Adoption of Internet of Things in Business

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ABSTRACT

Internet of Things is growing in popularity, but that popularity is overshadowed by the high failure rate of IoT initiatives. As IoT is a disruptive and complex technology, many factors play a role in the success or failure of those initiatives. A research gap was identified, namely that there was barely any literature which provided an overview on the influencing factors in the adoption process of IoT. This research aims to provide this overview, based on three research approaches. Firstly, existing IT adoption models were reviewed in a literature review. The factors that were found are general for most technologies and therefore also assumed relevant for Internet of Things adoption. Secondly, a literature review was conducted on the adoption challenges of Internet of Things in particular. This provides an overview of relevant factors that are specifically important for Internet of Things adoption. Thirdly, a case study in the form of an expert interview was conducted, which provided additional practical insights and factors. Furthermore, this also confirmed a number of factors that were found in the two literature reviews. The result of the research is a synthesis of the three research approaches into an integrated Internet of Things adoption framework. The framework consists out eighteen relevant factors that influence the adoption of IoT in business, divided across the contexts of the organization, technology and environment. In the end, the implications and limitations of the study are discussed and recommendations for future research are included.

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1. INTRODUCTION

An emerging technology called the Internet of Things (IoT) is growing in popularity. Internet of Things was first coined by Kevin Ashton in 1999, but in the past few years its growth has been staggering, and that growth is not expected to stop in the near future. In the predictions of Gartner (2017), the installed base (number of devices in use) will grow from 6.381 billion devices in 2016 to 20.415 billion devices in 2020. Next to the growth of the installed base, there is an increasing interest from researchers. When searching in Scopus for 'internet of things' or 'IoT' in the title, abstract or keywords, the number of articles has grown from 448 in 2010 to 12,003 in 2017 (Scopus, n.d.).

1.1 Definitions

1.1.1 Internet of Things

To understand IoT, the term 'Things' will be explained. A 'thing' could be defined as a physical or digital object, which exists, is identifiable and moves in space and time (Vermesan et al., 2009). Examples of 'things' are RFID, sensors, actuators and mobile phones (Giusto, Iera, Morabito, & Atzori, 2010). According to Vermesan et al. (2009), the Internet of Things is "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols" (p. 6).

In the latest Hype Cycle that Gartner presented (Panetta, 2017), Internet of Things can be found at the beginning of the 'Peak of Inflated Expectations'-phase. This phase usually means that a technology gathers publicity, followed by a number of success stories. However, these successes are most often accompanied by failures, according to the Hype Cycle. This is also confirmed by a survey of Cisco, which showed that only 26% of 1,845 enterprises have had an Internet of Things initiative that they considered a complete success. 60% of the initiatives stall at the Proof of Concept stage and even worse, a third of all completed project were not considered successful. This means that 74% of the enterprises have had Internet of Things initiatives that weren't a complete success, which is a high number of (partial) failures. Reasons for failures were long completion times, poor quality of collected data, lack of internal expertise, IoT integration and overrun budgets (Cisco, 2017).

1.1.2 Adoption

In this research the term 'adoption' has a very important role. Therefore, it is important to clarify the meaning of 'adoption' as it is used in the research. Cambridge Dictionary defines 'adoption' as "accepting or starting to use something new" (n.d.) and that is exactly the meaning of the word in this research. Some research papers use the word 'implementation' besides 'adoption', but these are interchangeable in this research.

1.2 Research Gap

As mentioned before, there is an increasing interest from researchers in the topic Internet of Things. Most of this research is done from the 'Computer Science' and 'Engineering' areas, with a total of 34,193 articles in the Scopus database. This is 93% of all articles on the topic Internet of Things on Scopus, so it is clear that most researches focus (partially) on the technology. 1,248 sources are categorized in the "Business, Management and Accounting", which is only 3% of all articles. When searching further and looking for literature on the factors that influence the adoption of Internet of Things in business, there is very little literature specifically on this topic. Sometimes a couple of factors are found, but almost always they are part of a broader research topic (Scopus, n.d.). An example is a research by Hsu and Yeh (2017). They focused on the logistics industry and used many sources on RFID adoption. They found factors relevant for their focus, but in this research the aim is to get a more general focus on Internet of Things.

An overarching overview of existing literature on the topic, bringing the most important information together in one research seems missing until now. There are some researches done by leading technology and consultancy companies like Cisco and McKinsey. These are very interesting, as they have practical experience with the topic, but they also don't provide an overview of existing literature.

That is what this research intends to offer. This research will hopefully provide businesses with more practical recommendations to take into account when starting their next Internet of Things initiative.

1.3 Management Problem

Enterprises struggle with the effective adoption of Internet of Things. As already stated before, Cisco's survey (2017) pointed out that 74% of the Internet of Things initiatives were a (partial) failure. This is understandable as Internet of Things is still an immature and complex technology, with not many people who have the expertise to make IoT projects successful. However, there are other factors influencing the success of IoT projects and enterprises have difficulties recognizing and facing those factors.

1.4 Research Question

This research is aimed at providing more insights in the factors that influence the adoption of Internet of Things in business. It is hopefully providing businesses with valuable recommendations and insights to become more successful with their Internet of Things initiative. The main research question is:

Which factors influence the effective adoption of Internet of Things in business?

To get to a satisfactory answer to the main research questions, several sub questions have been composed and are listed below.

a. *Which adoption factors are identified by existing IT adoption models?*
b. *Which adoption factors are identified by existing IoT literature?*
c. *Which adoption factors are identified by an IoT expert?*

The findings on the sub questions will be critically compared to each other. Overlapping factors could be found between the sub questions that might either strengthen or contradict them.

2. METHODOLOGY

To answer the research questions, three research approaches will be used. Firstly, a literature review will be conducted on the existing IT adoption models. According to Cooper (1999), "literature reviews can attempt to integrate what others have done and said, to criticize previous scholarly works, to build bridges between related topic areas, to identify the central issues in a field, or all these" (p. 3). This literature review will give insights into the most relevant factors that influence the adoption of technological innovations. Therefore, this will give general insights, not acuminated to Internet of Things.

Secondly, a literature review will be conducted on the challenges that occur when adopting Internet of Things in business. This will give insights into the factors that influence the adoption of particularly Internet of Things.

Thirdly, a case study will be conducted in the form of an expert interview. This interview will give additional insights from a practitioner's perspective and complement both literature reviews. It will be an informal and conversational interview instead of a structured interview with pre-determined questions. The main interview topics will be determined up front but, based on the conversation, certain additional topics might be discussed.

The conversational interview method has been chosen, since it allows the clarification of questions to the respondent (Lavrakas, 2008). Especially since Internet of Things is a complex technology and the respondent will be an expert in the field, it is assumed to be important that the questions are understood properly by either the interviewer and respondent to prevent any false conclusions. Normally, there are some considerations when using conversational interviewing, like the response bias when using multiple respondents & interviewers and the time limitation due to longer interview than with surveys (Lavrakas, 2008). These should both not be an issue for this research, since the only one expert is interviewed and therefore it is not expected to experience time issues

Furthermore, this research is aimed to be a 'problem-solving' research for enterprises who strive to adopt Internet of Things. Therefore, this research has several elements of an applied research. When done completely as an academic research, the research would have contained for example statistically substantiated factors for the adoption of Internet of Things in business and even correlations between the factors. This is an interesting focus for a research, however this research strives to provide enterprises with the tools to solve a practical problem which many are facing in the last few years. Namely, providing businesses with relevant factors that influence the adoption of Internet of Things.

