



# Critical Success Factors for IoT Implementation, and How They Differ for Organizations with Low Digital Maturity

Bartosz Trzaskoma

Dissertation written under the supervision of Louis-David Benyayer

Dissertation submitted in partial fulfilment of requirements for the MSc in Management with Major in Strategy and Consulting, at Universidade Católica Portuguesa and for the MSc in Management with Specialization in Internet of Things at ESCP Europe Paris, 15.06.2020.

## **Abstract - English**

**Title:** *“Critical Success Factors for IoT Implementation, and How They Differ for Organizations with Low Digital Maturity”*

**Author:** *Bartosz Trzaskoma*

The concept Internet of Things has existed for years, but it was just recently the interest around it truly started to grow. With the technological advancement introducing faster, more reliable networks and improved sensors, the true potential of Internet of Things became more evident. An increasing amount of organizations is investing in IoT technology, hoping to achieve benefits in terms of increased productivity, reduction of costs, or opportunities to create new business models. Yet, research shows that many IoT implementation initiatives fail. As the high rate of failure is known, many researchers have attempted to identify what it takes to succeed with these projects. However, nearly all of them present general factors necessary to succeed, without identifying variations caused by context. This study is addressing this issue, by exploring the critical success factors for IoT implementation, and by examining how the factors differ for organizations with low digital maturity. Insights from professionals with solid experience in IoT were gathered through a qualitative study in order to provide an answer to this question. The results suggest that the complexity of IoT implementation is reflected by the large number of critical success factors, which include factors related to characteristics of the organization, project management, level of expertise, and technological aspects of the solution. Additionally, the results show that the critical factors for organizations with low digital maturity are different, but mainly in terms of the significance each factor has, as the digital immaturity entails challenges which the mature companies do not have.

**Key Words** – Internet of Things, Implementation, Critical Success Factors, Technology, Digital Maturity, Machine to Machine, Project Management

## **Abstract – Portuguese**

**Título: “Fatores Críticos de Sucesso para implementação de IdC e como estes diferem para Organizações com Baixa Maturidade Digital”**

**Autor: Bartosz Trzaskoma**

O conceito de Internet das Coisas existe há anos, mas foi apenas recentemente que o interesse adjacente começou verdadeiramente a crescer. O avanço tecnológico introduziu redes mais rápidas e fiáveis e sensores melhorados, desvendando o verdadeiro potencial da Internet das Coisas. Um número crescente de organizações tem investido em tecnologia IdC, esperando atingir benefícios em termos de produtividade aumentada, redução de custos ou oportunidades de criação de novos modelos de negócio. Contudo, estudos indicam que muitas iniciativas de implementação de IdC falham. Sabendo que a taxa de insucesso é alta, muitos investigadores têm tentado identificar o que é necessário para ser bem-sucedido nestes projetos. No entanto, quase todos apresentam fatores generalizados necessários para o sucesso, negligenciando as variações contextuais. Este estudo foca-se neste tema, explorando os fatores críticos de sucesso para implementação de IdC e examinando como os fatores diferem para organizações com baixa maturidade digital. Conhecimentos de profissionais com sólida experiência em IdC foram agregados através de um estudo qualitativo no sentido de apresentar uma resposta para esta questão. Os resultados sugerem que a complexidade da implementação de IdC é refletida no extenso número de fatores críticos de sucesso, que incluem características da organização, gestão de projetos, nível de experiência e aspetos tecnológicos da solução. Adicionalmente, os resultados mostram que os fatores críticos para organizações com baixa maturidade digital são diferentes, mas essencialmente em termos da preponderância que cada fator tem, já que a imaturidade digital implica desafios que empresas maduras não enfrentam.

**Palavras-Chave:** - Internet das Coisas, Implementação, Fatores Críticos de Sucesso, Tecnologia, Maturidade Digital, Máquina para Máquina, Gestão de Projeto

**Table of Contents**

- 1. Introduction..... - 1 -**
- 2. Research Question ..... - 2 -**
- 3. Literature Review ..... - 3 -**
  - 3.1 Definitions ..... - 3 -**
  - 3.2 Presentation of Literature Findings ..... - 4 -**
    - 3.2.1 Reports and Articles Published by Organizations ..... - 4 -**
    - 3.2.2 Scientific Articles, Books, and Other Studies ..... - 12 -**
  - 3.3 Key Takeaways from Literature Review..... - 15 -**
- 4. Methodology ..... - 17 -**
  - 4.1. Choice of Method ..... - 17 -**
  - 4.2. Preparation and Execution of the Interviews ..... - 18 -**
  - 4.3. The Respondents ..... - 19 -**
  - 4.4. Methodology for Data Analysis ..... - 20 -**
- 5. Results ..... - 21 -**
  - 5.1. Differences between Digitally Mature and Not Digitally Mature Organizations ..... - 21 -**
  - 5.2. Critical Success Factors in Organizations with Low Digital Maturity..... - 22 -**
  - 5.3. Critical Success Factors in IoT Implementation ..... - 24 -**
  - 5.4. Other Characteristics of Businesses Affecting Implementation & CSF ..... - 28 -**
  - 5.5. Difficult Industries and Organization Types..... - 29 -**
- 6. Discussion ..... - 30 -**
  - 6.1. Critical Success Factors – A Comparison with Previous Findings..... - 30 -**
  - 6.2. Additional Findings on Critical Success Factors for IoT Implementation..... - 32 -**
  - 6.3. How the CSFs Differ in Organizations with Low Digital Maturity..... - 34 -**
  - 6.4. Similarities and Differences between Respondents ..... - 35 -**
- 7. Conclusion ..... - 36 -**
  - 7.1. Final Conclusion ..... - 36 -**
  - 7.2. Limitations of the Study and Future Research ..... - 36 -**
- 8. Bibliography ..... - 38 -**
- 9. Appendix..... - 40 -**

## **1. Introduction**

The Internet of Things, also known as IoT, is a very popular topic in the world of technology and business. The concept itself is not new, as it was introduced already in 1999 by Kevin Ashton (Lueth, 2014), who was working with supply chain optimization for Procter & Gamble at the time. Even then, the idea of connecting devices with each other was already around for quite some time. The interest and debate about IoT has intensified in the last years, and there are many reasons to why this happened. Faster, more reliable networks, improvements in sensor technology, and new possibilities of leveraging and analyzing data, are among the most significant reasons. There are also significantly more objects connected to the internet now, than ten or twenty years ago, which drives the IoT innovation even further, and the number of connected devices is likely to escalate at an even higher speed than we have seen so far.

Another important factor behind the growth of IoT is also the awareness of the technology and the opportunities it provides. A report published by McKinsey in 2015 included an estimate of the value created by IoT ten years later, in 2025. The report predicts that IoT will have the potential to create between \$3,9 trillion and \$11,1 trillion across the affected sectors (McKinsey & Company, 2015). Many papers and studies, including the report from McKinsey, are presenting the opportunities this concept brings in several sectors, such as retail, logistics, healthcare, production, just to name a few. Therefore, many businesses are excited about those new opportunities, that could create benefits like cost saving, higher efficiency, or possibility of realizing new, innovative business models.

With the future looking very bright for IoT, many companies from various sectors are investing in such solutions, and are very optimistic about the return of their investments. However, studies show that a large percentage of the implementation attempts of IoT solutions fail. Results from a study presented in a press release from Cisco, show that only 26% of IoT initiatives are considered a complete success, meaning that a majority of initiatives are, to some extent, failing (Cisco, 2017). Furthermore, a third of completed projects were complete failures, with no incremental benefits at all. These numbers are truly eye-opening, and one can wonder why there is such a majority of studies and other papers

focusing on the rewards, and why there is a lack of studies that could address the issues and potentially elevate the success rate of implementation attempts. Even more important is the question, what factors lie behind the success stories, that were missing in the ones that failed? And to what extent can those key factors be universally applied to all projects across functions and industries?

## **2. Research Question**

With such high percentage of IoT implementation attempts ending with a disappointment, the key success factors for implementing IoT solutions is undoubtedly an interesting and important topic in modern business. Despite its importance, however, a quick research shows that there are not many solid papers on this topic, and those that are available are usually simplistic and too general for all companies to use as support in their actual process. As the Internet of Things is relevant for a large number of various businesses across several sectors, it is ambiguous whether the key success factors differ between organizations with different characteristics. One can also assume, that the adoption and implementation process of such technology is different in a business where technology is embodied in the core processes, and a business where technology, normally, only plays a minor role.

**“What are the critical success factors for IoT implementation, and how do they differ for companies with low digital maturity?”**

This project has a purpose of exploring the topic of critical success factors for IoT implementation, and clarify the previously mentioned ambiguities related to the varieties in those factors between digitally mature businesses, and the ones that are not. The research question above will be answered through an analysis of existing studies and collection of original data.

### **3. Literature Review**

#### **3.1 Definitions**

Before the findings from research on this topic will be presented, there are some definitions and descriptions that will be provided in order to clarify any ambiguities. This is done in order to be clear about assumptions made in the process of creating the study presented further in this paper.

*Internet of Things* is the connection of objects from the physical world that are equipped with sensors, actuators and communication technology (Dijkman & al, 2015). The IoT technology is one of the technology trends which are predicted to leave a large mark on businesses across many sectors. Nowadays, one can already see businesses investing in IoT solutions, and implementing them in their processes, and new, innovative business models are being created with IoT as a foundation. In modern times, when networks finally reached a new level of stability and speed, the potential of IoT began to unravel. With such considerable improvements in the networks, the number of connected objects is also growing at a fast pace. A study executed by Cisco shows that the number of IoT endpoints at the end of 2016 was roughly 15 billion, and this number is expected to surpass 82 billion by 2025 (Cisco, 2017). Part of the reason behind IoT being in focus in the world of business, is that it has applications in a wide array of sectors and different businesses in all sizes. This study will concentrate on general critical success factors, and its purpose is to examine if there are differences in the implementation stage between businesses with high and low digital maturity. Therefore, there will be no limitations related to specific types of products or services, as long as the given case entails an implementation process.

*Critical Success Factors* (CSF) are conditions or variables which are crucial for an organization or project to achieve the effectiveness, efficiency, and viability needed to succeed. In this paper, an analysis of those factors in conjunction with implementation of IoT solutions will be executed.

*Digital Maturity* will also be central in this paper, as finding inequalities in critical success factors between businesses with varying degree of digital maturity will be attempted. The term digital maturity is meant to reflect how organizations “systematically prepare to adapt consistently to ongoing digital change” (Kane & al, 2017). In other words, it measures the

extent to which companies are adopting technology, and successfully aligning it with their strategy, culture, structure, and other aspects of their business. In this paper, digital maturity will be used to distinguish highly technological companies, from the ones that are not.

### **3.2 Presentation of Literature Findings**

#### **3.2.1 Reports and Articles Published by Organizations**

There are several types of literature that are relevant for this analysis. Due to the high expectations for IoT and its impact on business in the last years, many large companies were quick to conduct studies and publish reports, which they are still doing on an ongoing basis. None of the reports are, unfortunately, specifically addressing the varieties caused by different degree of digital maturity. However, there are several reports addressing critical factors for successful implementation of IoT solutions, which is highly relevant for further investigation of the issue.

The previously mentioned press release from Cisco from 2017, presenting low rates of IoT success, is concluding with a presentation of key findings. Those are, in essence, advices and insights to keep in mind in order to maximize the chances of success, based on the observations made in their study. In their study, 1845 decision makers from IT and business in the United States, UK, and India were surveyed. The respondents were from a wide array of industries, like manufacturing, retail, transportation, and local government, among other. The first observation presented is that the “human factors” matter. In the press release it is stated that three of the top four factors behind successful projects involved people. The most significant factor was cited by 54 % of the respondents, and it was “collaboration between IT and the business side”. The second most significant “human factor” according to the survey was a “technology focused culture, stemming from top-down leadership and executive sponsorship”, which was considered crucial by 49 %. Lastly, IoT expertise, internal or external, was the third highly significant “human” factor presented in the press release. It was selected by 48 % of the respondents.

Furthermore, another interesting observation is emphasized; organizations which achieved most success with their IoT initiatives leveraged ecosystem partners to a higher extent than the other organizations. The top five challenges in all stages of implementation, according to the study, are: time to completion, lack of internal expertise, quality of data, integration across teams, and budget overruns. Cooperation within the IoT partner ecosystem implies a smoother



learning curve, and new opportunities. A Cisco executive is quoted in the study, and she is emphasizing the value of sharing data and insights in order to obtain gains for business and society. Cisco's study is relevant for this paper, as the data was collected from a large number of respondents working with IoT. These findings may not address the precise issue in this analysis, but it lays a solid foundation of important critical success factors to take into consideration further in the process.

Another company addressing the critical success factors in the implementation stage is Telenor Connexion, a subsidiary of Telenor, a Norwegian telecommunications company active across the Nordics and Asia. Telenor group has nearly 186 million customers, spread across both B2C and the B2B market. The mentioned subsidiary is specializing in IoT solutions. In one of their blog posts, they present an article containing best practices on how to ensure a successful IoT implementation (Whitlock, 2019). The first important practice the Nordic company is presenting, is about putting strategy in the lead, not technology. In their elaboration, they point out that focusing too much on technology is one of the common pitfalls. Choosing the right technology is critical to succeed, but the technology should, in the end, serve the strategy. Further, the author of the blog post is stating that defining a vision and setting clear short – and long term objectives for the IoT initiative are important parts of the strategy that has to be developed for each project. To provide examples of the objectives, the author suggests achieving costs savings or increasing revenues through enabling new business.

The second important factor brought forward in the article, is management support. As described in the elaboration of the first factor, the idea behind IoT often originates bottom-up, from a R&D department or similar. In order to fully enable the potential benefits of IoT, a transformation of the business is often necessary, which is both time and resource demanding. Due to the fact that these initiatives tend to get so costly and comprehensive, they are not likely to succeed without support and full commitment from the top management.

Another advice provided by Telenor Connexion, is forming a “dedicated cross-functional team”. This can be done either in form of a regular task-oriented team or even as a separate business unit, in case of larger companies.

