COLLABORATION FOR INNOVATION

DESIGNING AN ICT PLATFORM FOR MATCHMAKING OF COMPANIES IN THE FIELD OF INTERNET OF THINGS

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Executive summary

Internet of Things (IoT), a network of smart, communicating objects, is expected to grow exponentially in the coming years. The number of devices connected to the internet already exceeded the number of people on earth in the year 2008. Some suggest that by 2020, there will be around 50 billion connected devices. It is expected that IoT will have a large impact on technological innovations in firms, and that such firms will either be enabled or forced to look beyond their current business models. Because of the multidisciplinary nature of IoT, it is believed that inter-firm collaboration is critical in the innovation process.

In innovation, small and medium-sized enterprises (SMEs) play a significant role. However, there is still little knowledge about how small and medium-sized enterprises innovate, and how innovation can be stimulated. Guiding the process of ecosystem creation is expected to have a positive effect on IoT innovation. This research aims to design a profitable and scalable service that guides SMEs in the process of ecosystem creation. Therefore, the main research question is posed as follows: *What are the requirements for a matchmaking platform that enables the development and growth of an ecosystem of (SME) companies that develop IoT solutions?* To clarify functionalities of the platform, a visual representation (mockup) of the key features will be made.

This project results from the cooperation of two Dutch firms: *Inpaqt*, a Delft based IT company specialized in offering customized solutions and tooling in the area of innovation management, and *Castermans Connected,* an IoT consultancy company based in Leiden. Although the design process should generate generalizable results, this thesis focuses specifically on stimulating IoT innovations in the (health)care domain in the Netherlands. The choice for this specific domain arises from the access to contacts in Dutch care-related firms.

The practical nature of this research requires an approach that draws from literature, but also acknowledges the importance of input from practice. The design process requires in-depth insight in a relatively small user group. These factors result in a predominantly qualitative approach, which we find in the Action Design Research method. The approach that is taken during this research consists of five phases. Phase one provides a deeper theoretical insight in the problem that this research aims to solve. This is done by examining literature on IoT business models, partnerships, business ecosystems and governance mechanisms. The findings in this phase are structured using the four business model domains (service, technology, organization, finance). Phase two aims at understanding multi-sided platforms (MSPs). Here we use MSP literature to analyze three existing B2B matchmaking platforms. In the third phase, we describe an initial, or 'first hunch', design of the platform in accordance with Verschuren & Hartog (2005). The platform is described by its goal [G], and a set of assumptions [A] and requirements [R]. Using interviews with several potential users of the platform, phase four aims to complement the initial requirements by composing a list of requirements from practice [Ri]. In the fifth and final stage of the design process, we reevaluate the initial goal, assumptions and requirements. This leads to a reformulated goal [G_2] and a set of updated assumptions [A_2] and requirements [R_2]. On the basis of these updated properties, we propose a business model for the platform. Finally, we describe the key functionalities of the platform and further illustrate them using screenshots of a mockup.

The results of this thesis can be divided into three parts. Firstly, by examining literature on partnerships, ecosystems, governance mechanisms and IoT business models, we are able to propose an IoT matchmaking requirement framework (Figure 17). This framework groups our findings from literature in seven requirement categories: Complementarity, Trust, Compatibility, Communication, Agreements, Commitment and IoT Business models. We argue that requirements related to finding a suitable business partner can be placed in one of these categories. Secondly, we establish a set of design principles (Table 11) for B2B matchmaking platforms in the second phase of this thesis. These principles are partly based on existing multi-sided platform literature. The other principles are based on an analysis of existing B2B matchmaking platforms.

Thirdly, we propose the tentative design of a specific IT artifact, a B2B matchmaking platform for firms in the IoT domain. During the interview phase we come to the conclusion that only three of the seven initial requirement categories (IoT business models, complementarity and communication) are perceived as pressing problems. Other requirement categories are perceived as important, but they are not directly perceived as problem areas. Furthermore, the awareness phase is deemed much more important than our initial estimation. This is mainly since users already face difficulties in estimating the implications of IoT on their firms. These difficulties already play a role before the explicit need for partnerships arises. Based on these findings, we describe the artifact using its primary goal [G_2]: *Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition*. This goal can be divided into four parts: Inform and inspire, situation analysis, demand articulation and matchmaking. Associated with this goal, we present a list of assumptions [A_2] (Table 17) and requirements [R_2] (Table 18).

Furthermore, we propose a business model for the platform. The four parts of the value proposition correspond to the four elements of the platform's goal. For simplicity reasons, the platform's focus is on two user groups. The two distinct user groups of the platform can best be described by a supply and a demand side. The supply side consists of firms of any size that are active in the field of IoT and/or healthcare. An addition to the supply side are firms that provide relevant, but more general services (complementors), such as legal advice and innovation management. The demand side consists of firms that aim to enter the domain of IoT, whether as incumbent or as startup. The platform's demand side will focus mainly on SMEs, since interviews pointed out that this target group is most in need of guidance in the IoT domain. To further clarify the functionality behind the four value proposition parts, we discuss the key features of the platform, accompanied by screenshots of a mockup.

One of the main purposes of evaluation in design research is to assess whether the artifact contributes to the desired goal. Due to limitations in this research project, we are not able to fully complete the design cycle. Therefore, the evaluation of the proposed artifact done in a reflective manner. We recommend that the design process is continued in an iterative fashion, with a primary focus on the *situation analysis* part of the value proposition.

1. Introduction

1.1 Internet of Things

Equipping everyday objects like consumer electronics, machines and vehicles with sensors is not necessarily a new phenomenon. However, when (wireless) connectivity is provided to these 'smart' objects, they can become part of the Internet of Things (IoT), a network of smart and communicating objects. IoT is expected to grow exponentially in the coming years. The number of devices connected to the internet already exceeded the number of people on earth in the year 2008. By 2020, it is expected that there will be around 50 billion connected devices (Cisco, 2015).

The rise of IoT has blurred the line between the physical world and computer-based systems. IoT enables objects to communicate with each other without the need for human interaction. The interconnectivity between physical and virtual objects opens doors for advanced services based on existing and evolving information and communication technologies (ICT) (Kurakova, 2013).

Castermans et al (2014) identify four technological developments as contributors to the growth of IoT. First of all, increasingly powerful and miniaturized hardware and broadband communication have led to countless new possibilities in product design. As a result, important functions of various industrial-age products have been digitized and aggregated in portable devices (Yoo 2010). Secondly, wireless connectivity is getting increasingly powerful and energy efficient, while the cost of data transfer decreases. The third contributor to the growth of IoT is the availability of an ever increasing amount of processing power and data storage. Cloud services make these services available to the public with very low initial capital requirements. Finally, worldwide consumer adoption of smartphones increases the potential market of many IoT applications. Smartphones often serve as remote control and intermediary for data transfer towards and from the internet.

Numerous companies already have seen opportunities in embedding physical objects with electronics, sensors, software and network connectivity. Collected information from sensors enables developers to determine the context of users or objects. This data can be utilized in applications that are 'context aware', adapting their services automatically to the context (Hegering et al., 2004). Next to the creation of a myriad of new products, the rise of IoT is a promising development for companies that are willing and able to develop completely new business models (Leminen et al, 2012).

When developing a new business model in the IoT domain, traditional business model approaches may fall short, partly since they are often focused on a single firm. The unique properties of the domain result in several challenges. To further clarify these challenges, we continue with explaining the concept of business models. Next, literature on business model innovation is discussed. Furthermore, we introduce the concepts value network and business ecosystem. After indicating the gap in literature, the context, objective and strategy of this thesis are set out.

1.2 Business models and innovation

The concept *business model* has many definitions. Its importance has been stressed by various scholars. Chesbrough (2010) sees a business model as the way to commercialize a technology, since a technology, product or service has limited value when it has not yet been commercialized. A business model can often be seen as a way to capture a firm's strategic choices. It consists of four domains: service, technology, organization and finance (Bouwman, De Vos & Haaker, 2008). Often, firms apply business models which are familiar to them. However, in some cases it is necessary for firms to look further than these familiar models, improving their business models to best capture the possible value (Chesbrough, 2010). When looking at the domain of IoT, firms designing applications for the Internet of Things may struggle to develop and market their product, if they continue to rely on their current practices and business models. We thus argue that the IoT domain is especially suitable for the creation of new business models.

According to Amit & Zott (2012), companies have often improved only processes and products in order to achieve revenue growth and sustainable profit margins. Because of significant upfront investments and uncertain future returns that accompany these improvements, the risk of such an approach is often substantial. As substitute or addition to product and process innovation, companies can move towards business model innovation (BMI). For this research, the definition of BMI is chosen identical to the definition in the ENVISION literature: “BMI is defined as changes in business logic that are new to the focal firm, yet not necessarily new to the world, and have to result in observable changes in the practices of a business model” (Pucihar et al., 2015, p. 6). For firms, it is often perceived as of vital importance to innovate business models. However, since organizational processes often need to change, innovation is far from easy to achieve. When incumbent business models experience degrading effectiveness, business model experimentation is proposed as the way to innovation (Chesbrough, 2010).

1.3 Value networks and ecosystems

In the context of this research, a value network describes the roles and interactions between different organizations, which can cross the boundaries of individual industries. When looking at a firm’s business model, these interactions are described in the organizational domain. Examples of companies within such a network are manufacturers, suppliers, investors, strategic business partners and customers. Firms in a value network convert their tangible and intangible assets into a more negotiable form of value (Allee, 2008). They exchange information, products, services and financial assets, which results in a strategical, functional and financial interdependence (Bouwman, De Vos & Haaker, 2008).

Literature also speaks of business ecosystems and their importance to innovation and the growth of IoT (Moore, 1996; Mazhelis et al, 2013; Leminen et al, 2012). As is the case with value networks, the concept business ecosystem is used to describe an economic community. An ecosystem however, extends beyond a single value network, since it also involves competitors and various stakeholders, such as government agencies. The diffusion of IoT technologies is generally expected to be widespread. As a result, IoT ecosystems are expected to materialize (Mazhelis et al, 2013). Some even argue that cooperation between companies is critical to the growth of IoT, because of its multidisciplinary nature and nonlinear value chain (Leminen et al, 2012).

Literature also stresses the importance of governance in networks. The complexity of interdependencies in such a community results in a multitude of formal and informal agreements. Thus, the collaboration requires sufficient governance (Bouwman, De Vos & Haaker, 2008). De Reuver (2009) identifies three dimensions of governance mechanisms. Relations in networks can be governed based on authority, trust or contractually. According to De Reuver, Bouwman & Haaker (2009), the performance of a network is significantly impacted by addressing issues like governance, entrance rules and partner selection.

1.4 The gap

Thus far, we are aware of the global development of IoT, and the large potential involved with this development. It is expected that IoT will have a large impact on technological innovations in firms, and that such firms will be either enabled or forced to look beyond their current business models. Because of the multidisciplinary nature of IoT, it is believed that inter-firm collaboration is critical in the innovation process. This will result in the formation of business ecosystems. The performance of such an ecosystem is influenced by factors such as governance, partner selection and entrance rules.

In innovation, small and medium-sized enterprises (SMEs) play a significant role. However, there is still little knowledge about how small and medium-sized enterprises innovate, and how this innovation can be stimulated. This despite the evident importance of innovation (Pucihar et al., 2015). Since the formation of ecosystems is said to be of great importance for innovation in the area of IoT, guiding the process of ecosystem creation is expected to have a positive effect on IoT innovation.

The focus of this research is on identifying requirements for a profitable and scalable service that guides SMEs in the process of ecosystem creation. These requirements will serve as input for a conceptual design of an ICT platform for matchmaking of companies in the field of IoT. In terms of the business model domains of Bouwman, De Vos & Haaker (2008), the platform can be placed within the technology domain. The platform is the architecture that provides the delivery of a (matchmaking) service. The organization domain contains the ecosystem that is created by the platform.

1.5 Domain

This design project results from the cooperation of two Dutch firms. *Inpaqt*, a Delft based IT company, is specialized in offering customized solutions and tooling in the area of innovation management. They have clients and partners in various sectors, like finance, manufacturing, healthcare, government, telecom, energy and knowledge institutes. *Castermans Connected* is a consultancy company based in Leiden. The firm's services revolve around their specialization in product, service and business model innovation in the domain of Internet of Things. Castermans targets both SMEs and larger corporations in the manufacturing and service domains.

By combining the IT capabilities of Inpaqt with the IoT domain knowledge of Castermans Connected, the two companies aim to create a scalable matchmaking solution in the form of an online platform. Although the design process should generate generalizable results, this thesis focuses specifically on stimulating IoT innovations in the (health)care domain in the Netherlands. The choice for this specific domain arises from two factors. Firstly, both Inpaqt and Castermans Connected have experience in the domain, and access to contacts in Dutch care-related firms. Secondly, IoT has risen in priority on the Dutch healthcare agenda. Because of the ageing population, the need for innovative (health)care solutions increases. These solutions should increase cost efficiency, but also improve the quality of life of elderly people (Solaimani, 2014). Mazhelis et al (2013) even describe the healthcare sector as one of the most promising sectors for IoT.

1.6 Research objective

Internet of Things is seen as one of the most influential innovation trends of the years to come**.** In this innovation, small and medium-sized enterprises are expected to play a significant role. Because of the multidisciplinary nature of IoT, and the perception of importance of time to market in a rapidly changing environment, firms often have to rely on cooperation with partners to develop new IoT products and services (Leminen et al, 2012).

To stimulate the creation of business ecosystems in the IoT domain, and thus to aid the innovation process, this research aims to conceptually design a scalable matchmaking solution. The solution will be in the form of an online platform for SMEs. The research aims to formulate functional requirements for such a platform, and includes the development of a business model behind the matchmaking platform. To clarify the value proposition and functionalities of the platform, a visual representation of the key features will be made. These will be further referred to as a *mockup*. We argue that the problem that this research addresses is merely an instance in a class of problems, as shown in Figure 1.

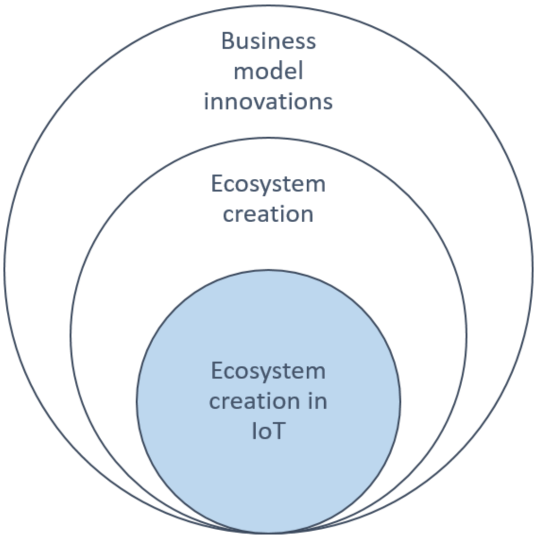


Figure 1: Scope of the research (problem as instance in class of problems)

To summarize, the objective of this research can be formulated as follows: Formulate functional requirements for, and design the business model of an online company matchmaking platform in order to facilitate ecosystem creation in the IoT domain. This objective leads to the main research question.

What are the requirements for a matchmaking platform that enables the development and growth of an ecosystem of (SME) companies that develop IoT solutions?

To limit the scope of this study, we define development and growth of an ecosystem as the formation of one or more collaborative partnerships between firms, which contributes to an economic community of interacting organizations. Since the concept *requirement* can be perceived in different ways, we first explicate the use of the concept within this thesis. Based on Verschuren & Hartog (2005), we treat a requirement as *a necessary condition of the artifact in order to achieve the desired goal*. Since the objective of this research has two separate aspects, we distinguish *functional requirements* from *business model requirements*. Functional requirements describe the functions or tasks that the artifact (platform) needs to fulfill in order to achieve its goal. These requirements are listed explicitly during the design process. Business model requirements are necessary properties of the platform that are specifically related to its business model. These requirements are not listed explicitly during the design process, but incorporated in a proposed business model. Non-functional requirements are not explicitly treated in this thesis. They specify the quality characteristics of the system (e.g. privacy, security, scalability etc.), and are deemed of such importance, that at this point they assumed to be fulfilled.

In order to answer the main research question, the following **sub questions** are posed. These questions will serve as guidelines for the research, working towards a final design.

1. *What requirement categories for matchmaking in the IoT domain can be derived from literature?*
2. *What design principles can be derived from multi-sided platform literature and analyzing existing matchmaking platforms?*
3. *What (first hunch) platform requirements can be derived from previous analyses?*
4. *What additional platform requirements can be derived from practices and problems as experienced by IoT-related firms in the healthcare domain?*
5. *What are the key functionalities and characteristics of an online B2B matchmaking platform, and how do these relate to its requirements?*

The first sub question aims to provide a deeper insight in the problem that this research aims to solve. By consulting literature, we are able to identify the main issues that collaborating firms in the IoT domain face. Partnership literature provides insights in how two firms collaborate in the classic sense. It describes cooperation forms such as strategic partnerships and buyer-supplier relationships. Ecosystem literature expands the view of collaboration to a network of multiple, interdependent firms. Governance literature looks at phenomena such as inter-firm agreements and input control. Literature on IoT dives deeper in the characteristics of this relatively new phenomenon. From this literature, we aim to generate requirement categories for the process of matchmaking in IoT.

The second sub question aims to discover generalizable design principles for multi-sided platforms from literature and practice. These design principles, combined with the requirement categories from the first sub question, result in a first hunch design. The requirements related to this first hunch design are related to sub question three.

Sub question four aims to generate empirical insight, by testing the theoretical requirements for matchmaking in IoT against practice. In addition, it should result in an understanding of other relevant problems in the IoT-healthcare sector. The last question demarcates the design process of the final product. This includes the visual representation (mockup) of its key features, and an indication of the platform's business model. The following sections deal with the applied methodologies and the proposed strategy to answer the questions above.

1.7 Methodologies

The practical nature of this research requires an approach that draws from literature, but also acknowledges the importance of input from practice. The design process requires in-depth insight in a relatively small user group. These factors result in a predominantly qualitative approach. Before we discuss the proposed research strategy, we first discuss the most important methodologies that we make use of during this research.

During the design process of the artifact (platform), we base our work on the design methodology of Verschuren & Hartog (2005). This methodology distinguishes six stages in the design process, including evaluation schemes for structured execution of these phases. Verschuren & Hartog (2005) advocate the explicit use of requirements during the design process, which can be seen in the manner in which our research questions are formulated. To complement the first methodology, we also draw from Action Design Research (ADR) literature (Sein et al, 2011). This method goes beyond traditional design science by recognizing the importance of organizational context. ADR explicitly takes into account opinions from a variety of stakeholders.

One of the principles of ADR emphasizes the importance of literature as the basis of a design. In order to structure findings from literature, we make use of the clearly structured STOF business model ontology (Bouwman, De Vos & Haaker, 2008). In the final phase of the design process, we use the business model Canvas methodology. This methodology provides support in the design of the platform's business model. In the following sections, we further clarify each of the methodologies mentioned above.

1.7.1 Evaluation in design-oriented research

During the design process, the design methodology of Verschuren & Hartog (2005) is used. This method distinguishes six stages in a design process: *First hunch, Requirements and assumptions, Structural specifications, Prototype, Implementations* and finally *Evaluation*. These six stages can roughly be clustered in three well known groups, as seen in Figure 2.

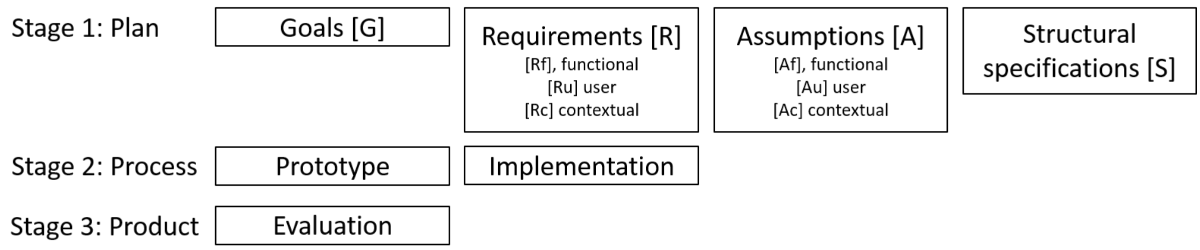


Figure 2: Evaluation stages (Verschuren & Hartog, 2005)

The design process is depicted as a linear process; however, in practice it should be highly iterative. Each of the three stages is evaluated separately.

The *plan* stage emphasizes the importance of clarifying requirements and assumptions in advance. These requirements and assumptions know three dimensions: functional, contextual and user-related. This stage is evaluated by assessing the quality of the design on paper. The set of requirements, assumptions and specifications are the means to achieve the goals. Evaluation consists of assessing the acceptability of the goal, the means and the relationship between the goal and the means. In this thesis, emphasis will lie on the elements in the plan stage.

The process stage deals with the materialization of the artifact into a prototype. Specifications defined in the plan phase should be preserved in this prototype. Evaluating this stage has a focus on the activities in the process of developing a prototype. These activities should be constructive towards realizing the goals. For our research, the attention to this phase is limited, due to time restrictions. The prototype will be replaced by visual representations (mockup) of the platform's key features, for communication and evaluation purpose.

The product stage checks whether the design goals are satisfied by the effects of using the prototype. Since the deliverable of this research is a mockup, the effects of using the prototype will be extremely limited. This will evidently lead to limitations in this stage.

1.7.2 Action design research (ADR)

The design process of this artifact will be guided on the basis of design science literature. In order to complement the rather generic method by Verschuren & Hartog (2005), we turn to Action Design Research (ADR) by Sein et al (2011). This method goes beyond traditional design science by recognizing the importance of organizational context. ADR explicitly takes into account opinions from a variety of stakeholders. It proposes a new Design Research (DR) method by taking elements from Action Research (AR), thus aiming to link theory with practice.

The ADR method is specifically used to design IT artifacts in an organizational environment. The method is aimed to build, intervene and evaluate in a specific problem situation. Four stages are distinguished in ADR. However, these stages are tackled in a more iterative way than traditional stage-gate models would. The method draws on a total of seven principles, which will be discussed in the appropriate stages. An overview of the ADR stages and principles can be seen in Figure 3.

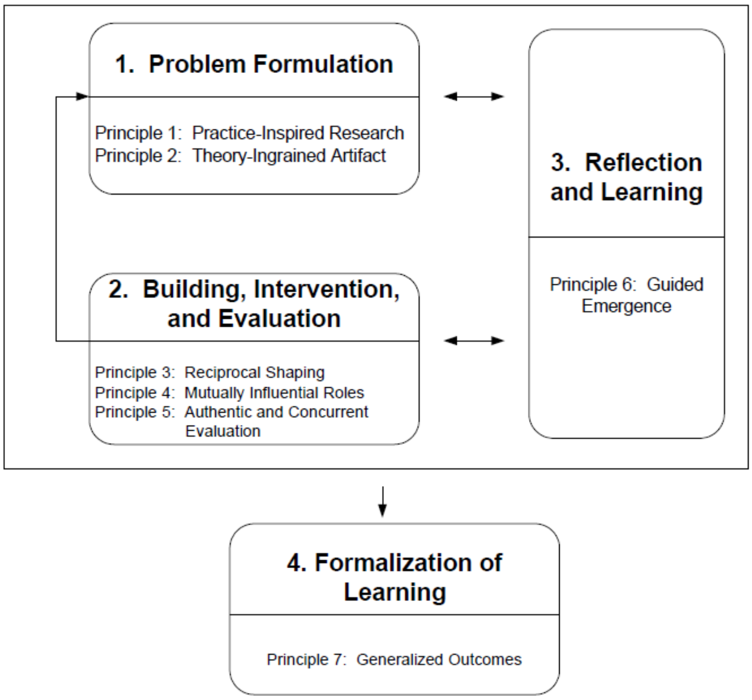


Figure 3: ADR method - Stages and principles (Sein et al, 2011)

In ADR stage one, the perceived problem is formulated. The input for this formulation comes from practitioners, combined with the first phase of this research. In this problem formulation stage, the roles of stakeholders in the design process are decided. The perceived problem also needs to be positioned as an instance of a class of problems in order to determine the scientific relevance of the research. This stage comprises two principles. The first principle is *Practice-Inspired Research*, which emphasizes practical problems as opportunities for knowledge creation. The researcher should thus aim to generate knowledge to solve the class of problems of which this instance is merely an example.

The second principle in this stage is *Theory-Ingrained Artifact*. This emphasizes that the artifact that is created by using ADR is both created and evaluated by means of theory.

The second stage in ADR is *Building, Intervention and Evaluation* (BIE). The problem description from stage one provides input for the initial design of the IT artifact. The artifact is then developed through a set of design cycles. ADR distinguishes an IT-dominant BIE from an organization-dominant BIE. Since the focus of this research is on organizational intervention, the organizational-dominant BIE cycle will be used. Figure 4 presents a graphical interpretation of the organization-dominant BIE.

For this specific research assignment, a note has to be made. As described in the research objective, one of the deliverables for this thesis is a visual representation (mockup) of the platform's key functionalities. The mockup has no functionality, which significantly impacts the organizational intervention capacity of the ADR method. Nevertheless, the mockup will be iteratively developed according to the BIE process as seen in Figure 4, albeit in an adapted manner.

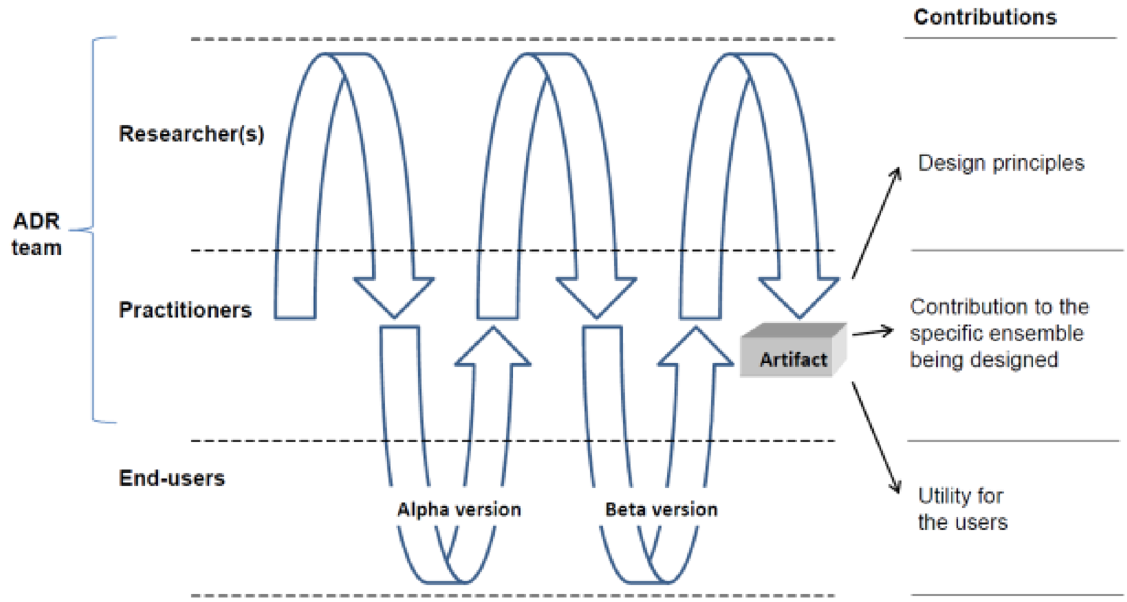


Figure 4: Generic schema for organization-dominant BIE (Sein et al, 2011)

In the design process, several stakeholders need to be involved. In this case, the practitioners are employees from the companies Inpaqt and Castermans Connected, combined with possible partners that will be involved. The end-users that the BIE cycle describes will be employees in a multitude of companies. Stakeholders will be involved by means of regular discussions, while end-users will be interviewed.