The outcome of each of the research approaches will be integrated into one overview of relevant factors that influence the adoption of IoT in business. In the results, each factor that was found will be elaborated on. The remaining of this methodology will explain the strategies that were used for the research approaches and give an overview of the key elements of different concepts and models.

In the results, a table (2) will be added which will contain a clear overview of all the factors that were found and in which of the three research approaches they were found. In case of an overlap between two or all of the research approaches, it will also become clear there. Lastly, this will also be visualized using a Venn diagram as shown in figure 1.

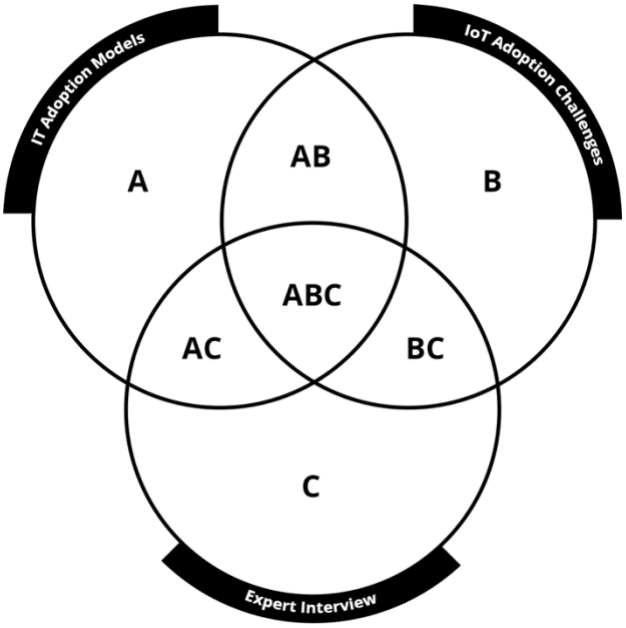

Figure 1: Venn diagram

In the following three sections, the methodological background of the research methods that were used, will be explained. In the results, a synthesis of the results of the three methods will take place.

2.1 Literature Review: IT Adoption Models

Existing IT adoption models are assumed to be a relevant starting point for this research, because they will most likely relate to IoT adoption challenges. Therefore, a literature review has been conducted on existing IT adoption models. There are quite a few models that serve this purpose. Some of them are very popular for technology adoption, which were found by searching other researches on the topic of technological innovation adoption. The Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), Theory of Planned Behavior (TPB) (Ajzen, 1991), Diffusion of Innovation (DOI) (Rogers, 1983) and TOE framework (DePietro, Wiarda, & Fleischer, 1990) are some of the most popular models that can be found in research papers. There is an important difference between the models, namely the scope of the model. The TAM, UTAUT and TPB are focused at the individual-level, while the TOE framework and to the largest extend also the DOI, are focused at the organizational-level (Oliveira & Martins, 2011). Since this research focuses at businesses, the TOE and DOI are assumed to be most relevant for this research.

They will both be introduced briefly. The idea behind the models will be explained and thereafter the key factors or contexts will be named. In the results of this research, a deepening on these factors will take place.

The findings from the literature review on existing IT adoption models give a good insight in relevant factors that could influence the adoption. It became clear that there is a clear difference between the adoption of individuals and the adoption of organization, even though they might be interrelated sometimes. Furthermore, Rogers' (1983) model for organizational innovativeness gives good insights into organizational factors that influence the adoption of innovations. A good complementary model is that the TOE framework by DePietro, Wiarda and Fleischer (1990). Besides organizational factors, they also take environmental and technological factors into account. Together, they provide a good foundation for the general technological innovation adoption factors, not focused on a single technology or industry. This can contribute to this research, since general adoption factors might be relevant for Internet of Things adoption too.

2.2 Literature Review: IoT Adoption Challenges

A more extended literature review has been conducted on Internet of Things adoption challenges. Where the previous literature review gave general insights in the most relevant IT adoption models and belonging factors, this literature review will complement these factors with the ones that are especially occurring for the IoT technology.

The search for literature will be done in academic search engines such as Scopus and Web of Science. To find all relevant research literature, Boolean operators and other advanced search options will be used. This ensures that synonyms for certain search terms were also taken into account. A search for "internet of things" would not give results for 'IoT' but by using Boolean operators it would. An example of such a Boolean search is '("internet of things" OR IoT)'.

Next to using Boolean operators a few other inclusive and exclusive criteria will be set to make sure the outcome is valuable. These are listed in table 1.

The literature that came out of the literature search was first filtered further based on its relevance by reading the abstract. After the selection was made, a few articles weren't available for download so that narrowed the selection down to a final selection of 40 articles, which will be used in this systematic literature review. The process of the article selection is illustrated in figure 2.

#	Type	Criteria	Reason
1	Inclusive	Only papers where the title, abstract or keywords contain the terms "internet of things" or "iot" and the terms "adoption" or "implementation".	Ensure that the key terms needed to find the relevant literature are set.
2	Inclusive	Only papers from 2010 until and including 2018.	Ensure that the literature isn't too old and outdated.
3	Inclusive	Only papers in the Web of Science categories "Economics", "Management Business" or "Business Finance" and in the Scopus subject area "Business, Management and Accounting"	Ensure that the literature focuses on business and not only on the technology.
4	Inclusive	Only papers written in English.	Ensure that the literature will be understood completely.
5	Exclusive	Exclude any duplicate literature between Web of Science and Scopus.	Ensure that relevant literature is only listed once.

Table 1: Criteria for literature search

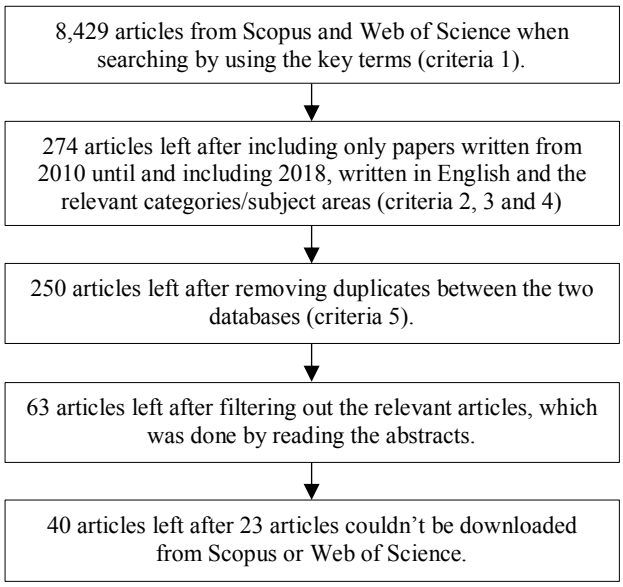

Figure 2: Process of article selection

The final selection contains articles from 2012 until and including 2018. The distribution of the number of articles over these years can be found in Figure 3, where can be seen that most articles were published in the last 3-4 years.

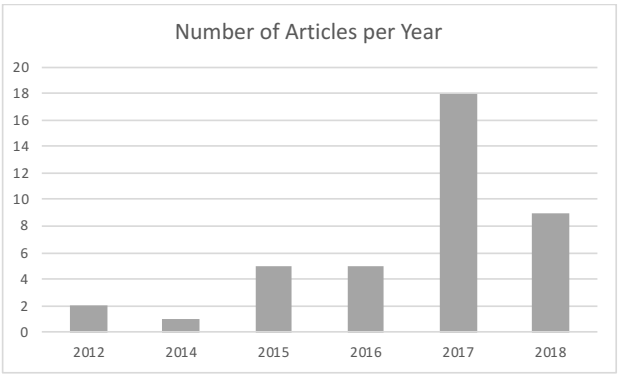

Figure 3: Number of published articles per year in selection

Besides the academic researches, a number of sources from practitioners like Cisco and McKinsey were found. These will also be used in this research, to create the best review possible. This way it is ensured that the research isn't focused only on the scientific perspective, but also on a more practical perspective.