The third important factor towards a successful implementation according to the article released on the company's website is to “start small and transform gradually”. This point implies starting on a small scale, for instance offering a new business model for only a small number of selected customers showing positive attitude towards trying something new. The

value of doing this, is to test and make adjustments before making the offering available across the organization.

The last key success factor provided in the article is somewhat linked to the last one, but is specifically dedicated to cases where new business models are enabled. It is to “deploy fully when outcome is predictable”, which means that the new model should not be prematurely scaled in full, until there is a confidence in the organization concerning the predicted outcome and any related risks are mitigated.

Another company which dedicated a white paper to critical success factors in IoT implementation, is DXC Technology, a consulting company specialized in IT services. The article is identifying six factors which they consider crucial in implementing industrial IoT in the manufacturing industry (Klement, 2018). Many companies in the manufacturing industry can be considered digitally mature, as they are often rich in business and tech skills (Sands, Bakthavachalam, 2019). Industrial IoT is a term describing the IoT applications specifically aimed towards the industrial setting (Boyes & al, 2018). As the purpose of this paper is partly to compare the technologically advanced businesses with those less advanced, factors for implementation of IIoT in manufacturing are considered relevant. From the total of six factors, five are considered within the scope of this paper.

The first success factor to extract from the article published by DXC is “strategic alignment”. The strategic alignment is about aligning the IoT initiative with business and technology strategy, where the business strategy sets a direction in form of objectives, and the technology strategy identifies the constraints around the chosen solution. This factor is directly linked to some of the factors mentioned before, as both Telenor Connexion and Cisco concluded that strategy plays a key role in this process, and alignment between business and IT has to be on point.

The second factor relevant for this study is not named by the other articles analyzed, and is called “business process focus”. As the author is emphasizing, business processes are a core element of every organization, but are especially important for manufacturing companies as their operating models tend to be complex. The author is referencing an article from McKinsey, where integration of IoT solutions in the existing business processes is a “top IoT capability gap”. The article further elaborates that software vendors often market their products as easy to integrate with business systems, but basic compatibility does not necessarily imply an end-to-end integration to other business processes, which is crucial to

meet the expectations of overall connectivity and things working together significantly more efficiently than before.

The next factor emphasized in the article, is quite similar to the last one, and is called “Operating model changes”. In short, this factor is based on the assumption that IT business systems and operational technology will converge. This implies opportunities to, for instance, improve the collaboration between the factory floor and the offices. However, there are also challenges caused by this, as changes in the whole operating model are likely to be necessary, and a new operating model will require new capabilities in the organization.

Further, the next factor is called “capability uplift” and is addressing an important issue in IoT implementation, but also any change management case in general. As the IoT applications allow new business models to be adopted, change business processes and in some cases even operating models, there is a need for employees to acquire new skills and knowledge. The extent to which the employees will have to adapt to the changes depend on how comprehensive the change is. However, in many cases, employees will have to learn to do new tasks or do their existing tasks differently. In some cases, their role may change completely. For that reason, it is extremely crucial that all employees understand IoT and the specific application being implemented, in order to minimize problems caused by misunderstandings. In order to overcome these challenges, focused educational and training programs should be in place, for employees at all levels affected by the new technology developed in the organization.

The last factor identified by DXC Technology is end-to-end security, which is among the most frequent concerns and risks regarding IoT solutions. This may be more relevant in some cases than other, but for industrial applications the security risks are a concern because they did not exist before the machines on “the floor” were connected to the internet. The article states that new “cyber-physical systems” are being developed, and “security by design” is an important factor for companies investing in IoT technology.

McKinsey is another company which shares their insights on numerous topics, and IoT is naturally one of them. Although there are not any reports or articles directly dedicated to the critical success factors in IoT implementation, there are several articles from which one can find relevant information on this subject. One of McKinsey’s articles, “The Internet of Things: Mapping the Value Beyond the Hype”, has received a lot of attention since its release in 2015. In the paper, potential value of IoT is estimated, and the biggest opportunities are elaborated on. Other interesting findings are also presented, such as the fact that a majority of

IoT data collected is not being used at all, and the one that is used is not fully leveraged. According to the article, less than 1% of data gathered at an oil rig, equipped with tens of thousands of sensors, is being actively used for decision making. Facts like this show the improvement potential of IoT, and prove that its true value is yet to be explored. Further in the article, the reader is presented with “enablers and barriers” to IoT, which outlines the conditions which have to be in place for IoT to reach its true potential. These factors are rather aimed for the general concept of IoT, but there are some conditions which can be considered relevant for implementation of singular projects. One of them, is interoperability. McKinsey’s article argues that IoT devices and systems have to work together in order to realize the full value of IoT applications. The authors also suggest open standards as a way to accomplish that. However, one can assume that interoperability is also relevant on a project-basis, as the IoT applications are likely to be more valuable if they can work with other, existing systems of a company. Furthermore, the article highlights the challenges with security and privacy. This is a large topic within IoT, as new devices are continuously being connected to the web, and more data is collected now than ever. As security was mentioned as a critical success factor in other reports, seeing it here only emphasized the importance of “security by design” of IoT projects. Lastly, McKinsey distinguishes “organization and talent” as another crucial condition. Under this point, it is stated that the IT operations are getting more involved with the business operations than ever before, and an alignment of these functions is necessary. Moreover, the understanding of the new IoT systems, correct mindset needed to fully adopt a data-driven decision making, and ability to adapt the company to new processes and business models, are listed as organizational factors which have to be fulfilled for IoT to produce maximum value. These are all very similar points to the “human factors” presented in the study conducted by Cisco, showing yet again how important the organizational and cultural management is in the implementation process.

In another article from 2019, “Ten Trends Shaping the IoT Business Landscape”, McKinsey provides ten trends on company level, market level, and technology level respectively. One of the trends provides a quite interesting observation about IoT and the financial value it creates. In many cases, an investment in new technology is not likely to be considered a success without resulting in financial benefit, whether it is through increased revenues or decreased costs, factors proved to create this value are likely to be relevant for many projects. According to the article, implementing more IoT use cases correlates with better financial results.

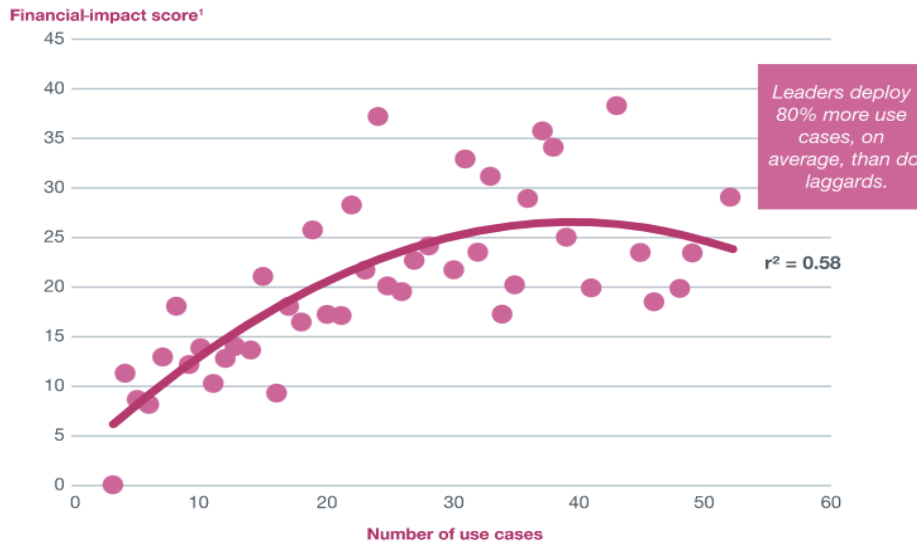


Figure 1. Number of use cases vs. Financial impact. (Lamarre, May, 2019)

Through supporting clients with their IoT initiatives and doing research, the company found that the most value in terms of improvement to the bottom line, comes from trying several use cases. Each of the use cases tried, should have a clear business case and strategy, and they should be executed with discipline. The greatest impact, as it is stated in the article, comes from following a learning curve across the use cases. As the graph above shows, the effect on financial impact is leveled out by 30 use cases.

Kalypso, a consulting firm specializing in digital transformation and innovation recently acquired by Rockwell Automation, also published a short post on how to succeed with IoT. In the short post, which they call viewpoint, they refer to an article published on the website of Quartz involving opportunities and risks related to IoT, and give their inputs on how to maximize chances of success. In their response, they emphasize identifying and setting strategic goals to be reached with the IoT initiative. Furthermore, they suggest that IoT should be handled with an iterative approach, where gradual learning is key to success (Timm, Mitchell, 2015).

Siemens released a 30 pages long white paper on IoT in 2019, called “Turning the Internet of Things into Reality” (Helmus, Grabenhofer, 2019). In the white paper, they present extensive information about IoT and digital transformation, along with the challenges and concerns around the topic. One of the chapters in the paper is also dedicated to successful IoT implementation. To start off the implementation chapter, Siemens distinguishes three things that all successful organizations have in common, namely high degree of leadership attention,

a value-creating use case, and an implementation conducted in an iteratively and pragmatic manner. Moreover, Siemens identifies five phases which build up the core of every IoT implementation process; developing a strategy, ideating and prototyping, connecting and integrating system, analyzing, and lastly, operating. In addition, Siemens emphasizes change management and cybersecurity as key factors which have to be considered from the very beginning to the end.

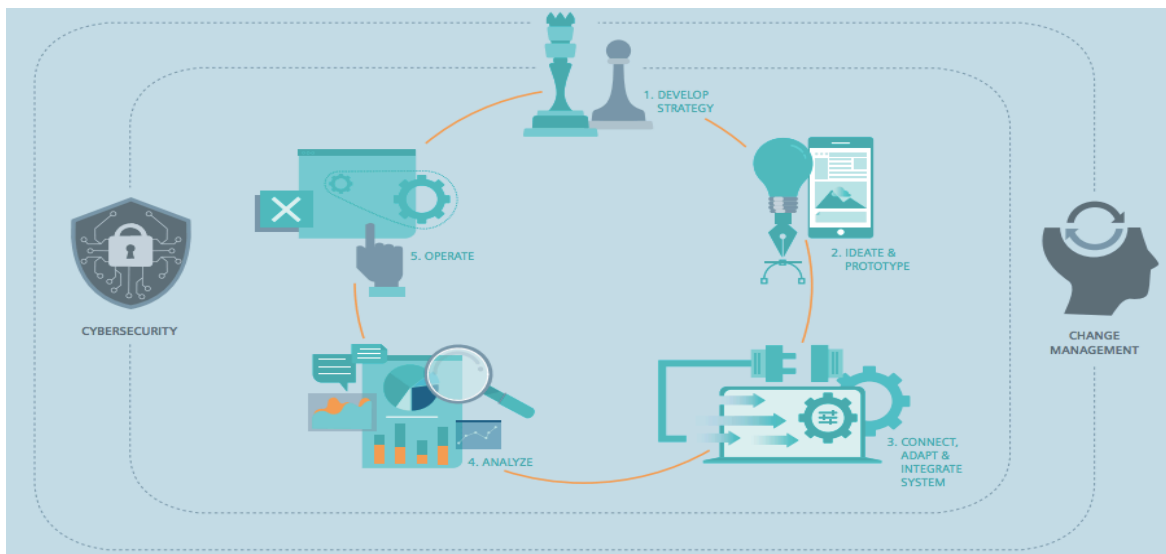


Figure 2. Five phases of IoT implementation. (Helmus, Grabenhofer, 2019)

The first phase is, in essence, similar to what has been presented in the previously analyzed articles. It emphasizes the alignment of the strategy with technology and operations, and incorporating the expected opportunities. The strategy is meant to be clear, as it will be the guiding light throughout the implementation process, and will likely need to be revisited underway.

The second phase, called “ideate and prototype”, should result in a proof of concept for technical feasibility and the implementation and integration of overall concept. In this phase, the use case has to be developed and tested for any pain points. Ensuring the feasibility of the whole initiative is important, as it identifies potential technical or legal challenges that will be easier to overcome if considered from the beginning. Here, access to quality data, and use of it, is being brought forward by Siemens as a core factor for every IoT implementation. The desired characteristics for the data depends on the project, but using historical data is generally a good place to start in assessing what existing information can be gathered and what is missing.

The third phase is about connecting, adapting and integrating systems. They distinguish sensors, devices, networks, cloud infrastructure, IoT platforms, and applications as the core

parts of a technology stack suitable for IoT. Without going into technical details, the key to succeed in this phase is to achieve a fully functioning system with data transmission, storage, and processing, through integration of the IT and OT systems and making all sources of data “speak the same language”.

The fourth phase is based on analyzing the data extracted from the IoT system. The key to success at this point is to have an application which analyzes the data from the initial phases, and extracts useful conclusions. As mentioned before on several occasions, IoT implementation is an iterative process. Lastly, the fifth phase called “operate” emphasizes the need for maintaining the new systems, and continuously making improvements and adjustments. This phase is not only crucial for creating maximum value, but also to ensure security which is an important issue for every IoT initiative.

As mentioned during the introduction of Siemens’ white paper, change management and cyber security were mentioned as critical components of all five phases. The change management side presents many organizational factors which have to be considered when making a change of any kind. Siemens elaborates that implementing such an impactful technology such as IoT to a firm’s processes, requires new skill sets. Therefore, organizations need to find a good mix of training, hiring, and outsourcing in order to meet those requirements. Furthermore, they emphasize the importance of involving all stakeholders and getting their support, which is often overlooked in digital transformation processes. The whitepaper also states that top management should lead the change, and appoint a team which will be responsible for driving the implementation efforts of all use cases and control the adaptations of processes.

As it was mentioned in articles previously analyzed, the risk cybersecurity is big for IoT solutions, because more devices are connected and more processes are automated. For that reason, the consequences and losses of a cyberattack can potentially cause significant damage in the company. Siemens, in their white paper, suggest to keep cybersecurity among the top priorities throughout an implementation process, and to include preventive, detective, and defensive measures in order to be prepared for the occurrence of such situations. In addition, they state that cybersecurity is often directly linked to the mindset and organizational culture, and distinguish three organizational success factors which are considered key for succeeding with including cybersecurity in the process. The three factors are; high extent of prioritizing and investing in security by top management, understanding that cybersecurity is an ongoing task, and understanding that cybersecurity is everyone’s job.