This second ADR stage rests on three principles. Firstly, Sein et al (2011) mention *Reciprocal Shaping*. This stresses the importance of the mutual influences of the IT artifact and the organizational context. Secondly, the importance of mutual learning is pointed out. This is described as *Mutually Influential Roles*. The practical knowledge from practitioners is complemented by the theoretical knowledge of action design researchers, and vice versa. The third and final principle in this stage is *Authentic and Concurrent Evaluation*. The key message of this principle is that evaluation should be considered a continuous process, in contrast to stage-gate models which treat evaluation as a separate stage following the building process. The importance of evaluation in the design process justifies the choice for the use of the method of Verschuren & Hartog (2005).

ADR stage three is *Reflection and Learning*. This stage is continuously present in parallel with the first two stages. It aims at generating knowledge that can be applied to a broader class of problems than merely this single case. A single principle is dominant in this stage: *Guided Emergence*. This attempts to merge the seemingly contradicting terms *design* and *emergence*. ADR aims at creating an ensemble artifact that reflects not only the initial design, but also the continuous input of stakeholder perspectives.

The last stage in the ADR process is stage 4: *Formalization of Learning*. In this stage, knowledge gained in the previous stages should be aggregated into general concepts for a field of similar problems. The last principle, *Generalized Outcomes*, explains that the result of ADR is (the implementation of) an IT artifact combined with organizational changes. Together, these are the solution to a problem. Although the situated nature of ADR is a challenge to generalize, both the solution and the problem can be generalized. Finally, from the research outcomes we can derive design principles.

1.7.3 STOF method

In the first phase of this thesis, we discuss literature on subjects relevant to the design of a matchmaking platform. In order to clarify the impact of this literature on the thesis, we aim to structure the findings using an existing business model ontology. For this purpose, the STOF method is used (Bouwman, De Vos & Haaker, 2008). This method proposes that a business model consists of four domains: Service, Technology, Organization and Finance.

The *service* domain places the value of a service centrally. The value proposition and the intended customer are assessed. The detail that this method delivers is partly in distinguishing intended value, delivered value, expected value and perceived value. In addition, STOF places a service in a multi-actor setting, which is more appropriate for firms that operate in a business ecosystem. Appendix II shows the descriptive model of the service domain.

The *technology* domain describes the required technical architecture behind a firm’s service. For information systems, this architecture includes aspects such as applications, devices, access networks and backbone infrastructure. Generally, this domain treats the technical aspects of a business model.

Issues in the *organization* domain revolve around resources that the company has to make available in order to provide the service. An assumption is made that a company requires partners in order to acquire all necessary resources. The business model thus becomes part of a value system, similar to a value network. Three types of partners are distinguished in such a value network: structural, contributing and supporting partners. Appendix II shows the descriptive model of the organization domain.

The finance domain houses one of the most important types of resources that a value network needs to acquire: financial resources. These correspond with the revenue streams and cost structure in the Canvas model. The two main issues regarding financial arrangements are revenue models and investment decisions. The STOF method dives deeper in the following topics: costs, revenues, risks and pricing. Appendix II shows the descriptive model of the finance domain.

1.7.4 Business model Canvas

During this thesis, we not only design an IT artifact (matchmaking platform), but also propose a corresponding business model. For the design of the platform's business model, we make use of the well-known business model Canvas (Osterwalder & Pigneur, 2010). The business model Canvas enables businesses to quickly design or map a business model by means of nine building blocks. Appendix I shows the Canvas as proposed by Osterwalder & Pigneur. The method is chosen since it is well known and easy to use for brainstorming and communication purposes. Each of the 9 building blocks of the Canvas is shortly discussed below.

Customer segments: The Canvas method begins with assessing the customer segments. For a single service or product, multiple segments can exist, each with its own characteristics. Each segment should explicitly be mapped.

Value proposition: The value that the service or product offers should be described here. It should correspond with a problem that the customer experiences, which the firm aims to solve.

Channels: The channels block analyzes the methods of reaching the customer segments. Examples are the company website, brick and mortar stores or partners.

Customer relationships: The way information is transferred to and from customers can differ per customer segment. This can be online only, but some customer segments possibly require a more personal connection like phone or face to face contact.

Revenue streams: Since the business' service or product needs to be monetized, it is important to describe in what way this will occur. Users can pay a one-time fee for purchasing a product, but often alternative revenue streams can be wielded. Examples are subscription models, licensing and revenue through advertising.

Key resources: These are the assets needed for the business to function properly. These resources can be physical, like equipment, but also intellectual and human, like skills and knowledge. When a firm doesn't have access to these resources, they might be provided by partners.

Key activities: Here, the most important activities of the company are described. Examples are production, marketing, sales etc.

Key partners: As mentioned in the key resources section, partners can provide essential resources to a business. Key partners can be suppliers, but also members of an alliance or joint venture. In this way, partners can also be used to share risks and costs.

Cost structure: Next to the revenue streams, the Canvas also enables a company to create insight in the costs of starting and running a business. In starting a business, investments are involved. A running business often has to deal with both fixed and variable costs.

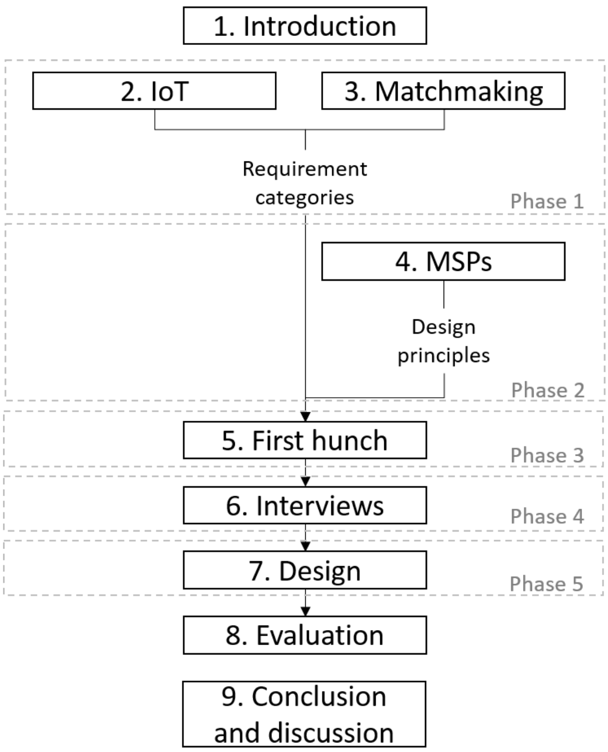
The business model Canvas is further discussed and applied in section 7.3. In the following section, we discuss how the above methodologies fit into the overall research strategy.

1.8 Research strategy

The previous section indicated the methodologies which are used throughout this thesis. This section clarifies the structure of this project. For consistency reasons, we adhere to the structure of the sub questions of this thesis. Each of the five sub questions represents one of the five design stages.

Phase one provides a deeper theoretical insight in the problem that this research aims to solve. The result of this phase is a framework of requirement categories in the partnership formation process. Phase two aims at understanding multi-sided platforms (MSPs). In this phase, we compose a MSP analysis framework on the basis of literature. Next, this framework is used to analyze three existing B2B matchmaking platforms. From this analysis, we derive a set of design principles for matchmaking platforms. In the third phase, we describe an initial, or 'first hunch', design of the platform. In accordance with Verschuren & Hartog (2005), the first hunch design is described by its goal [G], and a set of assumptions [A] and requirements [R]. With the first hunch design in mind, we enter a round of interviews in phase four. During interviews with several potential users of the platform, we aim to complement the initial requirements by composing a list of requirements from practice [R_i]. In the fifth and final stage of the design process, we reevaluate the initial goal, assumptions and requirements. This leads to a reformulated goal [G_2] and a set of updated assumptions [A_2] and requirements [R_2]. On the basis of these updated properties, we propose a business model for the platform. Next, we describe the key functionalities of the platform and further illustrate them using screenshots of a mockup.

Figure 5 indicates the relations between the phases by displaying the structure of the report. It also indicates the methods that are used in each phase of the research. Below, we discuss each phase in further detail.



	Phase description	Method
1	Understanding IoT business models and B2B matchmaking	Literature on IoT business models Literature on partnerships, ecosystems and governance
2	Understanding multi-sided platforms	Literature on (multi-sided) platforms Analysis of current B2B matchmaking platforms
3	First hunch design	Action design research (ADR) Evaluation in design research
4	Requirements from practice	Interviews with IoT and healthcare related companies
5	Platform design: functionalities, requirements and business model	Action design research (ADR) Evaluation in design research Business Model Canvas

Figure 5: Structure of the report, including description and methods per phase

1.8.1 Phase 1: Understanding IoT business models and B2B matchmaking

The first phase of this research aims to build theoretical insight in the problem that this research aims to solve. Chapter 2 takes a closer look at internet of things. Current literature provides a better understanding of different views on the phenomenon. On the basis of the STOF business model ontology, this phase discusses characteristics of IoT applications. We start by treating the service-related aspects of IoT. Subsequently, we discuss technologies that are related to IoT. Then, we take a closer look at the organizational aspects of IoT, by discussing ecosystems. Finally, the financial aspects of IoT business models are discussed in the form of value creation and value capture. Subsequently, chapter 3 discusses matchmaking. We start by treating literature on partnerships, which describes the relations between two firms. It identifies drivers for partnerships, but also explains the process of partnership formation. Next, we look at a multi-partner context by discussing business ecosystems. Finally, we briefly discuss governance mechanisms in networks of companies. We conclude the first phase by presenting a framework of requirement categories for matchmaking in the IoT domain. By making use of concepts from literature, we identify seven requirement areas that span the phases of partnership formation. In phase three, this framework is used to prioritize requirement areas for the platform design process.

1.8.2 Phase 2: Understanding Multi-sided platforms

Phase two aims at understanding multi-sided platforms (MSPs). Chapter 4 starts by discussing literature on multi-sided platforms (MSPs). We distinguish technical and economic views on platforms and look at strategic choices and obstacles for MSPs. Based on concepts from literature, we propose a framework for analyzing existing MSPs. Subsequently, we analyze existing matchmaking platforms. Using the MSP analysis framework, we describe characteristics of three B2B matchmaking platforms: Alibaba.com, Powerlinx and Enterprise Europe Network. This is done on the basis of information available on the respective websites. From the analysis, conclusions are drawn on how these current platforms try to overcome MSP-related obstacles. These conclusions lead to a set of design principles for B2B matchmaking platforms. Together with the requirement areas framework of phase one, the design principles are used to create a first hunch design in phase three.

1.8.3 Phase 3: First hunch design

In the third phase, we describe an initial, or ‘first hunch’, design of the platform. In accordance with Verschuren & Hartog (2005), Chapter 5 describes the first hunch design by explicating its goal [G], and a set of assumptions [A] and requirements [R]. We derive these by combining the findings from phases one and two with input from practitioners. To be consistent, we use the MSP analysis framework to describe the characteristics of the platform, which receives the working title ‘IoT-Match’.

1.8.4 Phase 4: Interviews: requirements from practice

To gain a detailed understanding of the practices and problems among the platform’s potential user groups, chapter 6 examines five Dutch care-related cases in the IoT domain (Handicare Stairlifts, Faber Electronics, Aspider M2M, Giant Leap Technologies and Innospense). Information is gathered through semi-structured interviews with potential users. These interviews are directed towards specific predetermined topics, while leaving room for further exploration in terms of additional areas of concern. To create a manageable variety, the research is limited to five companies. The companies are chosen on the basis of four main criteria. Firstly, in accordance with the research objective, the companies should provide an IoT related product or service. Also, the firms should have experience in the (health)care sector. Thirdly, the companies should represent different roles in their ecosystem.

Lastly, the total set of companies should represent all of the platform's generic user groups. During the interviews, the following six topics are addressed:

- Composition, type of collaboration and challenges in the current ecosystem
- View on IoT and challenges
- View on healthcare and challenges
- Current approach to partnership creation
- Current use of matchmaking services and substitutes
- Specific requirements for matchmaking platform

On the basis of the interviews, we derive a list of requirements from practice [R_i]. This list is used to complement the initial requirement list. The process of creating the updated requirement list is treated in phase five.

1.8.5 Phase 5: Platform design

In the fifth and final stage of the design process, we reevaluate the initial goal, assumptions and requirements. Chapter 7 first discusses the platform's updated goal [G_2] and assumptions [A_2]. Subsequently, the updated requirement list [R_2] is derived by selecting requirements from the first hunch [R] requirements list and those derived from interviews [R_i]. On the basis of these updated properties, we propose a business model for the platform. To do this, we make use of the well-known business model Canvas (Osterwalder & Pigneur, 2010). This method distinguishes a total of nine business model elements. The Canvas is used because it is widely known in the business world. It enables easy brainstorming and communication due to its visual nature. To further clarify the functionality behind the platform's business model, we end the fifth phase with a description of the platform's key features. These features are further elaborated on with the aid of screenshots of the mockup.

1.8.6 Discussion

This chapter explained the methods that will lead to the design of a company matchmaking platform for IoT and healthcare related companies. Given the practical nature of the assignment, theory is combined with input from practice. Literature provides a reference point for the design. Since this research leads to the creation of a business model, validation from potential users is essential. The design methods used are iterative in nature and facilitate this customer validation.

Reliance on customer feedback also poses a risk for the research. This risk is managed in two ways. By consulting literature, general insights can be derived without immediate need for contact with users. Secondly, there is a certain redundancy in the available network. Potential users, needed for feedback during the design process, can be reached in multiple ways. Both Inpaqt and Castermans Connected are committed and have their professional network to draw from. If these prove to be less than sufficient to find suitable candidates, personal networks can be consulted. Finally, cold calling potential candidates can be used as last remedy.

2. Internet of Things

Together with chapter 3, this chapter aims to answer the first sub-question: What requirement categories for matchmaking in the IoT domain can be derived from literature? In order to create a better insight in the IoT domain, we take the following approach. We start with a more comprehensive introduction in IoT, including the definition we adhere to in this thesis, and several examples of current applications. Subsequently, we introduce an organizing principle for analyzing the IoT domain. We pose that characteristics of IoT can be mapped on an existing business model ontology (STOF). Thus, to structure characteristics of IoT, we discuss the Service related, Technological, Organizational and Financial aspects of the IoT domain. We present a summary of IoT related requirement categories, and the main findings related to each of them. In Chapter 3, these requirement categories are incorporated in an IoT matchmaking requirements framework. We end this chapter by taking a closer look at IoT in healthcare, in preparation of the interviews in Chapter 6. We discuss healthcare-specific applications, trends, opportunities and challenges.

Literature in this chapter is obtained mostly through web search. Scopus, Google Scholar, TU Delft library, ScienceDirect and the Google search engine led to the majority of the covered literature. Key words included: *IoT, Internet of Things, technology, ecosystem(s), business model(s), value creation and requirements.* The comprehensive work of Mazhelis et al (2013) provided a large part of the structure during the search process, including various valuable sources.

2.1 What is the Internet of things?

The concept Internet of Things is difficult to grasp in a single definition. In literature (Atzori et al, 2010; Mazhelis et al, 2013), IoT definitions can be divided into three, partly overlapping visions. The first vision is focused on physical *things*, including their functionality and identity. It revolves around devices with embedded electronics and connectivity, which have a unique identity. Research that adheres to this vision discusses matters such as NFC (near field communication), RFID (Radio-frequency identification) and wireless sensors and actuators. The second vision relates to the *Internet* aspects of IoT. In this vision, the compatibility with the current Internet infrastructure plays an important role. This includes the IP protocol and other standards. In short, the vision revolves around communication capabilities between virtual and physical objects. The third vision is *semantics* oriented. The focus in this vision is on information generated by the IoT. This includes data storage and representation, but also semantic technology, which attempts to ‘understand’ data and transforms it into information and knowledge. This thesis adheres mostly to the things oriented vision.

Looking at various definitions and descriptions (“What is the Internet of Things (IoT) - Techopedia.com,” 2016; “Internet of Things - Wikipedia,” 2016), this thesis describes IoT as follows: **IoT is a concept used to describe a situation where, on a large scale, various physical ‘things’, objects or devices are embedded with electronics, software, sensors, actuators and connectivity.** The object can then exchange data and influence its environment. Such an object with embedded electronics and connectivity will be further referred to as “smart” object. Each smart object can identify itself toward other devices. The following paragraph provides an overview of some of the markets in which IoT is applied. A summary of these can be found in Table 2.

2.1.1 Markets

Within the Internet of Things, a myriad of devices can be fitted with (wireless) connectivity. Examples of such devices are tablets, PCs, mobile handsets, consumer electronics and machines. The last category refers to "machine to machine communication" (M2M), which describes direct communication between devices like industrial instrumentation, hospital equipment or any other kind of device equipped with sensors and connectivity. A common concept, often used interchangeably with M2M, is *industrial Internet*. Both M2M and industrial internet thus appear to be a subset within the umbrella term that is IoT. GSMA (2012) mentions that of all connected device markets, the M2M market is expected to dominate the IoT market, both in number of connected devices and in revenue. Schlautmann et al (2011) et al identify seven opportunity areas for smart objects: Medical and health, mobile devices, energy, building automation, moving objects, retail and industrial processes. Partly based on GSMA (2012), Mazhelis et al (2013) identify three comprehensive domains, which show the greatest potential for IoT. These domains, which are briefly discussed below, and Schlautmann's seven areas of opportunity are aggregated in Table 2.

Automotive and logistics includes in-vehicle applications, traffic control etc. These applications allow for automated toll collection, Pay-As-You-Drive (PAYD) insurance and other business models. This domain will grow, partly due to the increased adoption of hybrid and fully electric vehicles. These vehicles are often by default equipped with communication technology. Until now, adoption of M2M applications is highest this sector.

The *digital, smart* or *connected building/ home* is the development toward building or home automation or 'domotics'. This domain includes a range of consumer electronics, but also security measures and utility applications like smart meters.

Healthcare applications range from prevention and diagnostics to treatment. E-health is a term, used to describe healthcare processes that are supported by communication and electronic processes. The sector is said to have interesting opportunities, partly because of the expected annual growth rate. Examples of applications include remote monitoring, maintenance optimization and efficient scheduling of equipment use. A common division within the healthcare sector is 'cure' versus 'care'. Cure refers to recovery and nursing. Care focuses on limiting the disadvantages of diseases and limitations. The initial focus of the matchmaking platform is on the (health)care domain. In section 2.4 we delve deeper into the topic of healthcare, in order to generate a better understanding of the domain. This improved understanding of IoT in the healthcare domain contributes to the interview protocol, which is described in Chapter 6.

2.2 Business models in IoT

Through the introduction of smart devices and corresponding services, IoT enables and even forces businesses to implement new business models. Several scholars emphasize the importance of a shift in business model focus. Conventional business model design approaches focus on the level of a single firm, while IoT business models require consideration on an ecosystem level (Bilgeri et al, 2015; Chan, 2015; Turber et al, 2014; Westerlund et al, 2014). IoT-related business models differ from conventional business models in both value creation and value capture.

In order to structure the literature in this chapter, we propose the STOF business model ontology (Bouwman, De Vos & Haaker, 2008) as an organizing principle. The STOF method looks at four generic domains of a business model: Service, Technology, Organization and Finance. We use these four domains to structurally discuss specific characteristics of IoT.

The developments around IoT may seem promising, however there are also several pressing concerns for stakeholders in this domain. These concerns, both social and technological, may provide barriers for the development of IoT. Identifying challenges is an important step in creating a value proposition for the matchmaking platform that is to be designed. In each of the four domains, we also briefly discuss potential challenges. Figure 6 shows the four business model domains, and the main topics that are discussed below.

Service domain Value creation	Technology domain Technology stack
Organization domain Ecosystem roles	Finance domain Value capture

Figure 6: Four domains of IoT business models

2.2.1 Service Domain

The service domain of a business model revolves around value creation. Value creation refers to actions that make and improve a firm's offering. In this section, we thus look at how value is created in the IoT domain. In IoT, sources of value creation stem from five distinctive value layers, which each add value on top of the previous layer. Based on Fleisch et al (2014), Bilgeri et al (2015) describe the five typical value creation layers in IoT, as can be seen in Figure 7. This figure can be used to guide brainstorm processes in the initial phases of business model design. The first layer is that of the "physical thing", which delivers a direct benefit to the user because of its stand-alone value. The second layer contains the sensors and actuators, including a computing chip, that are needed to gather local data and interact with the immediate environment. The third layer bridges the gap between the physical and the digital world by adding connectivity to the product. The fourth layer, that of data analytics, combines data from multiple sources and distills information. The last layer is the digital service. This layer combines the previous layers into a structured service towards a customer.

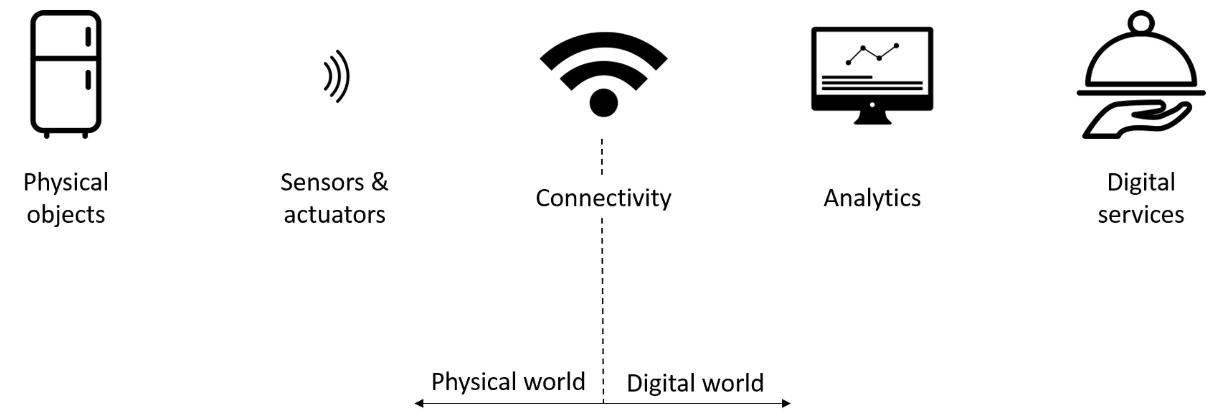


Figure 7: Value creation layers in IoT solutions (adapted from Fleisch et al, 2014)

As sources of value creation, Porter & Heppelmann (2014) identify four capability areas of smart products: monitoring, control, optimization and autonomy (Appendix III). Fleisch (2010) extends this to a set of value drivers for IoT applications. According to Fleisch (2010) it is nearly impossible to structure IoT applications, since they are almost as diverse as the physical world itself. Instead, he poses a total of seven origins of value of IoT applications. He claims that all of the nearly 100 IoT applications that were investigated are based on one or more of these value drivers. Value drivers one to four are based on M2M communication, while drivers five, six and seven find their basis in the integration of users. The seven value drivers are summarized in Table 1. A more comprehensive explanation can be found in Appendix VI.

Table 1: IoT value drivers (Fleisch, 2010)

Value drivers	**Explanation**
Manual proximity triggers	Simplify proximity verification (e.g. access control, payment)
Automatic proximity triggers	Proximity causes a series of reactions (e.g. business process)
Automatic sensor triggering	Communicate data to preprogrammed rules
Automatic product security	Security measures like anti-counterfeiting
Simple and direct user feedback	Energy-efficient feedback signal (LED, sound)
Extensive user feedback	Linking the object to software application and sources on the Internet (e.g. through smartphone, tablet)
Mind/behavior-changing feedback	Influence user behavior (e.g. smart meter)

Hui (2014) claims that a general shift in mindset is needed to create value using the Internet of Things, as is illustrated in Figure 8. According to Hui (2014), the value creation mindset of firms should shift in three different areas: Customer needs, product offering and the role of data. In the area of addressing customer needs, IoT applications can enable a shift from a reactive to a predictive manner. The product offering will no longer be a standalone product. Instead, software applications create a synergistic value while also being updated over the air. Finally, IoT enables the combination of multiple data sources in order to create new services.

		TRADITIONAL PRODUCT MINDSET	INTERNET OF THINGS MINDSET
VALUE CREATION	Customer needs	Solve for existing needs and lifestyle in a reactive manner	Address real-time and emergent needs in a predictive manner
	Offering	Stand alone product that becomes obsolete over time	Product refreshes through over-the-air updates and has synergy value
	Role of data	Single point data is used for future product requirements	Information convergence creates the experience for current products and enables services

Figure 8: Mindset change for value creation in IoT (Hui, 2014)

The service domain of IoT business models also faces potential challenges. Possibly the most obvious social challenge in IoT is related to *trust* and *privacy* (Atzori et al, 2010; Weinberg et al, 2015). Through various devices and applications, more and more aspects of a consumer's life are captured as data. Since consumer trust is essential for business models in IoT, firms' respect for users' privacy should naturally be present. Weinberg et al (2015) propose a solution in the form of *privacy by design*. In their view, privacy issues should be embedded in the entire design process of IoT applications. For the consumer, there will be a tradeoff between the convenience that IoT offers versus the amount of data he wants to disclose (privacy).

Services which are delivered through IoT applications are strongly dependent on technology. Therefore, the next section discusses technological characteristics of IoT.

2.2.2 Technology Domain

The technology domain of a business model is essential in creating and delivering value. In order to distinguish IoT technology from more conventional settings, we review specific IoT-related characteristics. The Internet of Things differs from the Internet in several different areas. Fleisch (2010) states a total of six main differences between the two. First of all, in IoT applications, hardware plays a significantly different role. Instead of high capacity workstations, IoT applications often feature hardware that is barely visible. These computers are mostly low-end and consume little energy, while delivering a fraction of the functionality. Secondly, the network created by the Internet of Things will be numerous times as big as the Internet is today. Where the Internet consists of several billion devices, IoT could possibly comprise trillions of devices. This volume suggests that direct human interaction with each connected device will diminish. Thirdly, the last mile bandwidth, or the communication speed between the device and the next network layer, is significantly slower in the case of IoT. Where PCs, tablets and smartphones have connection speeds ranging from 1 Mbit/s to 100 Mbit/s or more, the average low energy consuming device in the context of IoT has a connection speed of around 100 kBit/s. As a fourth characteristic of IoT, identification and addressing of devices is mentioned. The required capacity of current Internet-based schemes is often too much for IoT applications. Ideally however, a global standard protocol should be developed for IoT, in order to access connected 'things' from every computer. Fifthly, where the Internet is almost exclusively focused on human interaction, IoT is machine-centric. Connected 'things' often almost completely exclude direct human intervention. User involvement is often executed via PCs, tablets or smartphones. Lastly, IoT is largely focused on sensing and actuating in the physical world, where the Internet's focus is mainly on communication.