2.3 Case Study: Expert Interview

The literature reviews are obviously very theoretical. To validate what was found in the literature, a case study has been carried out. This will give a practical reflection on the theoretical findings of this research. An interview has been conducted with Boban Vukicevic, managing director of the Dutch company Comgate. The company Comgate calls itself the 'one-stop-shop' for Internet of Things solutions. Together with their IT-, software- and hardware-partners, they provide enterprises with a wide range of IoT services. Their main services are software, hardware, connectivity, consultancy and managed services.

There were two reasons why Vukicevic was approached for this interview, besides being managing director of Comgate. First of all, he wrote an article on the website Marketingfacts, titled 'Internet of Things shouldn't be a toy for technicians' (Vukicevic, 2018). In this article he discusses the importance of a management team that is convinced about the potential of Internet of Things and supports it. Furthermore, he states that Internet of Things creates a very complex environment which will influence industry structures, change the nature of competition and exposes enterprises to new opportunities and threats. The second reason is Vukicevic' book 'Implementing the Internet of Things' together with Emmerson (2017) . In this book they write about the critical business and management issues when implementing Internet of Things. They also state that "these aspects are often overlooked, particularly in on-line articles and papers, mostly because IoT is still seen as a topic for engineers and IT manager" (Vukicevic & Emmerson, 2017, p. 10). This is an interesting overlap with this research, as that is what the literature review on IT adoption models and Internet of Things adoption challenges also showed.

3. RESULTS

Two literature reviews and one case study have been conducted. The results of the different research approaches will be synthesized in an integrated Internet of Things adoption framework, which will give insights in the relevant factors for the adoption of Internet of Things in business. The framework will be structured in a comparable manner as the TOE model, since that model also has a technological and environmental context, which DOI does not have. These models are also elaborated on in the results below. There will be three contexts,

namely the organizational context, environmental context and technological context. The organizational context consists out of the relevant organizational characteristics and factors that influence the adoption of Internet of Things. Factors like structure and management support will get attention in that context. The environmental context will discuss knowledge and skills available in the market, but for example also regulatory challenges. The technological context consists out of factors like the security and privacy of the technology, but also the current systems in place at enterprises. Together these contexts will shape the Internet of Things adoption framework (figure 7) which will give more direction to researchers with the intention to study Internet of Things and its adoption, but also to enterprises who wish to adopt Internet of Things effectively in their organization.

The factors that were found after the synthesis of the IT adoption models, IoT adoption challenges and the case study, are presented in table 2. The factors have been appointed to the relevant context to which they belong. Furthermore, if a factor was found in one of the research approaches, this research approach is appointed to the factor. It could be the factor only showed up in one of the three research, but it could also be the case that it showed up in all three research approaches. The IT Adoption Models are assigned to the letter 'A', the IoT Adoption Challenges to the letter 'B', and the Expert Interview to letter 'C'. These were then used to fill the Venn diagram (figure 8) and visualize the factors' overlap along the different research approaches.

3.1 IT Adoption Models

Firstly, the IT adoption models DOI and TOE will be elaborated on. The models and their factors will be used in the IoT adoption framework later on and therefore it is important to understand them.

3.1.1 Diffusion of Innovation (DOI)

The Diffusion of Innovation theory was developed by Rogers (1983) and in his book he described diffusion as "the process by which an innovation is communicated trough certain channels over time among the members of a social system" (p. 5). According to Rogers, these members or individuals in a social system do not adopt an innovation at the same time but can be divided into adopter categories based on their first usage of an innovation. Rogers determined five categories, with each one containing individuals that have a similar degree of innovativeness. Rogers' categories are (from first to latest): innovators, early adopters, early majority, late majority and laggards. These are divided over a bell-shaped frequency curve that can be seen in figure 4 (Rogers, 1983).

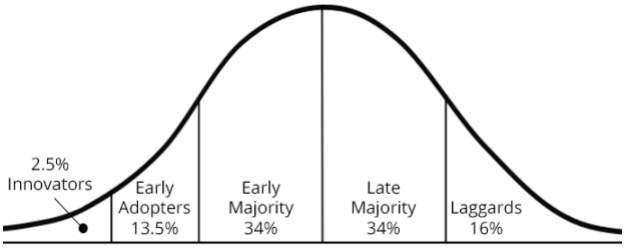

Figure 4: Diffusion of innovation: bell-shaped curve (Rogers, 1983)

The bell-shaped curve containing Rogers' categories is the part of the Diffusion of Innovation theory that is focused at individuals. This research aims to get insights in the adoption within businesses. Rogers refers to it as organizations. Rogers also answers the question on why it is important to focus on the organization, rather than the individual, in some cases. Rogers (1983) wrote that "a schoolteacher cannot use a microcomputer until the school district decides to purchase this item of equipment" (p. 347). The same is true for most other innovations, since an individual inside an organization cannot easily adopt a (technological) innovation when the organization doesn't adopt it first. Internet of Things needs to be adopted by organizations first, to achieve adoption by the individuals within these organizations (Rogers, 1983).

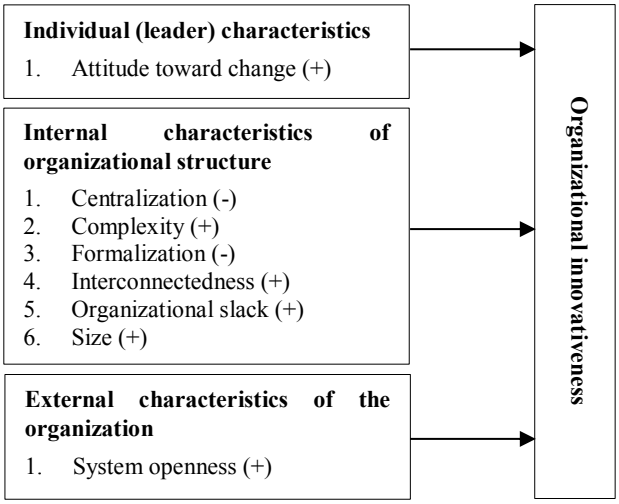

Figure 5: Diffusion of innovation: organizational innovativeness (Rogers, 1983)

Rogers came up with independent variables that influence the adoption of innovations at organizations. These are divided between three main characteristics groups. (1) *Individual characteristics* define the attitude toward change from the leader. (2) *Internal characteristics of organizational structure* define the characteristics of the organization itself that influence the organization innovativeness. Hereby, *centralization* "is the degree to which power and control in a system are concentrated in the hands of relatively few individuals" (p. 359). This has a negative association with innovativeness, which means that the higher the power-concentration, the less innovative the organization tends to be. *Complexity* "is the degree to which an organization's members possess a relatively high level of knowledge and expertise" (p. 360). A higher complexity improves the innovativeness of the organization. *Formalization* "is the degree to which an organization emphasizes following rules and procedures in the role performance of its members" (p. 360-361). This hinders innovation considerations by individuals, but it boosts the adoption of it. *Interconnectedness* "is the degree to which the units in a social system are linked by interpersonal networks" (p. 361). *Organizational slack* "is the degree to which uncommitted resources are available to an organization" (p. 361). This has a positive impact on innovation. According to Cyert and March (as cited in Rogers, 1983), "organizational slack provides a source of funds for innovation that would not be approved in the face of scarcity" (p. 361). *Size* can be defined as "a surrogate measure of several dimensions that lead to innovation: total resources, slack resources, organizational structure" (p. 359). (3) *External characteristics of the organization* define the system openness, which is "the degree to which the members of a system are linked to others who are external to the system" (p. 356). (Rogers, 1983)

These characteristics come together in a model for organizational innovativeness and can be found in figure 5. It can be stated that this model is mainly focused at the organization and not only at the individual alone.

