

## **Supplementary Materials S1: Interview protocol and interview questions**

### **Protocol of the first series of interviews**

#### **Interview Protocol**

##### **INTRODUCTION**

Thank you for participating in the interview. As you already know from my email, I am conducting the research about the implementation of IoT. Your opinion will contribute to the understanding of this process, its possible challenges, and risks. The goal of this study is a maturity model for IoT adoption in B2C companies.

##### **TAPE RECORDER INSTRUCTIONS**

I would like to record our interview for simplifying the note-taking process and making sure that no information is lost. Your answers and comments will be processed and reflected in the paper anonymously. The information you provide will only be used for the purpose of this research. Your participation is completely voluntary, and you may stop at any time.

##### **GENERAL INSTRUCTIONS**

In this interview we will discuss general topics of IoT implementation and try to identify the most important sections of this process, which will become the dimensions of the maturity model. I expect to cover all questions within 45 minutes. If there is anything unclear during the interview or you wish to clarify something, do not hesitate to interrupt me.

After the first version of the model is constructed, we will discuss the stages and sub-dimensions of the model in a second interview.

##### **A. General questions**

1. What do you consider the most important in the development of IoT products?
2. What do you consider the most important points when deploying your IoT products?
3. What business benefits do you expect for IoT technology to bring?
4. What kind of risks and challenges do you expect to face?

##### **B. Questions about dimensions of the model**

1. What do you think is most important for your clients in your IoT products?  
Follow up questions:
  - 1.1 Most frequent questions you get from clients before they purchase your products?
  - 1.2 Most frequent questions you get from clients after they purchase your products?
  - 1.3 Do your clients know that IoT technology is used in your product?
  - 1.4 Do your clients know what exactly IoT technology does and what benefits and risks it brings?
2. What would you say about the importance of data privacy and protection?  
Follow up questions:
  - 2.1 What do you do in order to ensure data protection and privacy?
  - 2.2 How can your customers be sure about the security of their personal information? Is your privacy policy transparent?
  - 2.3 Do your users have the access to the data that you have collected about them?
  - 2.4 Do you have a policy regarding what happens to customer data if your company/product/service is bought, sold, acquired or closed?
3. Do you think the adoption of solely IoT technology in the company is enough to get the best value and benefits out of it? Or are there some other factors to it?

Follow up questions:

- 3.1 Do you think the overall strategy of the organisation should be aligned with new IoT practices? If yes, how?
- 3.2 What about organisational culture? Should company employees be given general knowledge and training regarding new IoT technologies implemented in the company?
- 3.3 What changes should be made in the business processes of the organisation implementing IoT?
- 3.4 How does IoT technology used in the company affect the decision making in it?
- 3.5 Do you think the customer policy of the organisation should be aligned with new IoT practices? If yes, how?

4. What do you think about regulations in the IoT field?

Follow up questions:

- 4.1 Should it be governmentally-regulated?
- 4.2 Should there be common standards in the IoT industry regarding its adoption and use? For example, data security?
- 4.3 Should there be specific ethical standards in the IoT industry regarding collecting, processing and using private users' data?

#### Questions for model evaluation in the second series of interviews

1. First of all, we need to review the first version of the model, and decide which dimension and sub-dimensions to keep.

1.1 This is the initial maturity model. Could you please give your opinion on it and mention if there are some (sub) dimensions that should be added, excluded or merged?

	Maturity level				
<u>Dimensions &amp; Sub-dimensions</u>	Level 0	Level 1	Level 2	Level 3	Level 4
<u>Data</u> <ul style="list-style-type: none"> <li>• Data Security &amp; Privacy</li> <li>• Data Management</li> </ul>					
<u>Technology</u> <ul style="list-style-type: none"> <li>• Infrastructure</li> <li>• Standardisation</li> </ul>					
<u>Business Processes</u>					
<u>Organisation</u> <ul style="list-style-type: none"> <li>• Decision making</li> <li>• Strategy</li> <li>• Culture</li> <li>• IoT Team</li> </ul>					
<u>Communication</u> <ul style="list-style-type: none"> <li>• Partners</li> <li>• Customers</li> </ul>					

### 1.2 Business process dimension

The analysis of collected data showed that any IoT integration initiative in the company should have a solid business justification. That is, a business need should be identified, followed by the business use case definition, and finally BRP. How should this be reflected in the model? Is one "Business process" dimension sufficient, or there should be underlying sub-dimensions?