The white paper published by Siemens IoT Services certainly contains a lot of useful information on success factors from both the technological as well as the organizational perspective. However, one of the biggest messages to extract from the paper is that an IoT project involves many elements, such as strategy, existing assets, people, and processes among other. Therefore, each IoT project is in its own way unique, and the requirements to succeed will differ for every company and their specific situation.

### **3.2.2 Scientific Articles, Books, and Other Studies**

Companies are, naturally, not the only ones writing about IoT. There are several books on the subject, a large number of articles, and independent research papers dedicated to the topic. Here, one can find several topics that can be related to this paper in varying extent. Some articles, however, contain studies on IoT implementation in businesses from specific industries, and sometimes even specific industries in certain countries.

One research paper found six critical success factors for implementing IoT and smart devices in the construction industry in the Dominican Republic (Silveiro-Fernandez & al, 2019). The construction industry is generally very suitable for IoT applications, as information is usually very decentralized and the industry scores high on mobility (Bouck, 2014), meaning that the stakeholders at all levels can access information from a device close to them (e.g. tablet, smartphone, or laptop). The construction sector makes up a solid portion of the Dominican Republic's GDP, but the region is considered as "data-scarce". Therefore, the findings of this empirical study are assumed to be somewhat related to what the critical success factors are for companies which are not technologically advanced.

In their study, two factors were mentioned most frequently; leadership and technology awareness. As leadership has been mentioned by several other articles included in this paper, there is no need to elaborate it. In essence, the significance of involving the top management is being emphasized in the argumentation behind this factor. Technology awareness, on the other hand, is about facilitating for a collective mentality and common sense of awareness about the technology and the benefits it can provide. The authors provide an accurate observation of the construction industry, where there are young professionals who are usually up to date with the technological developments, but also older, more experienced professionals who tend to resist these kind of changes. This situation can also be found in several industries, but is often seen in the construction sector in particular. In order to



overcome this issue, organizations need to invest in education in order to ensure the necessary level of awareness about technology for all employees. A lot of the individual resistance comes from fearing the unknown, as some employees may not feel comfortable with uncertainty and are afraid that new technology would make them irrelevant. It is, therefore, up to the management to create a culture of entrepreneurial mindset, which can have a positive effect on the ease of implementation of new technology.

The third factor which was called by some of the respondents in the study is company size. The authors point out that larger companies are more suited for IoT solutions and have an advantage compared to the small ones, due to the budget constraints and the “robustness” in case of delays and so on. It is debatable whether size can be considered a critical success factor, but it certainly makes more sense for an organization to invest in IoT after reaching a certain size in terms of employees, number of projects etc.

The fourth factor called “usability”, refers to the quality of user experience of the implemented system. The respondents mentioning this factor, point out that user-friendliness is key, and that “fulfilling general requirements such as network infrastructure” is critical for IoT solutions to work in practice. In other words, not only are there necessary on-site preparations to be done, but raising awareness about the new solution is also something to consider, as it might directly affect the perceived ease of use.

The two last factors are “cost of implementation” and “interoperability” respectively. Cost of implementation refers to the fact that investing in IoT or smart devices of any kind, is usually quite expensive, especially for smaller businesses. The key success factor for this point is conducting an accurate and realistic cost-benefit analysis for each specific case, in order to avoid the initiative from failing due to unexpected difficulties with holding the budget. Lastly, interoperability refers to the equipment’s ability to integrate other systems and information, and was mentioned in other articles earlier in this paper. According to the study conducted on the construction sector, however, organizations should carefully assess existing equipment to fulfil this criterion, in order to avoid difficulties with creating one entity with the new systems about to be implemented.

There is currently a lack of scientific research papers involving studies on IoT implementation. For that reason, papers on similar topic were considered for this analysis, as they often contain elements that are relevant. For example, a study on radio frequency identification systems, or RFID, can have similar factors in the implementation stage, as RFID is a central component of many IoT solutions. In one research paper, initiation,

experimentation, and implementation of RFID systems is studied, and the findings for the implementation stage can be translated into critical success factors, even though it is not the main argument in the paper. Top management support is, yet again, being called as one of the most instrumental factors for implementation. This is caused by the need for organization-wide commitment and proper resource allocation (Matta & al, 2012). Furthermore, organizational size is called an influential factor for both the experimentation and implementation stage. Similar to the study conducted for the construction sector in the Dominican Republic, it is argued that larger organizations have a smoother progression with implementation, due to their superior financial and non-financial resources. Finally, it is recommended for organizations to cooperate with partners from their ecosystem. As partners and ecosystems are frequently mentioned in IoT-related articles, one can imagine that partnerships are, in fact, beneficial and play an important role in the implementation process. Through leveraging partnerships, organizations can expand their pool of expertise, which is needed in many disciplines in the case of IoT.

Implementation of internet based information systems is also a somewhat related topic to the one analyzed here. Despite the fact that internet based information systems do not necessarily involve any automated machine to machine communication or advanced sensors, implementing these systems implied making comprehensive adaption and change initiatives as well. For example, when a company implements IIS in order to conduct transactions with their customers, a transformation of processes, business model, and so on is likely to happen. One research paper from 2007 presented a study on factors affecting the implementation success of such systems (Lee, Kim, 2007), and there are a lot of similarities in their results compared to the analysis made on IoT in this paper. The research model in the study is based on a framework developed by Tornatzky and Fleischer in 1990. The factors presented in the study were split in three categories; characteristics of the technology innovation, organizational factors, and factors directly linked to the information system. In the first group, the suggested factors are compatibility, relative advantage, and complexity, where relative advantage refers to the perceived benefits of the incoming systems among employers and other stakeholders concerned. All these factors have been mentioned in articles previously analyzed in this paper. Top management support is mentioned under organizational factors, and infrastructure, expertise, and security are mentioned as crucial factors related to the information system itself.

In a book on managing IoT systems for institutions and cities, manageability is being brought forward as one of the most crucial factors for success (Benson, 2019). According to the Cambridge Dictionary, manageability means “the quality of being easy or possible to deal with”. In other words, it is related to the factors related to complexity and usability which were mentioned before. Here, it is argued that cities and institutions have limited ability to change other factors, such as lack of experience in system implementation and management, and constraints in resources, the significance of a controllable factor like manageability is strengthened. One can compare government institutions and cities to companies with low advancement in technology in terms of some of the challenges both types of organizations face, even though the projects likely to be conducted are of a different scale. The ease of using the systems is being brought forward several times, and it appears to be an important factor for the organizations limited in expertise in particular.

### **3.3 Key Takeaways from Literature Review**

The literature review has certainly provided a large number of factors to consider further in the study. While analyzing articles written by companies offering IoT services of any kind, there is a risk that the presented contents are biased. For instance, if a company is specializing in cybersecurity, they will naturally list security and privacy among the factors they consider the most critical. However, seeing the extracted factors from all of the articles, it becomes evident that despite some differences, a lot of the same factors are being repeated in multiple reports. Moreover, most of the factors found in research paper or books, were also mostly coherent with what was stated in the articles published by incumbent companies in the industry. Therefore, the biases, if present, should not affect the gathered results significantly.

Following the structure found in several analyzed articles, the findings from the literature review are be grouped in four distinct categories.

Company Characteristics	Project Management	IoT Expertise	Technological Factors
<ul style="list-style-type: none"> <li>- Entrepreneurial/Tech-Focused Culture</li> <li>- Understanding and Awareness</li> <li>- Organization Size</li> <li>- Prioritizing &amp; Investing in Security</li> <li>- Top Management Support</li> </ul>	<ul style="list-style-type: none"> <li>- Strategy (Vision &amp; Goals)</li> <li>- Alignment of IT &amp; Business</li> <li>- Cross Functional Team</li> <li>- Involvement of Stakeholders</li> <li>- Iterative Approach</li> <li>- Realistic Cost/Benefit Analysis</li> <li>- Multiple Use Cases</li> </ul>	<ul style="list-style-type: none"> <li>- Expertise in IoT &amp; Data Analytics</li> <li>- Partnerships</li> <li>- Ensuring Education &amp; Training</li> </ul>	<ul style="list-style-type: none"> <li>- Interoperability</li> <li>- Security &amp; Privacy</li> <li>- Feasibility (Proof of Concept)</li> <li>- Access to Data</li> <li>- Low Complexity (manageability &amp; usability)</li> <li>- Infrastructure</li> </ul>

Table 1: Presentation of Findings from Literature Review

The first three categories cover the organizational factors, split up in to more precise sub-categories. The company characteristics are factors related to the company itself. Top management support was the clearly most mentioned factor here, along with understanding and awareness. The factor “prioritizing and investing in security” is placed here, as it is not only a matter of technological characteristics, but something which needs to be in focus in the company in general as well. Cyber security has to be a top priority, considered an ongoing task, and considered everyone’s job, according to the detailed white paper published by Siemens (Dr. Helmus & al, 2019). Project management is a category containing factors related to the management of the initiative itself. Here, strategy, alignment of business and IT, as well as having a cross-functional team are the most frequently mentioned factors. They were mentioned in nearly every article, and are undoubtedly very central in succeeding with IoT. The factor “multiple use cases” placed under this category, refers to the observation made by McKinsey, where a correlation between number of use cases and positive financial impact was proven. The factors placed under IoT expertise are factors related to the knowledge around the technology. As it is shown above, ensuring expertise in IoT as well as data analytics is important, and the companies need to leverage their partnerships to increase their resource pool, and provide training and education for all relevant stakeholders. Lastly, technological factors refer to the characteristics of the technology to be implemented, as well as the existing technology. Here, interoperability, infrastructure, and low complexity were the factors with highest degree of agreement among the various sources.

To summarize, the literature provided a number of critical success factors and a solid foundation of knowledge to how IoT projects can succeed. However, the sources found were mainly general, or not directly addressed to the research question of this paper, which is to find the CSF differences in businesses with low digital maturity. The most relevant source was the research paper containing a study on the construction sector in the Dominican Republic, which is not enough to make a reliable conclusion on this topic. On the other hand, the success factors in that paper were quite similar to other findings, which may be indicating that the critical success factors do not necessarily differ, but are weighted differently between companies with varying degree of digital maturity.

#### **4. Methodology**

In order to explore the topic of critical success factors for IoT implementation, data was gathered from different sources, through conducting a literature review and semi-structured interviews.

##### **4.1. Choice of Method**

In order to further explore the topic of IoT implementation, and learn more about the differences in critical success factors for companies with low digital maturity, primary data had to be gathered from individuals with experience in that field. A qualitative study in form of semi-structured interviews was conducted for that purpose. Quantitative study was not conducted for this paper, due to limitations with number of respondents, as a survey or similar form of quantitative study would require a large number of responses from professionals with relevant experience to find valuable patterns and produce credible results. A qualitative study, on the other hand, allows for gathering valuable insights by paying closer attention to each respondent, and leveraging a freer format of observation. Moreover, qualitative studies tend to be more exploratory than the quantitative ones (Ochieng, 2009). This paper does not involve any clear hypothesis to validate through conducting large surveys, it is rather aimed to explore the topic and observe similarities and differences between independent opinions. As a consequence, a qualitative research approach was considered more appropriate for this study.

Semi-structured interviews were specifically selected as a method because they are appropriate when the purpose is to “ask probing, open-ended questions and want to know the

independent thoughts of each individual” (Adams & al, 2015), which is useful in conducting exploratory research. Moreover, the semi-structured interviews enabled asking follow-up questions, which was considered important due to the variety of experience the respondents were expected to have. Using this approach also allowed for some extent of flexibility, which made it easier to avoid missing out on significant information.

#### **4.2. Preparation and Execution of the Interviews**

In order to avoid guiding the respondents to any particular answers, the interview guide created for this purpose was rather simple, and it was in a way used as a framework to ensure that all the core topics are brought up during the interview. It consisted of 7 steps in total. A majority of the steps consisted of questions, while the remaining steps were placed in order to ensure a proper structure. Some of the questions had sub-points, which involved questions or topics which were asked only if the interviewee did not cover them. The most central steps of the guide were marked with bold font, to clearly distinguish them from the other steps, and to reduce the risk of forgetting something crucial for the study.

The guide started with a reminder for introducing the project and the purpose of the interview. After the introduction, a question regarding the respondent’s experience with IoT was placed in the guide, as well as a sub-question about the characteristics of clients the respondent has worked with. The latter was asked only if it was not mentioned during the participant’s answer. This was done in order to get an overview of the fields of expertise each respondents had, which could potentially shape the further conversation to some extent. Moreover, it was planned as a question to get the respondents to open up and get comfortable. The next step was a question regarding difficult industries or other types of organizations, in which implementation of IoT or other new technologies was particularly difficult. This was brought up in order to explore whether these things influence the ease of implementation of IoT solutions or other new technologies, and to indirectly test whether digital maturity would be mentioned. It was also expected from some of the respondents to share some of their bad experiences with specific categories of businesses, which allowed to further assess their background. Further, the respondents were asked which success factors they considered most crucial for IoT implementation. This open question was asked in order to give the respondents the freedom to point out the factors which they personally consider most important. It was also put in the interview guide as a central question, as the answers could be used to compare

with findings from existing studies. Addressing the main research question of this paper, the next step of the guide was a question regarding the differences in factors between digitally mature companies and the ones that are not. A follow up question was placed in the guide to assure that the answers clarified the nature of the differences, such as if the factors were different, or just were more significant. The respondents were also asked if any other characteristics of business affected the implementation process and the success factors, such as size, structure, or country of origin. This was done in order to test if some other aspects of businesses had more impact than digital maturity, as well as to search for any other interesting findings. The two last steps of the guide were made to signal that the interview is coming to an end, by asking if there is anything else the respondent would like to share, which they find relevant to the discussion. The ending of the guide was to ask the respondent if he or she had any questions for the interviewer.