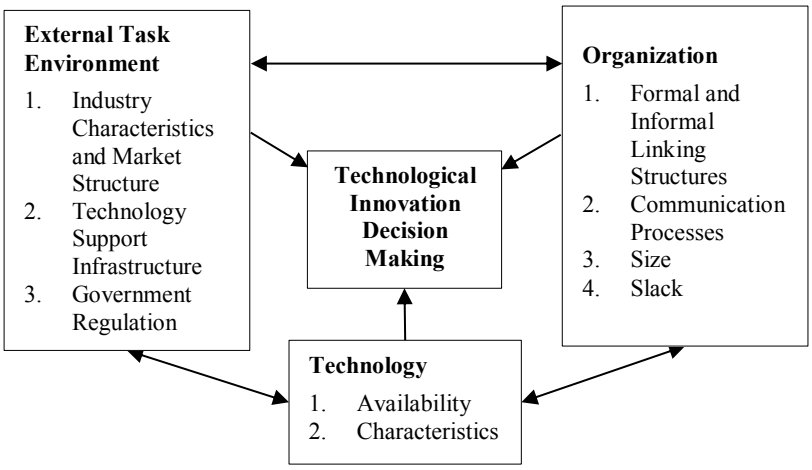

Figure 6: Technology-Organization-Environment framework (DePietro et al., 1990)

3.1.2 TOE Framework

TOE is the abbreviation for technology, organization and environment. The TOE framework was developed by DePietro, Wiarda and Fleischer (1990) and they focus on the context in which innovation takes place. The framework consists out of three contextual elements, namely: organizational context, technological context and external environmental context. These contexts together shape the technological innovation decision making of an organization (DePietro et al., 1990). The framework is illustrated in figure 6.

As stated by DePietro et al. (1990), the organizational context contains the structures and processes of the organization. Some of these are formal (e.g. standardization of processes) and some are informal (e.g. naturally occurring behavioral patterns). They state that the technological context of an organization consists out of the availability of technologies in the industry, but also the organization's current technologies. The third and last context they determined, namely the external environmental context, consists out of the availability of skilled workers & outside vendor expertise.

3.2 Internet of Things Adoption Framework

The previous section gave some general information on the two IT adoption models that were found. In this section, the synthesis will take place between the three research methods. Therefore, it also includes a more in-depth analysis of the factors found in IT adoption models, integrated with the IoT adoption factors that were found in the literature and insights acquired from the expert interview.

3.2.1 Organization

3.2.1.1 Structure

The structure of an organization in relationship to innovation has been the subject of multiple studies. DePietro et al. (1990) refer to Burns and Stalker's (1961) work on organic and mechanistic organizational systems and use it as a starting point. Burns and Stalker (1961) describe mechanistic organizations as bureaucracies with stable conditions and set boundaries. Organic systems are more flexible and have changing conditions. They suggest that the organic system is associated with the more frequent adoption of innovation in comparison to the mechanistic system. When looking at the variables within these systems, they found that *formalization* (number of rules and specified procedures) and *centralization* (concentration of power) both have a negative relationship with the adoption of innovation. On the other hand, they also found a positive relationship between *complexity* and the adoption of innovation. These three variables are supported by the Diffusion of Innovation theory (Rogers, 1983), which also found the same relationship between them and the organizational innovativeness.

DePietro et al. (1990) also elaborate on boundary-spanning structures. This is a way to obtain information about opportunities for technological change from the external environment and use that information to support decisions about adoption (DePietro et al., 1990). Galbraith (1973) identified seven strategies on the use of these boundary-spanning structures. Some of those strategies are: apply direct contact between managers with the same problem; create task forces for solving problems that exist in multiple departments; make permanent teams for returning problems between departments; create integrating role in case the managing of the lateral process becomes an issue (Galbraith, 1973). Such a strategy is especially important in "turbulent and dynamic environments, where technological innovation is occurring at a rapid rate and innovations are competing with one another for recognition and use" (DePietro et al., 1990, p. 157). This can be assumed the case for Internet of Things, as it is a disruptive technology (Ericsson, 2015). In Rogers' (1983) organizational innovativeness factors, he refers to a similar factor called the system openness. He defines system openness as the degree to which linkages exist between members of a system and other who are external to the system. He found that there is a positive relationship between system openness and organizational innovativeness (Rogers, 1983). Furthermore, he also refers to another factor called the interconnectedness, which is the degree to which linkages by interpersonal networks exist between the units of a system. For this factor, he also found a positive relationship with the organizational innovativeness. Interconnectedness improves the ease and speeds in which ideas move through an organization via the individuals (Rogers, 1983).

Regarding the relationship between Internet of Things and an organization's structure, Ericsson (2015) stated that enterprises experience that their mostly traditional governance structures withhold the adoption of Internet of Things. Major organizational and behavioral changes will be required when instigating the adoption (Manyika et al., 2015). This is confirmed by Vukicevic (personal communication, June 8, 2018), as he states that the disruptive technology IoT is a lot more than a simple IT-thing and will require turning the entire organization upside down. He says that change management is essential in that case and particularly for large enterprises, as it will result in resistance from the organization. He adds that there is a distinction between large enterprises, SME's and startups when it comes to adopting Internet of Things. Ericsson (2015) confirms this, as they state that the adoption is more easily done by dynamic startups, but a

lot harder for large enterprises or even SME's. More on this will follow when discussing the next factor: 'size'.

3.2.1.2 Size

The size of an organization is also an influencing factor of the adoption of technological innovations, according to DePietro et al. (1990) and Rogers (1983). They state that the size of an organization is one of the most important factors for adopting technological innovation. However, DePietro et al. (1990) do remark that size is an umbrella term for many underlying organizational aspects and different measures of size. Rogers (1983) concluded a similar thing, namely that size is "a surrogate measure of several dimensions that lead to innovation: total resources, slack resources, organizational structure" (p. 359). DePietro et al. (1990) state that it is inappropriate to use the umbrella term size as a variable for the adoption and implementation process.

The limitations of the variable size, as indicated by DePietro et al. (1990) and Rogers (1983), are important to take into account. As indicated earlier, Vukicevic (personal communication, June 8, 2018) makes a distinction between large enterprises, SME's and startups when it comes to the adoption of Internet of Things. Therefore, his insights might be a good deepening of the variable size in relationship to Internet of Things adoption.

According to Vukicevic (personal communication, June 8, 2018), large enterprises are often well-oiled machines. He said that large enterprises mostly have an R&D or strategy department, which has already researched what innovations are coming at them. He also said that they often also have more resources available than SME's and startups, but that management then has to make decisions on what to do with R&D's findings. According to him, this is often the moment where problems occur. As stated before, adopting Internet of Things will require turning the organization upside down (Vukicevic, personal communication, June 8, 2018). Since these are changes that have a lot of impact on large enterprises, they sometimes choose to execute a so called "cannibal" strategy, as Vukicevic mentioned. According to him, this means that they launch a subsidiary that needs to compete with the parent enterprise for the market share. This way, enterprises hope to instigate the change and sense of urgency in the parent enterprise. If the parent enterprise fails, it hopes to recapture the market share with the new entity. If the parent enterprise remains successful, they hope to increase their market share all together (Vukicevic, personal communication, June 8, 2018).

