.

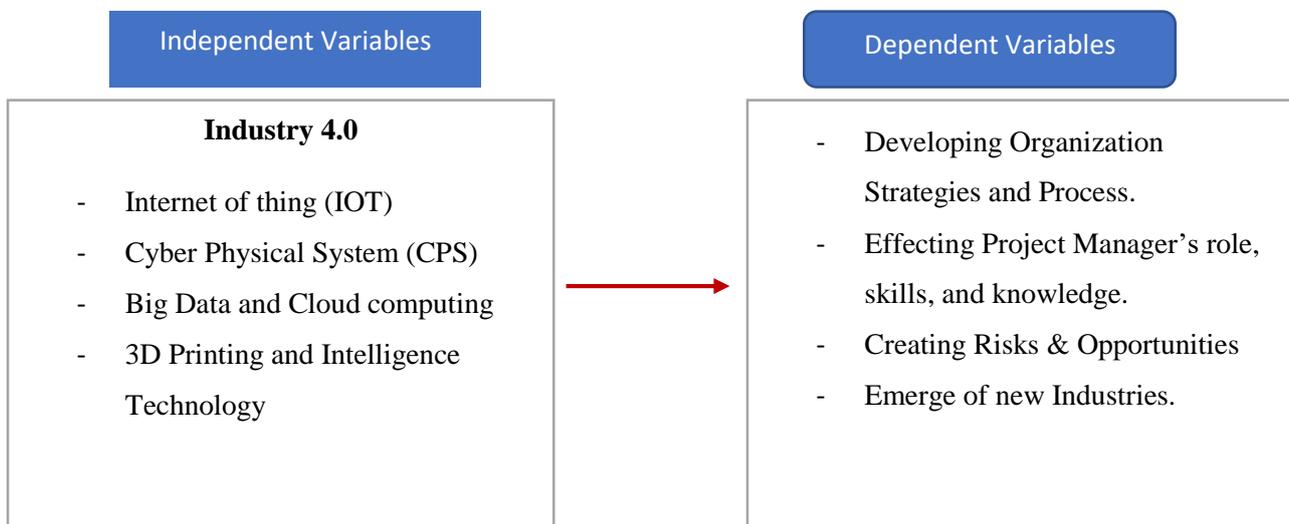
## 2.9 Conceptual Framework

The conceptual framework is the tool to bring different ideas together to support the main topic, aim and objectives. The variables in the conceptual framework are the areas of the study and this tool helps to map the expected relationship between them (PATTY MULDER 2017).

There are two variables independent and dependent variables:

- Independent variable: is the expected cause, predictor or the explanatory variable.
- Dependent variables: is the expected effect, response or the outcome of the independent variable (Swaen 2020).

The templet below explains the conceptual framework of this dissertation,



*Figure 5 - Conceptual Framework of Industry 4.0, Project Management Readiness, Risk Management*

The independent variables in the templet above demonstrate the causes of the dependent variables. The Industry 4.0 considered independent variables and it includes the IOT, CPS, Big data, Cloud computing and 3D printing; which play huge role in changing work processes in many industries such as manufacturing and construction.

That has led in causing a major effect on the industries, business, strategies, process, and the project management as well. First, organizations have developed it processes and strategies to keep up with current developments, such as using IoT and 3D printing in manufacturing processes instead of relying on manpower. Which consider as a negative effect on the workforce and decreasing the opportunities of employment; yet it has some positive effect such as shifting into a more accurate process and data, as well as, the completion of the work in less time.

Moreover, it effects the project management profession roles, skills and knowledge, therefore, project manager needs to be aware of the industrial revolutions and its consequences. The emerging of new industries has increased the level of competitiveness between organization which consider as both negative and positive effect.

## **2.10 Chapter Summary**

This chapter analyses and synthesizes existing literature related to readiness, industry 4.0 and project management. The considered theories suggest that it is inevitable for industry 4.0 to affect fields such as project management since modernization is a natural process. However, traditional project teams do not have the skills and competencies to match the impending demand. Thus, they ought to improve their capacity and adjust the gradual changes to capitalize on opportunities, mitigate risks, and survive in the profession. Regarding risks, research has shown that industry 4.0 will introduce various types of risks that will compel entities to change their approaches, strategies, models, values, supply chain, processes, skills, project expectations, and stakeholder relationships, hence calling for project managers to follow suit in making the relevant adjustments. However, an evident knowledge gap is the lack of a comprehensive analysis of project managers' readiness for industrial revolution 4.0. Subsequently, this research seeks to fill this gap using the case study of the United Arab Emirates.

## 3.0 Methodology

### 3.1 Introduction

In this chapter, the research design of this dissertation is discussed. Specifically, the data collection techniques, research strategy, data analysis methods, and such aspects are explained. The idea is to allow the reader to understand the methodological approach and assess the study's overall validity and reliability.

### 3.2. Research Outline

The research is organized into six main chapters as visualized in *Figure 6*. The first one is the introduction, which provides background information about the topic before discussing the research problem and outlining the research aim, objectives, questions, significance, and scope. As a result, it contextualizes the topic in a more specific manner. The second chapter is a literature review that thematically analyses and collates what other authors have said about various aspects relating to this phenomenon. Thirdly, the methodology chapter outlines the research design in an attempt to highlight the approaches and methods taken by the researcher to achieve the objectives. The next two chapters involve analysing and discussing the collected data to deduce relevant insights. The last chapter sums up the dissertation by providing a comprehensive conclusion as well as practical recommendations.



Figure 6 - Research outline

### 3.3 Research Approach

Notably, there are various types of reasoning that a researcher can use to construct knowledge, and the mainstream ones are deductive and inductive approaches. The former is a top-down approach that entails moving from general theoretical information to specific deviations that are derived from the encountered facts. Thus, a researcher may have a set of hypotheses that are based on a postulated mechanism, which they test to determine to determine whether the existing theories are applicable (Woiceshyn and Daellenbach 2018). On the contrary, an inductive approach takes an opposite path by following a specifics-to-general paradigm, where the status quo is empirically observed in an attempt to have new and in-depth understandings of the phenomenon (Woiceshyn and Daellenbach 2018). In this case, the focus is to assess the readiness of UAE's project managers in the wake of the industry

4.0. As a result, the inductive approach is the most suitable way of understanding the available facts related to this topic.

### **3.4 Research Strategy**

Like the case with approaches, a researcher can decide on the most appropriate strategy to adopt. In this research, a quantitative survey will be used to complement the literature review in achieving the outlined objectives. Specifically, a questionnaire consisting of ten questions was developed and sent via the Internet to all targeted participants.

### **3.5 Methodological Choice**

There are two major types of research methodologies: quantitative and qualitative. The former entails obtaining numerical data and statistical analyzing it to generate research-relevant insights. Notably, the key features associated with this method include the formal and systematic measurement of variables and the use of statistics to interpret the findings. This type of data can be sourced from the help of various instruments, including surveys and questionnaires. On the other hand, the qualitative method does not focus on numbers and numerical data; rather, it mainly involves observations, opinions, ideas, and other textual data. Moreover, this method is often associated with rich data since leads to the generation of in-depth views about the subject matter. The choice of the available options is largely dependent on the nature of research.

In this research, a mixed methodology was considered the most appropriate. Particularly, the researcher is keen to collect objective data that can be used to generalize the situation in the United Arab Emirates. Most significantly, the questions required both numerical and textual answers, an indication that both qualitative and quantitative data were collected. Having a semi-structured questionnaire with open-ended and closed-ended questions was an easy and inexpensive way to collect these types of data without necessarily having personal contact with respondents. Furthermore, the summarized and combined responses give a comprehensive overview of respondents' opinions.

### **3.6 Data Collection**

As noted earlier, a questionnaire will be the primary data collection instrument. Notably, it was developed based on the research aim, which has four key themes: project manager, industry 4.0, industries, and risk management. Collectively, questions about these aspects were expected to help in exploring the readiness amongst UAE project managers in relation to industry 4.0. Additionally, their responses were the cornerstones in developing recommendations for increasing the level of readiness. This questionnaire will be conducted

through an online survey, where respondents will be allowed to answer the questions at their convenient locations and time. Most importantly, each question was meant to achieve a specific purpose as outlined below.

**1. How ready are UAE’s project managers for industry 4.0?**

This question has a rating of 1 to 5 (1 = Poor, 2 = Fair, 3 = Good, 4 = Very Good, and 5 = Excellent). The question allowed the project managers to self-assess their readiness to embrace industry 4.0. Moreover, it acts as an introduction to the research by informing the respondents what the exercise will focus on.

**2. What is your job field?**

This question is closed and it contains five options: computers and technology, management and business, architecture and civil engineering, trade and transportation, and others. The goal is to obtain the specific demographics of the respondents.