The interviews were conducted digitally, as it was easier for respondents to find time for a remote conversation than having a physical meeting. Additionally, by doing the interviews digitally, the geographical distance was not limiting the pool of potential respondents. Most of the interviews were conducted through a platform allowing for video calls, but a couple of interviews were also conducted through a normal phone call. The interviews were planned to last about 30 minutes, which they did on average. However, none of the respondents were limited in terms of time if they had more opinions or comments to share and were willing to continue the conversation. Shortly after the interviews, transcripts were written as precisely as possible. The accuracy of the transcripts was secured through multiple revisions of audio recordings.

### **4.3. The Respondents**

The respondents asked to participate in the interviews were chosen based on their experience with implementing IoT solutions. Respondents were preferably employed, or previously employed, in companies either offering IoT solutions or offering relevant expertise as a service for IoT projects, such as consulting companies. This criterion was set as it is highly relevant for this study to get insights from individuals with practical experience within IoT.

	Respondent #1	Respondent #2	Respondent #3	Respondent #4	Respondent #5
Country	Norway	Norway	Norway	France	Norway
Gender	Female	Male	Male	Male	Male
Company Type	One of the "Big 4" Consulting Companies	A Nordic Tech and Consulting Company. Approx. 10 000 employees	A leading telecom company in Norway. Working with connectivity for IoT solutions	A global provider of IoT solutions, specialized in networks and connectivity	A Nordic Tech and Consulting Company. Approx. 10 000 employees
Role/Position	Analyst Digital Platforms/ Consultant	Data Engineer	Consultant	Chief Marketing Officer	Product Manager
Industry Experience	Oil & Gas	Public, Logistics, Banking ++	Smart Buildings, construction, logistics ++	No industry focus – broad experience	Public, Smart Buildings, Agriculture ++

Table 2: Overview of Respondents Participating in The Study

As it is shown in the table above, the respondents all had experience with IoT, although their roles were different. Some of them come from a more technological background, while others are mostly involved in the business aspect of IoT projects. This variety of expertise ensures answers from very different perspectives, which add depth to the results. There is also a variety of characteristics of companies the respondents are employed at, such as size and focus areas.

#### **4.4. Methodology for Data Analysis**

Analyzing qualitative data is a difficult and time-consuming task. For that reason, a specific approach was adapted in this study, in order to overcome the challenges in this process and reduce the risk of overlooking important data in the transcripts. The method chosen for this purpose, was inspired by the one presented by C. Schmidt (2004). It presents an analytical procedure to process big amounts of qualitative data, which is very similar to one of the most known approaches called Ground Theory. In short, the approach involved revising the transcript multiple times, and setting up categories of the material. Further, the information in the transcripts was coded, following those categories. By reading the transcripts several times, and carefully categorizing and coding the material, the similarities and differences between independent answers could be identified more easily. Lastly, the coded results were quantified and presented in a table, showing the frequency of individual codes (Appendix 3). The table created for the last stage was used as a foundation while presenting the results later in this paper, along with extracts from transcripts which were provided as examples.



## **5. Results**

In this part of the paper, the results from the qualitative research will be presented. In other words, the findings from five independent semi-structured interviews. The order of presentation will be decided by relevance to the research question. As the results provide several interesting findings which are not directly relevant to the research question as well, they will be presented at the end.

### **5.1. Differences between Digitally Mature and Not Digitally Mature Organizations**

The respondents were asked about differences between technologically advanced companies, and the ones that are not. This topic was brought up in order to understand how projects for those two types differ, in terms of approach as well as important aspects to take into consideration. The majority of sub-categories had a frequency of two or three respondents.

One of the most frequently mentioned differences is that the digitally immature companies rely heavily on external expertise. This implies that there is a significantly higher level of trust to the partner assisting with the implementation process, as well as the decision making in the planning stage. This leads the offering companies, or consultants, to take on a role as advisors. Multiple respondents stated something similar to what one of the respondents did here:

*“For instance, dealing with less technologically advanced companies often requires an approach based on advisory. In the more technological companies, the people involved in the project usually know what they want to achieve, as they have the technological competence.” (Interview Respondent #1)*

There is also emphasis on simplicity being required by the less technologically advanced companies. Simplicity involves explaining the technology with an understandable language, as well as offering solutions which are easy to operate. Moreover, the less technologically advanced companies require complete, end-to-end solutions, while the more advanced ones are usually very active in designing the solution as well as the overall implementation process. This is because they have more technological expertise, and know exactly what they want or need for their business. Due to the preference for simplicity, the less advanced businesses often get as much as they can through an “as-a-service” arrangement, which often create

issues in the implementation process due to the existing technology being partly owned by third parties.

Three of the respondents identified education as a difference between the two types of businesses. Education and training is, apparently, more in focus in projects for less technologically advanced companies. This argument covers both usability and manageability of the solution, as well as the awareness of the opportunities and limitations of the technology. The mindset is another difference brought up by three of the respondents, which also creates a strong need for informing and educating the stakeholders. The mindset also affects the overall culture in the company, which was mentioned as a significant difference between those two types by two respondents. In the more digitally mature companies, there is a technology-oriented, entrepreneurial culture which has change management at its core. This allows them to take more risks on new technology than the less advanced companies can, and decide to change more rapidly.

However, the implementation process itself usually lasts significantly longer in the digitally mature organizations, according to the interviewees. The reason behind this, is the decision making which is split over multiple layers. There are more relevant stakeholders involved, which leads to the overall project moving at a slower pace.

## **5.2. Critical Success Factors in Organizations with Low Digital Maturity**

The main goal of the qualitative study was to find critical success factors typical for less technologically advanced businesses. Even though the question regarding this aspect was perceived as difficult by the participants, there were several factors found in the results, which may be valuable for further discussion.

The two most frequently mentioned factors typical for digitally immature companies, directly address the differences between the mature and immature businesses which were elaborated in the previous part of this paper. The first one is simplicity. This factor relates to the necessity of simplifying the technological aspects of IoT, as previously mentioned, as well as the requirements to the product/solution. As one of the respondents said in the following statement, assuring a simple enough approach is key when dealing with companies with low digital maturity:

*“It is a key challenge, because this is the way we foster adoption. If the solution is too complex to understand, and the people do not understand it with their own words and relate it to their business needs, it means that we went out of scope.” (Interview Respondent #4)*

The other most frequently mentioned factor is education, which was also elaborated in the previous section. The awareness about the technology’s opportunities as well as the basic understanding of it, is important in order to succeed. Companies which lack the technological expertise need to ensure that all relevant stakeholders receive such education. Several respondents claimed that it is a crucial part of a hand-over of a project to make the clients self-sufficient.

Further, a couple of respondents pointed out another difference between the two types, which leads to a specific factor for the less advanced businesses, which is the mindset. The mindset needs re-structuring, in order to alter the existing attitudes towards new technology and change in general. As one of the respondents pointed out, IoT is still not a mature technology, which is why the bigger, more advanced companies have an advantage. They have a different way of thinking about the technology, and they can afford to take the risk. Affording the risk is one thing, but another important factor brought up is simply the willingness to bet and commit to such an initiative. This factor is, naturally, also a part of re-structuring the mentality. One of the participants also identified “betting on safer use cases” as a factor. This is specific to the less advanced companies due to their general risk avoidance. The use cases with some sort of proven record of benefits are more likely to succeed, and can therefore be easier to implement than an innovation involving bigger risk.

Lastly, one of the respondents emphasized the significance of scaling and planning out the implementation process properly. First and foremost, one factor he identified is to start with a small, simple project, and be able to scale gradually. He also added, that the less advanced company should identify partners who will help them to scale and carefully plan the process:

*“One of them is to start small, and be able to scale. Meaning that when you want to test IoT, you need to start with a specific use case, which is accurate in terms of the scope you want to address. It also has to be planned how you want to implement it, for it to be simple. For the beginning, you also need to choose partners that will enable you to scale.” (Interview Respondent #4)*

One of the things mentioned in the quote above, is having a use case accurate in terms of scope. Further in the conversation, the respondent identifies clear understanding of scope as a

success factor. Scope has to be understood both in terms of the technology and its purpose, as well as geographical scope, if relevant.

### **5.3. Critical Success Factors in IoT Implementation**

The interviewees were asked to point out the factors they consider the most crucial in implementation of IoT solutions. They were asked to do so because it is a very open question, encouraging the respondents to share the insights they found most significant, and it was interesting for this study to see which factors were chosen. Moreover, as a majority of the factors found through the literature review were for general IoT implementation, the answers of this question allow to compare the results from the interviews, with the ones from the literature review. A total of 17 different factors were identified under this category, and there was a strong agreement on some of them.

Of the 17 factors mentioned in this category, only one was shared between all five respondents. The factor mentioned by all, was interoperability. This factor was never mentioned first, but issues with integrating systems with one another were brought forward in every interview, sooner or later. As one of the respondents pointed out, the situation in most companies nowadays involve several systems of varying age and functionality, which often causes problems in IoT implementation:

*“Ideally, you should have one interface for everything. But in reality, you have something new, something old, and something that does not communicate with all the other systems. It is a very difficult challenge to overcome, but these things need to cooperate in order to truly succeed with an IoT initiative.” (Interview Respondent #5)*

Interoperability is also mentioned in the context of managing data flows, as several respondents have experienced issues with companies having proprietary software systems. In other words, third parties supplying the client companies made it hard for those systems to cooperate with new additions in the company’s portfolio of systems. It was mentioned by a several respondents that some of the third parties refuse access to data, which also complicated the data flow management.

Two factors with strong representation in the findings of the literature review were mentioned by 80% of the respondents of the interviews. The first factor is alignment of business and IT. One of the respondents was quick to point out that factor as the most crucial one, and stated the following:

*“If we consider my experience from the public sector, which was a tough project, the alignment between the technological part and the business part was a big challenge, and it generally tends to be.” (Interview Respondent #2)*

The respondent later explains that the business stakeholders and the stakeholders from tech had completely different motives for pursuing the same initiative, which ended up with a lot of ambiguities in terms of scope and goals of the project, making it impossible to be considered a success.

The second factor mentioned by 80% of the respondents is aligning the IoT project with the strategy of the company. In other words, the IoT initiative has to be motivated by a clear purpose, like reaching specific benefits, and being in line with the overall vision the company has set. Based on the responses, many initiatives are starting because of the so-called “hype” caused by the amount of attention IoT has gotten in the recent years, instead of a need to improve or to overcome a challenge. One of the respondents made the following statement, which a majority of the other interviewees would agree with:

*“A lot of initiatives are sourcing from hype, but you always have to be able to make a clear link to a specific challenge or goal. It has to be driven by a need to solve something.” (Interview Respondent #5)*

A total of 3 out of 5 respondents mentioned a factor which can reduce the risk of this evidently frequent mistake being made. They all stated that ideally, the initiative should be started, and ran by the business side of the organization. Many respondents are identifying the technological stakeholders as the ones who often fall into the trap of starting an IoT initiative for the wrong reasons. On the contrary, the business stakeholders are assumed to be more likely to start the initiative in order to solve an issue, making it more aligned with the overall strategy of the company. Another factor, mentioned by the same number of respondents, is also directly linked to the necessity of implementing the solution to solve a specific need. Awareness of own situation is important in order to identify needs and challenges in the first place. As one of the respondents stated, the self-awareness of companies is a crucial part on the way to success:

*“That is perhaps the most crucial factor I would point out, to really understand your situation and issues that need solving. There are surprisingly many technological solutions out there which are completely useless, because they were not aimed to solve anything specific.” (Interview Respondent #5)*

Further, there is a number of factors mentioned by two of the respondents, which constitutes 40% of the total number of interview objects. Keeping in mind the nature of this study, focusing rather on depth than quantity, all inputs were considered significant.

As three of the respondents had background from the technological aspect of IoT, some of the mentioned factors were focused on the technological feasibility and challenges related to it. Optimizing data flows was a frequently mentioned topic in the answers from those respondents. One of the respondents is identifying that as a central issue, and provides a simple example why:

*“The dataflow is also an important factor; you have to figure out where the data will be stored, for instance. If you want to store it in a cloud, it can quickly get very expensive. Therefore, you need to understand what you have to adapt locally to remove that need.” (Interview Respondent #5)*

The technological aspect of working with IoT, often involves optimizing and managing the data flows. With adapting locally, the respondent is referring to the in-house infrastructure which needs to facilitate for handling the data gathered and transmitted by the IoT solution about to be implemented. Another respondent also associates the increase in data flows with security issues, especially in companies where several systems have to exchange information between each other. The same respondent also points out that privacy can be an issue in some IoT implementations. More specifically, following the requirements of GDPR was identified as difficult at times, as it is difficult to assess whether the requirements were being held or not. In his answer, an example from his own experience was provided:

*“There is a lot of ambiguity in the regulation, and in some cases you do not know if you are following it or not. For instance, when tracking parcels, one has to be very careful with what kind of data is stored, and how long it is stored.” (Interview Respondent #2)*

Additionally, interview respondent #1 stated that security was one of the main focus areas during the education process of their clients.

One of the respondents with technical background also pointed out factors related to information technology and operational technology steadily merging to be more alike. This is the reason to why two of the identified factors need to be taken into consideration in the implementation process. First and foremost, the IT and OT need to be aligned. Business and

IT are two seemingly different functions growing into one, and IT and OT are doing the same. However, the stakeholders concerned with OT have different tasks than the ones from IT, and there can be a silo effect which can cause misalignment of goals for the initiative. The respondent summarises the situation in the following statement:

*“Although the technology is merging and becoming more alike, it does not mean that the processes and the people involved naturally change. They are also separate silos in a company, people that usually do not interact at all. Their goals and incentives can, for that reason, be very different.” (Interview Respondent #5)*

The same respondent points out that IoT projects often create a need to change processes, the way of operating, and sometimes the structure of some parts of the organization. He refers to it as the domino effect, as implementing the IoT solution often leads to further change in the overall operational model. Therefore, adapting the operating model is also a significant factor in some cases.