### 1.3 Business model transition

From the interviews it became clear that in B2C IoT there is a transition from the product to service orientation. Can then the company's IoT adoption maturity be measured in the way they are achieving the business model transition? If yes, should such (sub) dimension be added?

The maturity levels definitions are as follows:

**Level 0:** Non-existent

The process is not existent at all.

**Level 1:** Initial/Ad Hoc

No standardised processes are in place

**Level 2:** Repeatable but Intuitive - industry average

Procedures are followed but there is still a high degree of reliance on the knowledge of individuals.

**Level 3:** Managed and Measurable

Procedures are standardised and consistent, significant errors are detected and prevented.

Documentation is complete and the compliance with required procedures is measured.

**Level 4:** Optimal and Robust

A refinement of processes to a good level of practice took place and variances are constantly reduced.

The system is benchmarked against best in class standards and practices.

## **Supplementary Materials S2: Notes from the first series of interviews**

### **Interview with Expert 1**

#### **A. General questions**

##### ***1. What do you think is the most important in the development of IoT products?***

There are a few statements around this. First, IoT helps us to make better and faster decisions. And a key to IoT products is a lot more things become measurable. For the past ten years people have been way more effective in measuring what's going on and taking appropriate action. The whole learning process enables better and faster decisions. IoT is an engine of creating economic wealth because slow decisions with lower quality create waste, while faster decisions create prosperity. And this is the way in which IoT is contributing to society and makes this world a better place.

##### ***2. What do you think is the most important in the process of deploying IoT products?***

The most important is that people understand that the word IoT is very misleading. Same as the word smart home is misleading. It is not about the things or making the home smart, it is about collecting data and doing something with it that helps people make better decisions. The most important point deploying IoT is understanding how the data can be used to our benefit. Deploying IoT is not about things, but how to extract value from the data that is collected by the IoT.

***Follow-up: Do the misleading concepts surrounding IoT you mentioned give rise to risk of not using this technology correctly? Are there some other risks involved in it?***

No, it is just an overestimation of what technology can do. Talking about the things and not the value of the system.

##### ***3. What benefit does IoT bring?***

The value of the system is coming not from the collection of the data, but from being able to do useful stuff with the data. Smart things, like for example, fitness bracelets, are helping people to create change (become fitter), but only if they do something with collected data. The bracelet itself is not going to make one fitter.

The business benefit comes when you start to use collected IoT technology data.

The risk is that all the data that has been collected falls into the wrong hands. For example, a smart home system knows if you are home or not, so what if somebody can break into that system and also find that you are not at home? Everywhere where data is collected for the good, for doing things better and making better decisions, faster, the risk is that it falls into the hands of bad people. The risk is that data security is underestimated. Collecting data is a risk as well.

#### **B. Questions about maturity model dimensions**

##### ***2.1 What do you think companies can do in order to ensure data protection and security?***

Security is a very complex question. It is not about what companies can do, it is more about what we can all do. There are a lot of practices like making sure the software is up to date, changing passwords regularly and etc. But from a product perspective, we need to involve all kinds of proper security measures. Security needs to be put in place in all levels, not only one. Security is a disciplined lifestyle.

***Follow-up: You view security as being important on all levels, so what customers can do about it?***

From a customer side, they can make sure they have the latest software updates, they can change passwords regularly. From a product developer side, you need to make sure that all security holes are continuously filled, that you use the most up to date security measures, that are most difficult to break.

## **2.2 How does the transparency of the privacy policy impact this?**

Privacy is the legal issue and not a technical issue. It is not about being able to steal the data, but about this act being illegal. Privacy protection is coming from the law. It defines what privacy is and what companies need to abide by. It is not necessarily related to technology.