Table 2: Summary of IoT Characteristics and markets

Characteristics of IoT	**Main markets**
'Invisible' hardware	Automotive and logistics
Trillions of network nodes	Home / building automation (incl. consumer electronics)
Low last mile connection speeds	Healthcare / e-health
No global standard protocol for identification and addressing	Mobile devices
	Industrial processes
Machine-centric communication	Retail
Focus on sensing and actuating	Energy (smart grid, smart meter)

Above characteristics are made possible through various technological developments. Atzori et al (2010) describe *technology as an enabler* for IoT. They distinguish two types of enabling technologies. Firstly, identification, (wireless) communication and sensor technology are mentioned. These technologies not only become more affordable, but also smaller, lighter and more energy efficient. This results in an increased amount of possible applications. The second group of enabling technologies is middleware. This software layer is positioned between the technology and application layers. It simplifies the development of new applications and services since 'irrelevant' details are hidden from developers. Recent middleware is often developed according to the service oriented architecture (SOA) approach. This approach decomposes a complex monolithic application into a set of clearly defined, simple applications. In order to create some insight in the interrelations between these technologies, we continue with a recent view on a typical IoT technology stack.

Since a smart product consists of a physical, a 'smart' and a connectivity component, an increasing amount of technologies and disciplines are involved. Porter & Heppelmann (2014) present a "technology stack" of multiple layers to describe the technology infrastructure that is required to build smart products. A graphic representation of this technology stack can be seen in Figure 9. This visualization is especially suitable within the organizing principle of this chapter. It shows strong resemblance to the value layers in the service domain (Figure 7), and the ecosystem roles in the organization domain (Figure 10) of IoT business models. The relations between the representations of IoT value layers, technology stack and ecosystem roles is further discussed in section 2.2.5. A visualization that links these representations is shown in Figure 12. First we discuss the technology stack below.

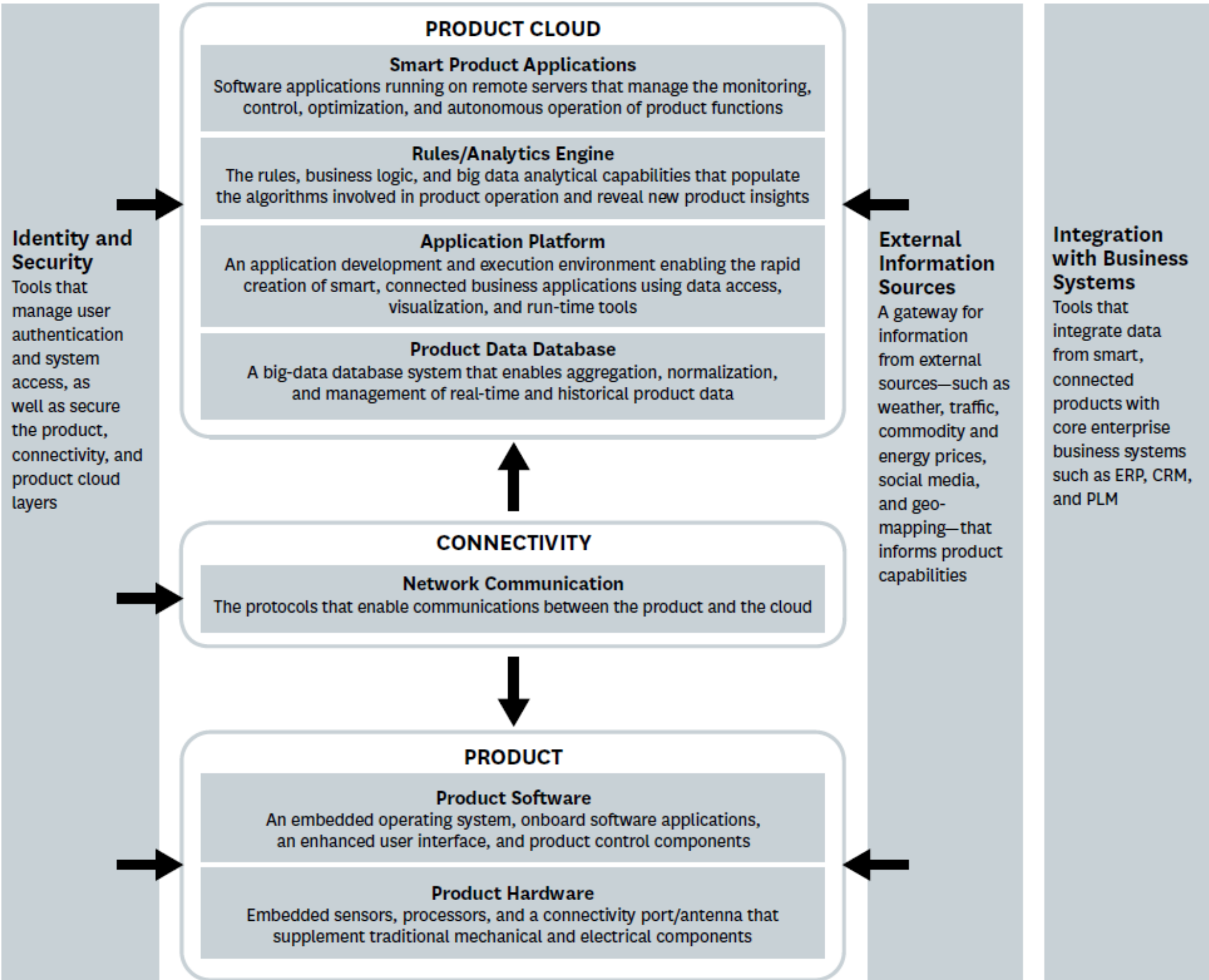


Figure 9: The technology stack (Porter & Heppelmann, 2014)

The technology stack shows the relations between the different layers of the technology infrastructure. The physical product is equipped with embedded electronics and software. Through network communication, the product interacts with a product cloud. This cloud processes and stores data, but also enables the development and deployment of applications. All these layers should be fit with proper security and authentication tools. The device's software and the cloud applications can be continuously fed by external information sources, like weather conditions and traffic status. Finally, through a layer of middleware, data from smart products can be integrated with core business systems such as enterprise resource planning (ERP), product lifecycle management (PLM) and customer relationship management (CRM). The variation of disciplines involved in an IoT product can lead to the development of an ecosystem (organization domain), which will be discussed in the next section. Knowing which disciplines are involved in a typical IoT ecosystem will help to identify the most important stakeholders for a matchmaking platform.

IoT also faces several technological challenges. Below, we discuss three prominent ones: Interoperability, Security and Scalability. IoT applications involve a range of disciplines, many of which are technological in nature. Westerlund et al (2014) see the diversity of objects in the IoT landscape as one of the major problems. Interoperability between different devices is still limited due to a lack of communication standards. Existing players (e.g. Google, Amazon) try to exercise control on IoT by imposing standards. This development is seen as both beneficial and limiting. The development of applications can be accelerated, but too much control by a limited set of firms can hinder innovation and limit consumer choice (Weinberg et al, 2015). Secondly, Westerlund et al (2014) foresee problems due to the immaturity of IoT innovations. Currently, IoT products and services do not yet live up to their potential. A solution is seen in coupling multiple components.

Security, which is closely linked with trust and privacy, is seen as a big challenge in IoT (Weinberg et al, 2015). The risks that hacking activities pose are naturally also applicable to IoT applications. A security breach can be costly, as is known from cases of e.g. identity theft and credit card fraud. As discussed above, IoT applications collect ever more data on users. Security breaches thus become more and more costly. Next to the costs associated with security, IoT also poses a new set of risks, since devices are often not only able to sense, but also act. Examples capture the imagination, especially in the healthcare sector. As connected wearables become more common (e.g. connected pacemakers), the danger associated with security breaches increases. As is the case with privacy, security should also be incorporated from the start of the design process (Weinberg et al, 2015).

Finally, considering the demands due to the scale of IoT, several other technologies need to be improved. Atzori et al (2010) identify scalability problems in the network, since IoT applications are estimated to run into multiple billion devices. Next to that IoT applications are characterized by their limited availability of computing resources and energy. Developments in this area will also contribute positively to the scalability issues of IoT. Weinberg et al (2015) pose concerns related to the vast amounts of data that are collected and processed by IoT applications. They identify the need for better storage technology and processing algorithms.

2.2.3 Organization Domain

The organization domain of a business model looks at the different actors that are required to deliver a product or service. Within an IoT ecosystem, these actors fulfill different roles. There is also a close link to the technology domain, since the required technology for a proposition is often supplied by ecosystem partners. Mazhelis et al (2013) argue that business ecosystems in the area of IoT form around a particular technology, which often has a focus on a specific application domain. Examples are the retail domain with its RFID services and ZigBee technology in smart homes. Analyzing existing ecosystems is helpful in increasing understanding of common patterns. Rong et al (2015) present a '6C' framework for analyzing ecosystems in IoT-based sectors. This framework is further explained in

Appendix IV. They distinguish three types of ecosystems, based on the amount of input from different stakeholders: highly open, semi-open and less open. They conclude that less open ecosystems are more common in mature industries that are dominated by a single firm.

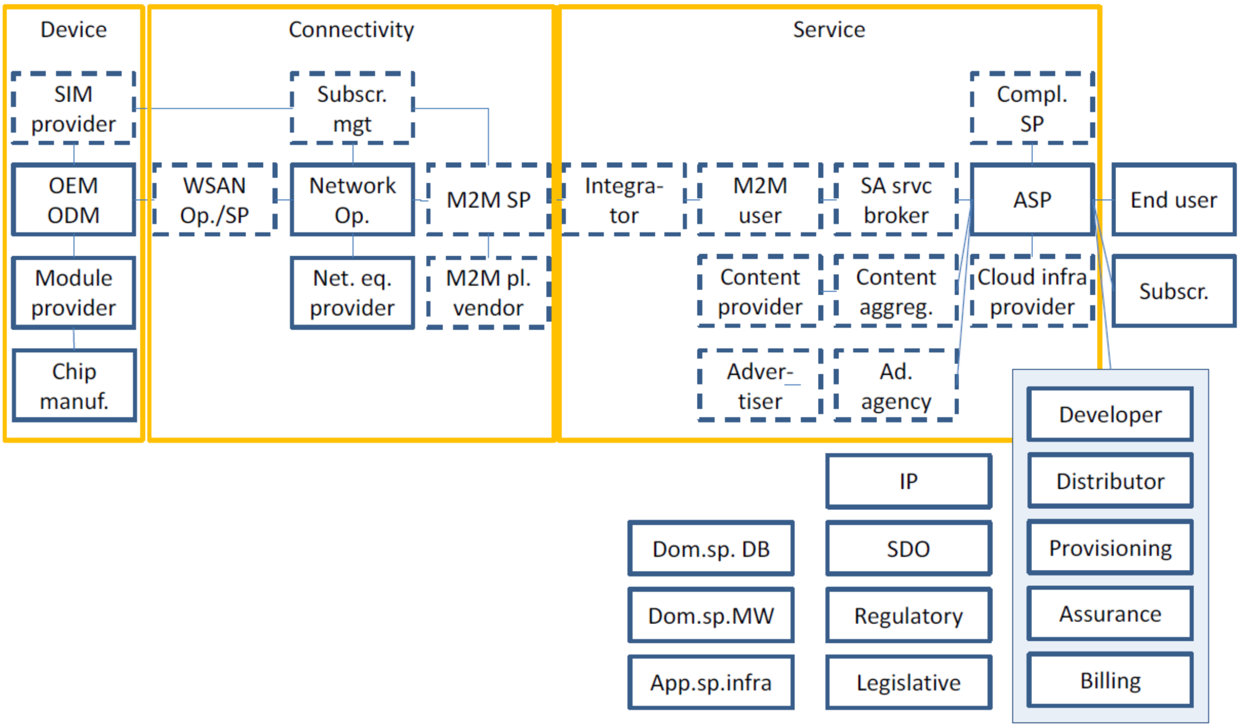


Figure 10: IoT Ecosystem roles (Mazhelis et al, 2013)

From literature, Mazhelis et al (2013) aggregate various roles of firms into an overview of an IoT ecosystem. Figure 10 shows the relations between the various roles. Dashed boxes indicate auxiliary roles, which may be redundant in some cases. Table 19 in Appendix V further clarifies each of the roles. The roles of firms within an IoT ecosystem are divided into three areas: Device, Connectivity and Service. The device area consists of manufacturing parties that create the physical product, including electronics such as sensors, actuators and communication modules. The connectivity area is composed of parties that facilitate communication over the network, like (mobile) network operators. The service area revolves around an application service provider and other firms that contribute to the service towards the end-user. These three areas roughly match the technology stack of previous section. Schlautmann et al (2011) predict that service-enabling firms, those that provide IoT platforms and applications, will profit most within an IoT ecosystem.

Sundmaeker et al (2010) argue that IoT ecosystems were still in a developing stage. New entrants and incumbent firms have been competing in the same market. Because of this, it has been hard to identify a single firm that fulfills the role of keystone or dominator. Incumbent firms are said to focus mainly on performance enhancement, which faces few problems with adoption. New entrants however, often favor competence destroying innovations. They can grow rapidly and take significant market share by conquering niches. This indicates that innovative business models of ecosystems around start-ups are most likely to be responsible for major changes in the IoT field. The common roles in an IoT ecosystem, as identified by Mazhelis et al (2013), will help to map relations between stakeholders in practice. This provides a heuristic during the interview phase as discussed in Chapter 6.

An organizational challenge is posed by Westerlund et al (2014), and is related to *unstructured ecosystems* around IoT. They pose that current ecosystems lack structure, governance, clear stakeholder roles and value creating logics. Part of the solution is seen in the development of new types of relationships or the extension of current ones. There should be a shift in business model focus from firm level to ecosystem level. Weinberg et al (2015) identify friction between stakeholders on the topic of data ownership. More complex ecosystems will most likely increase the conflict on this issue.

Concluding, we can state that there are still many developments possible in the IoT domain in order to make the domain more mature. A key aspect in this process is closely involving existing and new stakeholders in the design process of applications. During this process, it is vital that issues such as privacy, security and interoperability are taken into account from the first moment.

The IoT ecosystem, or organizational domain of a business model, is closely linked to the financial domain. Due to the importance of partnerships within an IoT ecosystem, the financial aspects of a business model differ from conventional business models. The characteristics and challenges are discussed below.

2.2.4 Finance Domain

We have discussed the value creation aspects of an IoT business model in the service domain section. This value creation is enabled by technologies (technology domain) and ecosystem partners (organization domain). However, a business model is not complete without assessing the methods of value capture (finance domain).

Value capture refers to the monetization of customer value, or the benefits that parties receive for collaborating. Also distribution of this value plays an important role. Since the focus of an IoT business model is no longer on the level of a single firm, each party involved in value creation should benefit. For a sustainable stakeholder network, the value proposition of each key stakeholder should explicitly be considered (Mazhelis et al, 2013). This does not necessarily mean that each stakeholder requires direct monetary rewards. However, it is desirable to have a win-win information exchange between stakeholders (Chan, 2015).

		TRADITIONAL PRODUCT MINDSET	INTERNET OF THINGS MINDSET
VALUE CAPTURE	Path to profit	Sell the next product or device	Enable recurring revenue
	Control points	Potentially includes commodity advantages, IP ownership, & brand	Adds personalization and context; network effects between products
	Capability development	Leverage core competencies, existing resources & processes	Understand how other ecosystem partners make money

Figure 11: Mindset change for value capture in IoT (Hui, 2014)

In order to capture value through IoT, Hui (2014) proposes a mindset change for firms. Three aspects are discussed: Recurring revenue, personalization and value distribution. An overview of these aspects is shown in Figure 11. While conventional business models often rely on device sales, IoT enables companies to generate recurring revenue through service offerings, subscriptions and apps. The possibility to 'lock in' a customer is generated through personalized content and the network effect that a family of devices can create. Finally, Hui (2014) emphasizes the importance of ecosystems in IoT, where all partners should benefit from cooperation.

In line with the earlier proposed mindset change, Dijkman et al. (2015) identify several revenue models that are enabled by IoT. These are mostly focused on recurring revenue. Examples are renting, leasing, licensing and advertisement models. Customer relationships are also impacted by IoT. Important 'new' relationship models are e.g. self-service, automated service and personal assistance. Fleisch et al (2014; 2015) state that the orientation towards service (servitization), which is one of the main aspects of IoT, enables seven business model pattern components. A description of each is found in Table 3.

Table 3: Business model pattern components (Fleisch et al, 2014)

BM pattern component	Description
Physical Freemium	Physical device is sold with a free digital service. Paid (premium) services are optional.
Digital Add-on	Physical asset is sold inexpensively; digital services have a higher margin
Digital Lock-in	Only original components/ applications are compatible with the system
Product as Point of Sales	Physical products become point of digital sales and advertising services
Object Self Service	Ability of things to independently place orders
Remote Usage and Condition Monitoring	Transmit real-time status/ usage data
Sensor as a Service	Collecting, processing and selling data for a fee

Literature indicates that one of the biggest challenges in the financial domain lie with the shift in business model focus (Hui, 2014; Mazhelis et al, 2013; Chan, 2015). Where traditional business models primarily take into account a single firm's activities, IoT business models require a shift in focus towards value creation and capture in ecosystems. Since multiple parties are often required in order to create an IoT proposition, each of these parties should in some way benefit from cooperation in order to have a sustainable ecosystem.

Concluding, we can state that firms that venture into IoT territory need to be aware of the business model related issues as discussed above. IoT enables and even forces businesses to implement new business models. In the creation of an IoT business model, conventional methods of thinking could prove to be insufficient. A change in mindset is required to create a model of recurring revenue that is beneficial for all important stakeholders involved.

2.2.5 Relations between business model domains

In the previous four sections we discussed the major aspects of IoT on the basis of four business model domains: Service, Technology, Organization and Finance. Within these domains, existing literature offers specific overviews of IoT value layers (Figure 7), the IoT technology stack (Figure 9) and typical roles in IoT ecosystems (Figure 10). This section briefly discusses how these three visions on IoT relate to each other.

Fleisch et al (2014) propose five value layers: Physical objects, Sensors and actuators, Connectivity, Analytics and Digital services. Value in an IoT proposition is increased by adding each of the consecutive layers. This closely relates to the technology stack by Porter & Heppelmann (2014). This stack consists of three technology areas: Product, Connectivity and Product cloud. Mazhelis et al (2013) propose a set of standard IoT ecosystem roles, which are divided into three categories: Device, Connectivity and Service. The relations between the value layers, technology stack and ecosystem roles can be seen in Figure 12. The figure is explained below.

The technology stack neglects the physical object, since this can be highly variable and is not necessarily IoT specific. The product mentioned in the technology stack corresponds to the sensors and actuators value layer, because the focus here is on product electronics (sensors, processors, antenna etc.) Within an IoT ecosystem, both the physical object and the electronics are captured in the device category. This category includes various kinds of manufacturers.

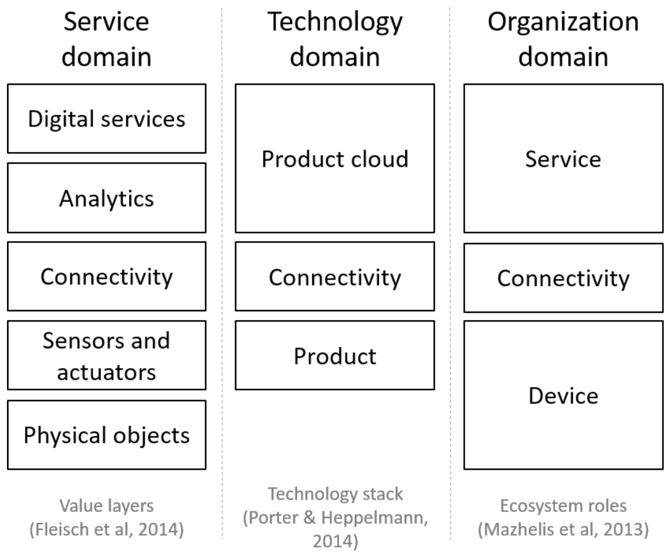


Figure 12: Relations between IoT value layers, technology stack and ecosystem roles

All three views on IoT mention a specific category for connectivity. Connecting a physical device to the Internet adds value for the user. It requires network communication technology. Access to this technology is provided by firms in the connectivity category, such as mobile network operators.

The last two value layers are analytics and digital services. In these layers, data is first stored, combined, processed and converted into valuable information. Subsequently, this information is offered to the user in the form of a service. These two value layers combined relate to the product cloud layer of the technology stack. In an IoT ecosystem, roles related to these layers are represented in the service category.

2.3 Requirement categories related to IoT business models

In this chapter we aim to identify requirement categories for developing a business model in IoT, by reviewing literature. In order to answer the first sub-question of this research, we summarize the findings of this chapter in Table 4. Because of the importance of business models in IoT, we adhere to the four generic business model domains as requirement categories for IoT business models. Per domain we summarize the main findings from the literature review. These findings will contribute to the creation of an IoT partnership requirements framework in Chapter 3.

Table 4: The four requirement categories of IoT business models and the main findings per category

Findings per requirement category	Source
Service Domain	
Main markets and opportunity areas of IoT (Table 2)	GSMA (2012), Schlautmann et al (2011)
Important IoT-related trends (Appendix VIII)	Jurvansuu (2011)
Four capability areas of smart products: monitoring, control, optimization and autonomy.	Porter & Heppelmann (2014)
Value drivers of IoT (Table 1)	Fleisch (2010)
Five layers of value creation in IoT (Figure 7)	Bilgeri et al (2015), Fleisch et al (2014)
Firms need to shift mindset in order to create and capture value with IoT	Hui (2014)
Explicitly consider trust and privacy when designing an IoT proposition	Atzori et al (2010; Weinberg et al (2015)
Technology Domain	
Five characteristics of IoT (Table 2)	Fleisch (2010)
Layers of the technology stack describe the technology infrastructure that is required to build smart products.	Porter & Heppelmann (2014)
Explicitly consider interoperability, security and scalability in an IoT proposition	Westerlund et al (2014)
Organization Domain	
IoT ecosystems can often around a specific technology	Mazhelis et al (2013)
IoT ecosystem can be analyzed using the 6C framework	Rong et al (2015)
Distinguishing property of an IoT ecosystem is degree of openness	Rong et al (2015)
Generic roles of firms in an IoT ecosystems and their relations (Figure 10)	Mazhelis et al (2013)
Incumbents often produce performance enhancing innovations, while new entrants are likely to produce competence destroying innovations	Sundmaeker et al (2010)
It is hard to identify keystone or dominator firms in IoT ecosystems	Sundmaeker et al (2010)
Establish ecosystem structure, governance and clear stakeholder roles	Westerlund et al (2014)
Finance Domain	
IoT enables new business models	Mazhelis et al (2013) , Fleisch et al (2014)
Data is an asset for new services and revenue models	Mazhelis et al (2013), Bilgeri et al (2015)
Services create possibilities to generate recurring revenue	Hui (2014)
Personalized content can be used in order to achieve lock in	Hui (2014)
Use a value-centric approach over a cost-focused approach	Mazhelis et al (2013)
Shift the business model focus from company to ecosystem	Bilgeri et al (2015)
Complex value streams occur in IoT (need to be visualized)	Bilgeri et al (2015)
The value proposition of each key stakeholder needs to be considered	Bilgeri et al (2015)

Most firms venturing into the domain of IoT will be faced with the four aspects of IoT business models. Since the empirical part of this research concentrates on IoT-related firms in the healthcare domain, the following section discusses the applications, trends opportunities and challenges of IoT in healthcare.

2.4 IoT in healthcare

In chapter 6 we discuss interviews with five IoT-related companies in the healthcare sector. Like most other IoT-related firms, these companies are faced with issues from the four IoT business model domains as summarized in Table 4. In order to get a sense of the specific situation that these companies are in, this section discusses types of IoT applications, trends, opportunities and challenges in healthcare.

Developments in the IoT domain seem to impact almost all major industries. Mazhelis et al (2013) describe the healthcare sector as one of the most promising sectors for IoT. Applications of IoT in the healthcare sector are often referred to as E-health applications. E-health is a term, used to describe healthcare processes that are supported by communication and electronic processes. Healthcare applications range from prevention and diagnostics to treatment. A common division within the healthcare sector is 'cure' versus 'care'. Cure refers to recovery and nursing. Care focuses on limiting the disadvantages of diseases and limitations. The scope of this thesis is directed at IoT solutions in the care domain. Below, we shortly discuss examples, trends and challenges for IoT in the healthcare domain.

2.4.1 Applications

Within the care domain, there are many application possibilities for IoT. Applications range from devices and services that directly aid the patient, to applications that serve physicians or other caregivers (Mazhelis et al, 2013). Examples of the first category can be seen in in the field of monitoring and drug management. Monitoring a patient's in real-time can be accomplished by wearables (e.g. heart rate tracker). Many wearables are already available to consumers, blurring the line between healthcare and consumer electronics. Drug management can be simplified by stationary devices like automatic drug dispensers (e.g. Medido drug dispenser).

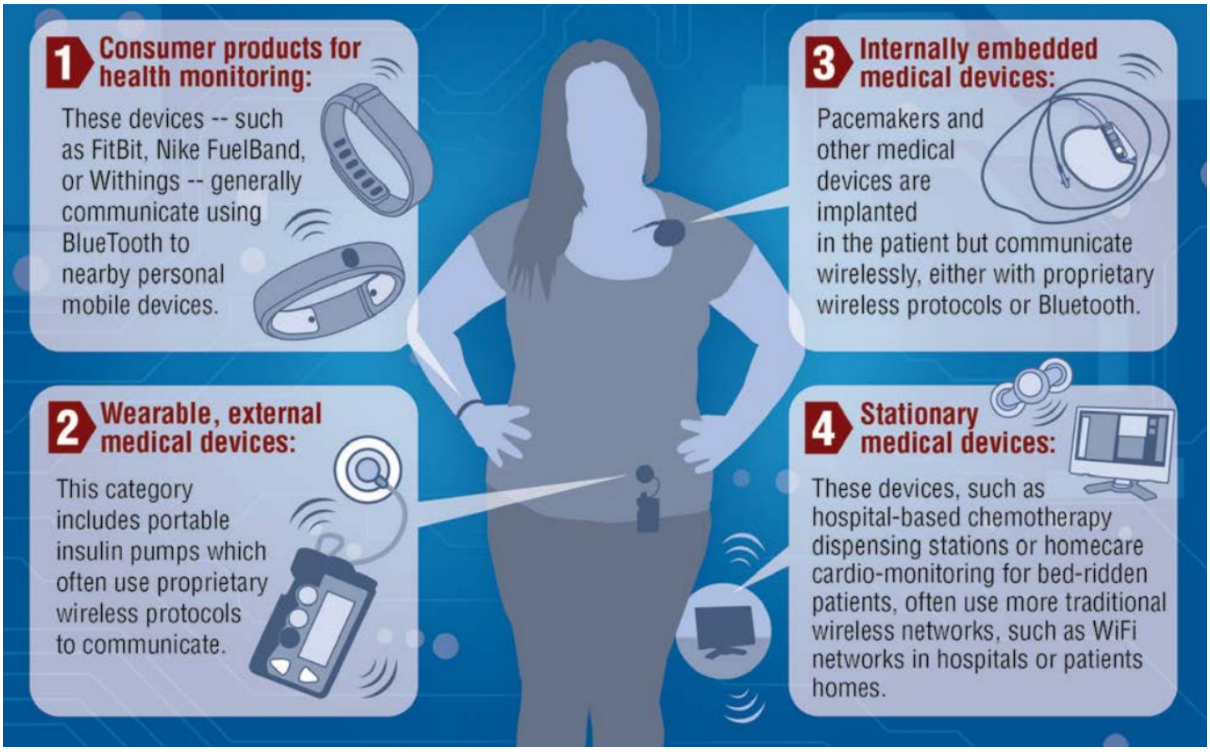


Figure 13: Four categories of connected medical devices (Healey et al, 2015)

Caretakers can also be aided in their tasks by using of IoT applications. Examples are device maintenance optimization and efficient scheduling applications. By remote monitoring a patient's condition, treatments can be timed more efficiently (Mazhelis et al, 2013). Figure 13 provides a graphic overview of four types of connected medical devices.