**3. Project managers play a huge role in the adoption of industry 4.0.**

In this question, the participants were expected to indicate the extent to which they agree or disagree with the statement. Thus, the scaled approach helped in capturing the respondents’ awareness of the relevance of industry 4.0 to their profession. It also allowed the researcher to explore different opinions on the importance of the project manager’s role throughout the revolution.

**4. What are the opportunities introduced by industry 4.0?**

The question is an open-ended one as it allowed respondents to write their opinions in a comment box. The list was collated and the researcher was able to identify common themes, which represents the perceived opportunities. Notably, the assumption is that some of the project managers are knowledgeable about industrial revolutions and that they are prepared to seize possible opportunities.

**5. What are the challenges that the project manager will face adjusting to industry 4.0?**

Another open-ended question was asked in an attempt to explore the perceived challenges that project managers associate with industry 4.0. Though the literature review section has extensively covered this issue, it is important to understand it from a project manager’s point of view. Furthermore, the answers are useful in developing relevant recommendations.

**6. Rank the most important competencies of a project manager in industry 4.0 from the best to the least.**

A list of competencies that are considered to be congruent with industry 4.0 were provided. They include task execution, decision making, communication, strategy formulation, teamwork, technical skills, critical thinking, and leadership. The ranking was

useful in finding the skills that UAE's project managers consider to be the most important going forward.

#### **7. How will the project manager adjust to changes caused by the industrial 4.0?**

As suggested, this question is also open-ended. Its underlying goal is to assess the individual preparedness to adjust to the impending changes. The answers constitute a set of strategies that UAE project managers could use to respond to the changes in the various fields, hence making the question helpful in devising practical recommendations.

#### **8. Which industry will be affected the most by industry 4.0?**

This question is a multiple-choice one that suggests to the respondent that industry 4.0 will have varying impact on different industries. Since they have already provided their affiliated fields, the question is useful in assessing whether they feel vulnerable to these changes or they feel that it will affect others. The choices are: manufacturing, construction, healthcare, and education

#### **9. Which Enterprise Risk Management (ERM) framework will work best in assisting project managers to increase their readiness for industry 4.0?**

This question is based on the assumption that standardized risk management approaches are suitable in mitigating the drawbacks associated with industry 4.0. Here, three options are provided: COSO ERM Framework, ISO 31000 – Risk Management Process, and both. Notably, explanations for the two options are provided to ensure that respondents understood what they entail. The responses were considered as an indication of preference.

### **3.7 Data Analysis**

The analysis of the collected data was two ways: qualitative and quantitative. The latter was analyzed through the generation of descriptive and inferential statistics while the former involved identification of common themes and patterns. The main difference is having both numerical and textual data arising from the closed-ended and open-ended questions, respectively.

### **3.8 Ethical Considerations**

This research involved human subjects, hence calling for the need to observe ethical considerations. Especially, the study participants were informed about the purpose of the study and they were expected to consent to be respondents. Additionally, the researcher ensured that the collected data was only used for the said purpose and that the data was held in confidential. Regarding the literature review, borrowed ideas were properly cited in an

attempt to credit authors for their contribution. The objective was to ensure that no one was harmed by this study in any way.

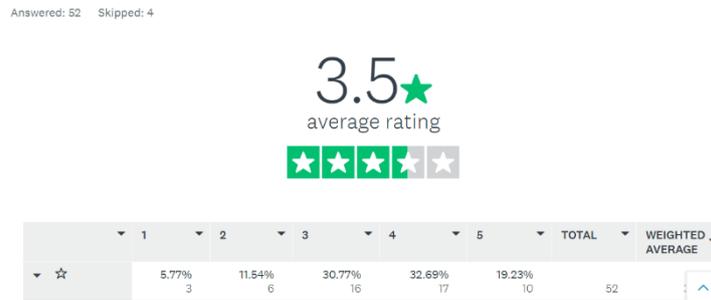
### **3.9 Summary**

This chapter has outlined the research design. Particularly, it shows the research approach, strategy, and method adopted and their relevance to this topic. Furthermore, it highlights the data collection and analysis tools that were used to obtain and deduce insights.

## 4.0 Data Analysis

This chapter is arguably among the most important since it presents the findings of the survey. Each question is analysed separately using graphical and textual methods. Note that the ten-question questionnaire targeted the UAE project managers working in different fields. The goal is to generalize the target population and report on what they collectively feel about the subject matters.

The first question of the survey is to perceived readiness for Industry 4.0; one of the most important inquiries was to allow the respondents to self-assess their readiness for industry 4.0. The assumption was that they were either aware of it or took time to find information since the questionnaire was sent online and they had enough time.



*Figure 7 - Q1*

| Rating   | 1               | 2               | 3              | 4             | 5                  | Results |
|--|-----------------|-----------------|----------------|---------------|--------------------|---------|
| The project manager is ready for Industry 4.0 in the UAE | Poorly Prepared | Fairly Prepared | Quite Prepared | Very Prepared | Excellent Prepared |         |
| Percent  | 5.77%           | 11.54%          | 30.77%         | 32.69%        | 19.23%             | 3.48    |
| Number of Respondents                                    | 3               | 6               | 16             | 17            | 10                 | 52      |

*Table 3 - Q1*

The results show that the majority were very prepared (N=17, 32.69%), quite prepared (N=16, 30.77%) or excellently prepared (N=10, 19.23%), hence collectively accounting for 82.69% of the total responses. Notably, 4 participants abstained from this question because they could not estimate their preparedness or for other reasons. The overall rating is 3.48/5.0, which suggests that UAE project managers feel prepared for the revolution to a certain extent. As shown in *Figure 6* and *Table 3*.

The second question indicates the job fields of the respondents, which shows the knowledge and background the respondents have on the readiness of industry 4.0 (see *Figure 7*).

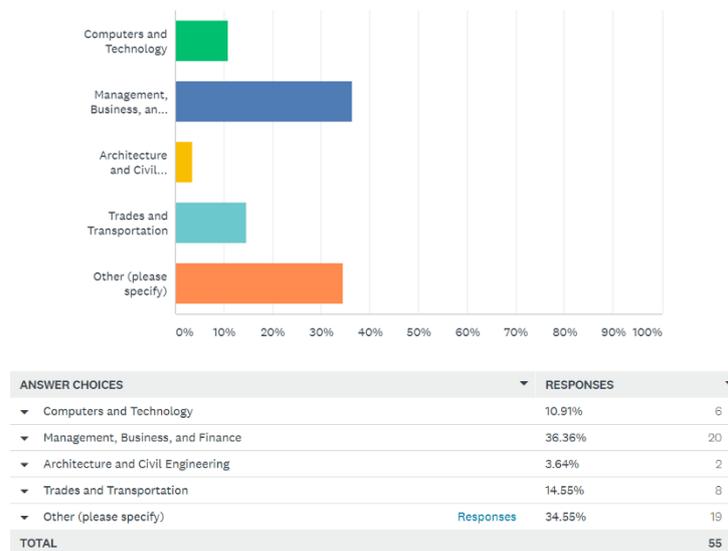


Figure 8 - Q2

The most common field is management and business (36.36 %), followed by trade and transportation (14.55 %), computers and technology (10.91 %), and architecture and civil engineering (3.64 %).

In the third question the respondents were asked to rate the extent to which they feel they will play a huge role in the adoption of the industry 4.0. As it shown in Figure 8, 96.36% respondents agreed that project managers role plays a huge part in the adoption of industry 4.0, while the remaining 3.64% disagreed (see *Figure 8*).

The project manager role plays a huge part in the adoption of the involvement of industry 4.0.

Answered: 55 Skipped: 1

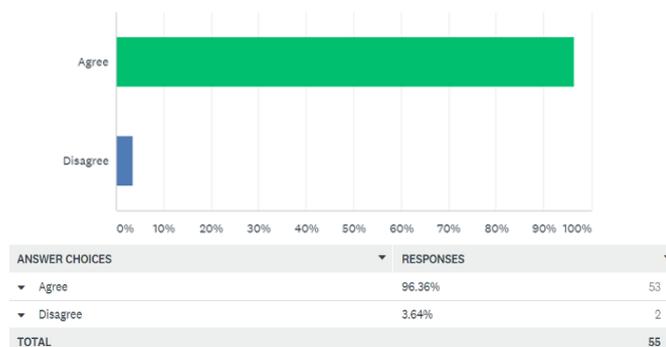


Figure 9 - Q3

A follow-up question was posed to ask the participants why they made that choice. A common theme was that most of them were acquitted with the trends affecting their

respective fields. For those who agreed with the statement, the following are some of their reasons:

- They have to determine project resources, which means that they have to understand the new requirements inspired by industry 4.0.
- Industry 4.0 will introduce new types of projects due to the technologies it will bring forth, and being project managers, they will be at the centre of it.
- The industry is likely to transform the workflow processes of various projects, hence calling for their attention to remain efficient in delivering the objectives.
- With the new dimensions of project management, project managers should help their team members to have a clear view of the changes introduced by industry 4.0.
- Industry 4.0 will significantly change the project manager's role since PM professionals are at the centre of delivering and adapting the organization to these changes.
- Project managers are often the ones who select their project teams. As a result, they ought to understand the new technical and soft requirements arising from the introduction of industry 4.0.