When it comes to SME's, Vukicevic states that these are often occupied with their own continuity and the management team is heavily involved in the operations. He stated that new technologies are often only seen when the market confronts them with it, due to a lack of resources. Mostly, people at SME's working on technological innovations do this next to other operational work, Vukicevic mentioned. Only when threats arise from the market, he states that the organization starts running. He found that the changes large enterprises face will also be faced by SME's; however, SME's are more flexible since they are smaller. The comparison that Vukicevic made was that of a container ship and a speedboat. He said that container ships are cumbersome when having to make a change in direction, while speedboats are more agile in their directional changes and that the containership can be compared to a large enterprise, while the speedboat can be compared to an SME.

Lastly, he named the startups. According to Vukicevic, startups are very eager to adopt new technologies but are mostly less effective in doing so. Typically, startups offer these new technologies themselves or they try to position a new product in the market based on the novel technology, he stated. According to Vukicevic, when they put the product on the market and start to reach the early adopters and early majority, they will often face stagnating sales. He mentioned that the gap between the early majority and late majority is often a big one, especially for disruptive technologies. According to him, that is the moment these startups are either being acquired by a bigger company or seize to exist once they run out of the initial risk capital.

3.2.1.3 Slack

Another important aspect of organizations when it comes to innovation is the slack, according to DePietro et al (1990). Cyert and March (1963) define the slack of an organization as the difference between the total resources of an organization and the total required expenditures. Rogers (1983) also indicates the importance of slack in relationship to innovativeness and defines slack as "the degree to which uncommitted resources are available to an organization" (p. 361). The importance of slack is confirmed by Vukicevic (personal communication, June 8, 2018), as he states that large enterprises have more resource available than SME's, while SME's often are confronted with new technologies late due to a lack of resources. DePietro et al. (1990) mention that this surplus of resources is a necessary condition for innovations, however it is not sufficient on its own. They state that there are internal and external factors of an organizations which influence the extent to which organizational slack fosters innovation. Firstly, the external task environment should, for example, be informed about specific technological innovations and observe early adopters to assess the opportunities of these innovations (DePietro et al., 1990). Secondly, there are different types of slack within organizations, according to DePietro et al. (1990). They state, that it is clear that there is a very different situation when there is financial slack in comparison to a slack in human resources. Taking the necessary actions for adopting an innovation requires human resources. These can of course be hired in case of a financial slack, however, this could be against the strategy of for example organizations with a lean approach (DePietro et al., 1990). Lastly, slack is dependent on the priorities of the organization. If an organization decides that a specific innovative department needs more resources, they could move the slack from one department to the other. The priorities of the organization are important to assign the slack to the right activities, in case there is any slack (DePietro et al., 1990).

3.2.1.4 Management Support

Another relevant topic within the organization is the behavior of top management leadership towards innovation (DePietro et al., 1990). According to Tushman and Nadler (1986), there are six methods that the executive team can use to nurture innovation. (1) They can develop and ensure a clear communication of the organization's strategy & core values and what the role of innovation is in this strategy. Without it, the focus of the organization will be on the existing situation. (2) They should act as a role model for their subordinates in the organization by sending consistent messages about the importance of innovation. If inconsistent, the subordinates will be faced with ambiguity and stick to the existing situation. (3) They should consistently reinforce innovation by using formal and informal rewards. It is important that there are no rewards for mediocrity or equal rewards for everyone, since that makes excellence disappear. (4) They should use the innovative aspects of an organization's history and create a new innovative culture or tradition based on the current competitive conditions. This fosters innovation. (5) They should (re-)shape their executive team so that they have the appropriate conceptual, technical and social skills for the tasks at hand. Furthermore, they should develop effective problem-solving processes at the executive team and make sure to anticipate on external opportunities and threats. (6) Lastly, the

executive team should exist out of visionary executives with a clear direction for the organization. By envisioning, energizing and enabling the organization with their vision and its execution, innovation will be stimulated (Tushman & Nadler, 1986). The need for management support is also stated by Vukicevic (personal communication, June 8, 2018), as he says that the Internet of Things will have a big managerial impact and that management has to make decisions on what to do with Internet of Things.

3.2.1.5 Costs

The high costs of the Internet of Things is seen as a barrier to adoption (Ericsson, 2015; Papert & Pflaum, 2017; Porter & Heppelmann, 2015). However, Ericsson (2015) noticed a positive trend. The total IoT cost is reducing, mainly due to the price reduction of IoT modules and the increasing availability of competitive IoT enablement platforms. According to Ericsson (2015), an IoT project and Proof of Concept would have cost between €27,000 and €54,000 with a time-to-market of six to eighteen months around five years ago. By the time Ericsson (2015) wrote the article, such a project would have cost around €1,000 to €4,000 with a time-to-market of three to twelve weeks. Vukicevic (personal communication, June 8, 2018) confirms that costs are a factor that influences the adoption of IoT as he states that the needed investment is high, whereas the returns are still small. Therefore, it is also important to look at the business model behind IoT applications for an enterprise.

3.2.1.6 Business Model

As Ericsson (2015) highlights, costs are even a bigger issue, if you don't know how to capture value from your IoT-enabled project. Most enterprises strongly trust in the potential of IoT but find it hard to determine its real value for them (Ericsson, 2015; Fan, Wang, Zhang, & Lin, 2013). Enterprises also struggle on finding how to capture value, due to the lack of knowledge (Ericsson, 2015). What also became clear in Ericsson's research (2015) is that some enterprises waited with their Internet of Things projects on competitor moves, customer demand, or regulation. This increases the risk of a competitor disrupting the market (Ericsson, 2015).

According to Vukicevic (personal communication, June 8, 2018), the IoT technology can influence existing competitive advantages. He states that if enterprises don't adopt this technology, their competitors will. Thus, he thinks it is very important for enterprises to understand what influence IoT can have on the value chain of the industry and organization itself. Then, enterprises can determine what they will do with the technology and understand what it will mean for their market positioning, strategy and marketing mix, he states. Questions like "Should I join or await?", "Should I start small or big?", "Should I develop internally or externally?" are very important to ask yourself as an organization, according to him. To support his statements, he gives an example. eCommerce started to gain popularity at the end of the 20th century. Then, in 2000, the dot-com bubble burst. After the burst, enterprises like Google and Amazon were rising. Traditional enterprises were and still are having difficulties following this eCommerce transition.

3.2.1.7 Customer Service

An example of a big change in the current business model of enterprises might be the role of the customer service, according to Vukicevic (personal communication, June 8, 2018). When selling physical products, the guarantee must be very good, and support can be provided within office hours. However, with Internet of Things the customer relationship starts only after selling the product, when it gets connected to the IT infrastructure. This is a long-term relationship, since the product won't work if anything happens with the infrastructure. People stay very reliant on the support of the enterprise. Thus, 24/7 support is very important, to cover such potential issues. Connected products should always be up-and-running.