2.4.2 Trends, opportunities and challenges

The Dutch healthcare sector, as many other sectors, is currently subject to declining budgets. As a result, employment possibilities shrink, especially among lower educated caretakers (UWV, 2015). Because of a shift towards a more elderly population, the need for innovative (health)care solutions increases. These solutions should increase cost efficiency, but also improve the quality of life of elderly people (Solaimani, 2014).

In his work, Jurvansuu (2011) presents a future vision towards a ubiquitous world by describing several IoT-related trends. In the healthcare sector, there is a shift towards care and treatment at home, facilitated by various instruments to monitor the patient's status. Personal 'wearables', like clothing and accessories, can enhance abilities like vision and hearing through embedded electronics. Personal devices will extend beyond context awareness. By sensing the user's behavior, these devices will become intention aware, better understanding the user's current situation in relation to the past. Constant monitoring of the user's physical condition can influence insurance premiums and claims.

Apart from the apparent gains of implementing IoT applications in the healthcare industry, there are still some important hurdles to be overcome. Healey et al (2015) identify four areas of concern: accidental failures, privacy violations, intentional disruption, and widespread disruption. Accidental failures are a concern because of their likeliness to negatively affect trust. If a malfunctioning medical device is a high-profile failure, the negative attention could severely delay further development and deployment. Privacy violations are a second area of concern. Health data is one of the most sensitive categories of user data. Both proper encryption measures and correct distribution practices are vital in preventing privacy violations. Intentional disruption is a valid concern, since medical devices will have the same types of vulnerabilities as other connected devices. In the case of internally embedded medical devices, such vulnerabilities potentially become life threatening. Finally, widespread disruption is identified as an area of concern. Although less likely, targeted malware could affect anyone with a vulnerable device, causing the device to malfunction.

2.5 Conclusions

This chapter aims to generate a thorough insight in the IoT domain in order to identify requirement categories for matchmaking in IoT. We start by defining IoT as "a concept used to describe a situation where, on a large scale, various physical 'things', objects or devices are embedded with electronics, software, sensors, actuators and connectivity". Through the introduction of these 'smart' devices and corresponding services, IoT enables and even forces businesses to implement new business models.

Due to the importance of business models in IoT, we introduce the business model as an organizing principle for analyzing the IoT domain. We pose that characteristics of IoT can be mapped on the STOF business model ontology. Thus, to structure characteristics of IoT, we discuss the Service related, Technological, Organizational and Financial aspects of the IoT domain. In the service domain, we discuss the methods of value creation in IoT. The technology domain is described using the IoT technology stack. In the organization domain, we emphasize the importance of ecosystems and show generic roles of firms within an IoT ecosystem. The finance domain mainly discusses methods to capture value.

We argue that characteristics for matchmaking in the IoT domain should be bundled into requirement categories. For IoT specific requirements, we make use of the four business model domains. In Table 4 we summarize our findings, categorized in the service, technology, organization and finance domains. These requirement areas contribute to the creation of an IoT matchmaking requirement framework in the next chapter.

Finally, in preparation of the interviews in Chapter 6, we take a closer look at IoT in healthcare. We discuss healthcare-specific applications, trends, opportunities and challenges. Applications of IoT in healthcare can be divided into four categories: Consumer health monitoring, external medical wearables, internal medical devices and stationary medical devices. One of the important trends in this sector is a shift towards a more elderly population. This increases the need for innovative (health)care solutions, which is a promising development for IoT.

3. Matchmaking: Partnerships, Ecosystems and Governance

In the previous chapter we explained that IoT business models often require multiple partnerships in order to create a new proposition. We argue that matchmaking, the facilitation of partnership creation, will directly contribute to the emergence and expansion of IoT ecosystems. In order to generate insight in these concepts, this chapter contributes to answering the first sub-question of this research: What requirement categories for matchmaking in the IoT domain can be derived from literature? To answer this question, we first define the concept matchmaking. Then, we take a look at partnership literature, which mainly treats relationships between two firms. Ecosystem literature expands this view towards multiple interrelated parties. We briefly discuss governance literature because of its importance to ecosystems.

We group the findings in this chapter into seven requirement categories. By combining these with the findings from previous chapter, we propose an IoT matchmaking requirement framework (Figure 17). In this framework, we summarize our findings per requirement category and position each category within the phases of the partnership process (Figure 15). To clarify the line of reasoning in this chapter, we start by discussing the concept of matchmaking.

3.1 Matchmaking

The concept of matchmaking finds its origin in human matchmaking. In this process, two or more people are brought together, often with the purpose of marriage. More generally, matchmaking describes the process of mediating between two or more suitable parties, in order to facilitate a transaction or partnership. In the business world, forms of matchmaking are often addressed as B2B matchmaking, business speed dating of brokerage events ("Matchmaking - Wikipedia," 2016; "Matchmaking - Dictionary.com," 2016). In the context of this research, matchmaking is regarded as: **The process of bringing two or more firms, and their resources, together to facilitate the creation of mutually beneficial partnerships, and therefore the creation and expansion of a business ecosystem, enabling the creation of new value propositions.**

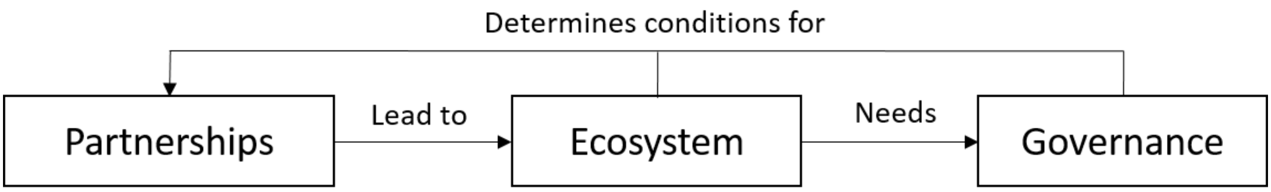


Figure 14: Relations between concepts in this chapter

To come to a list of requirement categories for matchmaking, literature on partnerships, ecosystems and governance is discussed. Figure 14 shows the relations between these concepts. Relevant literature for this chapter is obtained through several sources. Scopus, Google Scholar, TU Delft library, ScienceDirect and the Google search engine led to the majority of the covered literature. Search terms that were used for this chapter can be divided into three categories:

- *Strategic alliance*
- *Business matchmaking* and synonyms such as *B2B, Firm, company*, and *matching, partnering, relationship, cooperation and partnership*
- *(Business) ecosystem creation* and variations such as *value network creation, formation, development and governance*

Each of these categories was supplemented by a variation of keywords such as *criteria, success factors, conditions, driving forces* and *requirements*. Literature was selected on the basis of factors such as year of publication and scope of the article.

3.2 Partnerships

The main goal of business matchmaking, within the scope of this report, is the formation of long-lasting, mutually beneficial partnerships between complementary companies. This paragraph deals with the "what", "why", "when" and "how (not)" aspects of business to business (B2B) partnerships in general. First, a brief introduction into partnerships is given. Next, we analyze the drivers behind partnership formation, since these are most likely to be reasons for using a matchmaking platform. Finally, we introduce the seven requirement areas related to the partnership maturation process. These requirement areas serve as input for the IoT matchmaking requirements framework.

3.2.1 What are partnerships?

Business partnerships are collaborative relationships between firms, in order to achieve a specific goal. In cooperation, two or more companies share capabilities, resources or knowledge to complement their internal assets. Candidates for forming partnerships can include customers, suppliers, knowledge institutes and even companies in different industries (Devlin & Bleackley, 1988; Stiles, 1994).

Through history, partnerships have seen a development in nature. In the end of the 20th century, a shift in competition perspective was recognized. The most basic form of competition, "firm vs. firm", had become outdated. Instead, it was transformed into a competition between supply chains (Whipple & Frankel, 2000). In the search for competitive advantage, firms have shown an increased interest in *buyer-supplier partnerships*. These relationships are often long-term and have a basis in shared risk and benefits (Ellram, 1995). They combine firms' strengths and unique resources (Whipple & Frankel, 2000). When developing a new product or service, a partnership that provides complementary resources can assure a competitive advantage. Subsequently, another fundamental change is seen**.** Traditional supply chains often expand into *networks of companies*. The impact of this transition is that the scope of cooperation has moved beyond buyer-supplier relationships (Möller & Halinen, 1999). The consequences of the transition into more complex networks, and ultimately business ecosystems, are further discussed in section 3.3. The following section discusses drivers behind partnership formation.

3.2.2 Why do firms collaborate?

Partnership formation is instigated by several drivers. These drivers are relevant in the design process of a matchmaking platform, since they are likely to increase the need for a matchmaking service. Wernerfelt (1984) describes a resource-based view (RBV), which sees tangible and intangible resources as the competitive advantage of a single company. Resource dependence theory (RDT) (Pfeffer & Salancik, 2003) states that an organization's power is directly linked with resources, which ultimately come from a firm's environment. Acquiring resources is of both tactical and strategic importance to a company. Often, these resources are possessed by other companies, and can be in the form of capital, labor, raw material etc. We argue that resource dependence is one of the main underlying drivers for partnership formation. Other literature also identifies drivers for partnership formation. Several of these drivers are discussed below.

Devlin & Bleackley (1988) identify four drivers for companies to engage in this kind of cooperation. First of all, technological development has increased rapidly, accompanied by increasingly high costs of research and development (R&D). This results in partnering arrangements to help achieve innovative goals (Millson, Raj & Wilemon, 1996). This implies that matchmaking should comply with a firm's strategic objectives. Secondly, mature industries often see a high concentration of players. Smaller companies that had access to sufficient funds were encouraged to challenge the incumbent monopolies by cooperating. This means that matchmaking should also focus on financial problems of SMEs. Thirdly, governments have been identified as a stimulus for collaboration between firms. Such a stimulus can often be seen in the form of subsidies. During matchmaking, these stimuli should be utilized. Lastly, Devlin & Bleackley mention 'fashion and fear motives'. These motives are especially present when companies see competitor activity in the direction of alliance formation. It is thus important for a firm to be aware of its surroundings.

A development in the last decades that contributes to partnership formation is servitization of business. Especially manufacturing companies have shifted their business models from offering products, toward adding value by delivering a service in combination with a product. The appearance and increase of servitization has increased the need for forming partnerships (Vandermerwe & Rada, 1989). Cooper & Gardner (1993) have summarized multiple perspectives on building business relationships from literature. Next to the need for specific assets and a high frequency of transactions, they mention six critical contingencies for establishing relationships (necessity, asymmetry, reciprocity, efficiency, stability and legitimacy). Table 5 summarizes all drivers for business partnerships mentioned above.

Table 5: Driving forces for partnerships

Driver for partnerships	**Source**
(Tangible and intangible) resource dependence	Pfeffer & Salancik (2003), Wernerfelt (1984)
High cost of R&D; Fast technological development	Devlin & Bleackley (1988), Millson, Raj & Wilemon (1996)
Multiple smaller firms can compete with incumbent monopolies	Devlin & Bleackley (1988)
Government stimuli (subsidies)	Devlin & Bleackley (1988)
'Fashion and fear motives'; See competitor activity	Devlin & Bleackley (1988)
Servitization of business	Vandermerwe & Rada (1989)
High frequency of transaction	Cooper & Gardner (1993)
Need for specific assets	Cooper & Gardner (1993)
Necessity: E.g. government regulations	Cooper & Gardner (1993)
Asymmetry: The power-based ability to exert influence over another organization	Cooper & Gardner (1993)
Reciprocity: Cooperation toward a mutually beneficial goal	Cooper & Gardner (1993)
Efficiency: Need to improve efficiency and transaction costs	Cooper & Gardner (1993)
Stability: Risk management / Reduced environmental uncertainty	Cooper & Gardner (1993)
Legitimacy: Create credibility by franchising, or cooperation with large companies etc.	Cooper & Gardner (1993)

The driving forces which are discussed in this section give an idea of the various reasons behind partnership formation. The following section briefly discusses the circumstances under which partnerships should be formed.

3.2.3 When are partnerships formed?

Although the benefits of cooperation are evident, literature emphasizes that partnerships should only be formed when certain requirements are met, since there are also risks involved in collaboration. Brouthers et al (1995) recommend firms to engage in alliances, only when there are real resource shortages within the company. They pose four requirements that should be met before venturing into close collaboration. Firstly, partners in an alliance should offer complementary skills. This requires a thorough research into the experience and capabilities of possible partners. These parties should be able to make a real contribution and be willing to give and take within the partnership. Secondly, a cooperative culture between the partnering firms should exist. Similarity in size and working environments are favorable conditions. Next to that, peer relationships between top management need to be assured. Thirdly, partnerships should be based on compatible company goals. Ideally, strategic goals should converge, while competitive goals diverge. Lastly, risks should be clearly and proportionally distributed. Sharing risks reduces a firm's individual risk, but also serves as an incentive to maintain the partnership.

Assuming above conditions are met, firms that venture into partnerships will follow a process which shows several generic characteristics. The following section takes a closer look at this process of partnership formation.

3.2.4 How are partnerships formed?

In practice, partnership formation is a maturation process, rather than a discrete event. Dwyer et al (1987) distinguish five general stages in this process. *Awareness* refers to the acknowledgement of the need for exchange partners, which is before any interaction between potential partners has taken place. The *exploration* phase encompasses the search for potential partners. This phase may include trials and evaluation and leads to the development of norms and expectations within the partnership. *Expansion* describes the increasing interdependence and growing benefits within the partnership. Willingness and ability to perform in line with expectations are tested in this phase. The phase of *commitment* is initiated by an implicit or explicit agreement between the involved parties. It is characterized by mutual loyalty, significant resource exchange and consistency over a certain period of time. Finally, the *dissolution* phase is marked by the withdrawal of a party from the partnership.

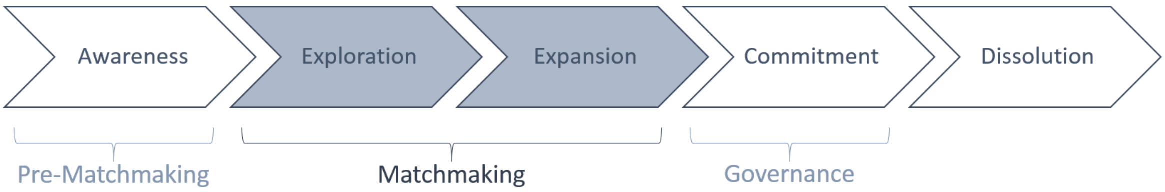


Figure 15: Partnership maturation process

In the context of this research, awareness is seen as the pre-matchmaking phase, since it occurs before any interaction between firms. It is in this phase that the drivers for partnerships play a significant role. The matchmaking process takes place in the exploration and expansion phases, as seen in Figure 15. After matchmaking has been accomplished, the commitment phase starts, in which governance becomes most important. In this report, the dissolution phase is excluded, since it is regarded as out-of-scope. The phases of the partnership process will be used to categorize the matchmaking requirement areas in the framework at the end of this chapter.

From literature, several requirements related to the partnering process can be derived. The requirements below are claimed to be vital throughout the process of partnership formation.

Whipple & Frankel (2000) found several requirements to be essential during partnership formation and commitment. The five most important requirements are shortly discussed. (1) *Trust*, the most important requirement, is reached through integrity, honesty, predictability, openness, competence and knowledgeability of the involved firms. (2) *Senior management support* is claimed to be the second most important requirement for partnerships. (3) *The ability to meet performance expectations* is the next requirement. This is reached through carrying out alliance responsibilities and performance evaluation. (4) *Clear goals* should be set and reviewed through regular contact. (5) The top five of requirements closes with *partner compatibility,* reached through similar operating philosophies, active improvement of the alliance and receptiveness to new solutions.

Cooper & Gardner (1993) have identified six requirements for business relationships from literature. The first requirement is *planning*, which requires close cooperation between partners. Secondly, both *benefits and burdens should be shared* by partners. As a third requirement, *extendedness* is mentioned, which is described as demonstrating trust and loyalty towards the partner. *Systematic operational information exchange* is the fourth requirement. This describes the (automated) transfer of routine information. Fifthly, the partner should receive at least some *control of and insight* in the firm's operation. Lastly, management should put effort in understanding the partnering firm's culture. This is described as *corporate culture bridge building*. To the requirements above, Ellram (1995) adds factors like having *shared goals* between the partnering firms, the presence of *distinctive added value* by the partner, showing *flexibility in the agreement*, *training personnel* in partnering philosophies, having *multiple points of contact* between partners and *recognizing and rewarding desirable behavior* and results. Some of these requirements imply a certain degree of equality within the partnership, which might not always be the case in practice.

Once firms have decided to participate in a partnership, there are several important attention points. Devlin & Bleackley (1988) pose eight requirements for managing an alliance. (1) The strategic alliance should receive *high priority with senior management*, which needs to be aware of the alliance's potential. (2) The alliance's *performance needs to be measured* and regularly reported to senior management. (3) Also in an alliance, clear lines of *accountability and responsibility* need to be established. Individual roles need to be composed and linked to realistic objectives. (4) *Information channels* are vital to an alliance's existence. Knowledge gained by employees when collaborating should flow effectively to the decision-making center of the firm. (5) *Sufficient resources* need to be contributed by all partnering firms. The size and quality of the contributed resources determine, for a large part, the potential for learning from the partner. (6) *Positive, high-quality personnel* should be allocated to the partnership. (7) Senior management should adopt a *positive attitude* towards the alliance, which should then be reflected throughout the organization. (8) Firms should *recognize the limits* of an alliance. Commitment is required to make a partnership durable and profitable. Clearly defined projects with finite goals and sufficient resources contribute to this.

Above requirements give an idea of important factors during the partnership process. We argue that, for firms that undergo this partnership process, it is important to be aware of these requirements, but also of failure factors. The following section briefly treats factors that contribute to partnership failure.

3.2.5 How do partnerships fail?

Ellram (1995) also discusses factors that contribute to the failure of partnerships. As can be expected, partnerships often fail because of the absence of, or non-compliance with, certain requirements. Ellram (1995) found that the five most prominent reasons for dissolving partnerships are poor communication, lack of top management support, lack of trust, lack of quality commitment and poor planning. Notable from Ellram's research is that physical distance between firms is not seen as an important reason for failure of partnerships.

Until now, this chapter discussed the "what", "why", "when" and "how (not)" aspects of business to business partnerships. To summarize, the following section gives an overview of all discussed requirements related to partnerships.

3.2.6 Partnership-related requirement categories

Since a matchmaking service should facilitate the creation of lasting partnerships, the service should strive to prevent the occurrence of failure factors. This can be done by ensuring compliance with the findings in this section. An overview of the findings for partnerships can be seen in Table 6. When observing these findings, it is already possible to distinguish seven themes or requirement categories. These seven categories will later make up the IoT matchmaking requirements framework.

In line with resource dependence theory, a partner should add valuable resources or capabilities. Other scholars describe this as distinctive added value or complementary skills. These requirements can be bundled in the first category, which we name *Complementarity*. The second category is *Trust*, which includes the initial attitude and support of firms towards the partnership. Thirdly we identify the *Compatibility* category. Here we group the less tangible concepts, such as culture, receptiveness, goals and vision. The fourth category is *Communication*. This category describes the information exchange requirements during later stages of the partnership. *Agreements*, the fifth category includes the distribution of risks and rewards. The sixth category is *Commitment*. Here we gather the requirements that describe actions that actively strengthen the partnership in a more mature stage, such as culture bridge building and personnel training. The final category refers to Chapter 2, since it is related to *Business models*.

Table 6: The seven requirement categories of partnerships and the main findings per category

Findings per requirement category	**Source** (adapted from)
Complementarity	
Commitment of sufficient resources is required	(Devlin & Bleackley, 1988)
Partner needs to add distinctive value	(Ellram, 1995)
Partner should have ability to meet performance expectations	(Whipple & Frankel, 2000)
Complementary skills between firms are required	(Brouthers et al, 1995)
Clear resource gap / shortage should be present	(Brouthers et al, 1995)
Trust	
Senior management support / priority / positive attitude is required	(Whipple & Frankel, 2000), (Devlin & Bleackley, 1988)
Trust between parties needs to be established	(Whipple & Frankel, 2000)
Compatibility	

Partner should comply with firm's strategic goals	(Millson, Raj & Wilemon, 1996)
Company goals need to be compatible	(Brouthers et al, 1995)
The partnership needs clearly defined / shared goals	(Whipple & Frankel, 2000), (Ellram, 1995)
Partner compatibility (operating philosophies, active improvement, receptiveness) is required	(Whipple & Frankel, 2000)
Cooperative culture between firms and peer relationships between top management is required	(Brouthers et al, 1995)
Communication	
Performance needs to be measured and reported	(Devlin & Bleackley, 1988)
Sufficient planning is required	(Cooper & Gardner, 1993)
Systematic information exchange / information channels (inter and intra organizational) is/are required	(Cooper & Gardner, 1993), (Devlin & Bleackley, 1988)
Multiple points of contact between firms are beneficial	(Ellram, 1995)
Operating insight and control is required	(Cooper & Gardner, 1993)
Agreements	
Partners should agree on: clear and proportionally distributed risks	(Brouthers et al, 1995)
… distribution of rewards	(Ellram, 1995)
… sharing benefits and burdens (costs and risks)	(Cooper & Gardner, 1993)
Flexibility in agreement contributes positively	(Ellram, 1995)
Firms need to recognize limits of alliance (clearly defined projects, finite goals)	(Devlin & Bleackley, 1988)
Clear lines of accountability and responsibility need to be established	(Devlin & Bleackley, 1988)
Commitment	
Extendedness should be demonstrated (trust and loyalty)	(Cooper & Gardner, 1993)
Positive / high-quality personnel need to be appointed to partnership	(Devlin & Bleackley, 1988)
Partnership should receive recognition	(Ellram, 1995)
Personnel should be trained in partnering philosophies	(Ellram, 1995)
Firms should exercise corporate culture bridge building	(Cooper & Gardner, 1993)
Business model	
Partnerships lower risks and costs of R&D	Devlin & Bleackley (1988), Millson, Raj & Wilemon (1996)
Firms should recognize limited financial strength of SMEs	(Devlin & Bleackley, 1988)
Firms should utilize government stimuli	(Devlin & Bleackley, 1988)
Firms should be aware of activities in the environment (competition)	(Devlin & Bleackley, 1988)
Firms should recognize and act upon servitization of business	(Vandermerwe & Rada, 1989)

Partnership literature mainly focuses on relationships between two firms. Chapter 2 already emphasized the importance of a shift in focus, directed to ecosystems. The next section defines the concept and discusses ecosystem literature. It ends with a summary of ecosystem-related findings.

3.3 Ecosystems

Matchmaking, which is the purpose of the matchmaking platform, facilitates the creation of business ecosystems. This paragraph discusses the definition and origin of the term 'ecosystem', followed by a description of the typical roles seen in ecosystems. Subsequently, we emphasize the relevance of this concept to the research project, concluding with a summary of the findings related to ecosystems.

3.3.1 Definition and origin

Moore (1996, p. 26) defines an ecosystem as "*An **economic community** supported by a foundation of **interacting organizations and individuals**—the organisms of the business world. The economic community **produces goods and services of value to customers**, who are themselves members of the ecosystem. The member organisms also include suppliers, lead producers, competitors, and other* *stakeholders. Over time, they* ***coevolve*** *their capabilities and roles*." The following paragraph treats the different types of companies in such an ecosystem.

Mazhelis et al (2013) explain the origin and use of the term ecosystem, as derived from literature. The metaphor 'ecosystem' is widely used in the business setting. It is borrowed from biology and describes the network of actors in which a company operates. There are several similarities between natural and business ecosystems. In both, the actors in the network are interconnected. The network is complex and adapts by co-evolving actors. In ecosystems, the environment is defined by activities of other parties. In business ecosystems, the status of the network influences its members. Co-evolution may also lead to self-organization (De Reuver, 2009). In a system of interdependent actors, a form of order and organization often arises without central control exercised by a single firm.

3.3.2 Ecosystem-related roles

De Reuver (2009) emphasizes that complex (service) industries require more than traditional value chain models. To better understand and analyze business ecosystems, Iansiti and Levien (2004) suggest three critical roles within a business ecosystem. These roles are similar to roles found in biological ecosystems. Each role represents a firm's strategy within the system and is concisely explained below.

A *keystone* player is a firm that acts as an enabler or hub within the ecosystem. Such a firm generates benefits for the entire network. One of the tasks of the keystone is minimizing negative effects within the ecosystem by limiting the amount of firms with negative contributions. A keystone enlarges the ecosystem's productivity, stability and diversity and delivers a fundament for other companies to flourish by providing for example a software platform. In contrast to their impact, keystone players often make up a fraction of the mass of companies in the network.

A *dominator* eliminates and absorbs other firms' functions within the ecosystem, which results in a decreased diversity. Dominator firms are significantly larger than keystones. An ecosystem which is dominated by a dominator firm is generally less tolerant to disruptions from the environment, because of insufficient diversity. The authors distinguish two sub-types of dominators. A classic dominator creates and captures value by vertical or horizontal integration within their value network. A hub landlord creates little value, with a focus on maximizing value extraction from the network. Both the classic dominator and the hub landlord leave little room for other firms in their ecosystem.

A *niche player* is a small firm that develops a specific capability set. In ecosystems that form around keystone players, a large number of niche players make up the majority of the network. Having niche players within the ecosystem increases the health of the system as a whole, and decreases duplication of effort. It is not uncommon that niche players are part of several ecosystems at once (Mazhelis et al, 2013).

These roles, as Iansiti and Levien (2004) suggest, aid in understanding the basic dynamics in ecosystems. Defining the exact boundaries of such a system is still a challenging task. Often it can be seen that the boundaries of an ecosystem expand those of a traditional industry, and can easily span across multiple industries (Mazhelis et al, 2013).

According to Moore (1996), a typical ecosystem of any size consists of three layers: The core business, the extended enterprise and the surrounding business ecosystem. Within these layers, several common roles can be identified. Figure 16 depicts these common roles per ecosystem layer. When forming or growing an ecosystem, it is advised to be aware of these different roles, since a lack of (active) roles might negatively influence the ecosystem's performance.