The fourth question was an open-ended question about the opportunities created by the Industrial fourth. This allow respondents to write their opinions in a comment box, since they used different wordings and expressions. The following are the main opportunities that will be brought by industry 4.0 according to respondents:

- Create new job opportunities
- Triggering economic growth
- Introduction of new technologies, which will increase error detection and chances of it
- Increased productivity and process efficiency
- Workflow automation, hence reducing budgets and leading to higher quality
- Increased creativity and competitiveness in the market
- Improved quality of life and income levels
- New businesses in different industries
- Open opportunities for research
- New strategies of enhancing work processes, especially in the manufacturing industry

- No system where artificial intelligence is in charge of itself will not be good
- Reduced labour costs.

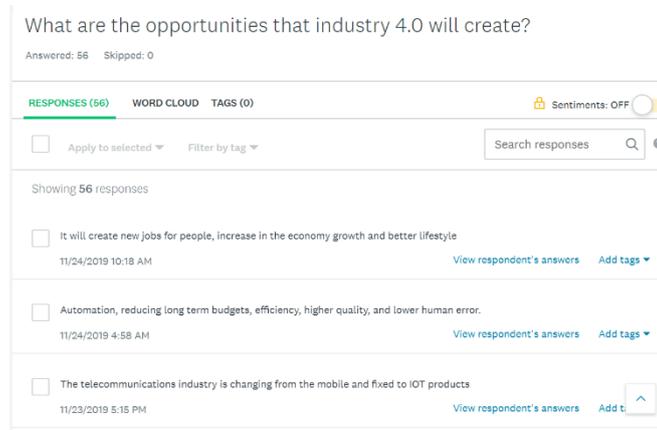


Figure 10 - Q4

The question five allow the researcher to explore the challenges that project managers are likely to face while adjusting to industry 4.0, at least according to their perspective. Being an open-ended question, it was important to analyse the opinions in an attempt to pick out the relevant choices. The following are common challenges:

- Ability to adopt new technologies such as IoT
- The introduction of “immature” technologies whose development is still in progress
- Lack of appropriate skills to match the new competence
- The cost implication of upgrading and automating processes and equipment
- Security of new infrastructure against cyber threats related to industry 4.0.
- The challenge of adapting and developing new project management strategies
- Changes in organizations’ objectives to cope with industry 4.0
- Difficulties in delivering heightened expectations and deadlines
- Effect of industry 4.0 on organizational culture, hence affecting the project manager’s role
- Conflicts arising from miscommunication amongst stakeholders
- Lack of proper training for those professionals already in practice.
- Challenges of reducing human resources
- Lack of precedent in the application of certain paradigms, which means that project managers lack historical records to reference.

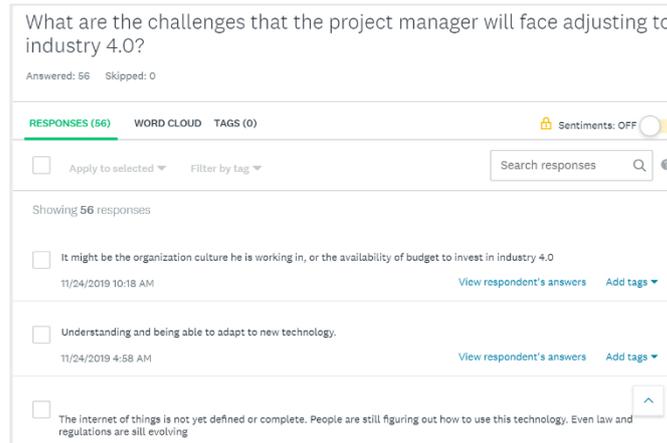


Figure 11 - Q5

In the sixth question the respondent is asked to rank the project management most important competencies to the least. The underlying goal was to rank them on the basis of their usefulness and relevance in the case of project management views on how important the competencies are in relation to Industry 4.0 and the readiness for the upcoming industrial revolutions. The results show that decision making (5.27), leadership (5.13), communication (4.73), strategy development (4.63), and team management (4.55) were ranked the highest, while critical thinking (3.54) is the last (see *Figure 11*).

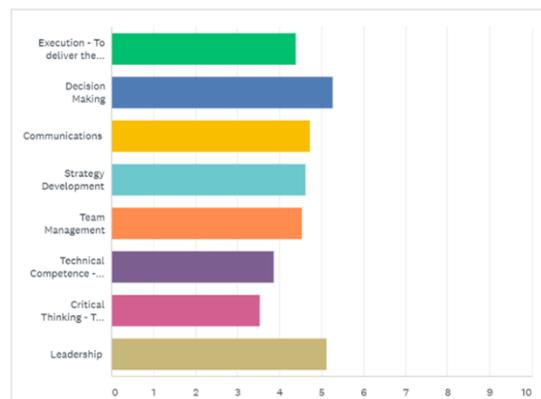


Figure 12 - Q6

|   | Competencies         | Score |
|---|----------------------|-------|
| 1 | Decision Making      | 5.27  |
| 2 | Leadership           | 5.13  |
| 3 | Communication        | 4.73  |
| 4 | Strategy Development | 4.63  |
| 5 | Team Management      | 4.55  |
| 6 | Execution            | 4.39  |
| 7 | Technical Competence | 3.88  |
| 8 | Critical Thinking    | 3.54  |

Table 4 - Important Competencies in Relation to Industry 4.0

Question 7 is an open-ended question that assess the preparedness of the project managers to adjust to the impending changes caused by the industrial revolution. Viewed differently, the answers represent some of the strategies that the respondents could use to respond to the changes in their various fields. The following is a list of the common responses to this question:

- Increase awareness of what industry 4.0 entails
- Training and workshop programmes
- Constituting project teams with the needed skills
- Through practice and hands-on experience
- Mentorship programs by experts of various technologies
- Changing organizational approaches to adapt to the changes
- Preparing contingency plans beforehand
- Gradually integrating new technologies with existing work processes
- Efficient communication with the project team.

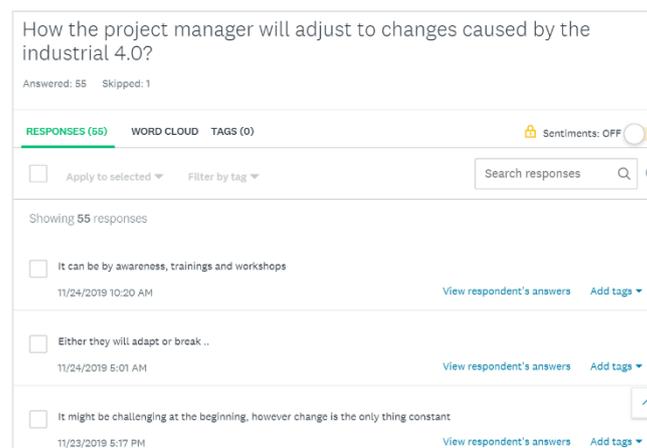


Figure 13 - Q7

Question 8: Project managers practice in many industries. In this regard, it was important to obtain a collective view of the most vulnerable sector. This question is based on the assumption that project managers are the ones who understand the dynamics of the profession, hence being able to determine the areas that are likely to receive shakeups following a revolution.

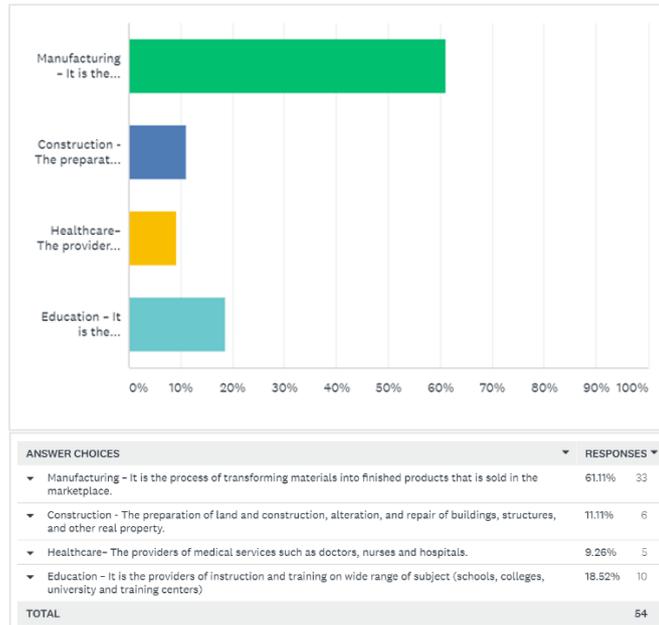


Figure 14 - Q8

The results show that the manufacturing sector is the one likely to be affected the most, followed by education, construction, and healthcare, respectively (see *Figure 13*).