Developing a strong in-house strategy was also emphasized by two respondents. One of the respondents stated that aiming to develop internal competence and having ownership of internal processes affects the ease of implementation, and facilitates for gaining more benefits after it. The respondent made a following statement:

*“Developing a proper in-house strategy is an important factor as well. To build internal competence and internal ownership of processes. This accelerates the overall implementation process, and is a driver for reaping the benefits of further use.” (Interview Respondent #1)*

Partnerships were also mentioned as a compulsory part of succeeding with IoT, both for companies offering the solutions, as well as the ones implementing them. The reason behind this is that the initiatives tend to get very complex, and the IoT value chain contains very different elements, from connectivity, to hardware and software.

Further, there were several factors mentioned by one respondent. Among those are assuring that data is trustworthy and assuring appropriate tools, as the traditional BI tools are not really suited to extract full value from an IoT solution. One of the respondents also specified that the end user should be put in the centre of the design of the solution, not the decision maker. This is in order to assure usability for the user. Furthermore, one respondent is stating that KPIs are unavoidable, along with a timeline to monitor the progress of the initiative. Lastly, scalability is mentioned among the critical factors. Apparently, some organizations are not prepared for

succeeding with IoT, and therefore not prepared to upscale the solution. This often causes a need for re-structuring and results in loss of time.

#### **5.4. Other Characteristics of Businesses Affecting Implementation & CSF**

In order to explore the influence of business characteristics on the implementation process of IoT, the respondents were also asked if there are any characteristics influencing the ease of implementation and the critical success factors for IoT projects, other than degree of digital maturity.

In this category, existing structure was the most frequent answer. The structure has an impact due to the complexity of dealing with third parties and proprietary software, as previously mentioned. As many companies outsource some of their processes, and other have suppliers delivering them services, their organizational structure can cause difficulties and additional challenges in an implementation process.

Furthermore, size is mentioned by two of the respondents as a relevant characteristic. According to the gathered information, the size can give both advantages as well as disadvantages at the same time. For instance, big companies have the stability and financial resources to take more risks and to conduct more extensive, and more rewarding projects. However, as their hierarchy tends to be more complex, the decision making is slowing the overall process down, as previously explained for the technological companies.

Other respondent identified the culture and attitude in a company as the most impactful characteristic, as it assures to avoid many of the challenges related to resistance of change, and a weak willingness to commit to technological investments.

Lastly, one respondent classified businesses in “front-runners” and “followers”, where the front runners are companies with entrepreneurial spirit and a heavy investment and focus on R&D. These companies have developed their processes to reduce the time it takes from an R&D initiative to a complete product creating revenues or other benefits. These companies are, naturally, also more willing to bet on the new technology which is still pre-mature. The followers, on the other hand, are companies which are less willing to alter their processes and overall structure, and tend to wait for a technology to reach maturity before committing to an investment. That way they reduce the risk of failing, and reduce the investment size as mature technologies are significantly cheaper than the pre-mature ones.



### **5.5. Difficult Industries and Organization Types**

The aim of questions regarding industries or business types where implementation of IoT is particularly difficult, is to see if there are any clear similarities or areas of agreement between the independent responses. Moreover, it is a way to indirectly test if less digitally mature industries or businesses are a challenge for professionals working in IoT implementation. Four out of five respondents started their answer with “it really depends on the client”, signaling that it is not possible to classify a whole industry, or a cluster of businesses, as being difficult in this field. However, some aspects of businesses creating difficulties were mentioned by the interviewees. Two of the respondents stated that the decisive characteristic of a client who is likely to be challenging is digital maturity, and that the companies far behind on technological development are particularly demanding. This became evident through statements such as:

*“Broadly speaking, companies that are far behind in technological development, find it difficult, obviously. Part of the problem is lying in the existing technology, but the most significant issue is what is going on in the clients’ head.” (Interview Respondent #5)*

The statement above pointed out the existing technology and the general mindset of the key stakeholders in the company as the main reasons for the significance of digital maturity. Another respondent provides the same statement, yet with a slightly different reasoning:

*“It is more a matter of maturity. It is harder when you are in industries where you need to explain what IoT is. There is a lot of buzz and hype around IoT, but sometimes it is surprising to hear what companies actually believe is behind this term ” (Interview Respondent #4)*

This respondent pointed out the lack of knowledge about IoT and the opportunities it provides as the reason behind the difficulties in less digitally mature companies. One respondent also pointed out the public sector for being difficult based on his own experiences, but explains his statement by emphasizing the specific arrangements of a project, and not a general fact about the sector as a whole. However, another respondent mentioned that the public sector is different than all private companies, as the incentives for investing in technology are different. The technological investments are often aimed to prepare for demographical changes which may require improvements in some areas of the organization.

## 6. Discussion

The results from the executed study certainly included several interesting findings. In this part of the study, the results will be interpreted in the context of the research question and the overall study. Comparisons to findings in the analysis of previously executed studies will be made, and findings giving additional value will be identified. In addition, the differences and similarities between the independent responses will be discussed.

### 6.1. Critical Success Factors – A Comparison with Previous Findings

The literature review resulted in identification of 21 different success factors for IoT implementation, which were grouped in four categories; company characteristics, project management, IoT expertise, and technological factors. As the respondents were asked to share their views on which factors are most central in IoT implementation, it is now possible to test whether those factors are coherent with the opinions of the participants of the qualitative study in this paper. The table below presents the same table provided after the literature review, with factors coded in colors in order to reflect whether they were mentioned by the respondents during the interviews or not. Green color represents factors which were mentioned, yellow color represents factors which were not mentioned specifically, but indirectly implied, and lastly, the red color represents factors which were not mentioned.

Company Characteristics	Project Management	IoT Expertise	Technological Factors
- Entrepreneurial/Tech-Focused Culture	- Strategy (Vision & Goals)	- Expertise in IoT & Data Analytics	- Interoperability
- Understanding and Awareness	- Alignment of IT & Business	- Partnerships	- Security & Privacy
- Organization Size	- Cross Functional Team	- Ensuring Education & Training	- Feasibility (Proof of Concept)
- Prioritizing & Investing in Security	- Involvement of Stakeholders		- Access to Data
- Top Management Support	- Iterative Approach		- Low Complexity (manageability & usability)
	- Realistic Cost/Benefit Analysis		- Infrastructure
	- Multiple Use Cases		

Table 3: Comparison of Previous Findings with Results from Study

As it becomes evident by looking at the table, a majority of the factors were coherent with the findings of the study. This was expected prior to conducting the interviews, as many of the factors in the table could be found in literature from various sources, meaning that there is an agreement among researchers. Out of the 21 factors, 15 factors were mentioned directly by the respondents. The two factors mentioned in yellow were also mentioned by the respondents, but were not specifically identified among the most crucial factors. Those factors were rather implied by the context of conversation. Therefore, they are also considered among the factors coherent with the findings of the literature review. Adding the two “yellow” factors, the total number of coherent factors grows to 17, which constitutes about 80% of the total pool of factors in the table. The factors most frequently mentioned in the analysis of literature, were all mentioned in the interviews, meeting the expectations set before contact with respondents was made.

Considering the frequency each factor was emphasized in previous research and this study, some of the factors stand out in terms of importance. The most frequently mentioned factor was strategy, or more specifically, to always align the new technology with existing goals or challenges. The IoT initiative should also be motivated by that, and not by a technological department, as the incentives behind a project can be decisive of its success. Another factor mentioned in nearly every source, which is directly linked to the strategy factor, is alignment of business and IT. As the two sides are getting more and more intertwined, it is important to be strategically aligned so the existing differences will not cause any issues. Those two factors were brought up often, and usually among the first factors which came to mind for the respondents of the interviews. Another factor which stands out in terms of frequency is interoperability. It was already observed in several other studies, however, the frequency in the interviews involved 100% of the respondents. Based on the findings of the study, interoperability is a very reoccurring hindrance of IoT implementation, and an unavoidable step to overcome in order to succeed with such initiatives. This was often explained by the complexity of system structure in many companies, as it consists of systems from different suppliers, which is complicating the process of making all systems communicate with each other. Another factor which was very frequently mentioned in other studies was top management support. This factor was also observed in a majority of the respondents’ answers, validating it as a key factor. However, due to the perceived significance this factor had based on the analysis of other research papers, top management support was expected to be mentioned by all of the respondents.

The four remaining factors, marked in red, were not mentioned in any of the conversations with the five interview objects. Realistic cost/benefit analysis was not mentioned, which is assumed to be caused by the fact that it is a quite natural part of making an investment. This factor would be valid for any kind of investment and project, not only for IoT solutions. Multiple use cases as a factor, was not expected to be mentioned either, as it was only mentioned in one study conducted by McKinsey (Lamarre & al, 2019). In other words, there was no clear agreement between researchers on this exact observation. Feasibility and a solid proof of concept were not brought up in any of the responses. This was expected to be mentioned, however, it is suspected that it was not due to the same reason as the cost/benefit analysis – it is an obvious part of applying any technological concept in a business context. It is also important to keep in mind, that the respondents were all professionals offering expertise to their client, and that assuring feasibility is probably a quite standard task for them.

The only factor which truly did not meet the expectations set before conducting the study, is the factor “prioritizing & investing in security” as a company characteristic. Although a similar factor, listed under the technological factors, called “security and privacy”, was mentioned by the respondents, the literature suggested that the company itself needs to have a strong focus on security to truly succeed with IoT. The respondents mostly brought up security in the context of technological changes and complexity, and did not really emphasize the significance of the security as a central part of the culture and operations in organizations. One could argue, that this factor is not really central, and that the respondents did not mention it because they did not consider it relevant for this study, or did not have the chance to bring up such topics due to time restrictions. Nevertheless, the lack of this factor in the study is surprising.

## **6.2. Additional Findings on Critical Success Factors for IoT Implementation**

Even though a majority of the factors found in other studies were also observed in this study, there were several factors which were identified through conducting interviews, which were not seen in the literature.

One of the factors which was not identified in the literature review, was “focus on in-house strategy”, which was referring to ownership of processes and building knowledge internally in

the organization. This factor was mentioned by two respondents, however, the difficulties related to working with companies which to high extent rely on third parties through outsourcing or similar were mentioned by three. This factor may not be crucial for success per se, but it certainly has a big impact on the ease of implementation, based on the results from the study.

Another two factors identified through the study are “Aligning OT and IT” and “Adapting Operational Model”, which were mentioned by two and one respondent respectively.

Similarly to the situation with business and IT, the information technology and operational technology are slowly intertwining. Earlier, they had very different tasks and were often seen in two different silos in organizations. Now, with technology such as IoT that can affect them both, there is a higher need to align the goals and incentives behind technology investments. As a consequence, OT needs to be considered and involved in the implementation process, as it is likely to be strongly affected by it. The model concerning the operational model refers to what one of the respondents called a “domino effect”. As previously mentioned in the presentation of results, implementing IoT often requires changes in a way an organization operates, their structure, and so on, in order to be able to achieve all the potential benefits of the new technological addition. Organizations should, therefore, carefully assess their operational models before an implementation, and search for a need to re-structure their operations.

Another factor which was not often mentioned in the literature is scalability. According to the response of one of the participants, businesses should ensure the ability to scale their IoT solution. Apparently, many organizations do not truly believe and expect succeeding with the new technology, and when they do and the need for upscaling becomes evident, they have to re-structure again and lose plenty of time and resources in doing so. According to one respondent working in a company offering connectivity for IoT solutions, this is a very central factor, and a common mistake made by their clients. The same respondent also identified clear and effective key performance indicators as a success factors, as well as a timeline for the project, in order to be able to measure the success and monitor progress. Before the study was conducted, these things were expected to be identified as crucial by a majority of the respondents, as they usually are expected to be a part of any implementation process. It is therefore quite surprising only one respondent brought it up, although one may argue that it is another obvious part which was left out due to time constraints and prioritizing of other factors which were considered more relevant or interesting by the respondents.

### **6.3. How the CSFs Differ in Organizations with Low Digital Maturity**

The results presented in the previous part showed that there are differences between digitally mature organizations, and the one that are not. These differences are often rooted in the culture, mindset, and lack of technological expertise, especially in the top management. There are also differences in existing technology, which often complicate the implementation process. According to the results, the technological issues are often caused by lack of access to historical data, and a strong preference for systems and processes delivered as a service, which involves third parties not always willing to cooperate and share data. These kind of differences were expected before the interviews were conducted. However, the lack of critical success factors aimed for this specific category of organizations in the literature was not promising in terms of findings of factors specifically applicable to those cases. The factors were rather expected to be weighted differently in those cases.

The results, showed that there are, in fact, some factors which the respondents specifically identified as crucial for digitally immature companies. These factors are aimed to overcome some of the most challenging differences in companies scoring low on digital maturity, such as lack of expertise and an unfavorable culture and mindset.

By taking a closer look on those factors, however, one can argue that they are crucial to succeed with every IoT implementation initiative. The difference is, as it was suspected, that those factors are usually taken for granted in digitally maturing companies, where the expertise is not a problem and they are generally very advanced in terms of technology. As one can expect digitally maturing organizations to fulfil those factors already from the start, the factors are not specifically mentioned in any reports or research papers. Other factors, likely to be more challenging for the mature companies, are emphasized instead. For that reason, the factors identified as exclusively relevant for organizations with low digital maturity are simply factors which are generally important, but are more crucial to focus on when implementing IoT solutions in less technologically advanced companies. In other words, the expectations of factors being differently weighted for the two concerned categories are met. For example, education was identified as a factor specifically for less advanced companies. This is supposed to raise awareness of the technology and make the users with

low technological capabilities self-sufficient. However, education is generally a part of a hand-over, according to some of the respondents working on several projects as consultants. The education is just significantly more crucial while dealing with digitally immature companies, as the gap in knowledge which has to be filled by the education efforts is much larger. Another factor proving this point is simplicity. Usability and low complexity was mentioned as a general factor, as it is favorable for most projects. However, the solutions and tools provided to the less advanced organizations have to be particularly simple, due to their lack of expertise and general resistance towards new technology. Therefore, the simplicity is weighted much higher, almost giving a new meaning to this factor. Nevertheless, it does not mean that it is insignificant for the organizations with strong expertise in technology.