***Follow-up: Do you think that there should be common standards in the IoT industry regarding data security and privacy?***

Yes, and it is in progress. There are many standards in the development, including for security. However, the standard is not an escape because what is secure today is not secure tomorrow anymore. Security is a race between things that need to be held secure and bad people that want to break security. There is no end point, security is constantly evolving.

### **1. What do you think is the most important for clients when they purchase and use IoT products?**

The most important is to learn and understand what is the value and what to do with it. End users should learn about the data and what to do with it. It is not about the look of the product, but what you do with the data. Don't buy IoT products because you want to collect the data, but to be able to assess what you can do with the data.

***Follow-up: Is there something companies can do to teach their clients about the benefits of the data and what they can do with it?***

It should be a part of the product. Initially, IoT products were sold as products, but now companies are learning that product collects data and the data needs to be stored and interpreted, and that is more of a service. IoT is not a product model, but a service model. Collecting, storing, interpreting, and giving feedback on the data is a continuous effort, it is closer to the definition of service than the product.

***Follow-up: If the clients are more informed about the use of IoT, do you think their general concerns before they buy the IoT product will change?***

There are marketing models for clients, so the concerns depend on the type of a client. For example, early adopters think that something is fun and they try it. If it works they become evangelists, if it doesn't they throw it away and don't care. If the product is accepted and becomes mainstream, then there is a market growth, which brings open-minded people who are willing to learn how to benefit from the product. Then comes the phase where people who don't have the product are in a disadvantage. All these people have different reasons to buy products and to understand and appreciate the benefits it brings. For each client group the company has to study their needs for wanting to buy the product and market it accordingly so that it becomes appealing.

### **3. Do you think the adoption of solely IoT technology in the company is enough to get the best value and benefits out of it? Or are there some other factors to it?**

The IoT exists already for 40 years, it might have been called differently or operated differently but it was there. IoT is all about understanding how having more data helps making more timely and accurate decisions. Currently IoT is growing everywhere and the base of growth is determined by how quickly people can understand the benefits data brings to decision making.

#### **3.1 Do you think the overall strategy of the organisation should be aligned with new IoT practices?**

Absolutely. It needs to be fully integrated. It needs to serve the products and help you do something better and more efficiently because you have data that can help you make better decisions immediately. That is what it is all about.

***Follow-up: When talking about full integration, do you also mean customers policy, organisational culture and business processes?***

Of course, maybe indirectly at some places. If you know how to make better decisions faster, you can think about changing other things to facilitate that, but it is not the purpose in itself. We should not overcomplicate things.

Better decisions bring change, and as a result there are different structures and organisations. Things change because you get more efficient, but change in itself is not the goal of IoT. It is also the painful part, because nobody likes inefficiency, but when you are used to doing things one way you may not like the change. There are a lot of secondary effects that create turn, and the change can be painful, but it doesn't mean that we should continue doing things the old way.

***Follow-up: Is there anything companies can do to educate their employees regarding this possible change and make the transition to the new technology smoother?***

It is more of a natural process. It is not about giving training to employees to prepare them for the next wave of IoT, it does not work like that. People are looking for the opportunities to collect more data to make faster and better decisions, which allows us to be relieved from everyday mundane tasks. The motivation behind using IoT does not differ between organisation and people. Of course, there is specific training required to interpret the data however.

***4.1 Do you think the IoT field should be governmentally-regulated?***

The privacy part should be governmentally regulated. The government needs to tell what is private and what is required to keep things private. In general, however, the government should stay out of it.

## **Interview with Expert 2**

### **A. General questions**

***1 & 2 What do you consider the most important in the development and deployment of IoT products?***

We work a lot with companies who use classic technology solutions to make the world smart and connected. IoT is very different (from those classic solutions). The most important thing is that people who we work with understand what IoT is. A lot of times people do not understand what it is and what it means. Education on what IoT is, what it brings, what are the risks related to it is important. Also, governmental organisations like European Commission or even national organisations of the governments facilitating and motivating the world going digital are important.