In question 9 – respondents were asked to choose between the Enterprise Risk Management Framework (ERM) that will work best in assisting project manager in increasing their readiness to the industrial revolutions. This research postulate that standardized risk management approaches are useful in mitigating the risks arising due to the introduction of industry 4.0. However, various frameworks are suitable for different contexts.

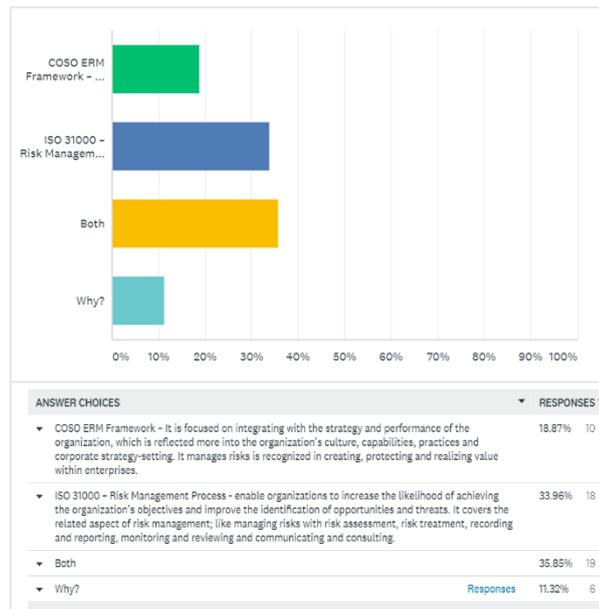


Figure 15 - Q9

The results show that the ISO 31000 – Risk Management Process was the most preferred at 33.96%. However, a good number of respondents (35.85%) said that both frameworks applied to their case, while only 18.87% picked the COSO ERM Framework (see *Figure 14*).

## 5.0 SPSS

### Results

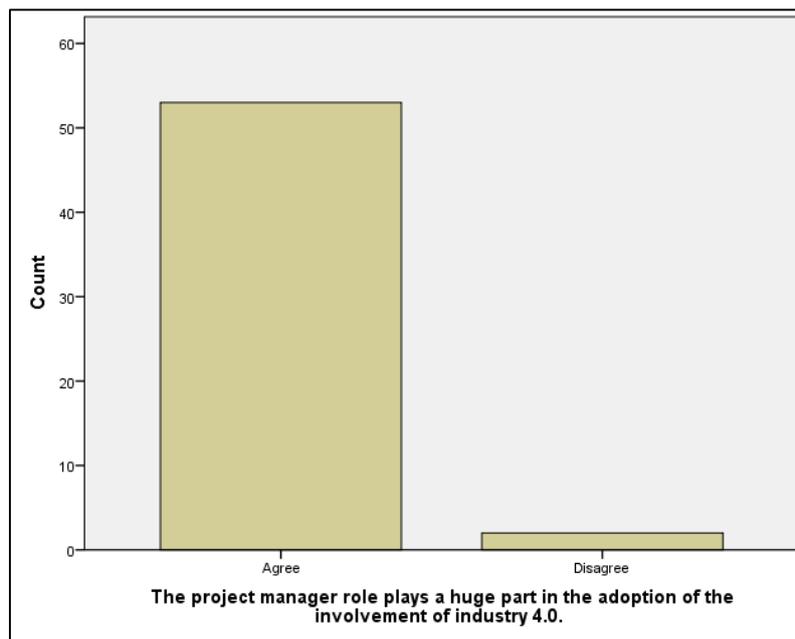
#### Data preparation

The questionnaire design was consisted of both open and close ended questions. These open-ended questions were analysed closely to derive variables with categories where each answer belongs. Thus, the variables such as opportunities, challenges, changes and risk were recoded into separate variables.

#### Data analysis

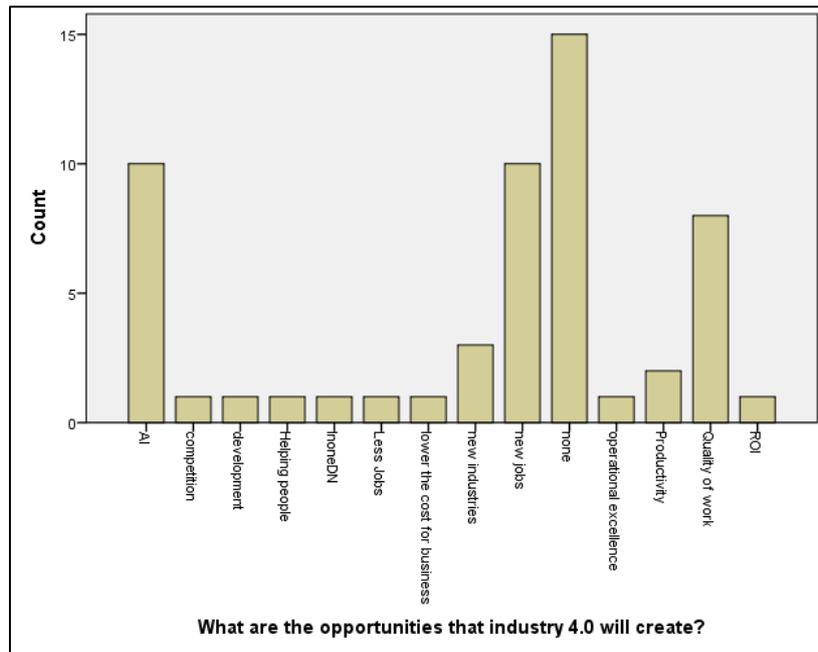
The below graph represents the perception of the project managers on the important of their role in the adoption of the involvement of industry 4.0. Most of the respondents agreed and only two respondents disagreed with the statement.

**Figure 1**



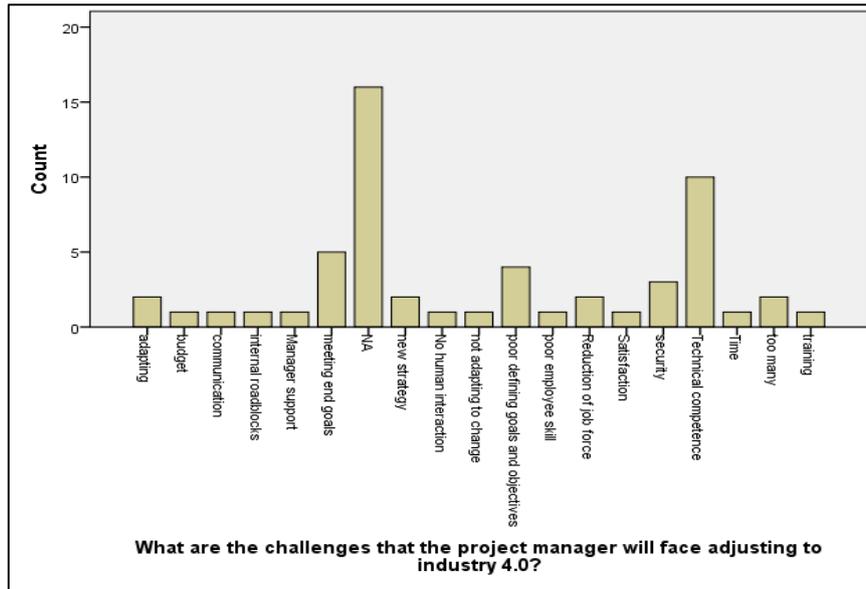
Most of the respondents did not answer the question or have no clear idea about the new opportunities that the industry 4.0 will create. A considerable number of individual thinks that industry 4.0 will lead to new job opportunities or artificial intelligence and automation would take over the industry with the new adoption and involvement of industry 4.0. The other opportunities which were suggested by the respondents are quality of work, new industries and factories and competition.