#### **6.4. Similarities and Differences between Respondents**

Although there was an agreement on some of the most central factors among the respondent, as previously mentioned, there were some differences as well. More or less every respondent brought up at least one new success factor or observation on the differences between companies scoring high and low on digital maturity. The differences can be explained by several things. First and foremost, the respondents were asked to share the factors they consider most crucial in IoT implementation. Therefore, the factors which were shared are based on their opinions, and are probably very influenced by their own experience with IoT projects. The individual experiences can be very varying, as there are a lot of solutions which can fit in the term internet of things, not to mention the differences between various business and industries. Moreover, the respondents also came from different backgrounds. Some of them were working as business consultants, while others had a more technological background, more focused on designing the solutions or making it technically feasible to implement them. As the backgrounds are so unlike, the challenges the participants faced were probably different as well. It is not by coincidence, for instance, that two of the respondents identified security as a success factors, while the others did not. The participants that did bring up security both had technological background, so it is likely that security was a more common task for them, than for those with more business-oriented roles. It is, therefore, not surprising that there were variations in the answers.

## **7. Conclusion**

In this part of the paper, the final conclusion will be made based on the discussion in the previous section. Moreover, limitations of the qualitative study performed for the purpose of this paper will be identified, and recommendations for future research will be presented.

### **7.1. Final Conclusion**

In closing, this study tested the critical success factors from existing studies, identified several new ones, and identified the differences in the implementation process as well as critical success factors for organizations with low digital maturity.

Assessing which factors are most crucial really depends on the characteristics of the project as well as the organization executing it. There are some factors, which the results of this study can suggest to classify as more central than other, such as having clear goals, support from the top management, and alignment of IT and business, as those are the most frequently mentioned factors in this study as well as existing literature. However, at the end, it is important to acknowledge that every factor plays a certain role, but their significance and impact on results differs depending on the challenges the project implies or the organization is currently facing.

This study identified the key differences in the implementation process for organizations with low digital maturity, and the results reflect what was being stated in the paragraph above. There are challenges in those organizations which do not exist in the digitally mature ones. Therefore, the key success factors are different, as challenges such as lack of expertise, lack of technology-oriented culture and mindset, or outdated system structure have to be addressed by a higher focus on education and simplicity. This does not mean, however, that those factors are not important for projects conducted in digitally mature organizations. The difference lies in the fact that digitally mature organizations have the expertise and culture in their core, and the factors mentioned above are therefore covered from the start.

### **7.2. Limitations of the Study and Future Research**

In order for the findings in this study to be treated fairly, the limitations of the study have to be presented. The major limitation of the study was the time constraint, which resulted in a



relatively small sample of respondents. While the findings can be perceived as both valuable and interesting, the size of the sample is simply not big enough to be considered representative. Moreover, there are some limitations related to the respondents. First and foremost, as four out of five respondents were working in Norway, it cannot be assumed that the results will be the same in other parts of the world. The one respondent outside of Norway was from France, which is still a European country, meaning that the results do not represent a global agreement on this topic. Moreover, all the respondents were employed in companies either offering IoT solutions, or employed in consulting companies offering their expertise to support their clients throughout their projects. While this was beneficial in terms of a broad experience from a wide array of industries and businesses, it was also a limitation as there were no respondents from companies actually implementing an IoT solution in their business.

In terms of future research, there are plenty of interesting topics which would be interesting to examine. It would be highly interesting to see a similar study to this one, being conducted at a larger scale, with participants from several geographical areas. Digital maturity is just one aspect of organizations which can be used to examine differences in the IoT implementation between different contexts. It would also be both interesting and valuable to conduct a study on other contexts, and see how the critical success factors and the overall process is shaped accordingly. This study showed that there are other categories which impact the implementation process, such as size or structure of organizations. There is also a reason to believe there is a need for further research in this field, as nearly every respondent in this study started by answering that the critical success factors, as well as the ease of implementation, heavily depend on the client organization. Expanding the research on IoT implementation to more detailed contexts and providing more specific insights to the public, could make it easier for many businesses to adopt and implement IoT, and hopefully lower the rate of failure which is too high at the moment.

## 8. Bibliography

Lueth, Knud, 2014, “*Why the Internet of Things is Called Internet of Things: Definition, History, Disambiguation*”.

McKinsey & Company, 2015, “Internet of Things: Mapping the Value Beyond the Hype”, June, p. 3-12.

Cisco, 2017, “*Cisco Survey Reveals Close to Three-Fourths of IoT Projects are Failing*”.

Dijkman, R.M & al, 2015, “Business Models for the Internet of Things” *International Journal of Information Management*, vol. 36, December, p. 672-678.

Whitlock, Martin, 2019, “*Here’s how you ensure a successful IoT implementation*”, Telenor Connexion.

Klement, Peter, 2018, “*6 factors crucial to the success of industrial IoT in manufacturing*”, DXC Technology Company, p. 2-5.

Sands, E.G, Bakthavachalam, V, 2019, “*Ranking Countries and Industries by Tech, Data, and Business Skills*”, Harvard Business Review, May, p. 8.

Boyes, H., Hallaq, B, Cunningham, J., Watson, T, 2018, “The Industrial Internet of Things (IIoT): An Analysis Framework“, *Computers in Industry*, vol. 101, October, p.1-12.

Lamarre, E., May, B., 2019, “*Ten trends shaping the Internet of Things business landscape*”, McKinsey & Company, January.

Timm, A., Mitchell, T, 2015, “*To Succeed with the Internet of Things, Start Smart*”, Kalypso, June.

Dr. Helmus, R., Grabenhofer, J., 2019, “*Turning the Internet of Things into Reality*”, Siemens IoT Services, April, p. 10-26.

Silveiro-Fernandez, M., Renukappa, S., Suresh, S., “*Evaluating critical success factors for implementing smart devices in the construction industry: An empirical study in the Dominican Republic*”, University of Wolverhampton, p. 8-14.

Bouck, Whitney, 2014, “*Mapping the Information Economy: A Tale of Five Industries*”, Box inc., June, p. 4.

Matta, V., Koonce, D., Jeyaraj, A., 2012, “Initiation, Experimentation, Implementation of Innovations: The Case for Radio Frequency Identification Systems”, *International Journal of Information Management*, vol. 32, 2, April, p. 164 – 174.

Lee, S., Kim, K., 2007, “Factors affecting the implementation success of internet-based information systems”, *Computers in Human Behavior*, vol. 23, 4, July, p.1853-1880.

Benson, Chuck, 2019, “Managing IoT Systems for Institutions and Cities”, Auerbach Publications, ProQuest Ebook Central

Adams, W., Newcomer, K.E, Hatry, HP, Wholey, J.S (2015), “Conducting Semi-Structured interviews” in *Handbook of Practical Program Evaluation*, Jossey-Bass, p. 492-503

Ochieng, Pamela A., (2009), “An analysis of strengths and limitations of qualitative and quantitative research paradigms”, *Problems of Education in the 21<sup>st</sup> Century*, vol. 13, p.13-17

Schmidt, Christine, (2004), “The Analysis of Semi-Structured Interviews”, *A companion to qualitative research*, SAGE Publications Ltd, p.253-258

G. C. Kane, D. Palmer, A. N. Phillips, D. Kiron, and N. Buckley, “Achieving Digital Maturity” MIT Sloan Management Review and Deloitte University Press, July 2017

## 9. Appendix

### Interview Guide

1. Introduction of project, and purpose of the interview
2. What kind of experience do you have within IoT?
  - a. What kind of customers did you work with?
3. **Are there any industries or types of organizations where it is harder to implement new technology such as IoT?**
4. **Based on your experience, what are the most important critical success factors for implementing IoT solutions? What kind of impact do they have?**
5. **Are the critical success factors different for less technologically advanced companies, than those with technology in their core?**
  - a. **Are some of the factors completely different, or are they just weighted differently?**
  - b. **Are there other characteristics of the company which influence the ease of IoT implementation? (size, country of origin, structure etc..)**
6. Is there anything else you would add to the topics we have discussed, which was not yet mentioned?
7. Do you have any questions for me?

## **Transcript Interview #1**

**What kind of experience do you have from IoT, and what industries have you been working with?**

*“Our company is working on a lot of different projects. I am working in technology, and my main project is in the oil and gas industry. As I am mostly involved with the technological aspect of the IoT projects, a big part of my work is optimization of data flows and similar.”*

**I know the oil and gas sector is known for being early adopters of advanced technology. Are there any industries where it is difficult to implement technology, compared with others?**

*“Some industries are generally more advanced technologically than others, it is correct that oil and gas is an industry in which technology plays an important role. Generally, the challenges can be a bit different, but it also depends on the particular client organization. For instance, dealing with less technologically advanced companies often requires an approach based on advisory. In the more technological companies, the people involved in the project usually know what they want to achieve, as they have the technological competence.”*

**What would you point out as the most crucial factors to succeed with implementing IoT?**

*“Speaking from a tech perspective, we spend a lot of time on optimization of data and data flows. Existing resources and access to data are important factor in a project. For instance, by implementing a solution for predictive maintenance, the ease of implementation can be determined by how much data is available. Also, combining the historical data is important, making all data sources speak the same language. We have to decide what can be used and where there is a lack of data sources, in order to be able to make more precise calculations.”*

**The most central research question in my paper is related to how the success factors differ in less technologically advanced companies. I know most of your experience is from a rather high-tech sector, but is there anything there which makes your job easier, that you would not have in a less advanced company?**

*“The oil sector is very driven by technology, so access to historical datasets is very strong compared to the majority of other companies. There is also a very technology-oriented mindset in this industry, and the oil and gas companies usually have strong technological expertise in the top management. This is also encouraging a strong company culture, which is*

*appropriate for executing change processes. It is especially important in hard times, like nowadays. The decrease in oil prices happening now, and similar external pressure, can affect the implementation process, as the change happens faster due to a stronger will to readjust.*

**Are there any critical success factors which are different for the less technologically advanced companies, than those with technology at their core? Or are they just weighted differently?**

*“One critical factor for the less advanced companies is awareness regarding the value of the IoT technology. This is often taken for granted in the more advanced companies, as they have a higher degree of technological knowledge, also among the decision makers. Another thing is the willingness to “bet” on the technology, meaning to invest and really commit to it. But there are also “shared” factors which will be significant, at least to some extent, for every project within IoT.”*

**Are there other characteristics of an organization which have an impact on the ease of implementation and the factors?**

*“Companies that actually own things themselves, and do not outsource too much, have a better initial situation than the ones who outsource many of their processes. The reason behind it, is that dealing with several different parties is avoided. It is also easier for them to truly understand what they want to achieve with this project. Ambition is always there, but sometimes things get more complex than expected.”*

**Is there anything else you feel should be added, which we did not yet discuss?**

*“Well, developing a proper in-house strategy is an important factor as well. To build internal competence and internal ownership of processes and so on. This accelerates the overall implementation process, and is a driver for reaping the benefits of further use. This also involves aligning IT and business, as it is important for the internal competence that the decisions do not source solely from business or solely from IT.”*

**How long do you usually stay involved in the process? How do you ensure that the client remains successful over time?**

*“As consultants, we usually participate over a longer period of time, including the time after the process itself. We are usually considered in the resource pool the company relies on. And of course, an important part of our role in those projects is to educate the client and the users of the new solution. A very crucial factor which is in focus during the training is security, as the IoT solution tend to introduce new risks along with its great benefits. Exactly how long we stay involved, really depends on the client and the project, though. A thing to consider while trying to estimate the necessary time of direct involvement, is how much technology expertise there is in the top management of the company we work with.”*

## **Transcript Interview #2**

### **What kind of companies or industries do you usually work with?**

*“In our company, we are not split into teams providing our services for specific industries, the organization is rather based on fields of skills and knowledge. For instance, I am working in cloud data & insights, so I am part of the delivery unit for projects which can be in any industry. During my time here, I have worked with the public sector (logistics), bank and finance, and some smaller projects here and there.”*

### **Are there any industries or types of companies where it was difficult to implement a relatively new concept like this? Is this a thing that affects how easily new technology can be implemented?**

*“Yes. In fact, one project for the public postal service turned out to be very difficult. In other projects, I was in charge of a wide range of tasks from solution architecture to implementation, so I had control over the whole project myself. In this particular project, I was not, and this was a place where implementing these kind of innovations was not easy at all.*

### **Are there any factors you would point out as crucial in order to succeed with implementing an IoT solution?**

*“If we consider my experience from the public sector, which was a tough project, the alignment between the technological part and the business part was a big challenge, and it generally tends to be. There was no clear chain of command. The business side had their own objectives; to invest money and get returns. The tech side, on the other hand, just wanted “cool things”. If you don’t have a clear hierarchy there, you end up dealing with a lot of different individuals from tech, who all want their “cool things”. This results in ambiguity around goals and scope, and milestones which are hard to achieve. In some cases, you might think you are done, and it turns out the business side did not get what they expected at all, even though you somehow managed to satisfy all the wishes from the tech side. At the end, the business side are the ones who pay for our services.”*

*Usually it is the business side that initiates the whole process of implementing IoT, based*



*on recommendations or requests from the tech side. If you do not have a clear plan for when this investment is supposed to give effects, what the effects should be, and how it should be measured, it is hard to consider anything a success.*

**Is there anything else in this topic you would point out?**

*“In certain companies, where the technological debt is high, and a lot of proprietary systems, it is difficult to implement an IoT solution as a “+1 architecture”, because it introduces a new way to operate in. In some companies, it was usual to have big hubs and use software like Citrix or similar, where everyone is working with their own tasks. If you suddenly have many agile sensor solutions, many data flows, and many ports which are open, security becomes an issue difficult to manage, and to get the data to the relevant systems. When a company has heavy, licensed software from several suppliers, who tend to have their own support teams spread all over Europe and might not be ready for something like this. Therefore, sometimes you have to adapt your solution a lot to fit the limitations, which no one wants, or you are forced to wait for the suppliers to be ready to integrate that specific use case.”*

**Do you think the critical success factors are different for less technologically advanced companies, than those with technology in their core? Or are they just weighted differently?**