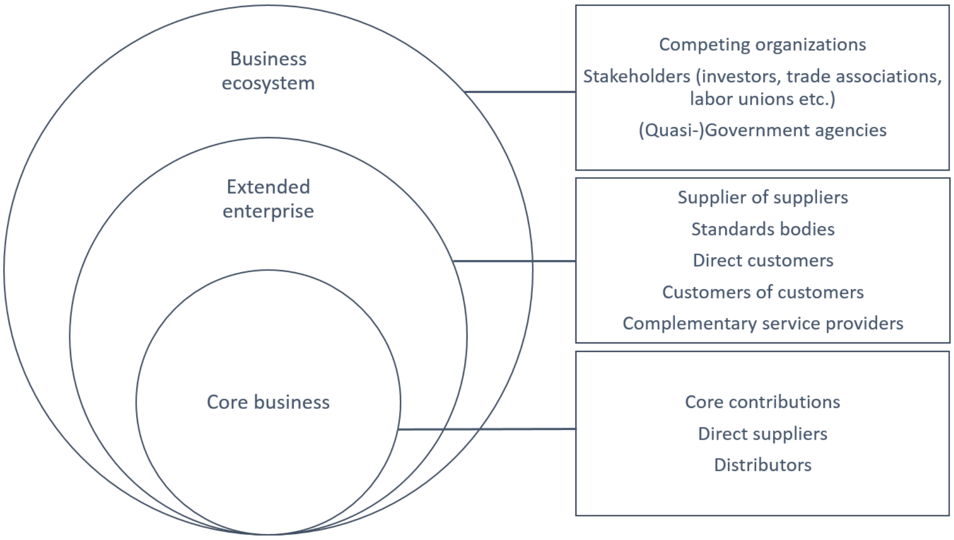


Figure 16: Roles in a typical business ecosystem (Adapted from Moore, 1996)

Within any ecosystem, several more specific functional roles can be identified. IoT-related ecosystems show roles related to physical devices, but also related to connectivity and service (Mazhelis et al, 2013). These specific roles, that typically can be seen in IoT ecosystems, have been discussed in more detail in chapter 2. The requirements that follow from operating in an ecosystem in general are summarized in the following section.

3.3.3 Ecosystem-related findings

The matchmaking platform that is designed during this research should lead to the creation and growth of ecosystems. In business ecosystems, requirements for partnership formation are possibly too limited to grasp all complexities. On the basis of literature, we thus derive several ecosystem-specific requirements. These supplement the partnership-related requirements of the previous paragraph and serve as input for the matchmaking requirement framework.

The high level descriptions in this paragraph implicitly or explicitly emphasize the importance of several issues, which can be translated into requirements for ecosystem creation and growth. In contrast to partnerships in 'simple' supply chains, a firm in an ecosystem has to be able to deal with interconnectivities between and co-evolution of multiple firms and individuals. All these parties should in some way contribute to the production of services or goods. By taking into account the generic ecosystem roles (Keystone, dominator, niche player), one can better analyze its own ecosystem. The typical roles across the three ecosystem layers (Core business, extended enterprise, business ecosystem) should be taken into account when creating and growing an ecosystem. They can serve as a generic blueprint for the business ecosystem.

Individual firms are, to a limited extent, able to shape and alter the ecosystem with their choices and innovations. However, dependencies in ecosystems are intricate. The actions of a single member are seen as too limited to predictably develop the whole ecosystem. Decision making processes are decentralized and the ecosystem is thought of as self-organizing (Mazhelis et al, 2013). In able to act effectively within an ecosystem, firms should realize their limited influence on the network. However, firms can influence their direct surroundings by choosing the right partners. According to De Reuver, Bouwman & Haaker (2009), selecting the right partner is crucial in gathering the necessary resources and capabilities to deliver a service. When multiple partners are involved in realizing a service offering, conflicts between partners can arise when similar resources are offered by two or more parties. A careful process of selecting the right partner for a specific role, without disappointing other partners, is likely to lead to an acceptable distribution of roles between all involved parties. Literature describes this form of control as 'input control'. Input control refers to partner selection and admission to an ecosystem. This process is executed by a dominant firm in the ecosystem in order to acquire desired skills and expertise (Mukhopadhyay et al, 2015).

To summarize, the ecosystem-related findings are shown in Table 7. These requirements are all related to the *Business model* requirement category. As seen in chapter 2, business models can be divided into four domains: Service, Technology, Organization and Finance. The ecosystem-related requirements specifically relate to the organization domain of business models.

Table 7: Main findings related to ecosystems

Findings per requirement category	**Source** (adapted from)
Business models (Organization domain)	
Ecosystems involve interconnectivities between multiple firms and individuals	Mazhelis et al (2013), Moore (1996)
All partners should contribute to the production of goods and/or services in ecosystem	Moore (1996)
Ecosystems feature co-evolving actors	Mazhelis et al (2013), Moore (1996)
Ecosystems require better visualization models than traditional value chains	De Reuver (2009)
There are three generic roles in ecosystem (Keystone, dominator, niche player)	Iansiti and Levien (2004)
There are three layers (core business, extended enterprise, business ecosystem) and corresponding roles in a typical ecosystem	Moore (1996)
An ecosystem should exercise selection of suitable partners (input control)	De Reuver, Bouwman & Haaker (2009), (Mukhopadhyay et al, 2015)
Ecosystems are often self-organizing networks (limited influence by single firm)	(De Reuver, 2009), Mazhelis et al. (2013)

Merely the creation of an ecosystem is no guarantee for a properly functioning and sustainable ecosystem. To sustain an ecosystem, relations between parties need to be governed. The following section discusses three mechanisms to achieve this.

3.4 Governance mechanisms

In the context of this research, the process of governing ecosystems with their dynamic relations is regarded as a post-matchmaking phase. However, since governance mechanisms need to be established during the matchmaking phase, the relevant mechanisms will be touched upon below.

The complexity of interdependencies in a business network results in a multitude of formal and informal agreements. Thus, the collaboration requires sufficient governance (Bouwman, De Vos &

Haaker, 2008). De Reuver (2009) argues that practitioners within these value networks ought to pay more attention to governance-mechanisms, since these are vital to their prosperity. In this context, the concept of governance is used to describe the way of organizing activities and resource exchanges within value networks.

De Reuver (2009) identifies three types of governance mechanisms in value networks. *Authority* is related to a hierarchy. Where within a firm there is often a case of formal authority through employment contracts, this mechanism mostly lacks between firms. In an inter organizational setting, authority stems from power differences between firms. This can be related to the concepts of keystone and dominator from the previous paragraph, where a single firm influences the actions of various others on the basis of its position within the network. *Contracts* are the second governance mechanism. Contracts are often regarded as extensive formal arrangements to capture uncertainties related to future events. Finally, governance can also be *trust-based*. Trust between cooperating companies is already discussed in §2.1 as being an important factor in partnerships. It is seen as complementary to formal arrangements. These three governance mechanisms within value networks can be regarded as independent dimensions, which do not exclude one another.

Consistent with previous paragraphs, the governance-related findings that we found relevant to the research are summarized in Table 8. When looking at the seven requirement categories, the requirements below can be interpreted in several ways. Depending on the active governance mechanism, it is possible to place the requirements in either the trust or agreements category. For consistency reasons, we attribute governance requirements to the agreements category. This because in any case, firms should implicitly or explicitly agree on the nature of their relation.

Table 8: Governance-related findings

Finding	**Source** (adapted from)
Collaboration requires governance	(Bouwman, De Vos & Haaker, 2008)
Three governance mechanisms in business networks: Authority, contracts and trust	De Reuver, 2009

3.5 IoT matchmaking requirements framework

To come to a workable set of requirements for the creation of partnerships in the IoT domain, we propose an IoT matchmaking requirements framework. This framework groups previous findings into seven *requirement categories* (Complementarity, Trust, Compatibility, Communication, Agreements, Commitment and IoT Business models). These categories are then plotted on the relevant phases of the partnership maturation process (Figure 15). The resulting framework can be seen in Figure 17. In the interview and design process, this framework is used to identify priorities from practice. First, we shortly discuss the contents of the framework.

In chapter 2 we discussed IoT business models. The requirements related to (IoT) business models (Table 4) can be divided into the four domains of business models: Service, Technology, Organization and Finance. Chapter 3 treated literature on three concepts, which are related to matchmaking: Partnerships, Ecosystems and Governance. The discussion of each of these concepts resulted in a set of findings for that specific concept (Table 6, Table 7, Table 8). We proposed to group these findings in seven categories, which make up the seven cells of our framework.

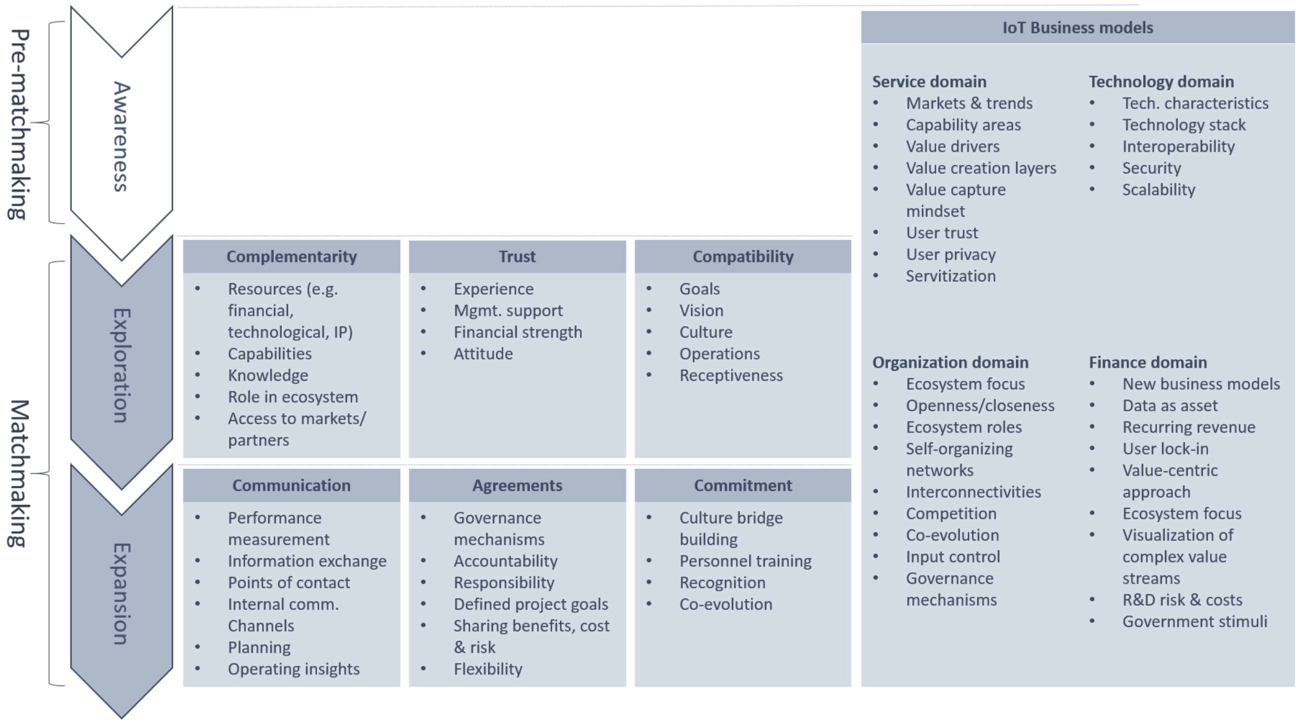


Figure 17: IoT matchmaking requirement framework

In line with resource dependence theory, a partner should add valuable resources or capabilities. Requirements related to this can be bundled in the first category, *Complementarity*. The second category is *Trust*, which includes the initial attitude and support of firms towards the partnership. Thirdly we identify the *Compatibility* category, which contains concepts, such as culture, receptiveness, goals and vision. The fourth category is *Communication*, which describes the information exchange requirements during later stages of the partnership. *Agreements*, includes the distribution of risks and rewards. The sixth category is *Commitment* which houses the requirements that describe actions that actively strengthen the partnership in a later stage, such as culture bridge building and personnel training. The final category is related to *Business models* and is thus divided into the four business model domains. The seven cells are plotted on three phases of the partnership maturation process (Awareness, Exploration and Expansion), which are displayed on the side of the framework. We defined matchmaking as a process that takes place in the exploration and expansion phase. However, some issues related to business models already play a significant role in the awareness phase. Therefore, the IoT business model category spans all three phases. The contents of the seven requirement categories are discussed below.

3.5.1 Complementarity, trust and compatibility

In the exploration phase, a firm identifies suitable candidates for partnerships. In any case, the partnership should deliver added value. Depending on the situation, the firm requires a new partner due to lack of resources, capabilities or knowledge. The candidates are then selected based on e.g. their expertise, but also their role in the ecosystem.

Subsequently, trust plays an important role in the selection process. Trust can be influenced by a potential partner's attitude and commitment, but also by confirmation of one's reliability. Requirements related to this are e.g. experience and financial strength.

In the exploration phase, partner compatibility is the final requirement area. Partner compatibility is assigned to factors like compatible goals, vision, culture and operations. A partner's receptiveness towards the partnership is also viewed as a factor that contributes to compatibility.

3.5.2 Communication, agreements and commitment

In the expansion phase, communication is of great importance. This implies that structural information exchange needs to be established, both within and between firms. It is desirable to have multiple points of contact between firms, and that the partnership's performance is structurally measured.

In line with good communication is the establishment of clear agreements between partners. These agreements can be trust-based, authority based or contractual. Important matters on which partners should agree are e.g. accountability, responsibility, definition of project goals and ways in which benefits, risks and costs are shared. A certain degree of flexibility in agreements is can contribute positively to the relationship between partners.

The final requirement area is extendedness. This area contains requirements that contribute to the experience of trust and loyalty between partners. Examples are showing recognition, actively practicing culture bridge building and training personnel in partnering philosophies.

3.5.3 IoT Business model generation

The process of generating and renewing a business model is seen as a continuous one. The need for partnership creation, often related to a developing business model, arises in the awareness phase. In this phase, several requirements arise, which continue to be important during the exploration and expansion phase. Examples are that a firm should be aware of trends, markets and opportunities. Prior to establishing new partnerships, it is also required that a firms realizes the potential implications of the business ecosystem on their developing business model. In line with chapter 2, the requirements of IoT business models are divided into the four business model domains.

The proposed framework will serve as a guideline during the interview phase of this research. In this phase, we prioritize and complement matchmaking requirements in order to generate a requirement set for the matchmaking platform.

3.6 Conclusions

The main goal of business matchmaking, within the scope of this report, is the formation of long-lasting, mutually beneficial partnerships between complementary companies. Selecting the right partner is crucial in gathering the necessary resources to deliver a service. A careful process of selecting the right partner for a specific role, without disappointing other partners, is likely to lead to an acceptable distribution of roles between all involved parties. Partnering in new product development is seen as a maturation process instead of a discrete event.

From literature, several driving forces and requirements are identified. These are related to both partner suitability and the process of matchmaking. Driving forces are stimuli that instigate partnership formation. Examples are the need for improved efficiency, common goals or government subsidies. Requirements for partnerships are closely related to compatibility and complementarity of companies.

Models of traditional value chains are unable to correctly describe complex situations in e.g. a service industry. The concept of ecosystems offers a solution. It is borrowed from biology and describes the economic community of interacting organizations and individuals in which a company operates. Three critical roles in a business ecosystem can be identified: keystone, dominator and niche player. Each role represents a firm's strategy within the system. A typical ecosystem can be divided into three layers: Core business, extended enterprise and business ecosystem. Each of these layers has several frequently seen roles.

The complexity of interdependencies in a network results in a multitude of formal and informal agreements. Governance mechanisms are said to be of vital importance in business networks. In the context of this research, the process of governing ecosystems with their dynamic relations is regarded as a post-matchmaking phase. However, since governance mechanisms need to be established during the matchmaking phase, they are briefly touched.

The findings that result from partnership, ecosystem and governance literature are combined with the IoT business model findings from chapter 2. We propose an IoT matchmaking requirements framework (Figure 17) that divides these findings into seven requirement areas (Complementarity, Trust, Compatibility, Communication, Agreements, Commitment and IoT Business models). These areas are plotted along three phases of the partnership maturation process (Awareness, Exploration, Expansion).

The proposed framework will serve as a guideline during the interview phase of this research. In this phase, we collect additional requirements in order to generate an updated requirement set for the matchmaking platform. However, in the next chapter we first analyze existing B2B matchmaking platforms in order to identify generalizable design principles.

4. B2B matchmaking platforms

In Chapter 3, we already defined the concept matchmaking as being the process of bringing two or more firms, and their resources, together. The aim of this thesis is to assess the feasibility of facilitating this process by means of an online platform. This chapter aims to answer the second sub question of this research: What design principles can be derived from multi-sided platform literature and analyzing existing matchmaking platforms? Therefore, this chapter explains first what a platform entails in the context of this thesis, by looking at both technical and economic definitions. Subsequently, we discuss common obstacles and strategic choices that similar platforms encounter. Then, these issues are combined in an analysis framework for platforms. Using the framework, we describe characteristics of three existing B2B matchmaking platforms: Alibaba.com, Powerlinx and Enterprise Europe Network. This is done on the basis of information available on the respective websites. From the analysis, conclusions are drawn on how these current platforms try to overcome common obstacles. These conclusions, and the findings from literature, are summarized as design principles for B2B matchmaking platforms in general. In the first hunch design phase of this thesis (Chapter 5), we build on these conclusions in order to generate an initial set of requirements for the platform.

4.1 What is a platform, and what isn't?

Platform is a concept that is widely used and to some extent misused. In computer science, a platform is a computer system that serves as the basis for applications to run on ("Platform definition - Techtarget", 2016). This system refers to one of three abstraction levels: hardware, operating system or application ("Platform - FOLDOC", 2016). When looking at the technologies involved in a general IoT ecosystem, as described by Porter and Heppelmann (2014), the word platform refers to an application platform. This is a software environment for development and execution of applications.

For the platform design process in this thesis, we adhere to a broader, more economic view on software-based platforms. This view is based on the interaction characteristics of multi-sided platforms (MSPs): **A (multi-sided) platform creates value by serving as a facilitator for interaction between multiple distinct user groups.** This definition excludes single-sided platforms, which can be seen as mislabeled products or services (Tiwana, 2014). Examples of MSPs are Windows, Facebook, Amazon, eBay, Google, Firefox, Alibaba, Airbnb and Uber. A common characteristic in MSPs is the presence of cross-side network effects, which result in strong entry barriers when starting an MSP. In such a case, customer value on one of the platform's sides is determined by the amount of participants on the other side (Hagiu, 2014). MSPs can also be subject to same-side network effects. In that case, customer value is determined by the amount of users on the same side of the platform. Challenges related to network effects and other obstacles in the design and growth of a MSP are discussed in the next paragraph.

4.2 Obstacles and strategic choices for MSPs

For the identification of common platform obstacles, we turn to literature on multi-sided platforms. In his research, Hagiu (2014) identifies several large obstacles related to building an MSP and expanding its user base. First of all, MSPs experience the *chicken-and-egg* or *critical mass problem*. As a result of cross-side network effects, users on one side of the platform are not willing to join without sufficient presence on the other side. Secondly, MSPs might experience *resistance from important stakeholders*, who don't want to be at the mercy of a platform. On the other side, MSPs want to create high switching costs for users with the intent to achieve lock-in. Thirdly, an MSP is subjected to *conflicting interests* of the different user groups, which contributes to the complexity of running such a platform. Finally, contributing to high entry barriers for MSPs are *economies of scale*. Development costs of a platform often require large investments, while the marginal costs of adding users is close to zero. A total of four strategic choices related to these barriers are discussed below. According to Hagiu (2014), specifically these four choices distinguish MSPs from other types of businesses. The issues discussed, related to these four choices, make up the rows of the analysis framework presented in section 4.3.

4.2.1 The amount of 'sides'

Multi-sided platforms are, as the name suggests, not limited to serving two sides. An example is the networking platform LinkedIn, which connects users (professionals), recruiters and advertisers. Other commonly seen user groups are application developers, sellers of goods or services and buyers (both consumers and firms). Adding more sides can bring advantages in the form of larger cross-side network effects, more diverse revenue sources and a larger scale. However, there are also burdens involved in having multiple sides involved. First of all, not every possible user group can serve as an economically viable side. Secondly, complexity increases by adding user groups. This can constrain the ability to quickly innovate, partly due to limited resources. Thirdly, there might also be conflicting interests between several sides. Hagiu (2014) proposes to start with a two-sided concept and possibly expand in a later stage.

4.2.2 Design issues

Platforms can offer a wide variety of features that can help to reduce users' search costs, transaction costs and development costs. Search costs incur before two sides interact. Transaction costs relate to costs that are incurred during interaction between sides. Development costs apply to the process of creating a new product or service. It is argued that most of these features can be included or excluded on the basis of a cost-benefit analysis: if the user's value of a functionality is higher than the development costs, the functionality should be included. However, the possibility for costly mistakes is not to be underestimated, since the estimated value of a feature might differ from the actual or perceived value.

Features that result in conflicting interests pose the most difficult design decisions that can even result in strategic trade-offs. An example is the balance between exposure of advertisers versus the intrusion of users. Hagiu (2014) proposes that trade-offs should be consistently solved by taking into consideration the preferences of the target user groups that are most vital to the MSP's long term existence and profitability. This might be in conflict with the interests of users that currently provide the largest revenue.

4.2.3 Pricing structures

Because of the distinct user groups that an MSP serves, it can potentially generate multiple revenue streams. However, it is commonly seen that platforms provide free or subsidized services to at least one user side in order to be able to generate profits on the other side. This is often related to overcoming the critical mass problem and the cross-side network effects mentioned earlier this chapter. Based on findings among business executives, Hagiu (2014) poses three pricing principles for MSPs.

Charge according to the price sensitivity of each distinct user group. This mechanism applies to almost any case. Each side of the platform represents a distinct user group, and should thus be charged differently. In case of a low price sensitivity, the platform can charge more to that user group. Price sensitivity is influenced by a platform's bargaining power over a certain user group.

In the absence of a monetary transaction between sides, set pricing according to which side benefits most. It is often seen that one user group is able to use the platform's services for a reduced price, since these users generate value for the other side of the platform. In many cases, the services are even provided free of charge. The other side is charged more, since it derives more value from the presence opposite side.

In the case of a monetary transaction between sides, charge according to which side extracts more value. Similar to the previous pricing principle, the side that derives more value from the use of the platform should be charged more. In this case however, there is a financial transaction involved between e.g. a buyer and a supplier of any sort. Since the supplier is expected to derive significant benefits from the transaction, he can be charged more. This alleviates the burden on the side of the buyer, that might otherwise be disincentivized to participate.

To conclude, a platform should aim to find a balance between value creation and value extraction. Value creation is linked to the size of a platform's user base. Subsidized services can help to grow the user base, and thus increase a platform's value. For the continuity of a platform, revenue creation should be mainly focused on the user group that benefits most from the platform's services, either directly or indirectly.

4.2.4 Platform ecosystem governance

As mentioned in the definition earlier this chapter, the common characteristic of MSPs is the facilitation of interaction between multiple distinct user groups. These user groups make up a large part of a platform's core ecosystem. In such a situation, the MSP itself typically fulfills a keystone role. In order to guarantee an MSP's value proposition, the platform can apply non-financial governance rules. Firstly, by applying *access rules*, the platform can control *who is able to join*. This is related to the input control, mentioned in Chapter 2. Secondly, by applying *interaction rules*, the platform controls what the distinct user groups are allowed to do. Both types of rules contribute to a desired quality level. However, since enforcing these rules may be costly, parts of quality assurance can be 'delegated' to users through e.g. rating systems (Hagiu, 2014).

In general, MSPs should be aware of possible market failures, which could lead to an improperly functioning ecosystem. According to Hagiu (2014), active governance should be applied when one or more of the following three sources of market failures are present.

Quality uncertainty: In case of a lack of transparency in the market, the quality of services and goods may be unknown. This is potentially dangerous for credibility, e.g. in the case that high-quality suppliers are driven out by low-quality suppliers.

Competition within one side of the platform: User groups of an MSP often expect a certain return on investment when they engage with such a platform. Without any form of entry restriction or quality control, competition within one side of a platform might become too high. A high degree of competition can disincentivize users to invest in e.g. high-quality products and services.

Concerns for spillover: Without strict platform governance, users are not likely to invest in actions that produce positive spillover effects for competing users. This is especially relevant for platforms where users invest in products and services, e.g. software applications, that are offered through the MSP.

To conclude, a platform can take multiple active governance measures to assure the quality of its ecosystem. This vital role can best be fulfilled by the keystone player in the ecosystem, in order to prevent common market failures. Mainly, an MSP can influence admission to the ecosystem through access rules, and actions of users through interaction rules. Practical examples of how current platforms apply these governance rules, and the consequences for the design of a new MSP are discussed in section 4.4. In the section below, we propose a framework that structures the analysis of existing MSPs.

4.3 MSP analysis framework

On the basis of Hagiu's (2014) main findings, we propose a multi-sided platform (MSP) analysis framework. This framework will serve as a reference for analyzing three existing B2B matchmaking platforms, as discussed in the next section. Table 9 gives a representation of the framework. The rows of the framework represent nine platform characteristics, which are derived from Hagiu's (2014) strategic choices for MSPs. For clarification purposes, each characteristic is shortly described in the figure. The columns of the framework will represent the analyzed platforms.

Table 9: MSP analysis framework (based on Hagiu, 2014)

MSP characteristic	**Description**
Amount of sides	Number of distinct user groups, served by the MSP
User groups	Description of each of the user groups
Primary functionality	Main value proposition of the MSP: Reduction of (1) search costs, (2) transaction costs, or (3) development costs
Secondary features	Specific value-adding features
Network effects	Type(s) of network effects applicable: (1) Cross-side, or (2) same-side
Market failure sources	Possible sources of market failure, that need to be counteracted: (1) Quality uncertainty, (2) same-side competition, or (3) spillover concerns
Pricing structures	Pricing mechanisms per user group
Governance: access rules	Manner in which user access is determined/restricted
Governance: interaction rules	Manner in which user interaction is determined/restricted

In order to systematically design a first hunch concept of our matchmaking platform, we use the above framework to analyze three existing B2B matchmaking platforms in the next section. The specification towards requirements for an IoT-specific matchmaking platform will be discussed in Chapter 5.

4.4 Existing matchmaking platforms

As input for the 'first hunch' design stage, a total of three B2B matchmaking platforms are analyzed using the framework as discussed in previous paragraph. The platforms discussed below are Alibaba.com, Powerlinx and Enterprise Europe Network. The choice for these three platforms as subjects for the analysis is primarily based on their variety. While all three platforms facilitate B2B partnerships, the platforms have varying properties (e.g. target users, features, age and size). Alibaba.com is the world's largest B2B search engine and trading platform. It is an established and profitable global player, which has been active for over 15 years. Founded in 2012, Powerlinx is a relatively young company, but the several millions (USD) of investments make it a promising player. Finally, Enterprise Europe Network is chosen because it doesn't have a commercial approach. It was launched in 2008 by the European Committee to stimulate SME cooperation within Europe.

Information for the analysis is gathered from each of the company websites. A summary of the findings is presented in Table 10. From the analysis, conclusions are drawn on how these current platforms try to overcome MSP-related obstacles. Based on these conclusions, we propose a first hunch design in Chapter 5.

4.4.1 Alibaba.com

Alibaba Group Holding Limited is an e-commerce company based in China. The company provides i.a. electronic payment services (Alipay) and C2C (Taobao), B2C (AliExpress) and B2B (Alibaba.com) trading platforms. The focus of this analysis is on Alibaba Group's B2B trading platform, equally named Alibaba.com. Alibaba.com is the world's largest B2B search engine and trading platform. Figure 18 displays a part of Alibaba.com's homepage. The platform serves at least four types of users: buyers, suppliers, advertisers and purchasing agents. The majority of the users are small and medium-sized enterprises. For buyers, the main functionalities of Alibaba.com are the reduction of search costs and transaction costs related to sourcing (Hagiu, 2007). This is facilitated by the Alibaba.com search engine and the online order management features. For suppliers and advertisers, the increased visibility is the main functionality of the platform. Purchasing agents can offer their intermediary services through the platform. Since purchasing agents are not one the platform's main user groups, they will not be treated further. The platform's secondary features are mostly related to selling tools and order protection. Examples of services for suppliers are online training programs and order management tools. Examples of buyer services are Alibaba's chat, payment protection, company inspection, logistics, business identity and financial loans services ("Alibaba.com", 2016).