**Figure 2**



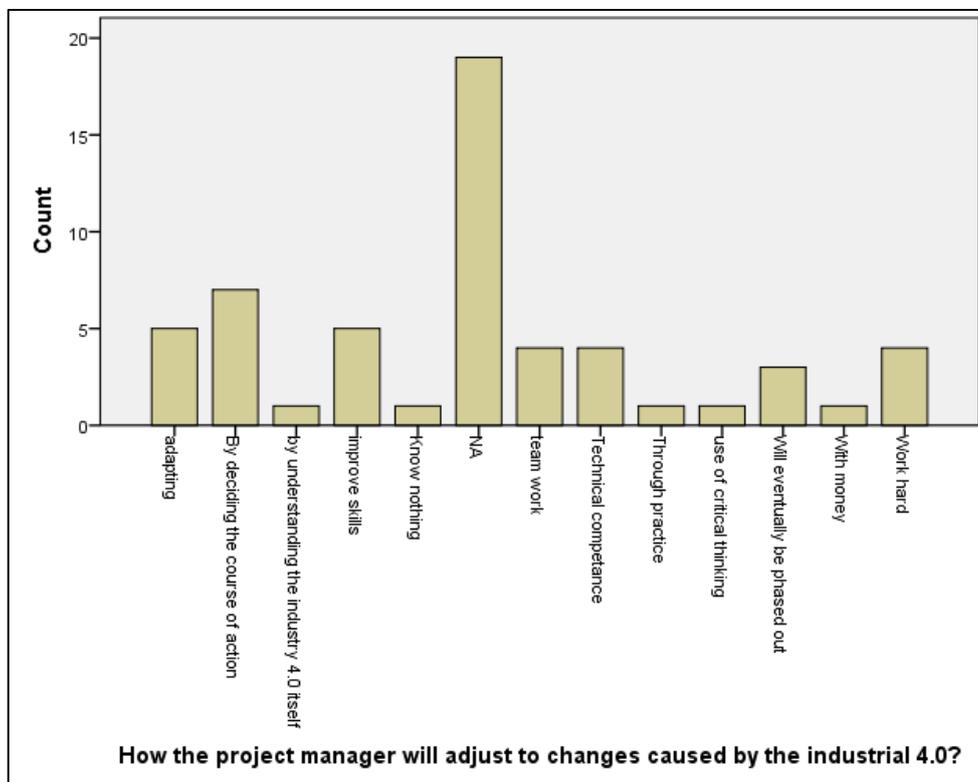
The adoption of industry 4.0 is a new revolution and the project managers being most responsible persons who are at the sharp end of the delivery change may face various challenges and risks. Most respondents did not have any opinion about the question and apart from that most of them perceived technical competencies as the biggest challenge. The poor definition of goals and objectives, and also meeting the end goals delivering the final outcome are the other challenges explained by the respondents.

**Figure 3**



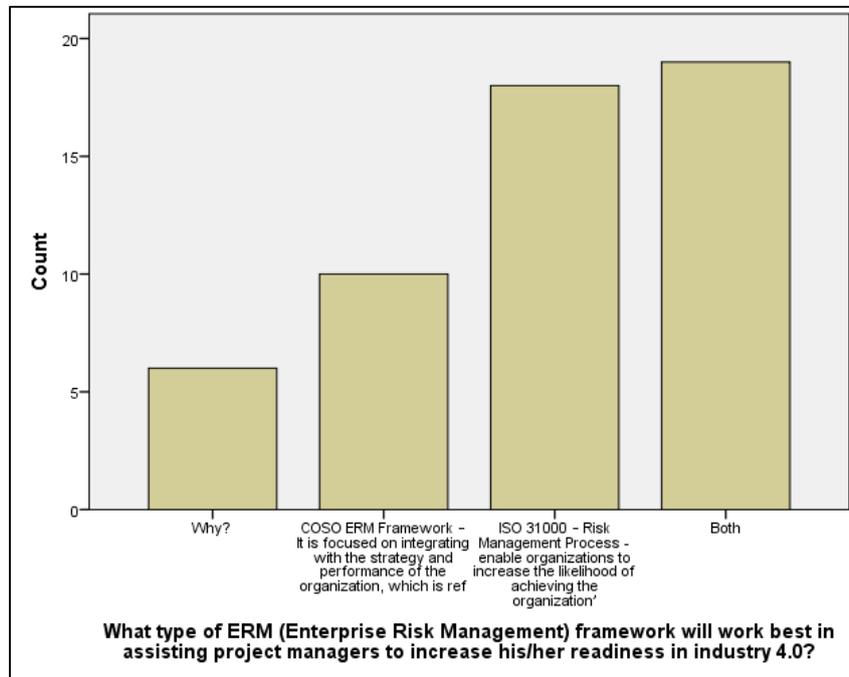
The change of every aspect of the roles, goals and work is a part of revolution and the below graph explains the changes that has to be faced by project managers adjust to the impending changes caused by the industrial revolution. Most of the respondents did not had any opinions about the fact. Most respondents answered the teamwork, deciding course of action and improving skills as better ways to adjust with new changes.

**Figure 4**



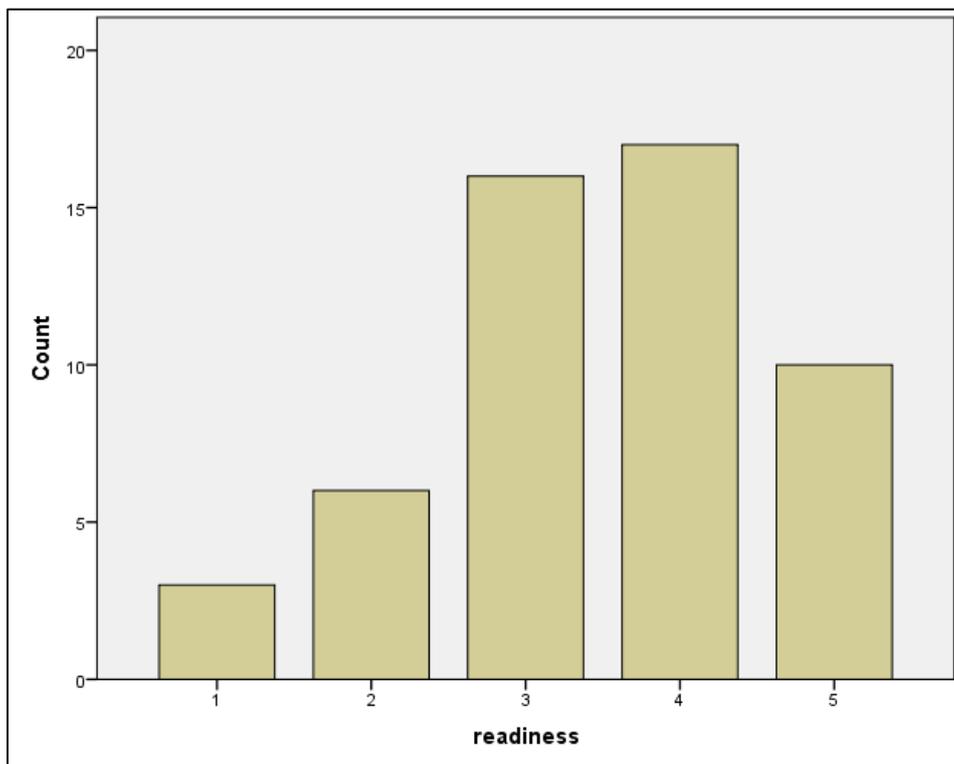
The perception on the ERM frameworks were asked from the respondents and most of them voted on both of the ERM frameworks as best for the risk management purpose.

**Figure 5**



**The impact of the industry 4.0 to the readiness of the project managers**

**Figure 6**



The readiness of the project managers was measured by using a score from 1 to 5 where 1 represents poorly prepared and 5 represents excellently prepared. Most individuals are quite prepared or vary prepared where only few are poorly prepared.

The association of the readiness of the project manager to the job fields were examined as follows using a statistical test. Both the variables are categorical variables with each having 5 categories. Thus, the chi square test was applied in order to examine the association between the two variables. The hypotheses for the test are as follows.

H0: Two variables are independent of each other

H1: Two variables are associated with each other

**Table 1**

| readiness * What is your job field? Crosstabulation |   |                              |                                |  |  |                                  |       |
|---|---|------------------------------|--------------------------------|--|--|----------------------------------|-------|
| Count   |   |                              |                                |  |  |                                  |       |
|   |   | What is your job field?      |                                |  |  |                                  | Total |
|   |   | Other<br>(please<br>specify) | Computers<br>and<br>Technology | Management<br>, Business,<br>and Finance | Architecture<br>and Civil<br>Engineering | Trades and<br>Transportati<br>on |       |
| readiness   | 1 | 2                            | 0                              | 1  | 0  | 0                                | 3     |
|   | 2 | 5                            | 0                              | 0  | 0  | 1                                | 6     |
|   | 3 | 6                            | 1                              | 6  | 1  | 2                                | 16    |
|   | 4 | 4                            | 2                              | 9  | 0  | 2                                | 17    |
|   | 5 | 1                            | 3                              | 3  | 1  | 2                                | 10    |
| Total   |   | 18                           | 6                              | 19                                       | 2  | 7                                | 52    |

**Table 2**

| Chi-Square Tests  |                     |    |                                   |
|---|---------------------|----|-----------------------------------|
|   | Value               | df | Asymptotic Significance (2-sided) |
| Pearson Chi-Square  | 18.391 <sup>a</sup> | 16 | .302                              |
| Likelihood Ratio  | 21.058              | 16 | .176                              |
| Linear-by-Linear Association  | 4.315               | 1  | .038                              |
| N of Valid Cases  | 52                  |    |                                   |
| a. 21 cells (84.0%) have expected count less than 5. The minimum expected count is .12. |                     |    |                                   |

As in the above tables most of the respondents is working in the field of finance and least of them are from the field of civil engineering. The readiness has scored from 1 to 5 which represents poorly prepared to excellently prepared. Most of the participants are very prepared and least of them are poorly prepared. The chi-square test has a p-value of 0.302 which is greater than 0.05. Hence, the null hypothesis can be rejected under 5% significance level. Thus, there is no association between the readiness of the project managers and the field they are working on.