3.2.2 Technology

The internal technological situation might have the same or even an higher impact on the innovation process as the external technological context (DePietro et al., 1990), which will be discussed later. The internal technological situation is obviously important, since current technological systems might need a change when adopting the technological innovation. However, it is somewhat unclear what the exact impact of it is on the adoption, according to De Pietro et al (1990). Therefore, different aspects of the technology context will be discussed.

3.2.2.1 IT Department

According to Bughin et al. (2015), the role of IT should change into one that extends beyond computers, networks, mobile devices and data centers. To succeed at IoT, the IT of an enterprise will have to join with line managers and look at the IoT systems that are necessary for the improvement of the entire organization. Besides, IT needs to unite with the operations technology (Manyika et al., 2015), which means that the leadership of those departments needs to be aligned strongly (Bughin et al., 2015). Another collaboration that could be necessary for the successful development of products with IoT integrated, is the collaboration between IT and R&D (Porter & Heppelmann, 2015).

Vukicevic (personal communication, June 8, 2018) states the same, namely that IT will change from office automation to an important part of the product development. According to him, this is essential, since Internet of Things isn't a standard part of product management for many enterprises. Smart connected products are very dependent on its IT infrastructure and therefore it is important that the IT department plays a key role, he mentions. He said that this will change the way of doing business tremendously, specifically for traditional production companies.

3.2.2.2 Current Systems

The current technological systems will be undergoing change when adopting technological innovation (DePietro et al., 1990). According to DePietro et al. (1990), is it not very clear what the exact impact is, but that it is almost obvious that there must be some impact.

3.2.2.3 Interoperability

Interoperability is another relevant factor for the adoption of IoT (Bughin et al., 2015; Manyika et al., 2015; Risteska Stojkoska & Trivodaliev, 2017; Zdravković et al., 2017). It is estimated that nearly 40 percent of the potential value of Internet of Things requires communication and data integration between different IoT systems (Bughin et al., 2015; Manyika et al., 2015). They name the example of an offshore oil platform and state that data from different components and systems needs to be integrated to predict a large part of the predictable performance issues. If every individual component sends back data only to its supplier, it has less predictive value than all data together. This requires the entire ecosystem of an organization to become interoperable, otherwise not all components will be able to communicate and integrate data with each other (Bughin et al., 2015; Holdowsky, Mahto, Raynor, & Cotteleer, 2015; Manyika et al., 2015). Large enterprises might have the power to enforce this at their IoT vendors, which is more difficult for SME's or startups (Bughin et al., 2015). More on this will be discussed on the environmental factor: 'market dominance'.

According to Manyika et al. (2015), we are still in the early stages of the development (and adoption) of IoT standards, which will increase the interoperability. With a collaboration of industry

associations, technology vendors and policy makers, such a common technology standard should be created (Fan et al., 2013; Manyika et al., 2015). However, application interfaces (API's) can also be used to increase the interoperability by managing the communication between devices (Manyika et al., 2015).

3.2.2.4 Privacy

There is an increasing risk to personal privacy due to Internet of Things (Fan et al., 2013; Manyika et al., 2015; Risteska Stojkoska & Trivodaliev, 2017; Zdravković et al., 2017). When it comes to personal data, the misuse can lead to damage to the person in question. Manyika et al. (2015) mention the example of personal health, wellness and purchasing data. This data could affect the insurance rates, employment opportunities and access to credit (Manyika et al., 2015). Since more and more consumers are getting aware of the potential risk that comes with sharing personal information with organizations, these organizations must address the privacy concerns properly. Organizations should create value propositions that are attractive for those whose data is collected and used. This is needed to gain the maximum benefits and adoption of IoT (Manyika et al., 2015). Another unintended consequence of Internet of Things could be influence on the privacy of other users (Verhoef et al., 2017). An example that Verhoef et al. (2017) give is the use of drones. Drones might fly over a neighbor's homes and capture privacy sensitive footage, while this might not be its intended use. Such unintended consequences could be a barrier to the adoption of Internet of Things (Verhoef et al., 2017).

The importance of privacy is recognized by Vukicevic (personal communication, June 8, 2018). He states that 'privacy by design' should be taken into account, but that privacy concerns should not become a barrier to progress. He also states that is good to keep in mind that not all processed data is necessarily privacy sensitive data.

3.2.2.5 Security

The adoption of Internet of Things also comes with security concerns (Bughin et al., 2015; Fan et al., 2013; Holdowsky et al., 2015; Porter & Heppelmann, 2015; Risteska Stojkoska & Trivodaliev, 2017; Verhoef et al., 2017; Zdravković et al., 2017). Besides the normal risks that are related to the use of big data there are also risks of system breaches, because enterprises will connect their IoT devices to a lot of others (Bughin et al., 2015). Malicious hackers could use each of those devices as an entry point and do damage from within the system (Bughin et al., 2015; Verhoef et al., 2017). As Manyika et al. (2015) state, "each device increases the surface area available for breaches, and interoperability expands the potential scope of breaches" (p. 105). In short, even though there are great benefits that the interoperability could reap, there are also risks that need to be taken into account by organizations (Bughin et al., 2015). According to Holdowsky et al. (2015), the security concerns might be tackled by using complex cryptographic algorithms. However, there might be limited possibilities due to technical limitations, like low processing power or power consumption concerns (Holdowsky et al., 2015). Still, security should be embedded in the product design and entire value chain, following the 'security by design' principle which means that security should be embedded as a fundamental standard (Porter & Heppelmann, 2015).

The security factor is also recognized by Vukicevic (personal communication, June 8, 2018) and he also states, just as with privacy, 'security by design' should be taken into account. However, he also states here that security concerns should not be a barrier to progress. He mentioned that a method should be developed in which the chance on possible breaches is minimized, by thinking about it upfront. Shortly the potential of blockchain to make IoT more secure was discussed with Vukicevic. Blockchain is known for making data storage and transactions more secure, so that could be interesting for the IoT infrastructure. However, Vukicevic states that the entire company's value chain ecosystem needs to work with blockchain. If not, the use of it is being limited, according to him. Besides, it is not a requirement for an operating IoT solution, so he believes the use cases should prove its value first. According to him, at the moment, it is not adding value, unless the entire ecosystem adopts it.

3.2.2.6 Data Ownership

Another factor that influences the adoption of IoT is the data ownership (Manyika et al., 2015; Verhoef et al., 2017). A lot of data is being collected from consumers and enterprises, but it is still the question who owns the data. It is important that the data ownership is addressed early in the contract phase of an IoT related project (Manyika et al., 2015). Furthermore, this means that clear agreements should be written which consumers must accept before using the product or service (Manyika et al., 2015).

3.2.2.7 Analytics

Competitive advantage isn't created by data on its own, but by analyzing and acting on it (Porter & Heppelmann, 2015). There is a significant analytics challenge (Bughin et al., 2015; Manyika et al., 2015; Risteska Stojkoska & Trivodaliev, 2017). Internet of Things could generate a lot of data, but the data's usage is often limited to control and monitoring (Manyika et al., 2015). Mostly, the data is not used for process optimization or the initiation of disruptions, while these are possible use cases (Manyika et al., 2015). Manyika et al. (2015) found that sometimes there is a lack of understanding of the potential of the use of the data. This can be linked to the difficulties enterprises face when they try to determine their value capture of IoT, which was found by Ericsson (2015). When not knowing about the potential of your data, you might be missing important value capture opportunities.

Furthermore, enterprises need to bring the collected data together and convert it to meaningful insights. According to Manyika et al. (2015), this is the biggest challenge for enterprises when it comes to data. Algorithms could become the decision-makers in enterprises, whereby managers need to monitor metrics and set policy. Thus, many challenges that enterprises face on the management of big data, could also be faced when adopting Internet of Things (Bughin et al., 2015).