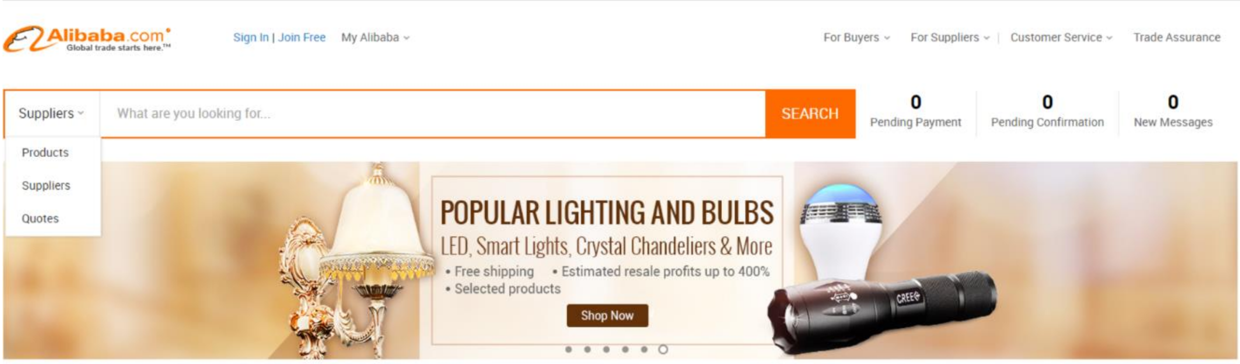


Figure 18: Homepage Alibaba.com (Source: www.alibaba.com)

The main sources of possible market failures in the case of Alibaba.com are the uncertainty of supplier quality and the competition between suppliers. The platform aims to solve these problems by its pricing schemes and by offering features like Business Identity service and Inspection Service. These services reduce the quality uncertainty for buyers and possibly prevent disincentives for high-quality suppliers. In order to quickly grow its user base, Alibaba.com offers its features for free to buyers worldwide. Suppliers outside of mainland China are able to use the platform's basic features for free. Suppliers in mainland China are required to purchase a premium membership, which is optional for suppliers elsewhere. The fee for this membership starts around $5000 (USD) per year. The premium membership requires authentication procedures to increase supplier credibility. It also offers promotional benefits, adding advertiser characteristics to this specific user group. This pricing scheme is an example of charging according to which side extracts more value. The mandatory assessment for Chinese suppliers also acts as a governance mechanism, assuring a certain quality level. Next to this access rule, the platform also enforces interaction rules. An example is that suppliers can only be contacted through the platform's inquiry form, since not all address details are disclosed ("Alibaba.com", 2016).

4.4.2 Powerlinx

Powerlinx is a globally operating B2B matching platform. The platform serves as a marketplace where companies can connect to other companies. It aims to facilitate the creation of strategic partnerships or other business opportunities. Figure 19 displays Powerlinx' homepage. The first user group of the platform consists of companies that want to find partners, thus looking for specific services or products (buyers). The second group consists of companies that want to be found, thus offering specific services or products (suppliers). Since these two groups are not necessarily mutually exclusive, the platform experiences not only cross-side network effects, but also same-side network effects. Simply put, the platform's value increases as the amount of users increases. The primary functionality of the platform is in the reduction of search costs related to partnerships. This is facilitated by the possibility to post partnering requests. The platform claims to predict compatibility between two firms based on collected data, both from the platform and from other sources. This feature is named PowerScore (Powerlinx.com, 2016).

Figure 19: Homepage Powerlinx (Source: www.powerlinx.com)

Also on Powerlinx, the main sources of possible market failures are the uncertainty of supplier quality and the competition between suppliers. Powerlinx partly aims to prevent these market failures through their pricing structure. A basic membership is free for all users and provides limited functionality. Premium memberships can be purchased for an annual fee of $1000 or $5000 per company, depending on the desired functionalities. In addition, premium users can increase visibility by promoting their request in exchange for a fee. The platform's governance mechanisms are fairly straightforward. Only premium members are allowed to contact other companies. This contact can either be a direct message, or through a representative of Powerlinx. Each method of contact has a limited number of uses, preventing misuse (Powerlinx.com, 2016).

4.4.3 Enterprise Europe Network

Enterprise Europe Network (EEN) is an instrument of the EU, launched by the European Committee, that aims to support SMEs in their business opportunities. The network offers a range of services, both on- and offline. They describe the services as local, free and tailored support for innovation. Online services are provided by a platform. Offline services are provided through a network of more than 600 supporting organizations across Europe. Both online and offline aspects of the network are treated below.

The platform connects business parties (SMEs) with either offers (suppliers) or requests (buyers) related to commerce, technology and R&D. A database of partnership requests and offers can be accessed through a search engine, as displayed in Figure 20. This should result in reduced search costs related to partnerships. Through a standard inquiry form, a company can contact a possible partner. Since the platform is subsidized, access is free for all users. This seems to limit possible market failure sources. However, quality uncertainty also plays a role in this platform. Since users can play different roles at different times, the platform is also subject to same-side network effects. The platform shows no apparent governance mechanisms that should limit quality uncertainty. Initial contact between parties however, is limited to the earlier mentioned inquiry form. The rather limited functionality of the platform itself is complemented by local support opportunities (Enterprise Europe Network, 2016; Enterprise-Europe (2016)).

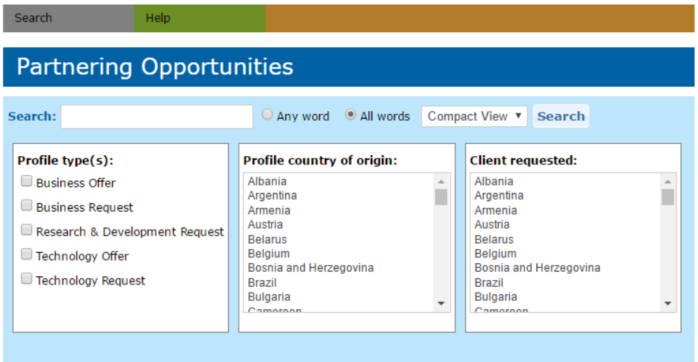


Figure 20: Enterprise Europe Network search engine (Source: een.ec.europa.eu)

Through the online platform, users are also able to connect to local support agencies. The network of more than 600 organizations consist of i.a. chambers of commerce, foundations, research agencies and firms form different industries. These organizations offer their services to mostly SMEs. In many cases, these services are sponsored by EEN. Examples of services offered through EEN are access to funding, new markets, technology, innovation management support and advise on sourcing, licensing, IP and legislation. The contributing organizations are divided into sector groups, with 10 to 60 partners each, in order to increase the level of service and effectiveness.

4.4.4 Conclusions of the platform analysis

As a result of the previous analysis, Table 10 shows an overview of the characteristics of the three discussed platforms. From the analysis of these multi-sided platforms, we can draw several conclusions on how these current platforms try to overcome MSP-related obstacles. Based on these conclusions, we propose a first hunch design in the next chapter. Below, we briefly discuss the amount of sides, features, trust building, network effects, pricing and governance. Subsequently we clarify in which way the IoT matchmaking platform can benefit from these examples.

Table 10: Overview of the matchmaking platforms analysis

MSP characteristic	Alibaba.com	Powerlinx	Enterprise Europe Network	Conclusions
Amount of sides	4	2	3	Initially limit to 2
User groups	Buyers; Suppliers; Advertisers; Purchasing agents	Buyers; Suppliers	Buyers; Suppliers; Local support agencies	Buyers; Suppliers
Primary functionality	Reduce search costs (find products and suppliers); Reduce transaction costs (manage orders online); Increase visibility	Reduce search costs (find partners, buyers or suppliers)	Reduce search costs (find partners, buyers or suppliers); Reduction of transaction and development costs (offline)	Reduce search costs (initially); Possibly use offline partners
Secondary features	Online training programs; Order management tools Payment protection; Inspection / verification; Logistics; Financial loans;	Predict compatibility (PowerScore); Promoting requests	Facilitate contact between firms; Access to funding, markets, technology; Innovation mgmt. support; Advice on sourcing, licensing, IP, legislation	Should contribute to perceived quality and credibility (warranty, testimonials etc.)
Network effects	Cross-side	Cross-side; Same-side	Cross-side, Same side	At least cross-side
Market failure sources	Supplier quality uncertainty; Supplier competition	Supplier quality uncertainty; Supplier competition	Supplier quality uncertainty	Overcome through offering features
Pricing structures	Free for buyers and (non-China) suppliers; Premium supplier membership (> $5000 p/y)	Free basic membership; Premium membership ($1000 - $5000 p/y)	Free (subsidized platform)	Freemium; Subsidize one side
Governance: access rules	Mandatory assessment for premium suppliers	N.A.	N.A.	Supply side access rules for quality assurance
Governance: interaction rules	Buyer-supplier contact only through inquiry form	Contact only for premium members	Contact only through inquiry form	Dictate content and frequency; Ensure platform power position

Looking at distinct user groups, or sides, the analyzed platforms choose fairly straightforward user groups. All platforms include at least a supply and a demand side. Only Alibaba.com, the largest and most mature of the three platforms, takes a more complex approach by servicing 4 user groups. The essential functionality of all the analyzed platforms is very similar: Reduction of search costs. Again, only Alibaba.com also aims to reduce transaction costs through their platform. Enterprise Europe Network (EEN) also aims to reduce transaction costs, and even development costs. However, this is not directly supported by the platform, but mainly by local support agencies. Secondary features on the platform either directly contribute to the primary functionality, or aim to increase user trust and credibility. User trust is built by quality assurance features like payment protection or company verification. EEN makes use of size and the local partners in their network to increase credibility and trust. All analyzed platforms use some sort of testimonial section to generate credibility. The chicken-and-egg problem related to cross-side network effects is mainly tackled by subsidizing at least one side of the platform. Alibaba.com and Powerlinx also make use of a freemium pricing model. This lowers the barrier for new users to interact with the platform. EEN does not have a commercial approach and it therefore has no pricing structure. Governance mechanisms are executed on two levels. Firstly, the composition of the user ecosystem is determined by access rules. All platforms require at least a complete user profile to be made, before any supplier-side features can be used. Alibaba.com shows the most extreme access rules. Partly to increase credibility and buyer trust, all Chinese suppliers require verification and a paid subscription in order to create an account. Secondly, in all cases, user-user interaction is limited by standard contact mechanisms. From a user perspective, this is less than ideal. However, from the perspective of the platform, these limitations serve multiple purposes. Firstly, the platform can dictate the way of contact, limiting unwanted interaction. Secondly, the platform ensures its continued value to the user by not enclosing all information directly. Thirdly, the amount of unpaid contact can be limited in order to stimulate the user to buy a premium subscription.

Of the three analyzed MSPs, Alibaba.com is clearly the most successful platform in economic terms. This suggests that mimicking the approach of Alibaba.com is likely to benefit the IoT matchmaking platform. However, the other two platforms possess interesting characteristics, which could prove to be beneficial as well. The essential takeaways of the analysis, which will be included in the first hunch design of the IoT platform, are as follows. Especially in the initial stages, it seems best to focus on no more than two user groups. The first user group should represent a supply side, while the other represents a demand side. The reduction of user search costs is an apparent primary functionality. Other functionalities, such as reduction of transaction or development costs can be added in a later stage. Especially Enterprise Europe Network shows interesting collaboration with a network of local organizations in order to expand their functionality. Quality and credibility assurance of the platform is clearly an important issue for all three platforms that were analyzed. Methods to assure quality and increase credibility vary among platforms, but boil down to similar principles. Quality can be assured through features, such as buyer protection or guarantees, but also through the verification of suppliers. The platforms mainly attempt to increase credibility by leveraging network size and displaying testimonials. Due to a freemium pricing model, platforms aim to overcome the chicken-and-egg problem. In practice, this results in at least one subsidized side of the platform. At the demand side, it is not common to have strict access rules for users. On the supply-side however, access rules are able to contribute to the perception of quality. Interaction rules are mainly used to dictate the method, frequency and content of interactions. However, these rules also ensure a platform's position of power, since users require the platform facilitation of communication.

The following chapter builds on the conclusions above in order to generate an initial (first hunch) design of the IoT matchmaking platform.

4.5 Conclusions and design principles

This chapter aims to answer the second sub question of this research: What design principles can be derived from multi-sided platform literature and analyzing existing matchmaking platforms? Therefore, we first distinguish two views on platforms: a technical and an economical view. For the platform design process in this thesis, we adhere to a broader, more economic view on software-based platforms. This view defines multi-sided platforms (MSPs) as software creating value by serving as a facilitator for interaction between multiple distinct user groups. Subsequently, we discuss common obstacles and strategic choices that similar platforms encounter. These issues are combined in an analysis framework for platforms. Using the framework, we describe characteristics of three existing B2B matchmaking platforms: Alibaba.com, Powerlinx and Enterprise Europe Network. From the analysis, we draw conclusions on how these current platforms try to overcome common obstacles. We summarize the conclusions from literature and the MSP analysis in design principles for B2B matchmaking platforms, which are shown in Table 11.

Table 11: Design principles for B2B matchmaking platforms

Design principle	**Description**	**Source**
Start simple	Preferably start with no more than 2 distinct user groups	Hagiu (2014)
Functionality	Primary functionality is the reduction of search costs, transaction costs or transaction costs (or combination)	Hagiu (2014)
Vital user first	Consistently solve trade-offs for the benefit of the most vital users	Hagiu (2014)
Price sensitivity	Charge according to the price sensitivity of each user group	Hagiu (2014)
Benefit costs	Charge more to the user group that benefits more / extracts more value	Hagiu (2014)
Access rules	Access rules (determine who joins) limit market failures	Hagiu (2014)
Secondary features	Secondary features can contribute to perceived quality (e.g. offer warranty, tools etc.)	MSP analysis
Testimonials	Testimonials of (well known) users increase platform credibility	MSP analysis
Distinguish supply side users	Market failures are limited by offering features that distinguish supply side users (e.g. rating mechanisms, quality mark etc.)	MSP analysis
Partners	Network of partners increases platform credibility	MSP analysis
Limit interaction	Limiting interaction between users (e.g. through standard contact form) limits market failures and can contribute to the platform's sustained added value	MSP analysis

The design principles aim to convey knowledge about the creation of other artifacts with similar properties. Therefore, these principles should be applicable to a class of platforms. The relevant class can best be described as platforms that facilitate interaction between distinct groups of business users. The conclusions of the analysis, and the previously discussed design principles, contribute to the creation of a first hunch design in the next chapter.

5. First hunch: Requirements and assumptions

Phase three of this thesis aims to answer the third research question: What (first hunch) platform requirements can be derived from previous analyses? Based on the experiences of practitioners involved in this project, and the previous analysis of other B2B matchmaking platforms, this chapter describes the first hunch of the IoT platform design process. Similar to the approach in the previous chapter, the platform is discussed using the MSP analysis framework. A summary of the proposed characteristics can be seen in Table 12. According to the method described by Verschuren and Hartog (2005), the first hunch description is accompanied by the platform's goal(s) [G], requirements [R], and assumptions [A]. The latter two can be divided into functional, user-related and contextual aspects. Emphasis should be placed on the fact that the requirements and assumptions are mainly focused on the functional aspects of the platform. Non-functional requirements are of such importance, that at this point they assumed to be fulfilled. These requirements are related to e.g. quality, privacy, security, sustainability, scalability etc.

5.1 IoT-Match

From this point onward, the artifact that is to be designed during this thesis will be referred to as 'the platform' or 'IoT-Match'. The latter serves as a working title for the platform. As discussed in Chapter 1, the goal [G] of IoT-Match is to ease ecosystem creation and growth in the IoT (care) domain, by facilitating partnership formation. This is done by facilitating interaction between two or more firms. This results in the following value proposition for the platform: *IoT-Match reduces partnership-related search costs for SMEs in the care domain, by recommending suitable partners.*

Table 12: First hunch characteristics of IoT-Match

MSP characteristic	IoT-Match
Amount of sides	2
User groups	Supply and demand of capabilities, knowledge and resources related to IoT and healthcare in the Netherlands
Primary functionality	Recommendation of suitable partners (reduce search costs related to establishing partnerships); Reduction of transaction and development costs can apply to a later stage
Secondary features	Reliability score; Compatibility score; Promotional opportunities
Network effects	Cross-side; Same side
Market failure sources	Quality uncertainty
Pricing structures	Set pricing according to which side benefits most; Free basic functionalities; Premium membership
Governance: access rules	Mandatory inspection or identity confirmation for premium suppliers
Governance: interaction rules	Limited contact possibilities between firms

As shown in Table 12, we use the MSP analysis framework from Chapter 3 to describe the proposed characteristics of IoT-Match. The platform will serve two distinct user groups in the initial stages. These two sides represent the demand and supply sides in B2B matchmaking. Both of the user groups consist of Dutch firms that can contribute to products and services in the care domain of the healthcare sector. The supply side of the platform mainly consists of providers of IoT-related capabilities, knowledge and resources. The supply can thus be tangible or intangible. More specific examples of users on this side of the platform are contract manufacturers and M2M solution providers. The demand side of the platform is represented by IoT-related firms that recognize a capability, knowledge or resource gap within the company when pursuing an innovative goal. Partially, this user group consists of (healthcare) startups that are in need for partners in developing their product and value proposition. Incumbent firms can also be part of the target group, when current value propositions are 'upgraded' to smart solutions. In this case, existing partnerships of incumbent firms might not suffice to create the desired products or services. Since supply and demand sides are not always clearly distinguishable in partnerships, firms can be part of both user groups, depending on the context. For example, a single firm can serve as supplier to its client while simultaneously being in need for a new technology partner. As a result, IoT-Match is subject to both cross-side and, to a limited extent, same-side network effects. Meaning that the value for user group A is not only dependent on the size of group B, but also on the size of group A. This also applies vice versa.

The primary value of IoT-Match lies in the reduction of companies' search costs related to the creation of partnerships. IoT-match should contribute in this process by advising on factors such as reliability and compatibility of possible partners. Next to the reduction of search costs, the platform could also lower transaction and development costs, by providing tools to facilitate the innovation process. Adding tools is possibly interesting in a more mature stage of the platform, since this could yield synergies with the existing tools of Inpaqt.

A possible market failure source for IoT-Match is quality uncertainty. There are multiple ways of reducing the risk of failure. First, the platform can deter low-quality suppliers through pricing mechanisms. Secondly, reliability and compatibility assessments should lower the quality uncertainty. Finally, governance mechanisms can contribute to a high quality experience. The first hunch on each of the measures is shortly explained.

In order to stimulate growth of the user base, some functionality should be available for free to all users. This includes searching the database and posting partnership requests. For the supplier side, a paid premium membership is optional. This membership should enable the user to make use of additional features. These features can be in the form of company assessments or promotional opportunities. The user on the demand side of the platform can be charged for contacting a supplier through IoT-Match. The availability of company assessments enables firms to increase their credibility. By limiting some of the assessments to premium accounts, quality uncertainty can be diminished. Governance rules can include a mandatory inspection or identity confirmation for premium users and limited contact possibilities between firms. The following section discusses what functional requirements follow from the proposed first hunch design.

5.2 Requirements and assumptions

In line with the method of Verschuren and Hartog (2005), the first hunch description of the platform is further specified. This paragraph explicitly shows the requirements [R] and assumptions [A] related to the artifact. These requirements are primarily derived from the first hunch characteristics, as described above. Additional requirements follow from practitioners. The requirements are divided in three sections: Functional, user-related and contextual. Functional requirements describe the functions that the platform should provide in order to reach the described goal. When looking at the interface between the platform and the outside world, we first sum up the user-related requirements. These requirements describe functions that the platform should fulfill on behalf of the targeted user groups. Finally, contextual requirements describe the prerequisites that the platform needs to meet due to its (e.g. social, juridical, economical) environment. An overview of the platform's first hunch requirements can be seen in Table 13.

Table 13: First hunch requirements [R] (categories from IoT matchmaking requirements framework in blue)

Functional requirements	**User requirements**	**Contextual requirements**
Authentication (multiple authorization levels: public, free user, premium user)	Subscription levels (free, premium)	Legislation
Possibility to create two types of accounts (supply, demand)	Complement existing company profile from database	Stakeholder contributions (e.g. initial database entries, website content, consultancy services)
Account features extensive company profile (complemented by user)	User complementarity search (resources, experience)	
Database with profiles of Dutch IoT / care related companies that contribute to product/service creation	User compatibility score (culture, goals etc.)	
Search engine (browse or filter profiles)	User reliability (trust) score (financial, technical etc.)	
Recommend potential matches based on company profile		
Section to post requests for cooperation (marketplace)	Verification of supplier profile (i.a. resources, quality, experience)	
Online company assessments		
Mandatory inspection or identity confirmation (paid subscription)	Promote cooperation request (paid subscription)	
Facilitation of inter-firm communication according to standard contact form (paid subscription)	Facilitation of inter-firm communication, agreements and commitment building	
Testimonial section	Facilitation of IoT business model creation	

Table 13 shows the requirements as derived from the first hunch characteristics and input from practitioners. The requirements in blue are derived from the IoT matchmaking requirement framework from chapter 3. Since the platform has two distinct user sides, it should offer the possibility to create both supplier and demand side accounts, including authentication features. The initial platform should already possess a database of profiles, albeit with limited content. Users should then be able to complement these profile when creating an account for that firm. To manually navigate through the database of profiles, the platform should have a search engine with filter capabilities. Factors such as compatibility and complementarity scores between firms should ease this search process. In addition, the platform should recommend potential partners on the basis of a firm's profile. A third method of searching for partners is a marketplace-like area on the platform. Here, firms can post requests for cooperation. In order to reduce quality uncertainty and increase credibility, the platform should provide features such as online assessments and profile verification. Due to the pricing structure, the platform should facilitate different subscription levels. The platform should also enforce interaction rules between users, which leads to limited communication possibilities between firms. A paid subscription should give access to better communication opportunities.

In this phase of the design process, there are still many assumptions related to the platform's functions, users and context. These describe the qualities that the platform's functions, users and context need to possess, in order for the platform to accomplish its desired goals. The most important first hunch assumptions are displayed below.

Table 14: First hunch assumptions

Functional assumptions	User assumptions	Contextual assumptions
Primary functionality is reduction of (partner) search costs	User's existing supplier network does not suffice for new IoT application	Platform stakeholders are willing to contribute
Basic functionalities should be free to stimulate platform growth	Platform demand side: care-related SME / startup; Supply side: IoT / care supplier	
Distinguishable supply and demand side	User's biggest problem is experienced in identifying the right partner	
Platform involvement only in exploration and expansion phase of partnership (Figure 15)	One platform can serve all ecosystem rolls through a similar approach (Target users can be any firm)	
	User is willing to create an extensive profile (industries, experience etc.) before having access to functionalities	
	User is willing to publicly disclose, objectives and information about future projects	
	User is willing to pay for communication with potential partner	
	All requirement categories (Figure 17) need to be integrated in the platform	

Table 14 gives an overview of the most important first hunch assumptions. Most assumptions are directly or indirectly related to the platform's users. From the start of this thesis, the assumption was made that the target users (care-related SMEs / startups) experience the identification of a new partner as a significant problem. The platform's features and other assumptions result from this basic assumption. Other assumptions are i.a. related to pricing and features. On the basis of the MSP analysis in previous chapter, we assume that basic functionalities should be free of charge in order to overcome the chicken-and-egg problem of platforms. However, we do require users to create a free account in order to access basic features. It is assumed that this does not pose a significant threshold for users. Another important assumption is related to the variation in user roles, since we aim to serve many types of IoT ecosystem roles with the same functionalities.

5.3 Conclusions

In line with the method described by Verschuren and Hartog (2005), this chapter describes the first hunch design of the platform. The first hunch description is accompanied by the platform's goal(s) [G], requirements [R], and assumptions [A]. At this point, we introduce the platform's working title: 'IoT-Match'. The goal [G] of IoT-Match is to ease ecosystem creation and growth in the IoT (care) domain, by facilitating partnership formation. This is done by facilitating interaction between two or more firms. This results in the following value proposition for the platform: *IoT-Match reduces partnership-related search costs for SMEs in the care domain, by recommending suitable partners.*

Based on the platform's goal, we propose the platform's initial characteristics. These characteristics are structured using the MSP analysis framework, as described in chapter 4. We bring together these characteristics with the categories from the IoT matchmaking requirement framework (Figure 17) and the views of practitioners, in order to create a list of first hunch requirements [R]. This list is followed by a list of assumptions [A]. Both lists can be divided into functional, user-related and contextual aspects. Emphasis should be placed on the fact that the requirements and assumptions are mainly focused on the functional aspects of the platform. Non-functional requirements (e.g. quality, privacy, security, sustainability, scalability etc.) are of such importance, that at this point they assumed to be fulfilled.

The first hunch description of the platform, including its requirements and assumptions serve as guideline for a round of feedback from potential end-users. This feedback serves multiple purposes. First of all, it generates insights in current practices and bottlenecks in the partnership process. Secondly, we aim to verify and complement the partnership requirements framework and the first hunch requirements. Lastly, some of the first hunch assumptions can be tested. The next chapter comprehensively covers the feedback process and results.

6. Interviews with potential users

In phase four of this research we aim to answer the fourth research question: What additional platform requirements can be derived from practices and problems as experienced by IoT-related firms in the healthcare domain? To gain a detailed understanding of the practices and problems among the platform's potential user groups, we examine five Dutch care-related cases in the IoT domain (Handicare Stairlifts, Faber Electronics, Aspider M2M, Giant Leap Technologies and Innospense). By means of interviews with the five companies, we first aim to verify the list of requirements [R] for the platform. Secondly, we complement the initial requirement list with a list of additional requirements derived from the interviews [R_i]. Thirdly, many of the assumptions [A] made for the first hunch design can be verified or refuted. This chapter first treats the interview process, by discussing the topics that are addressed during the interviews. Secondly, it discusses the most important findings of each interview. Subsequently, we cover the cross-case findings. We end this chapter by discussing the platform requirements and conclusions derived from the interviews.

6.1 Interview approach

In order to derive platform requirements from practice, information is gathered through semi-structured interviews with potential users. These interviews are directed towards specific predetermined topics, while leaving room for further exploration in terms of additional areas of concern. To create a manageable variety, the research is limited to five companies. The companies are chosen on the basis of four main criteria. Firstly, in accordance with the research objective, the companies should provide an IoT related product or service. Also, the firms should have experience in the (health)care sector. Thirdly, the companies should represent different value layers in their ecosystem. Lastly, the total set of companies should represent both of the platform's user groups (supply and demand), as discussed in Chapter 4.

To generate practical insight in the IoT and care domains, we examine five Dutch companies that are active in both domains. The platform is aimed to target a large part of the spectrum of IoT-ecosystem roles. Each examined company thus represents a different role in the spectrum. Figure 21 displays the five companies divided over the five value layers as in Figure 7 (Fleisch et al, 2014). In practice, there seems to be no clear interface between value layers. Firms' activities are usually not limited to a single value layer. Therefore, the value layer on which each company is plotted, corresponds to the main value adding activities of each firm.