The association of the readiness with the opportunities, challenges, changes and risks of adopting industry 4.0 was tested by using chi-squared statistics under the null hypothesis of independence of the variables.

**Table 3**

| Variable      | Chi-square value | p-value |
|---------------|------------------|---------|
| Opportunities | 46.778           | 0.523   |
| Challenges    | 75.498           | 0.366   |
| Changes       | 34.509           | 0.715   |
| Risk          | 12.355           | 0.418   |

The readiness of the project managers is not associated with the challenges, changes, opportunities or risks of industry revolution. The introduction of industry 4.0 can does not impact the readiness of the project managers.

## Association between the competencies of the project manager and the readiness

**Table 4**

| Competency  | Chi-square value | p-value |
|---|------------------|---------|
| Execution - To deliver the project expected results | 31.471           | 0.297   |
| Decision making                                     | 18.394           | 0.783   |
| Communications                                      | 34.580           | 0.182   |
| Strategy development                                | 18.213           | 0.921   |
| Team management                                     | 25.859           | 0.581   |
| Technical Competence                                | 28.179           | 0.455   |
| Critical thinking                                   | 23.601           | 0.702   |
| Leadership  | 26.854           | 0.526   |

The above table represents the chi-square test results for the association between the readiness of the project managers and their competencies. None of the considered competencies are associated with the readiness of the respondents.

**The importance of the project management role and the industry mostly affected by industry 4.0**

**Table 5**

| <b>The project manager role plays a huge part in the adoption of the involvement of industry 4.0. *</b> |          |  |   |   |   |       |
|---|----------|--|---|---|---|-------|
| <b>What is the most industry that will be affected by industry 4.0? Crosstabulation</b>                 |          |  |   |   |   |       |
| Count   |          |  |   |   |   |       |
|   |          | What is the most industry that will be affected by industry 4.0?   |   |   |   | Total |
|   |          | Manufacturing<br>– It is the process of transforming materials into finished products that is sold in the marketplace. | Construction -<br>The preparation of land and construction, alteration, and repair of buildings, structures, and other real | Healthcare–<br>The providers of medical services such as doctors, nurses and hospitals. | Education –<br>It is the providers of instruction and training on wide range of subject (schools, colleges, university an |       |
| The project manager role plays a huge part in the adoption of the involvement of industry 4.0.          | Agree    | 33   | 6   | 5   | 8   | 52    |
|   | Disagree | 0  | 0   | 0   | 2   | 2     |
| Total   |          | 33   | 6   | 5   | 10  | 54    |

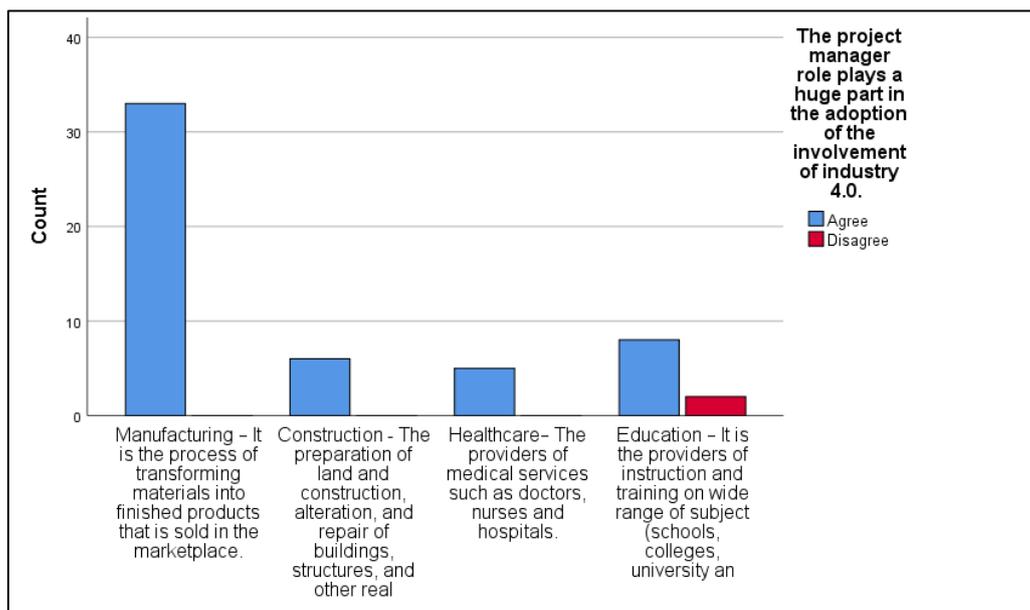
**Table 6**

| <b>Chi-Square Tests</b> |                    |    |                                   |
|-------------------------|--------------------|----|-----------------------------------|
|                         | Value              | df | Asymptotic Significance (2-sided) |
| Pearson Chi-Square      | 9.138 <sup>a</sup> | 3  | .028                              |
| Likelihood Ratio        | 7.100              | 3  | .069                              |

|  |       |   |      |
|--|-------|---|------|
| Linear-by-Linear Association   | 6.613 | 1 | .010 |
| N of Valid Cases   | 54    |   |      |
| a. 5 cells (62.5%) have expected count less than 5. The minimum expected count is .19. |       |   |      |

Most of the respondents have agreed with the fact that the project management role is very important in the process of adopting the involvement in industry 4.0. Also, most of the participants thinks that the manufacturing industry will be affected by industry 4.0 than other industries. The opinion on the importance of the role and the field that will affected by industry 4.0 are highly associated with each other. Almost all the respondents who thinks that the manufacturing industry will mostly be affected by industry 4.0 agrees with the fact that the project management role is very important for adoption of industry 4.0.

**Figure 7**



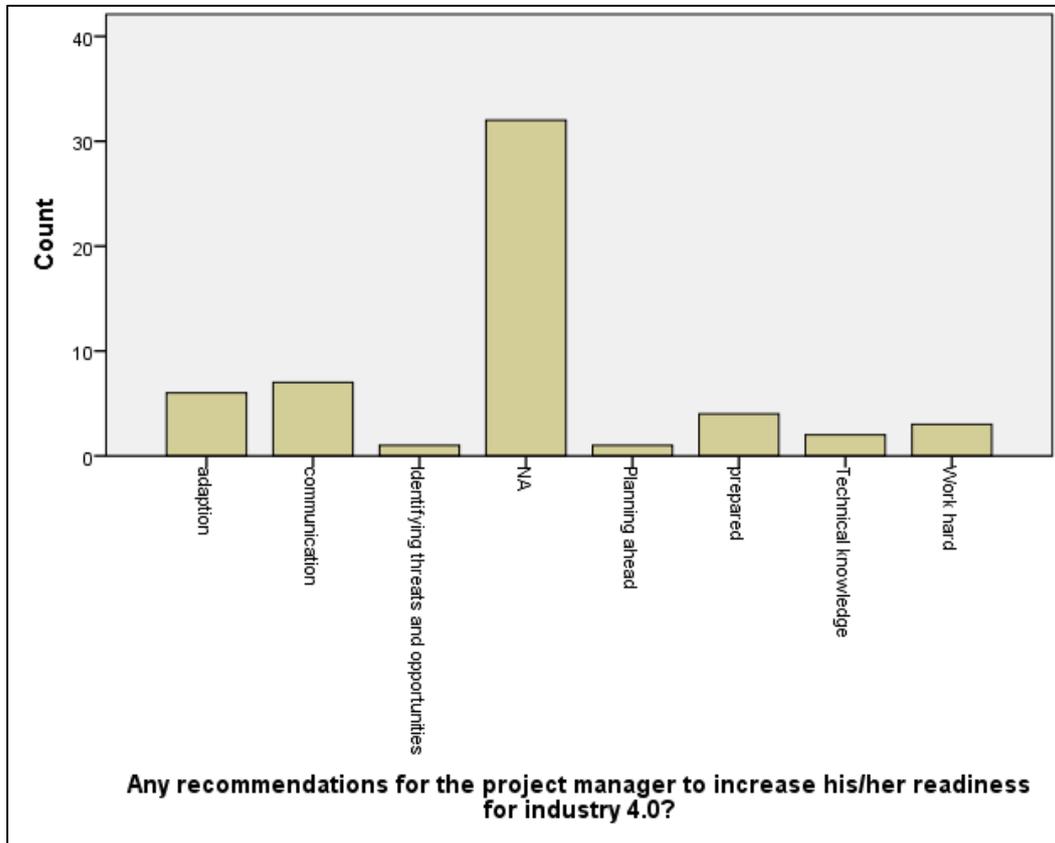
Only two respondents have disagreed with the fact that the project manager is an important role. They both think that the education industry will mostly be affected by the industrial 4.0.