*“From a consultant perspective, the whole process of change is easier for the less technologically advanced companies. However, there are some challenges as well. For instance, they don't have expertise in the technology, so you have to simplify things in order for them to understand. At the same time, they trust the partner which brings the technological expertise to a much higher extent, and they are more willing to listen. In a highly technological company, you usually deal with a large team responsible for the project, with a strict change management “regime”. Maybe there is a hint of prestige as well, they don't want to exclusively follow your advices in order to “save face” in a way. The decisions are also made significantly slower, for instance one week for every design proposal.”*

**You mentioned that you have to simplify things, in order to make things seem less complex. In another interview, I learned that for less technologically advanced**

**companies, education and awareness is something consulting companies focus on, because they do not have that kind of expertise in-house. Do you also do that?**

*“Yes, absolutely, it is something we do a lot. It is a natural part of a “hand-over”, to make the customers self-sufficient. That is extremely crucial. I had a long conversation with some representatives from a municipality, where we discussed the concept of “digital twins”. They are used to standard CRM systems, a simple website, and basic ERP solutions. We spent quite some time explaining the new concept we wanted to implement for their use, and after our best efforts, they still asked about which CRM system will be included. This shows that such changes require a complete re-structuring of the client’s mentality, as they have a way of thinking which is very rooted in the traditional solutions. One funny comparison can be made with the “Alien” movies, where we can find elements of retro futurism. In the older movies, we can see technologically advanced space ships, where the science-fiction authors and producers were able to imagine that people will be easily able to travel through space. However, inside the spaceships, you could see old cassette-players, because they could not imagine any advancement in technology for playing music. Problems like that can occur when you are dealing with companies which are less technology oriented. They have a frame of reference which is hard for them to escape. During a conversation, you can think you are talking about the same thing, but in reality, they can only imagine certain aspects of it. This leads them to be stuck with a mindset which leads to ordering the same, familiar solutions.*

**We have been talking about the extent of technology orientation in a company, but are there any other categories of business which influence the success factors?**

*“We can see a shift in preferences businesses have, as they do not want to create or implement any IT solutions themselves, and prefer to use Software-as-a-Service for everything. If you come to an organization where nothing really exists internally, as everything is service-based from third-party suppliers, you can experience some challenges. The existing architecture, and the previous choices made by a company, can therefore be very relevant for the success factors of the project.*

**Can an example here be companies who outsource a majority of their processes?**

*“Yes, but outsourcing is not the only aspect here. It can also be important who their existing suppliers are. For instance, a lot of offices use Adobe Photoshop. You are never in touch with a customer support employee from them, but you pay a license every month and everything works as it should. We can see that happening more and more in big, corporate software*

*systems as well, they can be easily acquired through a standard license off the internet, and it works pretty good. Normally, users of such solutions do not have any relation to the people running their system, they just get a system which works fine, and if they have a bug, they send a report and it will get fixed.*

**I see. Is there anything else you would like to add, that you find relevant but we did not discuss yet?**

*“Specifically for IoT?”*

**Yes, but as I was analyzing the existing studies on this topic, I was not impressed by the amount of literature out there, and therefore started looking into similar technologies, such as cloud solutions. I noticed there are a lot of similarities between the critical success factors in implementing other technologies and IoT. All in all, it is a change process initiated by technological innovation, so if there is anything you would consider applicable, feel free to share.**

*“IoT is a very broad concept, there are a lot of different use cases which can be included in that term. For instance, implementing sensors in a factory, is not likely to involve difficult challenges, other than the hardware which is already there. However, in some implementation processes, like the one from postal services we talked about, GDPR turned out to be a tough hurdle to overcome. There is a lot of ambiguity in the regulation, and in some cases you do not know if you are following it or not. For instance, when tracking parcels, one has to be very careful with what kind of data is stored, and for how long it is stored.*

### Transcript Interview #3

#### **What kind of projects do you do in your company?**

- *“We are specialized in communication technology, so that is what we usually deliver, but we have some ongoing IoT projects as well. One example of a big projects we did is for a large bank, which was moving in to brand new offices. This was a smart building project, and our solution was aimed to fix an issue with meeting rooms. Earlier, employees were running around the building searching for rooms to have meetings or to have a silent space. This was actually a pain point in their daily operations, as the windows were tinted and they had to actually open the door to check the availability, which needless to say, caused many interruptions of meeting and similar. We set up sensors in all the rooms, like rooms for meetings, for silence, and even toilettes, which measured the CO2 levels and temperature, among other things. When there were people in the room, the sensors could sense a rise in temperature and a decrease in air quality. After the people left the room, the air quality and temperature would go back to normal within a few minutes, and the sensors would notify the system that the room is free. A map was included in the interface of the system, so the users could quickly get an overview over rooms and their availability. This saved money for the client as the employees became more productive, with less time spent on searching for rooms. In this case, the hardware (the sensors) was delivered by a smaller supplier..*

**I actually heard a company presentation that was doing something similar, they were selling a device that could measure the air quality and notify about too high CO2 levels.**

*“Yes, a solution like that consists of the sensor technology, and communication technology. In this case, the communication was relying on the Wi-Fi network owned by the customer. In other cases, for instance were such solutions are implemented outside and have to be more mobile, the communication is based on a mobile network. In some cases, you can also have both, like in security companies, where the sensors usually run on Wi-Fi, but also have mobile receivers built-in which get activated when the primary network fails. We also do projects in asset management, condition measurement, and predictive maintenance, among other. For instance, we did one project for a company renting out heavy machinery for construction and similar activities. They needed a system which could track the condition of each vehicle, in order to have control over their fleet, which enabled them to guarantee their customers that the vehicles are well maintained and that they do not have to worry about them breaking down in use.*

**Are you working with companies from all sorts of industries?**

*“We are working with all sorts of industries. However, we do not develop the hardware for the IoT projects we do ourselves. We usually leverage our partners for that purpose. The customers contact us, and then we place an order of a specific solution from one of our partners. Another part of an IoT solution is a system, or for most customers, a simple interface which enables them to read and use the gathered data efficiently. That is also usually handed over to partners. We specialize and focus on the third part, which is the network and the infrastructure. However, in certain projects, like for smart building solutions for example, we do more than just communication. There we are offering our clients the “whole package”.*

**One of the most central aspects about my study, is to explore how the critical success factors differ for less technologically advanced companies, compared to the very technology-oriented companies. Would you say the factors are completely different, or just weighted differently in terms of importance and impact?**

*“I would say the factors turn a little different in that case, because when you are dealing with a less technologically advanced company, you have to offer a more complete solution. They often have a goal to achieve with the technology, and our job is to make it possible. That usually implies offering a simple software with a dashboard presenting the results from data gathered by the devices. They need to be educated about what the technology can do, and get a complete solution which automatically gathers data, processes it, and makes it easy to interpret the results for further use. The results can be given in daily reports or a live overview, it really depends on their characteristics and needs.*

**Do you usually focus on educating the clients in these cases, or is that rarely necessary?**

*“Usually, educating the users is a vital step in an implementation process, but whether we are doing it really depends on the project and to what extent the components are delivered by our partners. If partners are responsible for delivering hardware and software, they usually take care of the educating and making the client self-sufficient. When dealing with high-tech companies, it is not rare to experience that they want to choose their own dashboard solution or hardware, or other components. You will not experience that with the less technological ones, they are likely to need everything. Then, our role changes, we have to focus on being good advisors, as this will be crucial in succeeding with the project.*

**Is that one of the factors specifically crucial for less advanced companies?**

*“Yes, but it really depends. All factors have, in a way, the same importance. It depends on the project, the use case and so on. What we often see, though, is the complexity related to existing systems. For instance, in the case of smart buildings, clients often have systems based on proprietary software from various suppliers which they used for years; one controls the water, one the electricity and so on. There was never a common solution linking everything, which can be done through IoT. But it is not an easy task to make everything cooperate.*

**Yes, I have actually heard this from other respondents, that such situations often cause challenges.**

*“Exactly, they use proprietary software from third parties who are not willing to grant access to data gathered and stored in their systems. A client from a more technologically oriented company would probably demand access to such data from their other suppliers, in order to control their costs to a higher extent.*

**Are there any other characteristics or categories of businesses which influence the ease of implementation, and the critical success factors?**

*“Digital maturity is a term we frequently use when analyzing the client and their situation. If they are digitally mature, it is easier to reach agreement on solutions and so on. It is also important that the client is actually aware of the value the IoT solution will bring, so the high costs of devices will not be the decisive factor while planning the solution. The consequence of such situation is usually that the implementation process stops in the pilot phase, very early, because it loses support from the decision makers. One success story I can share, is for a client working in damage restoration on buildings, after accidents related to fire or water. They had a problem with wastage, as they owned many expensive dehumidifiers, and they lost about 20% of them due to theft and generally poor control. With sensors, they could easily track the location, but also the humidity levels remotely, making their work more efficient and their wastage significantly lower. In the recent years, the client was considered among the top damage restoration companies in Europe. This is because they invested in IoT solution, and they were aware of, and acknowledged that they can have a competitive advantage over their competition themselves. When we work with clients, we somehow organize workshops where we sit together with relevant stakeholders from the client, and design the solution based on their needs and desires. If you do this with a company with little technological knowledge, it*

*happens that such discussions get too complex, they do not understand and get lost, and therefore withdraw from the project.*

**Yes, I have heard from other interview respondents that explaining the solution in a simple enough manner is crucial.**

*“Yes, and in order to overcome this issue, you can help yourself with bringing proper demos of the components. We once had a meeting where a colleague of mine was presenting a solution, with a sensor lying on the table. At the end of the presentation, he released the sensor into a glass of water, and the dashboard on the screen presented the temperature and the amount of inclination of the glass, and such. When it becomes so simple that you can see the benefits immediately, it is easier for us to advise the client and making the implementation succeed.*

## Transcript Interview #4

### **Can you tell me a bit about what your company is doing?**

*“Yes, sure. We are a mid-sized company founded 15 years ago, and we are an IoT-pure player from the very beginning. The core focus in the company is to provide IoT connectivity. If you are familiar with the IoT value chain, we are delivering the connectivity part, the radio network, infrastructure, and management tools. In addition, we provide the API’s for the end user and providing expertise in designing devices. In the past, we used to have devices on our own, but we do no longer provide them. However, we still have the expertise, so we are helping companies with it. Our portfolio is made of a combination of hardware and software, and we are the link between the connected device and the application platforms. I joined this company around 3 years ago, and there is a strong engineering culture here, very technical and characterized by pride of the products. My experience with IoT is several years longer, though, so I know the market quite well. The challenge is always to avoid falling in the technical promise and technological pitch. Talking about these solutions gets technical very quickly, and a common error is to go on with very technical conversations and losing the end users. Therefore, we try to focus on the end-user standpoint, and selecting the end use case and find the appropriate pitches to answer specific, operational challenges with our solutions. We have an offer that is very transversal, we are not experts in one specific market as we focus on connectivity. We are a global company headquartered in France, and we have offices in four other countries. Our customers are from all over the world. We are relatively small, but we are among the leaders in our industry and the technology we are offering.”*

### **I actually had a chance to interview a person from another company, which also specialized in connectivity. He really emphasized the importance of having strong partners, in order to be able to offer more complete solutions. Are you also doing that?**

*“Yes, of course. That is truly compulsory if you want to succeed in this market. That is one of the key challenges of IoT, it is a complex value chain where you have to combine at least four key components. You have the end device, the connectivity, the application layer, and usually an integration layer, because you need a “glue” between the different parts. In this value chain, each company is a specialist in a domain. Some are device makers, some focus on connectivity, and others make the applications. Therefore, you need to work with them in order to bring the end-to-end solutions to the customers. The parts need to work well together to simplify the customer experience, and to bring a pre-integrated solution that ideally works*



*out of the box. This is very difficult, partly because we, as a connectivity specialist, do not have expertise in each industry, like the specific challenges. A device for the healthcare sector can be very different from a track-and-trace solution. Therefore, you need to find appropriate partners who can bring the expertise of the various markets, and sometimes even bring their credibility and brand. Usually, we are selling our solution through our partners, who deliver an end-to-end solution to the end customer.*

**Using this kind of strategy with partners, you can basically do projects in every industry, right?**

*“Yes. Internally, we qualify and split what we call “partners”. Because the word itself is very wide, which can include very different meanings. We have three types of partners. We have what we call “value adding re-sellers”, the distributors bringing expertise and support on top of distribution. We have “device makers”, manufacturers of the devices our clients ask for, and lastly, we have the “service providers”. Those are the ones bringing the software and applications. In other words, the tools that the end users will use on their tablets or laptops to monitor their business. It is the visible part of the IoT solution, it is where you can see the data and take actions. At this time, our total network of partners is close to 500, split across those three categories. We are continuously reviewing and adding to our network, because it is a key element to remain in a central position in this business, and in finding new opportunities.*

**Like I mentioned, my paper is about implementing IoT and the CSF in this process. But I am also interested in taking a deeper look into specific industries. Are there any industries in which it is harder to implement IoT, or is that an irrelevant thing?**

*“It is more a matter of maturity. It is harder when you are in industries where you need to explain what IoT is. There is a lot of buzz and hype around IoT, but sometimes it is surprising to hear what companies actually believe is behind this term. It is easier, of course, with businesses which are more mature, meaning that they understand IoT and what they can do with it. I think this is a key starting point to succeed in deploying an IoT solution, to have an upstream, clear vision of the goals, and what benefits the company wants to achieve. Too often, the IoT project is ran or initiated by a technology department, from R&D or innovation, that thinks it is “cool” to do a project with IoT. But if you do not have a clear business goal or operational goal behind it, and you do not have strong commitment from the executive team, it will be hard for the project to succeed. We often see companies doing a lot of trials,*

*but they do not scale. There is no rationale behind to justify the investment, or people do not know what they will do with this kind of solution. Key questions every company should ask themselves, is what to do with IoT and for what purpose.*

**What you are saying, in essence, is what I heard in other interviews and what I read in the literature, that alignment between IT and business has to be on point.**

*“Exactly.”*

**While working with companies that do NOT have this maturity, are there any success factors that are particularly important?**