***4. What are the major risks associated with the use of IoT technology?***

Typically, security and privacy is an issue. Being able to intuitively work with the IoT product. Also, robustness of the system. These are typical product-type issues, which emerge. And of course, once moving to digital systems, non-digital people need to be kept on board with this. They should understand what we try to do or how it works or how they can benefit from this. For many people working in a digital environment compared to a classic environment requires a change in their thinking and behaviour. We have to keep it simple, friendly, and understandable.

***3. What business benefits does IoT technology bring?***

The most important things in terms of the benefits we try to enable, like systems becoming faster and more accurate, lower cost, users getting more insights and richer information. It is important to highlight and focus as much as possible on those kinds of things.

### **B. Questions about the dimensions of the model.**

### ***2.1 What can companies do in order to ensure data protection and privacy?***

First of all, take the point seriously. For example, there are a lot of cheap Asian digital products, which you can easily connect to the internet, but at the same time it turns out that these products are easy to corrupt. There are major risks connected to it that people misuse them for fraud. It is important that we have regulations and government standards, e.g. products should adhere to certain minimum specification levels, or should comply with certain formal standards and regulations on security, safety, and privacy. On one hand, the developers of the products don't like regulations, government bodies, and quality institutes that do statements on quality and functionality. On the other hand, from a security point of view, or even system robustness point of view this is important and is the only way to make the systems and products sustainable. The sweetness of the low price or installation simplicity is quickly forgotten once you have had a major security issue. Once people have a corruption of the system or corruption of a product, or a theft of personal information, they start to spend much more resources on the subject of security.

### ***2.2 How can your customers be sure and trust the company about the security of their personal information? What can companies do in order to build that trust? How transparent should the privacy policy be?***

As long as you see that the maker of the product is referring to privacy or security standards, and as long as he can refer to organisations who approve the quality of the products. It is important for the end users to see the labels on the product indicating that it has been approved by those kinds of organisations. If consumers know that when they see such a logo it is okay, it is easier for them and it increases their trust.

### ***1. What do you think is the most important for clients in the IoT products?***

For people in general new functionality, new things that you can do. IoT should unlock new benefits. New benefits can be very different depending on what type of person you are or where they are in the value chain. It can mean lower cost, new functionality never seen before. Or in terms of music IoT opened up mobility and made music more mobile through making it part of your small media player and later on of your telephone. Also, it provides new ways of shopping and changes the distribution chain. IoT has many different benefits. In general, it boils down to easier, quicker, cheaper, more integrated, faster. In organisations it is easier to do group calls and digital meetings, not only talk to each other but also share pictures and slides, and even work online. In that sense, for organisations it makes life simpler - people are not physically needed anymore in the office building, everybody can work from home or another office. Also, decision making processes become simpler, faster and less hierarchical, which is a benefit as well. Overall, there are many different benefits.

### ***3. Do you think the adoption of solely IoT technology in the company is enough to get the best value and benefits out of it? Or are there some other factors to it?***

In general digitalisation is not only related to products, it is also related to processes and people. Looking at the organisation and the ways it can digitalise, exploit digitalisation and benefit from it, you always have to think in terms of people, processes, and products. In the sense of the products, what you are making as a company, there are questions like how do we make them competitive and valuable in the digital society. How do we make our products suitable for the digital world? It can go very extreme. For example, you have your health watch, which shows you statistics on how often you move, or how many steps you take per day, but you can also connect it over the internet to some databases and see how you compare against the other people of your age and similar lifestyle. That is an interesting new digital feature, when you can connect it in the digital cyberspace to other people and see how you are doing compared to them. You could also add a game element to this, and see whether you can become the best of your peer group. That is in terms of products and making them more digital-savvier and valuable in the digital world.

In the company there are also processes, like working processes and digitalisation is also related to the way we work in our company. The question is how can we make that process more active, simple, rich, and appealing. Also, how can we make it more integrated with other digital things in the company. This is a big internal digitalisation discussion.