### **Key practices and strategies that can improve project managers' readiness in relation to industry 4.0**

Most of the respondents did not provide any opinions on the ways that can improve the project managers readiness for the industry. The communication, adaptation and preparing ahead of

times can be considered as most common types of recommendations given by respondents in order to improve the readiness.

**Figure 8**



### **Discussion**

The impact of the adoption of industry 4.0 to the profession of project management was accessed by using different factors such as opportunities, challenges, changes and risks. The project managers themselves consider them as an important role to the industries. The industry 4.0 can lead to new job opportunities, factories and industries while stepping into the automation of everything using new technologies. When aligning with the new revolution, the project managers will have to improve their skills, technical competencies and will have to adapt to the new processes taking up new challenges. The project management profession is related to the industry 4.0 as the project managers are the personals who are associated with the deliverable outcomes from the beginning to the end of a project in a cooperative environment. Thus, the adoption of industry 4.0 directly impact the profession in considerable number of ways.

As explained by the above analysis, with the expected number of new opportunities, technology and automation, the project managers will have to face the new competencies and will have to adapt to the change by improving their skills and knowledge in a fast-phased environment. Even the industry revolution provides new opportunities, it comes aligned with a number of associated risks as well.

The biggest challenges of the industrial revolution are technical competencies, meeting the end goals inside a newly designed frame of responsibilities, etc. The perception on the readiness of the project managers on the other hand were accessed initially and most of the respondents are in the state of quite prepared to very prepared. There is no any statistically significant association between the readiness and the various challenges they think they will have to face. Also, the changes, opportunities and risks associated with the adoption of the industry 4.0 are not associated with the readiness of the project managers.

The perception on the improvement of the readiness of the project managers were measured by using an open-ended questions. When examined more closely, it was found that most of the respondents have been recommended communication, being prepared ahead of time and adapting to the changes as ways to improve the readiness of the project managers.

## 6.0 Discussion

In this chapter, the gathered information in relation to project manager readiness is critically analysed, particularly in light of the literature review. As highlighted in chapter 1, the objectives of this dissertation are; (1) to review the literature concerning industry 4.0 and its integration to project management, (2) identify the different risks and opportunities arising from the introduction of industry 4.0 in project management, (3) review the literature on project management readiness with a focus on project management profession, (4) examine the extent to which industry 4.0 has an impact on project management profession readiness, (5) review the current state of UAE project management practices in relation to industry 4.0, and (6) propose an integrated framework which will improve project managers' readiness for the introduction of industry 4.0. The first three have largely been answered by the literature review section while the remaining three have mainly been addressed in the survey.

Notably, the study considered the assertion that project managers should be able to identify the current status of the industry and its trends, as well as means of implementing the changes to their organization's projects and work processes. As noted in the survey results, it is evident that project managers agree that flexibility, adaption, and preparedness for future changes should be one of their key traits. Subsequently, they should be able to plan and react to dynamics associated with industry 4.0, which include educating individuals about the changes that will emerge from the fourth industrial revolution. Moreover, the current research has found that most project managers (96.36%) believe that their role plays a huge part in the adoption of industry 4.0. Thus, they acknowledge that industry 4.0 has a significant impact on the project management profession.

Risk assessment has been identified as one way of assessing the current states of project management as well as the perceived impact of industry 4.0 on the profession. Chapter two of this research shows that various categories and types of risks are likely to affect project managers and their profession. As a result, they need to be prepared to address each one of them. However, common themes on the respondents' answers show that UAE's project managers are mainly concerned about three categories of risk: economic, social, and technological. For instance, most of them indicated that new technologies will require additional costs to automate and replace certain processes. Furthermore, they stated that investment is required to match the demands of industry 4.0, particularly in implementing

infrastructure and obtaining necessary skills. Moreover, they were concerned about the competition that will arise among them as they learn new methods and prove their ability to meet heightened requirements and shortened deadlines. Other technology aspects that came up include cyberattacks, data security, and implementation of futuristic technologies such as IoT, which is the backbone of smart manufacturing plants. On the social aspect, they expressed their worry that some of them may lose jobs due to shifting competencies; organizational structures, leadership, and communication channels will change; work processes will be replaced, and it will be imperative to obtain additional training. In this regard, it was established that the respondents were acquainted with two major risk management frameworks: COSO ERM Framework and ISO 31000 – Risk Management Process. This research suggests that companies should seek to implement the ideal of the two approaches in an attempt to develop a hybrid framework of risk management. Nevertheless, though UAE project managers did not identify other risk factors such as ecology and politics, their awareness of most of them means that they understand the impact of industry 4.0 on their profession.

The other primary factor used to assess readiness for industry 4.0 is the awareness of the challenges that will arise. To adjust to changes in industry 4.0, project managers are expected to face several drawbacks. A notable challenge that the respondents identified is adapting to new organizational cultures that will arise as entities adapt to the revolution. For instance, reliance on technology for project design or decision-making means that the collaborative nature of an organization may change. Similarly, without accepting the changes in technology and skills, project managers may be unable to fulfil the requirements of their organizations. However, the participating project managers noted that it will be challenging to cope with these changes. Nevertheless, they will be compelled to develop new strategies and processes. Further, applying modern technologies such as IoT in the manufacturing sector will be difficult for project managers. Moreover, some of these technologies are already replacing people's roles, hence reducing human resources available to project managers. In this context, the extent to which project managers will cope with these and other challenges is indicative of their preparedness for industry 4.0.

Amidst the risks and challenges, seizing the resultant opportunities is equally a show of preparedness to practice project management profession in the era of the fourth industrial revolution. For instance, new technology may be useful in increasing the efficiency and effectiveness of managing projects. Thus, failing to adopt means that a project manager will be disadvantaged in the market. Additionally, the new introductions will be useful in creating better systems such as smart factories, which will lead to increased productivity, quality, efficiency, and effectiveness. Competitors who are not scanning their industries in preparedness to make the necessary changes risk being pushed out of the market. However, the current research has established that UAE project managers understand the need to exploit various opportunities, which include new jobs, enhanced technologies, automation, creativity and competitiveness, new business ideas, and research openings. In addition, as it mentioned in Chapter 4 – Data Analysis – Question 8 the most sector to be likely affected is manufacturing sector, that is because the sector is more likely to apply modern technologies such as IoT into their work processes and operations. Therefore, it's resulted to be the most sector that is ready for industry 4.0 and for the upcoming industrial revolutions. Therefore, it is very essential for project managers in manufacturing industry to be highly skilled and knowledgeable of what is going on around them.

However, though the majority of UAE project managers appeared to understand the implications of industry 4.0, a significant percentage of them were unconcerned. In extreme cases, the respondents were completely unaware of the concepts being discussed despite the researcher providing brief explanations to contextualize the phenomenon. Additionally, some who understood the chronology of the industrial revolution discounted any assertion that industry 4.0 will have an impact on their profession. Statistically, about 40% of the respondents were either unaware of the revolution or believed that the arising risks, challenges, and opportunities will not affect the project management profession, with the remaining 60% demonstrating a notable level of preparedness for industry 4.0. As a result, various industry regulators should prepare their workforce to adapt to the gradual entry of the revolution, which is already in progress.

## **7.0 Conclusion and Recommendations**

### **7.1 Conclusion**

This dissertation has investigated the readiness of project managers for industry 4.0, using the case study of the United Arab Emirates. The findings show that the majority of the studied population is aware of the fourth revolution and prepared to a certain extent to deal with the impact. However, a significant minority is not ready to mitigate the resultant risks, address the challenges, and seize the opportunities, which means that they can render their respective organizations obsolete at the full realization of industry 4.0. It has been established that the changes will transform industries in terms of operations and structure. As a result, project managers ought to change their approaches and strategies. The study has established that there is a correlation between industry 4.0 and project management. Moreover, it has identified the different risks and opportunities that will arise from the introduction of industry 4.0 in project management. Furthermore, it has postulated that affected entities should adopt a hybrid risk management approach that comprises of the COSO ERM Framework and ISO 31000 – Risk Management Process, which have been proven to be standardized approaches to dealing with revolutionary changes and risk factors. The objective was to find responses to the outlined research questions, which was successfully achieved.

### **7.2 Limitations**

Being a cross-sectional study, time and cost were major constraints. The research narrowed its focus to a small population of UAE project managers, which means that the findings are limited in terms of generalization. Particularly, it was difficult to reach more participants from many fields, which compelled the researcher to only deal with selected industries. Moreover, conducting an extensive study would have required more resources than what was available. What is more, being a contemporary phenomenon, lack of awareness about industry 4.0 means that the quality of collected information and opinions was not at an expert level. Nevertheless, the results were sufficient to draw an insightful conclusion about the subject matter.