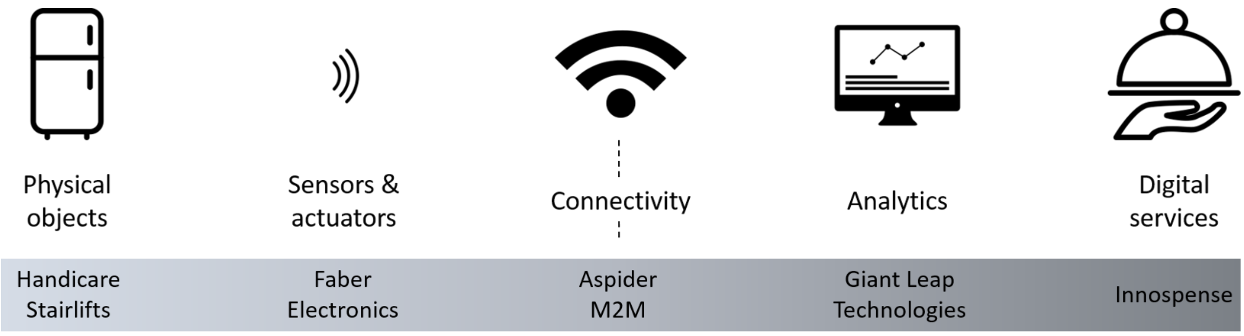


Figure 21: Representation of companies on five value layers as in Figure 7 (Fleisch et al, 2014)

The purpose of the interviews is to gain an in-depth understanding of several topics. Table 15 gives an overview of the discussed topics and the chapters of this thesis they relate to. The duration of each interview is scheduled to be one hour. Using a voice recorder, the interviews are recorded, with permission of the interviewee. On the basis of these recordings, a written summary is produced. The summaries can be found in Appendix IX to XIII. Using concepts from literature, the responses are coded and summarized in Appendix XIV. First, the most important findings of the interviews are discussed below. Each interview summary also features a VIP diagram which schematically displays streams of value, information and processes between ecosystem partners. These diagrams are intended to give a rough impression of the relations between the interviewed firms and their ecosystem. However, partly due to confidentiality reasons, the diagrams show limited detail.

Table 15: Interview topics related to thesis chapters

Interview topic	Sub-topics	Chapter
Company introduction	Location; Value proposition; Future vision	N.A.
Current ecosystem	Composition (roles); Partner size; Collaboration type; Challenges	3.3
IoT business models	Type of clients; Problems of clients; Client acquisition; Value creation; Value capture; Challenges	1
Healthcare	Involvement; Trends; Challenges	2.4
Partnership process	Partner type; Search methods; Perceived importance of requirement categories (Section 3.5); Other challenges	3
Current matchmaking platforms	Current use; Experiences; Alternatives	4
Platform requirements	Expectations; Features; Concerns	4; 5

Per case we draw preliminary conclusions on the implications for the platform requirements. In section 6.3 we draw cross case conclusions that lead to a revised set of platform requirements.

6.2 Interviews

6.2.1 Handicare Stairlifts

Handicare is a globally operating company that produces mobility and safety solutions for elderly and disabled people. The company was founded in 1986 in Norway and currently employs around 1300 people worldwide. In 2007, Handicare acquired the Dutch stair lift manufacturer Freelift, which employed around 200 people. Since 2010, Freelift carries the name Handicare Stairlifts, which currently still operates from Heerhugowaard. The company offers a range of built-to-order stair lifts, including some connectivity features (“Over Handicare – Handicare,” 2016).

The development and manufacturing processes of Handicare’s stair lifts are executed in-house. The manufacturing company’s core ecosystem is fairly straightforward and resembles a classic supply chain (Figure 22). The firm represents a user group of finished product producers that has limited knowledge on IoT. In order to overcome this bottleneck in innovation, external suppliers are sought. The regular approach of finding a new partner starts with consulting Handicare’s (the parent company’s) procurement organization. From the existing database, a shortlist of potential partners is generated. Then, a selection procedure is initiated.

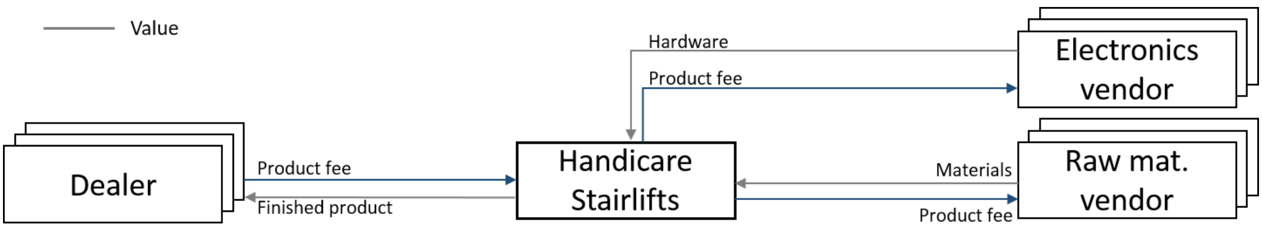


Figure 22: Handicare Stairlifts - VIP diagram of the core ecosystem

Since Handicare Stairlifts has the procurement organization of its parent company at its disposal, the firm doesn't experience partner identification as a bottleneck. A bigger problem is seen in the absence of specific knowledge (e.g. on communication technology). Also implications of adding new technology on factors such as assembly, installation, customer contact and personnel training play a part in this.

When considering a B2B matchmaking platform, the firm poses several issues. In the competitive stair lift business, publicly disclosing sensitive information on current or future innovation projects is out of the question. On the other hand, a platform that only compares and displays potential partners will be received skeptically, since information can be subjective. Much more beneficial would be a platform that aids in creating a functional design of an IoT proposition. Since specific knowledge on technologies and implications of IoT lacks, such a platform could indicate which factors a company should take into account when designing an IoT proposition. If the platform would showcase instructive examples of other projects, it could help employees convince their management to execute similar projects.

Concluding, we can say that Handicare Stairlifts represents a user group of finished product producers that has limited knowledge on IoT. External suppliers are sought in the absence of internal knowledge on e.g. connectivity. The search for suppliers is not seen as the biggest bottleneck, since there is an existing procedure in place. The company is skeptical towards a platform that only displays and compares potential partners, since information can be subjective. To convince a company like Handicare Stairlifts, the platform should thus aim to actively decrease quality uncertainty. Also, the company is reluctant to engage in a marketplace-style platform, since that would imply publically disclosing sensitive information. The platform should thus at least guarantee a certain level of anonymity or confidentiality. A new platform would add more value to the firm when its functionality is focused on the implications of adding new technologies. Such a platform could aid in creating a functional design of an IoT proposition and display important factors that need to be taken into account.

6.2.2 Faber Electronics

Faber Electronics is a manufacturer based in Velp, the Netherlands. The company started as producer of emergency lighting and developed its business into PCB (printed circuit board) assembly, product tests and repairs and full product assembly. The company also provides its clients with global component sourcing services and logistics services. Faber Electronics is active in several markets, including automotive, traffic engineering, audio and healthcare. Ideally, Faber Electronics is involved early in its clients' design process. This way, Faber Electronics can execute a feasibility analysis and optimize the design though a DfM (design for manufacturing) process (Faber Electronics, 2016).

Faber Electronics is specialized in the assembly of PCBs. The circuit board and the components that need to be assembled are supplied by various suppliers. Since the board is a critical component, the relationship with the supplier of these boards is close and long-term. Most other components are supplied by a handful of distributers. In the case of custom components, the firm is often required to approach new supplier. However, these suppliers are often specified by the client. Often, the client also specifies other components, such as the product casing. Faber Electronics appeals to its supplier networks to manufacture such components. Since there is a clear difference between development and manufacturing, the firm's clients often make use of third parties to develop a product. Faber Electronics temporarily collaborates with such product developers in order to review the product design. In this Design for Manufacturing (DfM) process, Faber Electronics critically assesses the choice of components and factors like testability of the design. For certification purposes, Faber Electronics only refers its clients to the appropriate agencies, since manufacturing and certification are strictly separated. Both Faber Electronics' clients and suppliers vary from SME to larger corporations. However, the bulk of both consists of SMEs. A simplified overview of the core ecosystem is seen in Figure 23.

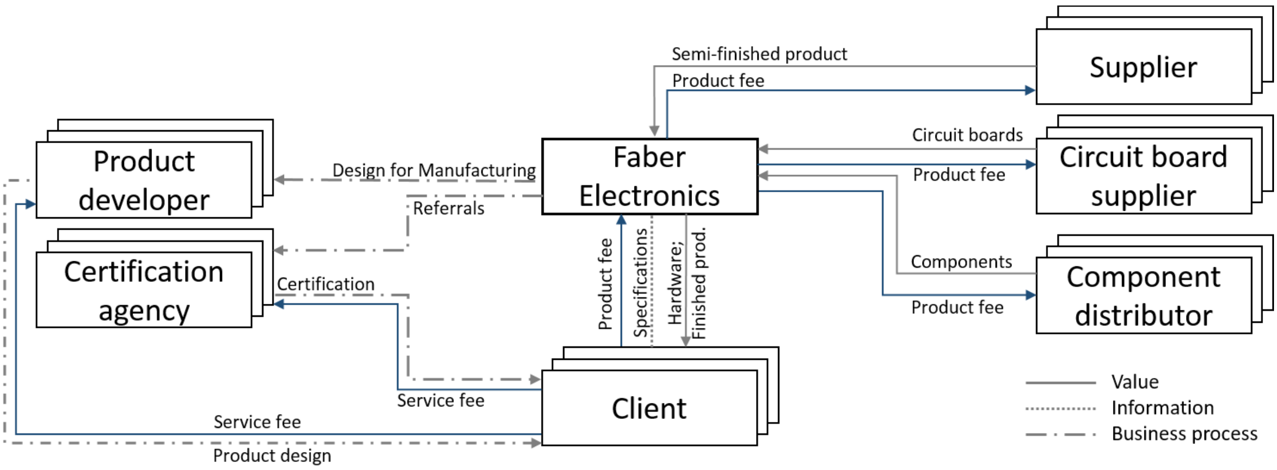


Figure 23: Faber Electronics - VIP diagram of the core ecosystem

Operating in the healthcare sector has several implications for manufacturing companies such as Faber Electronics. Specifically, for healthcare products, it is mandatory to track and trace the origin of each component throughout the value chain. The track and trace process is handled internally by Faber Electronics and does not pose any additional problems.

New clients are acquired in various ways, i.a. through word of mouth (WOM) and cold calling. Especially the latter method requires significant effort and could be improved. Early establishment of trust between the client and Faber Electronics is seen as essential in the product development process. The preferred type of cooperation is long term (at least multiple production series). Factors such as compatible company vision, goals and culture are not essential to Faber Electronics, as long as communication and commitment are sufficient. A problem that Faber Electronics encounters is the lack of technical knowledge at the side of the client, especially in the area of IoT. As a result, clients often tend to look for proven or off-the-shelf solutions. These components are often not cost effective in larger production series, especially since IoT products often require low production costs.

Currently, Faber Electronics does not make use of matchmaking or similar services, both for supplier search and client acquisition. Although the firm sees few bottlenecks in the client acquisition process, it does prefer an earlier involvement in its client's product design process. This involvement is suitable to close the technical knowledge gap between the firm and its client. If the platform features supplier rankings and reviews, this would be received with limited credibility. However, if company reviews were to come from a firm's own professional network, the credibility of these reviews would increase dramatically. An addition to the client profile would be a quality guarantee, such as a credit rating.

We conclude that Faber Electronics is mainly suitable to represent the supply side of the platform. The company has specific knowledge, including on connectivity and IoT related issues. The knowledge gap between the firm and its customers is seen as one of the bigger problems. Therefore, the firm prefers an earlier involvement in its client's product development process. Since the platform can be used for client acquisition purposes, it should stimulate early contact and trust establishment between firms. The platform could add value by integrating network features. In this way, users can see if parties from their current network recommend a certain supplier. This limits the perceived quality uncertainty.

6.2.3 Aspider M2M (Wyless)

Aspider M2M is a mobile virtual network enabler (MVNE) based in Woerden, the Netherlands. The firm provides connectivity solutions to companies such as Stedin (smart meters), Philips (Citytouch) and Wyless, i.a for applications in the healthcare sector. Due to its license as mobile virtual network operator (MVNO), Aspider M2M is able to provide complete connectivity solutions and greater control to its clients. In 2014, Aspider M2M was acquired by Wyless. Wyless is a mobile (virtual) network operator, active in the IoT domain. The company was founded in 2003 and is headquartered in Boston, Massachusetts. Other offices are located in Brazil, Germany, the UK, Switzerland and the Netherlands. Next to providing connectivity solutions for IoT-related applications, the company offers i.a. engineering services and a software platform for remote management of IoT solutions. (Wyless, 2016).

Aspider M2M has various long-term partners that contribute to the company's value propositions. Figure 24 gives an overview of the most important members of the core ecosystem and their interactions. Possibly the most important partners are mobile network operators (MNOs). These parties provide access to their mobile infrastructure. Aspider M2M's service delivery platform (SDP) is developed and maintained by an external ICT firm. This platform provides i.a. connectivity management services. It is notable that Aspider M2M does not sell any hardware (e.g. gateways). This is usually delivered directly to the client by one of Aspider M2M's verified hardware partners.

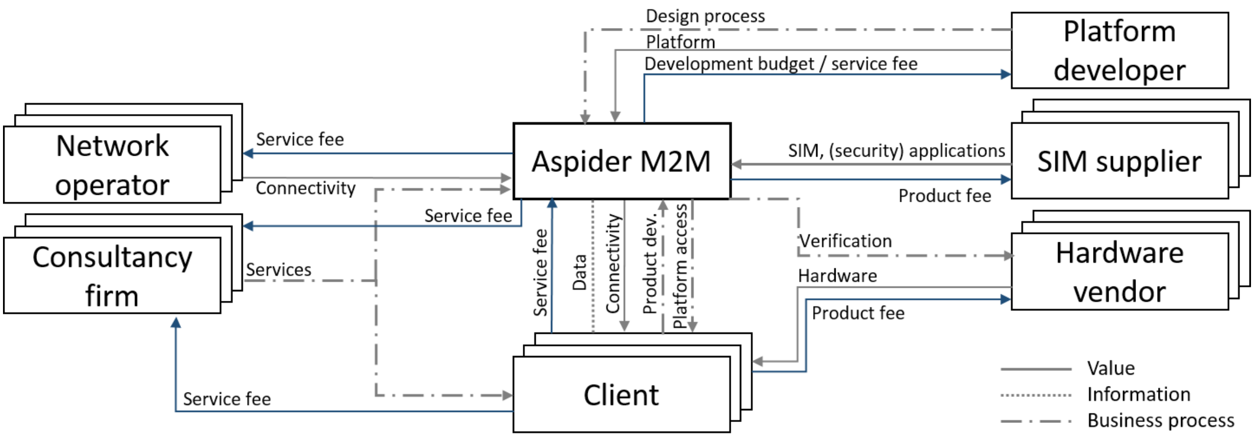


Figure 24: Aspider M2M – VIP diagram of the core ecosystem

The main bottlenecks that Aspider M2M identifies in the IoT partnership process are related to uncertainties. Since the discipline is relatively new and fragmented, it is often unclear what IoT can contribute to a company. Currently, when the existing partner network is insufficient to serve a client, a new partner is sought. When various suppliers are available, usually the company's and personal networks are consulted. A common approach is posting a message on networking sites like LinkedIn.

Several websites, platforms and consultants that aim to clarify the domain of IoT already exist. Also MNOs often fulfill such roles, but these firms are perceived as biased. A new platform should thus aim for a neutral, unbiased image. This image can be compromised by a too commercial approach. The value of a matchmaking platform for Aspider M2M is perceived as limited. A possibility to lower the threshold of such a platform is to integrate it in existing services like LinkedIn.

We conclude that Aspider M2M mainly acts as a supplier towards other firms and is not new in the IoT domain. Therefore, the firm's supplier network is largely in place. The network exists of a few large firms, such as mobile operators. When looking for new, smaller partners, Aspider M2M makes use of its current network through networking sites. However, the company can still exhibit its services on a matchmaking platform, thus being counted among the supply side of the platform. Several requirements need to be met before the firm is willing to invest time in such a platform. Other matchmaking services are perceived as biased, partly due to a clearly commercial approach. Unbiased, verified company information is therefore required in order to reduce quality uncertainty. Credibility of the platform should be significant before the company considers to engage in such a service. This credibility can be achieved in various ways. Ease of use is also required, which can be achieved by integrating the platform in existing services such as LinkedIn. The main bottleneck that the company identifies is the information overload and uncertainties that accompany IoT. Therefore, the platform can add value by clarifying what IoT can contribute to a company (SME) that is new to IoT.

6.2.4 Giant Leap Technologies

As an M2M service provider, Giant Leap develops complete custom solutions to monitor, control and manage machines. This is done through offering a variety of software and hardware. The company is active in the areas of M2M consulting, development, implementation and operations, mainly for the SME market. Specific services are remote monitoring and control, access control, automated meter reading and development of web based applications. The Amsterdam-based company is active in the M2M field for around 10 years (Giant Leap, 2016).

Giant leap currently operates in four main markets: industrial machines, access control, indoor fleet management and healthcare. The firm's most important partners are shown in Figure 25. The company aims to serve as a one-stop-shop for their clients, which are mainly finished product producers. While offering a complete range of M2M solutions with the aid of multiple partners, Giant Leap is specialized in communication between devices and their proprietary cloud platform. Applications, including business logic and dashboards, are developed internally.

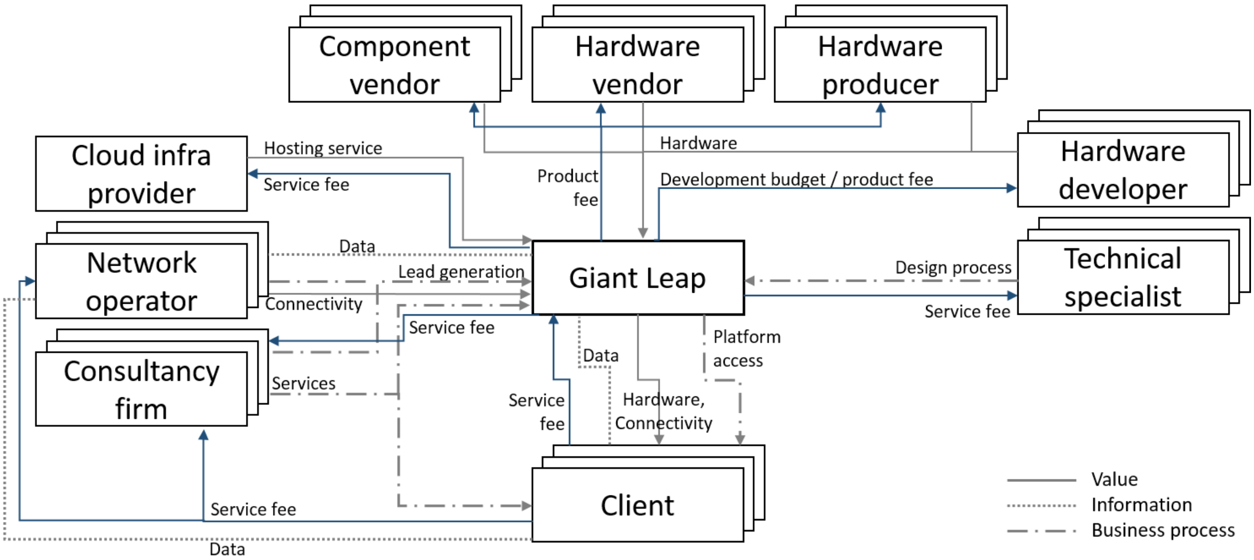


Figure 25: Giant Leap – VIP diagram of the core ecosystem

In the (health)care industry, there are two main obstacles for IoT propositions. Firstly, products in this industry need to be certified before entering the market. Secondly, stakeholders (e.g. government, insurance companies, municipalities) often disagree on a distribution of costs. This is one of the factors that hampers innovation in this industry.

Currently, when the existing partner network is insufficient to serve a client, a new partner is sought. In most cases, such a partner is a technology provider. The search process starts with consulting the existing connections and browsing the Internet. Technical complementarity, reliability and compatibility of a potential partner are indicated as key issues during this process. Factors related to cooperation during the beginning phase of the partnership (expansion phase) require less attention.

When trying to identify a technology partner, capabilities and track record are of vital importance. An explicit categorization difference between (verified) experience, and industries in which a company is able to operate, is thus desired. Disappointing experiences with existing company databases result in some skepticism. Experience in the M2M market learns that is it very difficult for prospects to find the right solution. However, consultancy firms often already fulfill this networking role.

We can conclude that Giant Leap fits in both the supply and the demand side of the platform. In order to reach potential customers, the firm incidentally directly approaches prospects. In most cases, leads are generated by Giant Leap's partners. The firm acknowledges a difficulty for prospects to find the right partners when engaging in IoT projects. Several other firms (e.g. consultants) already aim to add value in a matchmaking role. Looking at the demand side of the platform, Giant Leap fits in that user group when looking for a technology partner. The firm experiences difficulty in finding a new technology partner, especially in the areas of technical complementarity and reliability. The preferred partner type is often an SME, because of equality reasons. The current search process starts with consulting the company's professional network and browsing the Internet. Disappointing experiences with existing company databases results in skepticism towards a new platform. Subjective or low quality information is the culprit to this. In order to engage with a new matchmaking platform, Giant Leap expects verified information on company capabilities and track record.

6.2.5 Innospense

Innospense is Dutch company in the pharmaceutical telecare, founded in 2006. They are known for their automatic medication dispenser Medido, which is currently also sold by Philips in the Benelux area. The product is mainly used among independently living elderly people. Currently, these people are assisted several times per day by a district nurse, i.a. for medication use. In the case that at least one visit per day can be replaced by use of the Medido device, placement of the dispenser is cost effective. Until recently, placement of the dispenser was possible under the Dutch general law on exceptional medical expenses (AWBZ). Since early 2015, reimbursement is provided by health insurance companies (Innospense, 2016). Innospense's web portal facilitates information exchange between several stakeholders (e.g. pharmacists, caregivers, doctors).

Innospense's ecosystem is increasingly complex due to the nature of the healthcare sector. The basis of the ecosystem is briefly described and a simplification of the relations can also be seen in Figure 26. Hardware is developed in house. Software development and optimization is done in collaboration with external developers. Currently, hardware developments are mainly focused on quality increase and cost reduction. Software developments are focused on the web portal, device firmware and connections with other firms. Production and assembly of the device is fully outsourced to a manufacturer. Connectivity (2G, 3G), including SIM card is provided by a mobile network operator. Innospense's web portal is hosted on their own servers, located at a cloud infra provider. On the other side of the network are parties that benefit directly from the product. Examples of such parties are pharmacies, medication packaging firms, health insurance companies and home care organizations.

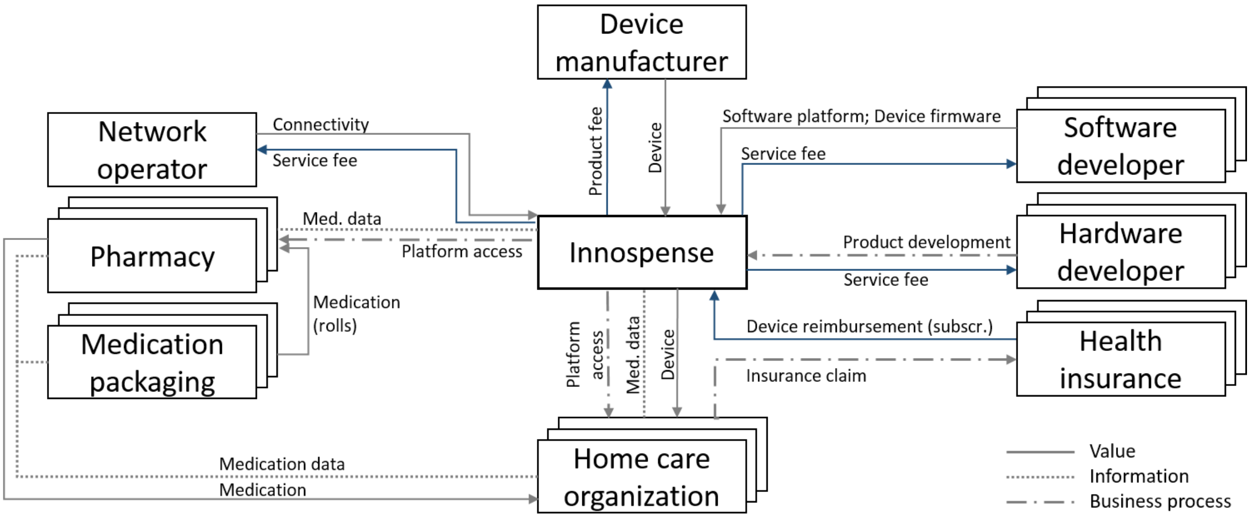


Figure 26: Innospense – VIP diagram of the core ecosystem

The healthcare sector is strongly subject to changing regulations and insurance companies change their policies regularly. This instable environment creates a high degree of insecurity and risk for a company that develops healthcare products. Establishing long term commitment proves difficult, which hinders innovative solutions.

When developing an innovative proposition, partners are indispensable. Hiring large development firms is too expensive for a startup, even with significant investments. As a result, Innospense mainly cooperates with SMEs. Finding a suitable new partner is not seen as a large problem. In previous cases, the existing network was always able to put forward suitable candidates. During cooperation however, issues occur on a continuous basis. These issues are mostly related to the insecurity that innovation brings. As a startup, Innospense is hesitant to share risks and benefits with partners, except for investors. The reason for this is related to commitment and focus.

Intuition plays a large role in entrepreneurship. Making sure you have the right network to get things done is essential. Although a platform can provide firms with a place where they can offer their services, there are not many firms willing to actually take a large amount of risk. This commitment however, is required when developing an innovative proposition. For Innospense, the added value of a matchmaking platform seems limited. However, during collaboration, facilitation of a regular reflection on the partnership is a valuable addition.

We conclude that Innospense is primarily suitable as a demand-side user of the platform, since the firm doesn't provide IoT-related services to other firms. However, finding a suitable new partner is not seen as a bottleneck by Innospense. The firm's existing business network has been able to put forward suitable parties in previous cases. During cooperation, the firm indicates that issues arise on a continuous basis, which are mostly related to (financial) insecurities. The firm also indicates that cooperation should preferably be on a buyer-supplier basis, since risk sharing is regarded as undesirable. Although a platform could speed up the process of finding a suitable partner, true added value is seen in a later stage. The platform could facilitate regular reflection on a partnership.

6.3 Cross-"case" conclusions: Requirements from practice

We look at five cases of IoT related companies and their ecosystems. The companies represent users on either the supply or demand side of the platform, or both. There are several recurring elements that we identify from these five cases. Multiple companies indicate that the search process for a new partner does not pose a big difficulty. If a platform would provide a service that facilitates this partner search, it should at least meet several requirements. These requirements are mostly related to the quality of information on the platform, aiming to reduce quality uncertainty. Furthermore, multiple firms indicate that the platform can add additional value when focusing not only on the identification of new partners, but also on other IoT related services.

Using concepts from literature, the responses of the interviews are coded. Answers are grouped into six categories, derived from the topics in Table 15. An overview of the most important responses is shown in Appendix XIV. The rightmost column of the table shows the platform requirements that are derived from the interviews, sorted per topic. Figure 27 shows that only three of the seven initial categories (IoT business models, complementarity and communication) are perceived as pressing problems. Other requirement categories are perceived as important, but they are not perceived as direct problems. Furthermore, the awareness phase is deemed much more important than our initial estimation. Table 16 shows a summary of the platform requirements [R_i] that are derived from each interview category. Below, the implications of the interview responses are more comprehensively discussed per category.