Then, certainly you have people in general, because it's people who have to work with the processes and products. There is a big difference between different kinds of people in different cultures. There is a big difference in how we are working with people who are in their 20s, who grew up in the digital world, and so a lot of things for them are native and logical. On the other hand, we are working with people in their 50s, who have to think about what does digital mean, and they have to work with things which are not always completely intuitive. So, age difference is important. Then, there is also of course a difference in culture. Are people we are talking about California Silicon Valley kind of digital people, or are they classic German people in Southern Germany or in Austria and do they have different ways of thinking, valuing, and perceiving certain things? So, there is a big difference in cultures as well.

The IoT technology will not bring its full value to the company, unless it is aligned with the product, process, and people. Of course, there are always quick wins, but if you want to use more digital interconnected products, people need to at least a little bit understand how they work. Otherwise, it quickly becomes the bottleneck. IoT can do wonderful things, but if the people, who work with it don't understand how it works, or if there is a problem and they don't know how to solve it, there is an issue. Everything is interrelated.

Organisational culture. Digitalisation is not only related to technology, processes, it is also related to people.

#### ***4. What do you think about regulations in the IoT field? How much should it be regulated?***

Gradually more and more people are aware of the fact that things need to be regulated. Technology is running ahead of the regulations. In the early days regulations are behind, but once sufficient problems pop up people start to understand that regulations are important. There are regulations discussions on national level and then on international level, and we will see several rules and regulations, and formal standards, and national law popping up, to which the products have to adhere to. Organisations issuing security standards will also play a role in security and privacy discussions, and they will become official parties that will manage this, partly held by government organisations.

#### ***Follow-up: With technology changing so fast, to what degree do you think it is possible to achieve standardisation and whether it is possible at all?***

Standardisation is another big challenge. As long as new technology is not stable it is difficult to have regulations about it and standardise it. Talking about internet connectivity, and objects communicating with each other, they are considered relatively stable on the market for a long time and so more and more rules and solutions are popping up. Also for things like 5G, this kind of connectivity solutions are pretty mature, and so a lot of industry players or other authorities are trying to develop privacy and security solutions for it. In general, regulations in this field are coming.



## **Supplementary Materials S3: Notes from the second series of interviews**

### **Interview with Expert 1**

1. ***First of all, we need to review the first version of the model, and decide which dimension and sub-dimensions to keep.***

#### ***1.1 This is the initial maturity model. Could you please give your opinion on it and mention if there are some (sub) dimensions that should be excluded or merged?***

The first question is always what to call dimension and what to call sub-dimension. I can imagine data management is part of technology. Because data is something you call security and privacy.

***So, you would like to for the data management to go under the technology dimension and have a separate dimension for data security and privacy?***

Yes, right. I also recognise there is no black and white. I am not saying that this is wrong and it should be something else. What am I saying is that I see data management more as a technology thing. They always cross-connect, it's a question of how to cut the cake, you can do it in many ways. The question is always what is practical and how does it lead to more insights. I recently followed a course on security and privacy, so I have some idea about them and the difference between the two. Security is more from a company perspective, it's closer to data management, while privacy is more person-related. For example, I want to ask you to delete all my data and to be forgotten in your system. Of course, there are always links to the technology. If the data management is done improperly, my right to be forgotten is impossible to execute.

***So, we can actually separate them in the model?***

No, not necessary. Again, it is a question of how you cut the cake and whether you want to have five six, or eight dimensions. And dimensions should be on the level with other dimensions, so I can imagine that if you do five dimensions that would be proper. What I would add on data is something like content and usability. What data do you want to collect, and what about its security and privacy? But if you want to have a data category, then you should have a sub-dimension like, do you understand what kind of data you want to collect.

***So, we have two sub-dimensions under the data, right?***

Right. There also might be a whole other section, which is data processing. Because data gets into a data base, so I would add a new dimension and I would call that data retention. Data bases should not blow up and grow and grow and grow. The more mature you are the better you understand how to retain data. There is also a category like data integrity. For example, if sensors out of the sudden start to produce wrong data and get into your data base, they start corrupting your data base, so the question is how to keep the integrity of your data base. How do you purge your data base from data that is of not right level of integrity?