### **7.3 Recommendations**

This study recommends several courses of action that project managers can follow to increase their readiness to industry 4.0. Notably, some of the solutions were derived from the survey responses after an analysis that was guided by the considered literature materials. The recommendations include:

- Increase awareness of the industrial revolutions by presenting workshop and appropriate training for both project managers and the team. Which will facilitate coping with changes caused by the upcoming industrial revolutions.
- Preparing beforehand; since industry 4.0 impacted a lot of industries such as manufacturing, it will be necessary for the project manager to prepare well for the new industrial revolutions. That is as following:
  - To attend training and workshops about new technologies and methodologies affecting their field of practice.
  - Constitute balanced project teams that draw from different contemporary competencies in an attempt to have a collaborative workforce.
  - Developing and implementing revised work strategies and processes that seek to adapt their organizations to new developments.
  - Gradually integrating current work processes with usable modern technologies to improve efficiency and effectiveness in aspects such as error detection.
  - Invest and purpose to develop necessary competencies that will give them an edge in the market.

One of the main recommendations that will assist in increasing the project manager readiness for the next industrial revolutions is implementing the Enterprise Risk Management (ERM) models; as it mentioned in the literature review that ERM allows project manager to identify, assess, and prepare for any kind of risks that will affect in accomplishing the business's objectives. Two ERM models were presented in the research paper, and the purpose was to find out the optimum model that can work perfectly for the project manager. That is, of course, was decided after intensive research of both models and asking for respondents' opinions on the type of model that will work best in assisting the project manager to increase his/her readiness for upcoming revolutions.

Both models will work perfectly depending on the organization's objective and need. But based on the research, the ISO 31000: 2018 Risk Management Guidelines will be the most suitable model in increasing the project manager readiness for industry 4.0. The reason behind that is ISO 31000 present a massive risk model that can be used internationally and in different types of organizations regarding its size, activities, and sectors. On the other hand, the COSO ERM framework focuses more on financial reporting (Lynch 2018).

However, ISO 31000 is not only focusing on organization strategies but it also aligns the risk management to the organization's activities through its principles, framework, and processes.

The principles will help the project manager to link the framework and practices of risk management into the organization's goals and strategies. While the framework will integrate risks into the organization's activities and function. Finally, the process will help the project manager in making decision on risks and communicating it throughout the organization.

Hence, this will allow project managers to manage risks more effectively, and increasing his/her readiness by measuring the maximum benefits of the current industrial revolution while minimizing the negative ones. Moreover, it will increase awareness of understanding the risks as well as, mitigating those risks to accomplish the organization's objectives. An additional advantage for project managers using ISO 31000 is improving the stakeholder trust. All of that will help the project manager to be completely ready to move to a new industrial era.

#### **7.4 Further Research**

Industrial revolutions represent a wide-reaching study area. Particularly, industry 4.0 affects or will affect many other areas and professions. This study only focused on project managers in specific economic sectors. Future studies can replicate this research in other contexts using other approaches such as pure quantitative method with the aim of either refuting or affirming the findings of this study.

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## Appendix A: Online Survey

Recent

OPEN

**The readiness of Project Manager to Industry 4.0**

Created: 11/17/2019 | Modified: 11/24/2019

56  
Responses

98%  
Completion rate

6 mins  
Typical time spent

⋮  
Options

Showing 1 of 1 survey

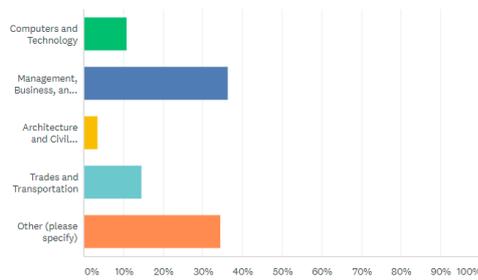
SURVEY GALLERY
CREATE



Q2 Customize Save as

What is your job field?

Answered: 55 Skipped: 1



Q3 Customize Save as

The project manager role plays a huge part in the adoption of the involvement of industry 4.0.

Answered: 55 Skipped: 1



Q4 Save as

What are the opportunities that industry 4.0 will create?

Answered: 56 Skipped: 0

53

2

**RESPONSES (56)** WORD CLOUD TAGS (0)

Sentiments: OFF 55

Apply to selected  Filter by tag

Showing 56 responses

- It will create new jobs for people, increase in the economy growth and better lifestyle  
11/24/2019 6:18 AM View respondent's answers Add tags
- Automation, reducing long term budgets, efficiency, higher quality, and lower human error.  
11/24/2019 12:58 AM View respondent's answers Add tags
- The telecommunications industry is changing from the mobile and fixed to IOT products  
11/23/2019 1:15 PM View respondent's answers Add tags
- New technologies  
11/23/2019 12:04 PM View respondent's answers Add tags

**Q5** Save as

What are the challenges that the project manager will face adjusting to industry 4.0?

Answered: 56 Skipped: 0

**RESPONSES (56)** **WORD CLOUD** **TAGS (0)** Sentiments: OFF

Apply to selected Filter by tag Search responses

Showing 56 responses

- It might be the organization culture he is working in, or the availability of budget to invest in industry 4.0  
11/24/2019 6:18 AM [View respondent's answers](#) [Add tags](#)
- Understanding and being able to adapt to new technology.  
11/24/2019 12:58 AM [View respondent's answers](#) [Add tags](#)
- The Internet of things is not yet defined or complete. People are still figuring out how to use this technology. Even law and regulations are still evolving  
11/23/2019 1:15 PM [View respondent's answers](#) [Add tags](#)
- Teaching employees on these new technologies  
11/23/2019 12:04 PM [View respondent's answers](#) [Add tags](#)

**Q6** Customize Save as

Rank the most important competencies of project manager in industry 4.0 to the least.

Answered: 54 Skipped: 2

**ANSWER CHOICES** RESPONSES

| Competency           | Percentage | Count     |
|----------------------|------------|-----------|
| Decision Making      | ~65%       | 33        |
| Communications       | ~55%       | 6         |
| Training Development | ~45%       | 5         |
| Team Management      | ~40%       | 10        |
| <b>TOTAL</b>         |            | <b>54</b> |

**Q7** Save as

How the project manager will adjust to changes caused by the industrial 4.0?

Answered: 55 Skipped: 1

**RESPONSES (55)** **WORD CLOUD** **TAGS (0)** Sentiments: OFF

Apply to selected Filter by tag Search responses

Showing 55 responses

- It can be by awareness, trainings and workshops  
11/24/2019 6:20 AM [View respondent's answers](#) [Add tags](#)
- Either they will adapt or break..  
11/24/2019 1:01 AM [View respondent's answers](#) [Add tags](#)
- It might be challenging at the beginning, however change is the only thing constant  
11/23/2019 1:17 PM [View respondent's answers](#) [Add tags](#)
- By staying updated  
11/23/2019 12:05 PM [View respondent's answers](#) [Add tags](#)

**Q8** Customize Save as

What is the most industry that will be affected by industry 4.0?

Answered: 54 Skipped: 2

**ANSWER CHOICES** RESPONSES

| Industry                       | Percentage | Count     |
|--------------------------------|------------|-----------|
| Manufacturing - It is the...   | ~65%       | 33        |
| Construction - The preparat... | ~15%       | 6         |
| Healthcare - The provider...   | ~10%       | 5         |
| Education - It is the...       | ~20%       | 10        |
| <b>TOTAL</b>                   |            | <b>54</b> |

**Q9** Customize Save as

What type of ERM (Enterprise Risk Management) framework will work best in assisting project managers to increase his/her readiness in industry 4.0?

Answered: 53 Skipped: 3

**ANSWER CHOICES** RESPONSES

| Framework                   | Percentage | Count |
|-----------------------------|------------|-------|
| COSO ERM Framework - ...    | ~18%       | 10    |
| ISO 31000 - Risk Managem... | ~33%       | 18    |
| Both                        | ~35%       | 19    |
| Why?                        | ~10%       | 5     |

**Q10** Save as

Any recommendations for the project manager to increase his/her readiness for industry 4.0?

Answered: 54 Skipped: 2

**RESPONSES (54)** **WORD CLOUD** **TAGS (0)** Sentiments: OFF

Apply to selected Filter by tag Search responses

Showing 54 responses

- To be updated and to update the team  
11/24/2019 6:21 AM [View respondent's answers](#) [Add tags](#)
- Be open to change, don't be afraid to go back to the basics, understand the process from inception to completion. Learn to adapt and overcome unexpected obstacles which will occur.  
11/24/2019 1:03 AM [View respondent's answers](#) [Add tags](#)
- No comments  
11/23/2019 1:18 PM [View respondent's answers](#) [Add tags](#)
- Learn the new systems and apply them in the workplace  
11/23/2019 12:06 PM [View respondent's answers](#) [Add tags](#)