3.2.3 Environment

3.2.3.1 Regulation

The regulation factor can either have a positive or negative impact on the adoption of technological innovations, according to DePietro et al (1990). They state that on one hand, governments stimulate an exploration for innovative alternatives to current practice, by inflicting operational constraints and costs on industry. On the other hand, regulations can codify certain existing practices, which will raise significant barriers to innovation. Regarding the specific technology of the Internet of Things there will raise particular challenges for policy makers, according to Manyika et al. (2015). They state that existing regulations on privacy, security, data ownership and data sharing need to be reviewed and updated.

Vukicevic (personal communication, June 8, 2018) states that, when looking at the history, the government has always been sitting on two chairs. According to him, they want to stimulate the market innovations, but also regulate it. By regulating the innovation to fast, he says they risk that they slow down the development, which is not something they want. On the other hand, when they wait too long with the regulation, the politicians

risk that they are being judged by the public, according to him. Vukicevic gives the example of the GDPR. He thinks this regulation on data processing and privacy comes rather late, because they didn't want to slow down the developments. He states that the government prefers that companies self-regulate themselves and the market. When one company is being criticized by the customers, the competitor will most likely adopt to the criticism and make sure that they do a better job, he says. This way, he believes customers will leave the criticized companies and become a client of the competitor. In short, Vukicevic states that you should always take governmental interference into account, but that it shouldn't stop you from innovating. By stretching out up to the legal boundaries and in the process not damaging someone else, you can be most innovative, according to him.

3.2.3.2 IT State of the Art

As DePietro et al. (1990) state, different organizations could face different technological opportunities and not all opportunities are relevant to all industries or organizations. Some organizations might be operating in a mature industry with a low amount of technological innovations being adopted by the industry. Others might operate in a very dynamic industry when it comes to technological innovations in which the organizations must constantly reevaluate new opportunities (DePietro et al., 1990). Another relevant distinction can be made on the basis of the type of innovation. Technological environments in which radical innovation happen more often do also require different responses from the organizations in it (DePietro et al., 1990). The existing IT adoption models are quiet general on this factor, as the entire models are very general themselves too. Therefore, it is important to look at the factors that matter specifically for IoT.

According to Vukicevic, Internet of Things is still in its early stages of adoption. However, it is a technology that is enormously hyped and Vukicevic expects the technology to become very important within a couple of years. He mentioned Rogers' bell-shaped curve (Diffusion of Innovation) and Gartner's Hype Cycle. According to him, when looking at Gartner's Hype Cycle it can be stated that IoT will reach the late majority within 2 to 3 years. Currently, most commercial IoT projects are in the phase of early adopters or the early majority phase, he states. According to him, enterprises came up with a Proof of Concept, but then it appears to be more complex than initially thought. He states that to reach the late majority, the IoT product needs to be complete, which means that elements like ease-of-use, after-sales, seamless updates and online support should be perfect. Without too much effort of the user, the product needs to be satisfactory.

Vukicevic says that IoT is an overarching technology for many other technologies. Technologies like Artificial Intelligence, Augmented Reality, 3D printing and nanotechnology fit in Internet of Things, he says. All other new technologies present improvements for a specific activity. He states that the Internet of Things technology is often a combination of new and old technology appliances engaged to improve the processes and/or offer new services or product features. According to Vukicevic, the IoT is a system of technologies where all mentioned new technologies can be part of, but do not have to be. He gives a few examples. Artificial Intelligence plays an important role when a lot of data is collected, and purposeful actions should be taken on the basis of this data. Nanotechnology makes it possible to create smaller "Things", which will enable more applications of the Internet of Things. In short, he sees Internet of Things as an overarching technology for multiple disruptive technologies that are upcoming at the moment.

3.2.3.3 Knowledge

According to DePietro et al. (1990), enterprises require a change in the skills they demand from their employees when dealing with new technologies. Enterprises might need to develop general knowledge on IoT and new skills of their employees to get ready for a data-driven organization (Bughin et al., 2015; Holdowsky et al., 2015; Manyika et al., 2015; Papert & Pflaum, 2017). Furthermore, Ericsson (2015) points out that many enterprises don't have sufficient knowledge on the capabilities of Internet of Things. Therefore, they find it harder to determine how they can capture value with it (Ericsson, 2015). This knowledge gap was signaled among top management, but not limited only to them. Most enterprises did not have the capabilities that they needed to adopt Internet of Things effectively (Ericsson, 2015). Ericsson (2015) comes up with several options to cover the knowledge gap, which are the training of staff, recruitment of IoT talent or use of external consultants.

Related to that, DePietro et al. (1990) state that enterprises have lower innovation-related training costs when they operate in a labor market with plenty of skilled and experienced employees. They also mention an alternative way to access the needed skills, which is the delegation of some tasks to outside specialist. According to DePietro et al. (1990), enterprises have more options and flexibility for their innovation strategies, when they operate in industries or geographic regions with high-quality and low-cost suppliers of technology-related training and consulting.

The knowledge factor is confirmed by Vukicevic (personal communication, June 8, 2018), who states that there is almost no chance that one enterprise manages all aspects of Internet of Things. Therefore, he says it is important to create stable ecosystems in which enterprises work together on IoT projects. He refers to his own company Comgate. At Comgate, they work with many partners to provide IoT solutions. Comgate itself provides hardware sales, connectivity and consultancy, but it needs its partners for software and hardware development.

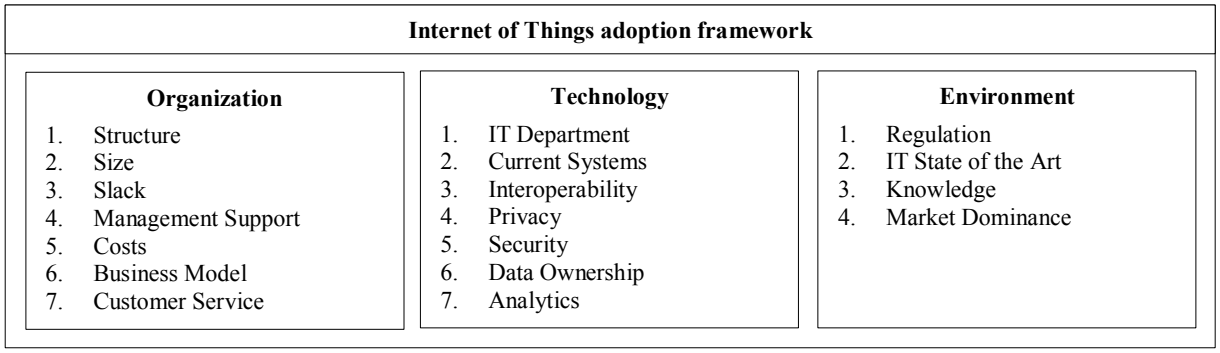

Figure 7: Internet of Things adoption framework

3.2.3.4 Market Dominance

DePietro et al. (1990) state that dominant players in the market can occasionally dictate what technologies should be used by the enterprises that work for them. According to Kamath and Liker (1990), if enterprises give a high priority to a particular innovation, they must choose a supplier that is highly dependent on the enterprise. They also state that this is quite obvious, since the large enterprises will be treated differently than smaller ones.