Then, there is also a whole category of data processing. Think about how to query a data base, and other type of things you execute on the data base to extract value. This is about information extraction. From my experience people start to collect a lot of data in data bases and then they are going to wonder what to do with it, and in this process realise that they are, missing an essential kind of data. For example, they forgot to record the date and time at which the data was collected.

***So, this is more of a data analytics and interpretation dimension?***

Yes, there should be a section on analytics. I call it data processing, but you can call it analytics.

So, in technology we have infrastructure and standardisation. If we talk about technology and data, it's almost a sub-dimension in standardisation. The first thing you have to do when you start working on data base is to check the date formats, because everyone is using different ones. There is also technology connectivity, there are many standards in technology for generating data and for producing results. When you talk about technology and standardisation you need to be standardised on how to communicate and how to connect sensors to the gateway to the cloud. You also need to standardise the language.

Here is the smart home that is connected to the cloud and data is collected in the controlled database. The controlled database is controlled by usually a subscriber management system and then you need to be able to interact with your controlled database and your object to work with this as a system. This is what I call an IoT system.

You can also take Fitbit. Fitbit communicates with the cloud and the Fitbit collects your data in the cloud and on your phone, you look at what is happening and you control your life. So, a Fitbit also fits this picture.

If this is a factory you have a big database, and you have controlled centre, with bug screen on the wall, therefore I call this picture an IoT template because this picture almost applies everywhere. You always have controlled environment (smart home, Fitbit, or factory), you have controlled database.

There is another important thing on IoT and data collection. You want the database to take initiative if something goes wrong. For instance, if the controlled environment is a smart meter in your house and you have a massive leakage, but if controlled database just measures that you are using a lot of water, but it doesn't send you a message about it, something may be wrong and you need to check, maybe a pipe has broken. If that is not happening you don't have a real and mature IoT system. You have a data collection system, which doesn't send alert or interrupts. It should say something like "You are using too much water now, we have closed the wealth to your house, because something must be very wrong."

The controlled environment is almost the object of IoT. You need to have a clear understanding of what you want to control. The better you understand the environment that you want to control, the object you want to control, the better you are able to control it. So, if we go back to maturity models, I would add something like controlled environment. Now the data kind of hangs in the air. There needs to be another dimension – controlled environment. It needs to include things like conditions, boundaries, exceptional situations. If you don't define the controlled environment you don't know where the system starts and ends. Again, I am brainstorming here, so it is not binding.

With IoT you want to control the environment, and to do that you need to define it first. The second thing to do it defining who is doing the controlling – the subject. In terms of IoT you need to determine what are the aims and goals of the operator or the subject, who wants to control the object. Is it making money, or provision of environmental safety? If IoT is for nuclear power plant, what are the goals of the use of IoT?

***Do you think this might relate to the business process dimension, where we also talk about the definition of business need and business use case?***

Yes. I am almost inclined to say that this is the first dimension – the goals and the purpose of the subject. When you know the aims, you can talk about the data, technology, the business process.

***Can we then maybe view the business process as a part of business dimension?***

Yes, you can view it as part of object and subject. Define subject and object as two dimensions. The subject includes aims, goals, intention, and reach, and object includes constraints, boundary conditions, what do you include and what you do not include. And then you can make business processes a separate dimension, because it also goes back to infrastructure management, or to

subscription. There needs to be an overarching structure that defines who can go in and out of the system.

Then coming to the organisation. I think we have unrevealed a little bit of organisation in object, subject, and business processes. And I am not too sure about the culture. I can imagine that decision-making is part of business processes. Culture becomes very vague and then everybody can throw in everything. I would say working with maturity model is culture in itself and I would not make culture as such. What we are trying to do is unravel what is the culture and what are the elements of culture. I do not know your definition of culture, but you know me separating subject and object, and talking about data and data integrity and about technology and infrastructure and standardisation – that is all parts of culture. I am not so sure about making culture itself as a part of the maturity level.