*“Yes, there are several success factors. One of them is to start small, and be able to scale. Meaning that when you want to test IoT, you need to start with a specific use case, which is accurate in terms of the scope you want to address. It also has to be planned how you want to implement it, for it to be simple. For the beginning, you also need to choose partners that will enable you to scale. This is a thing we see frequently, people do not anticipate from the beginning that they will be successful, and could potentially have to scale quickly. In this case they are not properly prepared, they will be forced to re-design the solution, change the suppliers, and re-investigate the business model or the way they operate. In other words, they lose time. Another factor is clear understanding of the scope you want to address, also in terms of geographical scope. This is where the discussion and agreement between the business guys and the tech guys is key. In addition, ideally, the project should not be driven by a technological team, but should be driven by a business team or operational team, depending on your goals. Once again, it is about having the right technology for the right purpose.”*

**I know you work mostly with connectivity, but if you consider the end-users, are there any challenges related to adapting the solution to be easy enough to use by the end users? In companies which do not have that technological expertise?**

*“I think that is our challenge, to provide a solution simple enough, and provide tools to monitor, control, and operate it. We do not expect our customers to be experts in wireless technology or in designing products, but we have to bring them the tools to operate the solutions. It is a key challenge, because this is the way we foster adoption. If the solution is too complex to understand, and the people do not understand it with their own words and relate it to their business needs, it means that we went out of scope. It is also a key challenge to make integrated solutions, simple solutions, and have solutions which can be deployed*

*using different devices. For example, you want to use an application in your smartphone, and you can easily make that happen using a QR code. These is building up the customer experience, and customer experience is key. The customer, or end user, should be put in the center of the design, and not the technical people.*

**Are there any other characteristics of companies which influence the ease of implementing, like company size or structure?**

*“The bigger the company, the more complex the decision making process. You can also see some silo effect on the projects. This is especially true for cities, in smart-city projects. The solutions are usually initiated only from people working in technology, which leads to several challenges. Once again, the most important is for the project to be driven by the executive team, to have a clear view of the challenges which the company want to achieve, and to have KPI’s. It is key to have KPI’s, as well as timelines to make sure that the project will come to life and be deployed in the operations. Otherwise, it will be stuck by the proof of concept. The KPI’s assess the benefits and the additional business value brought by the solution. Some company structures, for instance big companies with multiple decision layers could find it difficult to have overview of the project and succeed with the initiative. Then, perhaps also betting on use cases that already have some sort of proven record is always safer. We see companies that want to be very innovative, and have great ideas in terms of what they could do. But it is key also to anticipate the entire customer journey. If you want to connect a device, and you want to sell a new solution leveraging this device, you need to anticipate the entire journey, meaning not only thinking about connecting a device and focusing on who will design it. The device is, at the end, only a part of the solution. As a company that will provide solutions for your end user, you need to anticipate how you will handle the customer, handle the support, and understand how the customer will use this connected device. Sometimes, it is only a focus to connect something, and as soon as it is connected, it is not clear what you can do with it.*

## **Transcript Interview #5**

**Can you tell me a bit about your experience with IoT?**

*“Right now, I am in a product manager position for a specific geographical area. My areas of responsibilities are edge computing and IT enablement, and I work mostly in the infrastructure part rather than the consulting part. However, I originate from the consulting part, where I worked with AI, machine learning, among other, and I was a business developer in projects covering those technologies. Therefore, I have experience from both the business side as well as the technological side. I will attempt to give as complete answers as I can on this topic, using insights from both perspectives. However, the critical success factors are a difficult topic, as they are very different even in one business, depending on the stakeholders you are considering. They are different for one person working with on the industry floor and the guy counting the money, for instance.”*

**Sounds great. Could you tell me quickly what kind of customers and industries you have been working with?**

*“Everything from the public sector, like “welfare tech”, to kindergartens with facility management, and agriculture where IoT and IT solutions were implemented in farms. I have also worked with process industries and engineering companies supplying companies in the oil and gas industry.”*

**It is a quite wide array of industries.**

*“Yes, we are service integrators, so we work broadly across the different verticals. Our focus is to deliver what we specialize in, across various industries.”*

**I see. Since you have been working with so many different businesses, are there any industries or types of businesses where it is particularly difficult to implement new technology?**

*“It is a difficult question. I would say it heavily depends on the specific client in the end. Broadly speaking, companies that are far behind in technological development, find it difficult, obviously. Part of the problem is lying in the existing technology, but the most significant issue is what is going on in the clients’ head. For instance, the public sector, does not have the same incentives as private companies, because their goal is not to make money,*

*hence the pressure driving the change is completely different. They rather focus on improving their processes, and preparing for future challenges related to demographical aspects, for example.”*

**So in other words, it is less driven by competition. But when you say “what is going on in the clients’ head, do you refer to the mindset, or the technological knowledge?**

*“It is both, really. But knowledge and expertise can always be bought. When it comes to the tech aspect, what is missing in knowledge can be bought by paying for a service. The mindset enabling to go in and actually execute the transformations, that is a different story.”*

**If you had to point out the most critical factors in implementing an IoT solution, what would you suggest?**

*“Starting from a business developer perspective, as that was my primary role, I have to say that IoT projects should never be done for IoT’s sake. What I mean by that, is that it should not be done because it is “cool” or “fancy”. A lot of initiatives are sourcing from hype, and you always have to be able to make a clear link to a specific challenge or goal. It has to be driven by a need to solve something. For instance, we had a client with issues to deliver what promised through their sales. They are now using sensor data to optimize their manufacturing site, in a way that it produces more in less time, or more in the same amount of time. This is a simple, but good example on how such solutions should be driven by a specific business need or challenge. That is perhaps the most crucial factor I would point out, to really understand your situation and issues that need solving. There are surprisingly many technological solutions out there which are completely useless, because they were not aimed to solve anything specific. You also need to keep in mind, that implementing such solutions often requires downward changes in many different parts of the company, in order to create value from it. If we consider the manufacturing site mentioned earlier, how are you going to operate everything now? How will your processes look like? What do you need to change to squeeze out the value? Is it necessary to let people go, or re-structure the organization? This little change of implementing an IoT solutions, can create a domino effect in larger areas of the company than we might think.*

**Yes, the whole operational model is changed to some extent.**

*“Exactly. I can also provide another example. We once did a project for a company doing repairs on roads and similar, and they have a large fleet of vehicles driving all over the country. For them, one idea could be to use the sensors already attached to the vehicles, to sell the data to, for instance, a meteorological institute which studies weather. Because they will gather a lot of local data anyways, but driving their vehicles around. This opens up a whole new business line. Which again, means that you have to think about what changes are necessary to make it happen. Another thing, which I think is relevant for your study, is that we usually distinguish IT and OT, operational technology. Earlier, the people with expertise about the technology on the factory floor, had a very different job than the ones sitting in an office working in IT. What we see now, is that they become more and more similar. However, although the technology is merging and becoming more alike, it does not mean that the processes and the people involved naturally change. They are also separate silos in a company, people that usually do not interact at all. Their goals and incentives can, for that reason, be very different.*

**So it is necessary to align all sides, right?**

*“Yes, you have to break up a quite large part of the company to be able to achieve the benefits. From a technological aspect, I think sensors can be a pain point, to be honest. Because, it is not always easy to interpret the data gathered and transmitted by them. For example, if you consider a solution for a building. You can place sensors to monitor how much something is used, when it is used, where some tidying is necessary, and so on. Typically, you want to optimize the temperature as well. The problem in these cases is that the trustworthiness of data coming in, is difficult to assess. You also need to be extremely cautious when placing the sensors, because controlling that the sensors are placed where they should be is crucial when comparing building A to building B. The dataflow is also an important factor; you have to figure out where the data will be stored, for instance. If you want to store it in a cloud, it can quickly get very expensive. Therefore, you need to understand what you have to adapt locally to remove that need. Furthermore, the tools you use for the data are important. Most solutions include a dashboard when you can see the data, which is nice. But to get proper value, you need to actually do something with that data, which is not always easy. For instance, the old BI tools are not always suited to enable capturing all the potential value. Lastly, integrations are crucial. Without them, many of the solutions will not work. For instance, if you have a solution which has the purpose of sensing*

*fire outbreaks, and a threshold is surpassed to initiate an alarm, you need to be sure that the notification reaches the correct systems. Ideally, you should have one interface for everything. But in reality, you have something new, something old, and something that does not communicate with all the other systems. It is a very difficult challenge to overcome, but these things need to cooperate in order to truly succeed with an IoT initiative.*

**I have also heard repeatedly in other interviews that companies tend to have a lot of licensed software systems, which also creates complexity while dealing with interoperability.**

*“We often see that the data is proprietary, so it demands an effort to retrieve all the necessary data. Some suppliers of solutions do not place their value in the hardware, but in collecting and visualizing data. Meaning that if you want to retrieve data from hospital beds, for instance, you are not retrieving from the beds but from the databases of the supplier. This does definitely not make things easier.*

**Are there any critical success factors which are different for the less technologically advanced companies, than the more technologically developed ones? You mentioned, for example, that you have worked in agriculture?**

*“There, we worked with a company supplying farmers in the area with various materials, equipment, machines, and so on. Earlier, what you sold to the farmer was seeds, livestock, and other miscellaneous goods like that. Now, even the farmers understand that the most precious good of the future is information. Therefore, our clients set up a data hub containing useful information which can improve the efficiency of farming. These are usually statistics, like how much water is applied in the fields in the most successful crops, for example. This kind of data is gathered by farmers, and shared, sold to other farmers. For the smaller companies, say a single farm, it is different, because they buy these insights as a service. If you are less advanced and are owning less on your own, as long as you do not get limited by your own mindset, you understand that the necessary information from the bigger companies. The bigger ones are most suited for trying out technological solutions, because they can afford to fail and are more willing to take the risk. They can, therefore, have more responsibility over the whole IoT stack, as they are more likely to have the technological expertise. And therefore, they do not necessarily have to buy it. Generally speaking, we have to remember that IoT is still not mature enough. Therefore, we see that the bigger companies*

*have started, while the smaller ones have not. It takes time for the technology to mature, and for the smaller players to “gather courage”, and will afford to try and fail.*

**I have also read about organization size as a general factor for IoT, as the bigger companies have more solid financial resources and therefore more willing to take a bet on a new concept like IoT.**

*“Big and small is one thing, but another thing is how essential is IoT in producing their end product. For instance, the corona situation can be used as an example. When the pandemic forced countries to introduce restrictions, solutions like MS Teams became increasingly popular. Why? Because in many businesses, cooperation is essential to be able to continue providing their services.”*

**I know many factors are relevant for all IoT projects, but are there any factors which are solely relevant for a technological or non-technological sector, or are they just weighted differently?**

*“If you consider a smaller company, when you walk in as a service provider, you see the majority of the executive team sitting together to discuss with you. The information flow is therefore much shorter and easier than in a bigger company. Most likely, it is a company with about 20 employees. In the bigger ones, on the other hand, you usually approach one exec whose role is to align business and IT, which was very separate before and now it is not. You also sometimes deal with a task team. There are generally way more stakeholders which are relevant in a more advanced company, and the time of the project is way longer.”*

**Are there any other categories of businesses which affect how easily the implementation process will be, other than the ones we already discussed?**

*“These initiatives are usually dependent on the cultural aspect of the company. It really depends on the attitude companies have, towards trying and failing.”*

**Yes, and change in general I assume?**

*“Yes, because it all ends up being some kind of change management thing, in order to achieve value. One of the barriers is that no one likes change, and no one likes to fail. When you try new things, like IoT, the probability of failing is big. The mindset can therefore be a big barrier. You can split businesses into front runners and followers. If you are a front runner, you will likely have a different mentality, different structure, and general layout, than a*



*follower. Every company has their strategy and a way of doing things. You can see how much the biggest companies, like Google, are spending on R&D. The expenditures are extremely high. It is clear that there is a strong underlying culture there, especially when you consider how quick their R&D ideas turn into products they create value with. You do not have the same “muscles” in a smaller company, or if you are a follower. To lead the market forward is always very expensive.”*

## Final Results – Complete Codebook with Categories & Sub-Categories

Difficult Industries/Businesses	Depends on Client	4	80
	Far Behind in Tech	2	40
	Digital Maturity Decisive	2	40
	Public Sector	1	20
Most Critical CSF	Data Flows (Existing & New)	2	40
	Interoperability	5	100
	Focus on In-House Strategy	2	40
	Alignment of IT & Business	4	80
	Strategy (goals & visions - clear purpose)	4	80
	Security & Privacy	2	40
	Top Management Support	3	60
	Awareness of Own Situation (Challenges)	3	60
	Adapting Operational Model	1	20
	Aligning OT and IT	2	40
	Assuring Data is Trustworthy	1	20
	Assuring Appropriate Tools	1	20
	Scalability	1	20
	Initiated by Business or Operation	3	60
	KPIs and Timeline for Process	1	20
	End User in Center of Design	1	20
	Partnerships	2	40
Difference Between High and Low Digital Maturity	Access to Data (Historical)	1	20
	Mindset	3	60
	Culture	2	40
	Unmature Companies Rely More On External Expertise	3	60
	End to End Solutions for Immature Companies	2	40
	Slower Decisions in Mature Companies (longer project time)	2	40
	Education More Important (Awareness&Usability) for Immature	3	60
	Simplicity Required for companies with Low Maturity	3	60
	Consultants More Advisory Role in Companies w/ Low Maturity	3	60
	Existing technology - Issue in Immature Companies	1	20
	Immature Companies Rely More on "as-a-service" solutions	2	40
	Immature Companies Less Suited for Trying/Failing	1	20
More Relevant Stakeholders in Mature Companies	2	40	
CSF for Companies with Low Digital Maturity	Awareness of Value	2	40
	Willingness to Bet and Commit	2	40
	Simplicity	3	60
	Education (Awareness + Self-Sufficiency)	3	60
	Mentality (Re-Structuring)	2	40
	Interoperability (Often Harder)	1	20
	Start Small And Be Able To Scale	1	20
	Clear Understanding of Scope	1	20
	Betting on "Safer" Use Cases	2	40
Other Relevant Characteristics	Existing Structure (Degree of ownership)	3	60
	Size	2	40
	Culture - Attitude	1	20
	Digital Maturity	2	40
	Front Runner vs. Follower	1	20