4. CONCLUSION AND DISCUSSION

The goal of this research was to provide an overview of relevant factors that influence the effective adoption of Internet of Things in business. The current literature is incomplete on this area and this research strived to be as complete as possible on the subject. To get to this goal three different research approaches were used, and their outcomes were synthesized into an integrated Internet of Things adoption framework. The framework has been divided into three contexts, namely organization, technology and environment. Together, they give an overarching overview of the relevant factors that influence the adoption of Internet of Things in business. Insights in these factors should give enterprises a head start for an effective of adoption of Internet of Things in their organization.

To get to the framework, three research approaches were used. Firstly, a literature review was conducted on existing IT adoption models, which gave insights in general challenges that businesses could face when adopting technological innovation. This answers the first sub question; namely which adoption factors are identified by existing IT adoption models. Secondly, another literature review was conducted on the adoption factors that are identified by existing IoT literature, which answer the second sub question. Thirdly, a case study in the form of an expert interview complemented the literature reviews with insights on the adoption factors of IoT from an expert's viewpoint, which answers the third sub question. The challenges (or factors) that were found were visualized in a Venn diagram, to show the overlap in findings between the research approaches.

Reflecting back to the sub questions of this research, we can summarize the findings as follows:

a. The existing IT adoption models showed the factors: market dominance, current systems, size, slack, IT state of the art, management support, knowledge, regulation and structure.
b. In the literature on IoT adoption challenges, the following factors were found: interoperability, data ownership, analytics, costs, privacy, security, IT department, business model, knowledge, regulation and structure.
c. The expert interview showed the factors: customer service, size, slack, IT state of the art, management support, costs, privacy, security, IT department, business model, knowledge, regulation and structure.

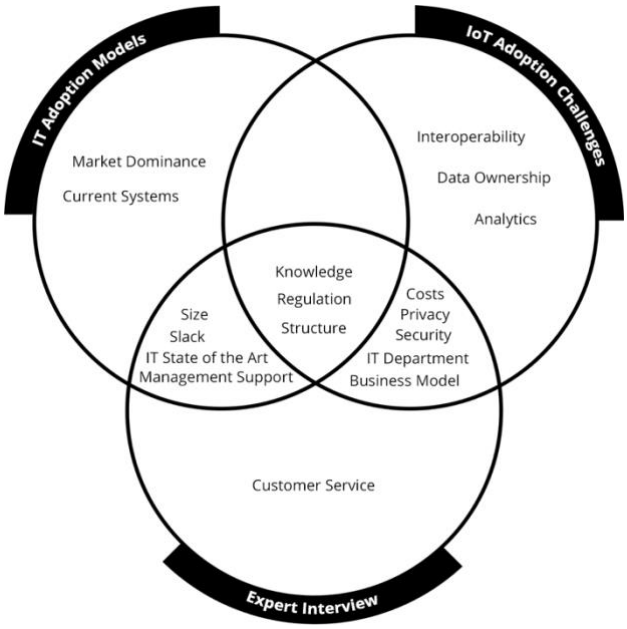

Figure 8: IoT adoption factors' overlap between research approaches

Factors	**Context**	*IT Adoption Models*	*IoT Adoption Challenges*	*Expert Interview*	**Overlap**
Structure	Organization	A	B	C	*ABC*
Size	Organization	A		C	*AC*
Slack	Organization	A		C	*AC*
Management Support	Organization	A		C	*AC*
Costs	Organization		B	C	*BC*
Business Model	Organization		B	C	*BC*
Customer Service	Organization			C	*C*
IT Department	Technology		B	C	*BC*
Current Systems	Technology	A			*A*
Interoperability	Technology		B		*B*
Privacy	Technology		B	C	*BC*
Security	Technology		B	C	*BC*
Data Ownership	Technology		B		*B*
Analytics	Technology		B		*B*
Regulation	Environment	A	B	C	*ABC*
IT State of the Art	Environment	A		C	*AC*
Knowledge	Environment	A	B	C	*ABC*
Market Dominance	Environment	A			*A*

Table 2: Factors that influence the adoption of Internet of Things

Three factors were found in all three research approaches, namely knowledge, regulation and structure. Four factors were found in both the IT adoption models and expert interview, namely size, slack, IT state of the art and management support. Five factors were found in both the expert interview and IoT adoption challenges, namely costs, privacy, security, IT department and business model. Two factors were found only in the IT adoption models, namely market dominance and current systems. One factor was found only in the expert interview, namely customer service. Lastly, three factors were found only in the IoT adoption challenges, namely interoperability, data ownership and analytics. In total 18 factors were found in all research approaches together. These are all part of the Internet of Things adoption framework, which can be found in figure 8.

4.1 Theoretical Implications

This research has both theoretical and managerial implications. First of all, the theoretical implications. As far as known, there is no scientific research paper available at the moment, that gives such a complete and general overview of important factors that influence the adoption of Internet of Things in business. There is some literature, mostly from practitioners (Bughin et al., 2015; Ericsson, 2015; Manyika et al., 2015), that give some insights on these factors. However, they miss a few key parts from existing IT adoption literature and are mostly focused at the technological context of Internet of Things. When it comes to the adoption of such a disruptive technology in business, it is assumed to be good that more contexts are covered.

Furthermore, there is a research by Hsu and Yeh (2017) on the factors affecting the adoption of Internet of Things, but they focused their research on the logistics industry in Taiwan only. Also, they used many sources on RFID adoption specifically. This could be highly relevant for the logistics industry, but in this research is was chosen to focus on Internet of Things in general. There are many more IoT applications than RFID and therefore that would have made this research less general.

In short, this research aims to provide such a general overview of factors that influence the adoption of Internet of Things in business and it is believed that it will contribute to the existing IoT research material.

4.2 Managerial Implications

The Internet of Things adoption framework can be used by businesses to more effectively adopt the Internet of Things. The combination of general factors and IoT-specific factors gives a broad overview that organizations can use to create their adoption strategies. This research intends to provide the most important factors and therefore we assume that using this research will cover most of the adoption hurdles that a business might encounter in their own IoT adoption. By knowing them up front, they can be taken into account early on, which will lead to less surprises and barriers later on.

Furthermore, this research was knowingly included with practitioners' papers and an expert interview with a practitioner. This way it was tried to make the research not only scientific, but to give it some insight from the practitioner's perspective. As the research goal is to find the relevant factors influence effective adoption Internet of Things in business, it is assumed to be the best practice to also include insights from businesses and not only academic research.

5. LIMITATIONS

This research was conducted with great care, but there are some limitations to it. First of all, in the case study only one expert was interviewed. Now, the information that was gathered from one expert is used when developing the framework. It could have been better to interview multiple experts to increase the reliability of the findings and to be able to critically compare the answers they gave. Future research should conduct a more extended case study on Internet of Things adoption in business.

Secondly, this research has limitations since it did not include all possibly relevant IT adoption models. During the last phase of the research a third IT adoption model from Iacovou, Benbasat, and Dexter (1995) was found. Future research should consider that IT adoption model too and see if any relevant factors raise that didn't raise in this research. Furthermore, it could also be used to further strengthen the findings of this research by confirming certain overlapping factors.

Lastly, the second literature review on the IoT adoption challenges is limited. Initially, 40 articles were found in Scopus and Web of Science. These were selected based on reading the abstract. However, a lot those articles weren't relevant after all, when reading them completely. Therefore, only 8 of the 40 articles were used to determine the challenges that occur when adopting IoT in business. Besides, 4 relevant papers from practitioners were found and used. Future research could strive to find more relevant literature by using other databases or different search criteria. This could be a good addition to the factors that were found with this research.

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