***I included culture because it was in the literature mentioned that resistance to change of employees has an impact on the adoption process.***

That is true, but it is of another level. If you are working with IoT and if you are working with data and if you want to understand the maturity of your implementation, culture is sort of a back drop and given. I would not bring that in because it creates vagueness that you do not want. What you want to establish is that you want to be able to talk about the maturity of an IoT system or an IoT implementation, and it assumes a culture of embracing IoT. By bringing culture you are bringing something from a higher order to a lower one, it is almost as if you start defeating the purpose of what you are doing. What you want to do is talk more rationally about IoT systems in terms of maturity model, and it assumes a certain culture. It is a starting point, and talking about it rationally, you want to unravel what all the elements are. And bringing culture is like bringing something very vague when you are trying to unravel something in more clear things.

Team? Yes, but I would say team structure instead and link it back to decision making. Strategy is one point in time, but if you want IoT systems to be manageable and understand their maturity you need to understand the process of changing strategy, not a strategy itself.

***So, you see team grouped together with the decision making, not separately?***

Well decision making needs to have a basis, so it needs to be done by whom? Is that by the head of the organisation or is that by a consensus, or is that by a clear process? And who is involved in the process, does it require consultancy? Does it require waiting time for making the decision?

***I saw this dimension more as the degree to which the collected data is used in the decision making of the organisation.***

Fair enough. Not exclusively though. As for communication, the sensors surround around the operator and the operator doesn't have to be the subject. In the case of Fitbit, the operator is the same as the subject. I would like to use my Fitbit for my personal health, but if you are an operator in the factory, you need to be able to work with the IoT system that manages the factory, but that is part in the communication. Who is involved with the whole exchange in the IoT system. If we go back to what I said originally, about defining the subject and object. Actually, the communication is about the object and the link between the object and the external world. It is communication around the IoT system.

***This kind of communication is more under the technology dimension, don't you think? It is what enables the whole system, and is integral to the functioning of the whole IoT environment.***

Well, yes. There is internal communication between the players of the system and there is communication between the system and the external world.

***Originally, when I included communication dimension I meant it as a communication of the benefits the IoT system can bring to the customers of the company and the establishment of the contracts with partners and other parties to support the functioning of this system.***

Yea... But that goes back to the internal communication and goals of the organisation and the benefits from the system. But there is also external communication, when the alerts need to be created. For example, there is an IoT system measuring and tracking climate change. And communication is also about being able to communicate with the people impacted by the climate change. And the insight you have of the external environment. There is internal and external communication. It is also the communication between the system that collect data and the people that create the data, and then it goes back to security and privacy and how you communicate that. I mean, you can make it as big or as small as you want in the result. I was inclined to broaden communication a little bit. Partners and clients is not wrong, but I am thinking a little bit broader.

***1.2 The analysis of collected data showed that any IoT integration initiative in the company should have a solid business justification. That is, a business need should be identified, followed by the business use case definition, and finally BRP. How should this be reflected in the model? Is one "Business process" dimension sufficient, or there should be underlying sub-dimensions?***

So, I have talked already about the business process.

***1.3 From the interviews it became clear that in B2C IoT there is a transition from the product to service orientation. Can then the company's IoT adoption maturity be measured in the way they are achieving the business model transition? If yes, should such (sub) dimension be added?***

No, but I would make service a part of the business process. And in business process I would also include something like extracting value. Because ultimately the business process supports the goal of the subject. Value extraction needs to support the goal of the subject. There are different goals defined by the subject that need to be understood and be in harmony with the business processes. Business processes support that value extraction.

***So, we can say that the maturity evolves as a degree to which the value is extracted from the use of IoT.***

Yes, exactly.

## **Interview with Expert 2**

***1. First of all, we need to review the first version of the model, and decide which dimension and sub-dimensions to keep.***

***1.1 This is the model with dimensions and sub-dimensions that were identified from the expert interviews and from the analysis of the adoption cases. Could you please give your opinion on it and mention if there are some (sub) dimensions that should be excluded or merged?***

First of all, dimension data. It is of course a very important dimension. The importance of IoT is that it generates data and increases value of the business operations with these insights. Data management, data Security and privacy are right. However, data analytics sub-dimension needs to be added. Because some companies figure out the way to collect the data, but do not have the ways to analyse it, find value, and understand what to do with it. Another point is where you get your input from. So, data collection should be added as a separate sub-dimension.

***Do you think data security and privacy should be included as separate sub-dimensions, or we can understand them together?***

Well, data security and privacy are different concepts, although they are very close. You can choose how to include them. All in all, for dimension data you would have four points: data collection, data management, data analytics, and data security and privacy.

Then, we have technology. Infrastructure for sure should be included. Standardisation also. Standardisation can also be a sub-part of infrastructure. The question is: Are we in our infrastructure making use of sufficient standardised components and does it help? Are we already standardised enough? Are we not using too much proprietary technology? A lot of companies have trouble installing IoT systems because they have a lot of proprietary technology, which is not according to the architecture of internet technology. Overall, I think the technology dimension is complete like this. Inclusion of infrastructure and standardisation sub-dimensions explains enough.

The third one is a business process. You could say that it is part of the organisation dimension. I think that organisation is for sure an important part. If I think about it, I think in terms of strategy, which would be the first sub-dimension, then the business process, and then decision-making. I would call it a decision-making process. You should maybe rename culture to change culture or culture of change. Some companies are indeed very flexible and adaptive, while for others adoption of new things is a painful experience even when they see the benefits of it. Then, you need things like training and stuff like that. I can understand what you mean by team, but I would instead call it IoT implementation team. A big part of success is related to the team, so you should indeed include it in the model.

Communication we can understand as interaction with several key external stakeholders. So, you could say external stakeholders interaction, or partner communication and when you say customers or clients it is more education sub-dimension I think. There are also external stakeholders, to whom you have to communicate that you are compliant with the security, privacy, or trustworthiness standards. Probably you can call them authorities, this can be a topic as well. So, you can include it in the partner communication sub-dimension.

**1.2 *The analysis of collected data showed that any IoT integration initiative in the company should have a solid business justification. That is, a business need should be identified, followed by the business use case definition, and finally BRP. How should this be reflected in the model? Is one "Business process" dimension sufficient, or there should be underlying sub-dimensions?***

I think that we covered this before. So, business process should be included under organisation dimension.

**1.3 *From the interviews it became clear that in B2C IoT there is a transition from the product to service orientation. Can then the company's IoT adoption maturity be measured in the way they are achieving the business model transition? If yes, should such (sub) dimension be added?***

Business model transition is a very valid question. It depends on the exact type of the company and their business strategy. In terms of digitalisation, the question whether to stay in products or also go into services is a fundamental question. Such transition has many requirements regarding the technology, infrastructure, or business proposition. You can include it either under technology or as a part of strategy. The questions here would be "Is the business of tomorrow not totally different from how we did business in the last 25 years?", "Do we need to change something?"

### **Supplementary Materials S4: Initial model**

<u>Dimensions</u> & Sub-dimensions	Source of dimension identification	Specific source of dimension identification
<u>DATA</u>		
Data Security & Privacy	Literature Analysis	Section 4.5
	Expert Views	Section 6.1, Section 6.2
	Case Studies Analysis	Section 5.1
Data Management	Literature Analysis	Section 4.2
	Expert Views	Section 6.1
	Case Studies Analysis	Section 5.2
<u>TECHNOLOGY</u>		
Infrastructure	Literature Analysis	Section 4.1
	Case Studies Analysis	Section 5.1, Section 5.2, Section 5.3
Standardisation	Case Studies Analysis	Section 5.1
<u>BUSINESS PROCESSES</u>	Expert Views	Section 6.2
	Case Studies Analysis	Section 5.1, Section 5.3
<u>ORGANISATION</u>		
Decision-making	Expert Views	Section 6.1, Section 6.2
Strategy	Literature Analysis	Section 4.6
	Expert Views	Section 6.1, Section 6.2
	Case Studies Analysis	Section 5.1
Culture	Literature Analysis	Section 4.3
	Expert views	Section 6.2
IoT Team	Case Studies Analysis	Section 5.1
<u>COMMUNICATION</u>		
Partners	Case Study Analysis	Section 5.1
Customers	Expert Views	Section 6.2
	Literature Analysis	Section 4.4