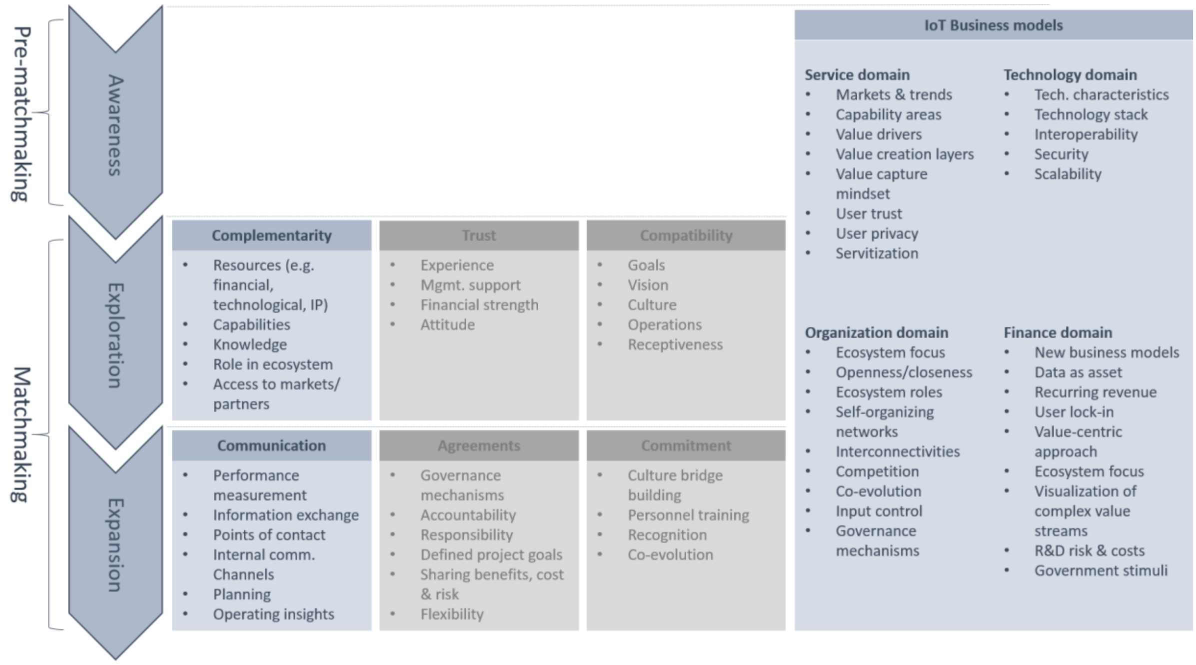


Figure 27: Three most pressing requirement categories (IoT business models, complementarity and communication)

Table 16: Additional platform requirements [R_i] per interview category

Current ecosystem	**Partnership process**
Clearly distinguish ecosystem roles for supply side	Distinguish supply and demand side profiles
Supply side focus on, but not limited to SMEs	Resemble ease of use of current methods (e.g. Linkedin); Include network/WOM functionalities
Focus on long-term relationship development	Provide demand articulation; Distinguish partnership phase of user
Reduce perceived ecosystem complexity	Focus on technical complementarity and reliability of suppliers (exploration phase)
Map capabilities of current ecosystem	Stimulate inter-firm communication (expansion phase)
	Guide partnership beyond search
IoT business models	**Current matchmaking platforms**
Demand side focus on SME	Integrate with existing services (e.g. LinkedIn)
Provide guidance in possibilities, implications and pitfalls of IoT (awareness phase)	Warrant credibility and neutrality of platform; Clearly communicate added value
Assess current state and necessary actions for development of IoT proposition	Ensure fit in current search process; Provide added value above existing methods
Healthcare domain	**Platform requirements**
Include both (health)care-specific and generic suppliers in database	Be findable; Respect sensitive information or warrant anonymity
Provide guidance in possibilities, implications and pitfalls of healthcare (awareness phase)	Register and verify firm capabilities and experience; Provide review mechanism
	Low/no financial threshold for new users

6.3.1 Current ecosystem

Most of the analyzed core ecosystems consist of fairly classical buyer-supplier type of relationships. In most cases, SMEs form a large part of the core ecosystem, but also large firms play an important role. Often, firms aim to create long-term partnerships. However, these partnerships seldom go beyond product development and thus involve limited to no risk sharing. The types of roles found in the analyzed ecosystems can be related to the generic IoT ecosystem roles of Mazhelis et al (2013) as seen in Figure 10. However, in many cases, a single firm performs multiple roles, by contributing to more than one technology type (Porter & Heppelmann, 2014; Figure 9), or adding value to multiple value layers (Fleisch et al, 2014; Figure 7). For the platform design, these observations lead to several requirements. First, the supply side of the platform should make a clear distinction between ecosystem roles and provider type. A firm however, can fulfill multiple roles, albeit through reselling services or products of third parties. Secondly, the platform should not be limited to SMEs, since large companies play an important role in many ecosystems. Thirdly, the platform should aim to create long-term partnerships, but should not necessarily limit its scope to risk-sharing partnerships. Fourthly, the platform should aim to reduce the perception of complexity of the ecosystem, since this can become overwhelming to firms.

6.3.2 IoT business models

When looking specifically at factors related to IoT, we see that (B2B) clients are generally SME's. Relations with clients are preferably long-term, since this creates a certain degree of stability for a supplier. Especially SME's that are new to the IoT domain tend to struggle with creating a new value proposition. Technical know-how is often missing, which emphasizes the necessity of finding the right partner. Uncertainty on what IoT can offer, where to start and which partners are required, can be overwhelming to these firms. Information is abundantly available online, but tends to be too much to process. The platform should take into account these factors in the following ways. Firstly, the demand side of the platform should focus on SMEs, since this group is regarded as 'underserved'. Secondly, also from a supplier perspective, the platform should focus on generating long-term clients. For these clients (the demand side), the platform should provide easy to swallow guides on the possibilities, implications and pitfalls of IoT.

6.3.3 (Health)care

The involvement of firms in the healthcare domain varies largely. Some firms fully focus of care applications, while others serve as a more general supplier. As seen, these different types of companies are able to operate in the same ecosystem. As is the case in the generic IoT domain, also healthcare specific firms can struggle with creating a new value proposition. Especially for firms that are new to this domain (e.g. startups), the platform can provide a guide on possibilities, implications and pitfalls of the healthcare domain. This should include care-specific implementations of IoT technology. Furthermore, the platform should offer a range of both care-specific and generic IoT-related companies and services.

6.3.4 Partnership process

As expected, different firms experience different bottlenecks in the partnership process. A supplier of a product or service wants to exhibit it's offer, while another firm is better served by finding a (technology) partner. The platform should thus explicitly take into account the both user groups. Current methods for finding partners vary, but show several similarities. Most firms make use of their current network (social media) and word of mouth (WOM). Especially recommendations by trusted parties are perceived as an important first step in building trust towards a new partner. The platform should take into account these mechanisms by making use of companies' current networks. When looking at the IoT matchmaking requirement framework (Figure 17), the analyzed firms identified several factors that are most important to them. In the exploration phase, (technical) complementarity is regarded as first priority. Trust and compatibility follow. In the expansion phase, communication is perceived as most important. Specific other issues that were mentioned relate to dealing with insecurity, commitment, focus, intellectual property (IP), physical distance and the process of innovation. The platform should take these factors into account by identifying in which phase a firm or partnership is at a specific moment. During the awareness phase, the platform can offer guides on IoT and healthcare. During the exploration phase, the platform should focus on (technical) complementarity. During the expansion phase, the platform should stimulate inter-firm communication.

6.3.5 Current matchmaking platforms

Among the respondents, the use of similar B2B matchmaking platforms is very limited. Some firms use substitute services such as social media, consultancy firms or an internal procurement organization. Other firms avoid such platforms because of disappointing results. Especially credibility and neutrality are seen as an important factor in deciding whether or not to use a platform. Furthermore, the platform's ease of use plays an important role. In short, the expected benefits of the platform should outweigh the effort of using it. Part of this is a fit with the current search method. The platform should first of all warrant its credibility and neutrality. Secondly, it should clearly communicate its added value. Thirdly, the ease of use can be increased by integrating the platform with existing services such as LinkedIn.

6.3.6 Platform requirements

When discussing the expectations of a matchmaking platform, several requirements become clear. Firstly, credibility and neutrality should be warranted. Credibility can be increased by being recommended by trustworthy parties, but also by ensuring topical content. The platform's users can increase credibility by obtaining certificates. The perception of neutrality can be increased by verifying company information, experience and capabilities. Secondly, the platform should handle sensitive information discreetly, not forcing a firm to disclose it publically. This limits the possibilities of a B2B marketplace. Thirdly, the platform should possess a review mechanism which ideally is linked to a firm's current network. Such a mechanism aims to build trust by verifying supplier or customer experience by actual partners. This mechanism can also include WOM functionalities. The platform should have a low (or no) initial financial threshold for users in order to increase adoption.

6.4 Conclusions

This chapter aims to gain a detailed understanding of the practices and problems among the platform's potential user groups. Therefore, we examine five Dutch care-related cases in the IoT domain (Handicare Stairlifts, Faber Electronics, Aspider M2M, Giant Leap Technologies and Innospense), by means of interviews. These interviews serve three purposes. First, we verify the list of first hunch requirements [R] for the platform. Secondly, we complement the initial requirement list with a list of additional requirements derived from the interviews [R_i]. Thirdly, many of the assumptions [A] made for the first hunch design can be verified or refuted.

The semi-structured interviews are guided by a total of seven main topics, based on earlier chapters (Company introduction, Current ecosystem, IoT business models, Healthcare, Partnership process, Current matchmaking platforms, Platform requirements). Of each interview, a written summary is produced. The summaries can be found in Appendix IX to XIII. Using concepts from literature, the responses are coded and summarized in Appendix XIV. The platform requirements [R_i] that are derived from the interviews are sorted by the seven interview topics and summarized in Table 16.

One of the conclusions is that only three of the seven initial requirement categories (IoT business models, complementarity and communication) are perceived as pressing problems, as shown in Figure 27. Other requirement categories are perceived as important, but they are not perceived as direct problems. Furthermore, the awareness phase is deemed much more important than our initial estimation. This is mainly since users already face difficulties in estimating the implications of IoT on their firms. These difficulties already play a role before the explicit need for partnerships arises.

The next chapter discusses the following phase in the platform design process. In this last phase, we come to an updated set of requirements and assumptions for the platform, and translate these into a mockup.

7. Design of the matchmaking platform

In the previous chapter we derived a set of platform requirements from interviews [R_i]. This chapter discusses the next iteration in the platform design process. By processing the newly acquired requirements, we update the first hunch design of the platform. We do this by first reevaluating the platform's goals and assumptions. This leads to an updated set of assumptions [A_2] and an updated goal [G_2]. Subsequently we discuss the merger between the first hunch requirements and those that are derived from the interview phase. This leads to an updated requirements list [R_2].

Next, we present the business model of the platform. As discussed in chapter 1, the business model is structured using the business model Canvas method (Osterwalder & Pigneur, 2010). We briefly discuss each of the nine building blocks of the business model and emphasize that the platform's value proposition consists of four elements: Inform and inspire, situation analysis, demand articulation and matchmaking. Then, we dive further into the key features of the platform by describing how the four elements of the value proposition are delivered. The key features are further clarified with the aid of screenshots of the mockup.

7.1 Goals and assumptions

This research aims to find a viable method to facilitate ecosystem development within the IoT domain. In chapter 5 we discuss the first hunch design of an online matchmaking platform. The initial goal [G] of this platform is to reduce the user's partnership-related search costs by recommending suitable partners, based on company profiles. In the same chapter, this goal is accompanied by a set of assumptions [A] and requirements [R]. One of the key assumptions in this first hunch phase, is that the user experiences identification of new partners as a significant problem. By interviewing several potential users, as described in chapter 6, we aim to validate if our initial assumptions are correct. This process leads to the updated list of assumptions as shown in Table 17. We shortly discuss the most important changes below.

7.1.1 Updated assumptions

In order to update the initial list of assumptions [A], we execute a limited validation process during the interview phase. The limitation is related to the relatively low number of interviews conducted for the validation of our initial assumptions [A]. Despite this limitation, we propose a tentative list of updated assumptions [A2] in Table 17. Assumptions that are supported by interviewees are displayed *italic*. Some initial assumptions remain unvalidated. Starting with the 'validated' requirements, the interviewed parties recognized the need for new partners when developing a new IoT proposition. When facilitating the partner search process by an online platform, a clear distinction between user roles (e.g. supply and demand) is indeed needed. Basic features of the platform should be free, since several firms indicated that they were not willing to pay for features such as a company search engine. Possibly the most interesting finding during the interviews is related to the user's perception of the problem. One of the key assumptions in the first hunch phase, is that users experience identification of new partners as a significant problem.

In practice, the need for new partners is recognized. However, finding suitable partners is not identified as a primary problem. A much more pressing issue is experienced in an earlier stage, namely in the awareness phase. When firms become aware of the relevance of IoT for their business, the lack of knowledge is seen on one of the most pressing problems. This knowledge gap is often technical, and related to new partners, but in many cases much broader than that. In general, the possibilities, implications and pitfalls of developing an IoT proposition are unknown to newcomers in the IoT domain. As a result, the platform should not only be involved in the exploration and expansion phase of partnership formation, but should mainly focus on the prior awareness phase. Another interesting finding is related to publicly displaying partnership proposals. In competitive markets, firms indicate to be very cautious in disclosing sensitive information (e.g. objectives and future projects). This unwillingness to share information seriously limits the possibilities of a public partnership marketplace.

Table 17: Updated list of assumptions [A_2] (italic = supported by interviews)

Functional assumptions	**User assumptions**	**Contextual assumptions**
Primary functionality is not limited reduction of (partner) search costs	*User's existing partner network does not suffice for new IoT application*	Platform stakeholders are willing to contribute
Basic functionalities should be free to stimulate platform growth	*Platform demand side: care-related SME / startup; Supply side: IoT / care supplier*	
Distinguishable supply and demand side	*Identifying the right partner is not experienced as the user's biggest problem*	
Platform involvement should not be limited to exploration and expansion phase of partnership (Figure 15)	One platform can serve all ecosystem rolls through a similar approach (Target users can be any firm)	
	User is willing to create an extensive profile (industries, experience etc.) before having access to functionalities	
	User is not likely to publicly disclose, objectives and other information about future projects	
	User is willing to pay for communication with potential partner	
	Not all requirement categories (Figure 17) are perceived as important for the platform	

Still unanswered questions are e.g. related to the approach towards different types of firms. At this point we assume that the platform is able to serve all types of firms within an IoT/care ecosystem, regardless of their rolls. Another important assumption is that the user is willing to create an extensive profile before having access to subsequent functionalities. Finally, the user's willingness to pay for certain functionalities still requires additional research.

7.1.2 Updated goal

Due to the updated assumptions related to the matchmaking platform, the platform's initial goal no longer describes the most important user needs. Therefore, before we describe the updated requirements for the platform, we first rephrase the platform's goal. Instead of focusing on reducing partnership-related search costs for the user, the focus shifts towards familiarizing the user with the implications of the IoT domain and identifying relevant actions. The updated goal [G_2] will therefore be: *Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition*. This goal can be divided into four parts, which will be briefly discussed below.

Inform and inspire

In order to familiarize newcomers with the IoT domain, the platform should firstly offer guidance on possibilities, implications and pitfalls of IoT. Interviews showed that firms are confronted with many questions about what IoT can mean for them. Information is abundantly available, but highly diffuse.

The platform should therefore offer an overview of condensed information on subjects like best practices and inspirational examples. This should create awareness among the user, which ideally leads to interest in the next part: situation analysis. How we plan to achieve this part of the goal is further discussed in section 7.3 and 7.4.

Situation analysis

In order to effectively guide the client towards integrating IoT in the company strategy, the client's current situation first needs to be analyzed. Through an IoT capability maturity assessment, based on literature and expertise of practitioners, the client can gain insight in the readiness of the firm for developing an IoT proposition. This readiness is determined by internal factors, such as the company's capabilities, but also by the current partner network. By comparing the client's score to a benchmark, the platform is able to identify gaps or areas of improvement. Based on these deficiencies, the platform will recommend certain actions or additional services. In section 7.3 and 7.4, we discuss the IoT capability maturity assessment in more detail.

Demand articulation

In a more advanced stage, when the client has a clear view of what IoT can contribute to the company's strategy, the platform can offer demand articulation services. These services guide the learning process related to emerging technologies. In a creative process, consultancy services and possibly online tools can contribute to the creation of a functional design of an IoT product-service combination. Section 7.3 and 7.4 discuss this topic in further detail.

Matchmaking

The final part of the platform's goal relates most to the first hunch goal, which is described in chapter 5. During the maturity assessment, a firm's current capabilities and partners are identified. In the demand articulation process, the firm's desired situation is determined. This information contributes to a company profile. By analyzing a firm's current situation and determining the desired state, relevant new partners can be proposed. Candidates for this matchmaking process are drawn from the database of suppliers.

In the following section, we discuss the impact of the interviews and updated assumptions and goals on the platform requirements.

7.2 Updated requirements

Due to insights gained in the interview phase of this research, we were able to test the initial assumptions about the platform's functions, users and context, as discussed in the previous section. During the interview phase, we were also able to derive additional requirements [R_i] for the platform, as discussed in section 6.3. This section discusses the impact of these additional requirements on the platform's total set of requirements. Therefore, we first present an updated requirement list in Table 18. Subsequently, we discuss the selection process that led to this list, and the most notable findings during this process.

Table 18: Updated platform requirements [R_2], sorted by platform function (Essential requirements in bold)

	Functional requirements	User requirements	Contextual requirements
General	**Authentication for different subscriptions (multiple authorization levels: public, free user, premium user)**	**Warrant credibility, neutrality and confidentiality of platform**	**Stakeholder contributions (e.g. initial database entries, website content, consultancy services)**
	Testimonial section	**No financial threshold for new users (free basic functionalities)**	
		Findable and clearly communicated added value	**Comply with legislation**
Inf. & Insp.	**Provide showcase section of other projects for inspiration**	**Inform about possibilities, implications and pitfalls of IoT and healthcare**	
Situation analysis	**Account features extensive company profile with clear ecosystem role**	**Complement initial company profile with comprehensive user input**	
	Mandatory inspection or identity confirmation of supplier profile (i.a. resources, quality, capabilities, experience) for paid users	**Assess current situation of client in order to adapt services and advice**	
Demand articulat.		**Awareness phase: Provide demand articulation services / tools**	
		Facilitation of IoT functional design creation	
Matchmaking	**Database with profiles of Dutch IoT / healthcare related companies that contribute to product/service creation**	Include network functionalities (e.g. LinkedIn connection), WOM functionalities and review mechanisms	
	Possibility to create two types of accounts (supply, demand)	Exploration phase: User complementarity and reliability search (resources, experience)	
	Recommend potential matches based on company profile and standard ecosystem roles	Expansion phase: Facilitate and stimulate inter-firm communication during and beyond initial search (e.g. moderation)	
	Search engine (browse or filter profiles)		
	Focus on long-term relationship development, mainly for SME		

When looking at the table above, it is clear that the contents closely resemble the first hunch requirements [R] from Table 13. The requirements derived from the interviews [R_i] (Table 16) have been added to the first hunch requirements, in order to form the table above. We distinguish essential requirements from 'nice-to-have' requirements by displaying the former in bold. As expected, the merger of two requirement lists resulted in conflicting and overlapping requirements. We briefly discuss the most important findings below.

The first important finding is that the list of requirements has been expanded. Several interviewees indicated that a platform that focused solely on partner search would not add significant value to their business. Therefore, we propose a value proposition that is split into four parts: Inform and inspire, situation analysis, demand articulation and matchmaking. The first hunch requirements are primarily related to the matchmaking part of the value proposition. Additional requirements, derived from the interview phase, mostly add to the three other parts. By means of different background colors, Table 18 distinguishes each part of the platform's value proposition. The second notable finding is related to online versus offline functionalities. Initially, we proposed to facilitate as much of the platform's functionality as possible online. However, interviewees indicated that some offline processes are highly unlikely to be replaceable by an online substitute. Therefore, at this point it seemed more realistic to facilitate some processes offline. Examples are determining a user compatibility score (based on culture, goals etc.) and building commitment between new partners.

A third issue that surfaced during the interview phase is related to confidentiality. The first hunch design featured a marketplace where users were able to (publicly) post cooperation requests. This feature conflicts with some users' desire for confidentiality. Paid promotion of these cooperation requests affects the platform's impartial image, which is highly desirable. Therefore, both the marketplace and the option to promote cooperation requests are removed from the requirement list. Fourthly, the function of demand articulation has been added. This category offers services such as facilitation of the creation of a functional design for an IoT proposition. This function includes requirements related to IoT business model creation.

Although the design process is iterative in nature, Table 18 explicates the tentative requirements that are used in the last phase of this research. The following section builds upon these requirements by discussing the platform's business model.

7.3 Business model

In order to further illustrate which functionalities that the platform offers, and how it will be economically viable, this section elaborates on the platform's business model. The business model builds on the platform's assumptions and requirements, as described in previous sections. To do this, we make use of the well-known business model Canvas (Osterwalder & Pigneur, 2010). This method distinguishes a total of nine business model elements. The choice for this method is mainly based on its ease of use in brainstorming and communication. The platform's business model has taken shape in an iterative process, closely linked to the involved technology and users. Because of its importance, the business model has been a recurring topic during the weekly project meetings with the practitioners from Inpaqt and Castermans Connected. In order to establish the platform's business model as described below, a workshop was held at Inpaqt. In this workshop, the positions of Inpaqt and Castermans Connected were both represented. During the workshop, the business model Canvas was used to structure the thought process, since the nine business model elements were discussed in the suggested order. The result is a two-sided business model, catering to the two distinct user groups of the platform (Figure 28). Using the results of the interview phase, the value proposition was shaped in four distinct sections. These four sections form the basis of the business model. For the case of IoT-Match, the nine business model elements are roughly illustrated in Figure 28. Each of the elements is further elaborated on below.

7.3.1 Customer segments

In chapter 4 we defined a (multi-sided) platform as a facilitator for interaction between multiple distinct user groups. In the case of IoT-Match, we focus on no more than two user groups. Especially in the early stages, this limits the complexity of developing and running a platform. The two distinct user groups of the platform can best be described by a supply and a demand side. The supply side consists of firms of any size that are active in the field of IoT and/or healthcare. These firms are able to offer products or services to the demand side of the platform. The platform's supply side also includes complementors, which are advisory firms that are not necessarily related to IoT or healthcare. These complementors provide additional services to the demand side of the platform. The demand side consists of firms that aim to enter the domain of IoT, whether as incumbent or as startup. The platform will focus mainly on SMEs, since interviews pointed out that this target group is most in need of guidance. Most of the services that the platform offers are aimed at the demand side. However, in this highly multi-disciplinary domain, it is expected that many firms meet the criteria of both customer segments. Therefore, the services described in the value proposition section are not strictly limited to a single customer segment.

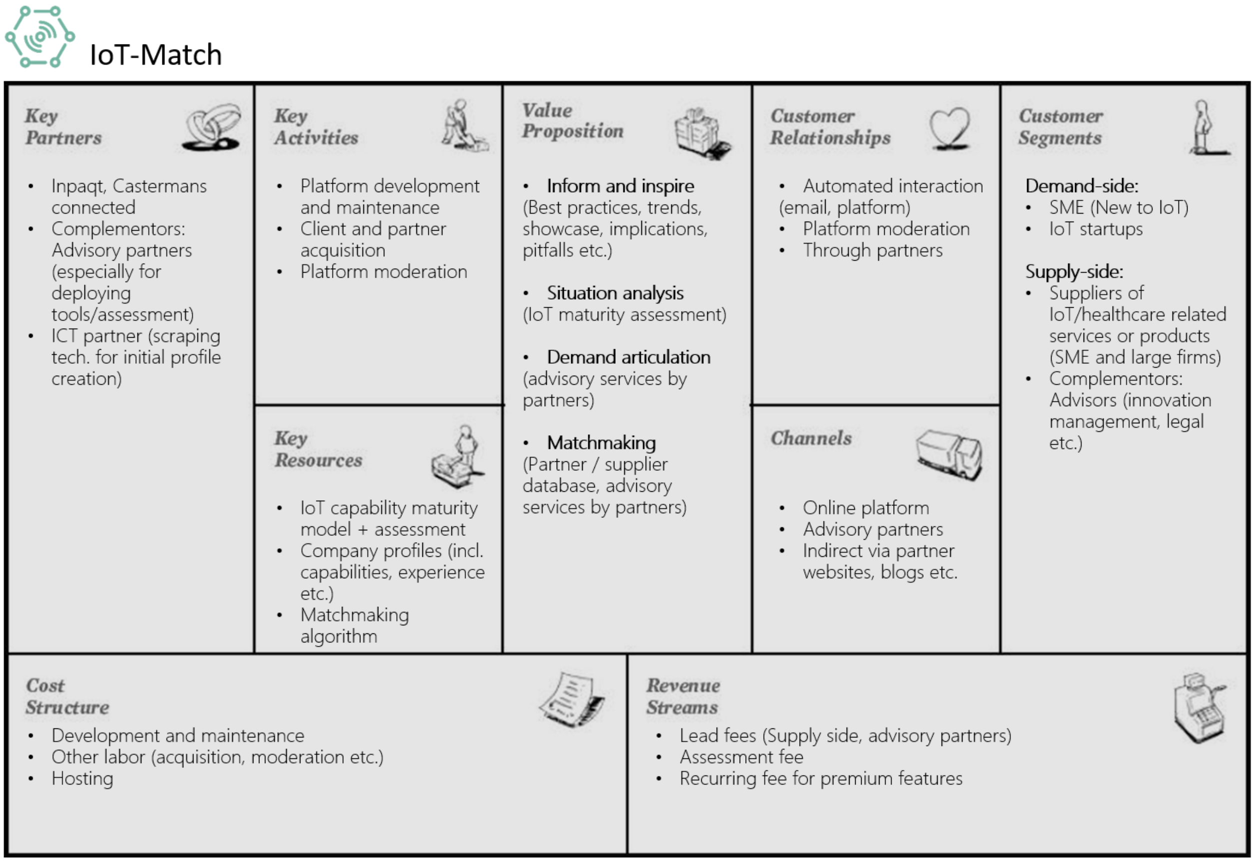


Figure 28: Business model Canvas for the IoT-Match platform (based on Osterwalder & Pigneur, 2010)

7.3.2 Value proposition

The value proposition of a business model describes the products and services a firm offers, in order to solve the problems of each of its customer groups. The bulk of the platform's services are aimed at the demand side of the platform. The services aim to solve problems in four main categories: Information overload, strategic implications, proposition development and partner search. As discussed earlier this chapter, we defined the platform's goal [G_2] in four parts. Each part represents a part of the value proposition. *Inform and inspire* is a fully web-based service that tackles the user's information overload. *Situation analysis* describes the IoT maturity assessment that the platform offers. This assessment is automated, but the full version can be implemented in combination with advisory services of partners. In order to lower the threshold for the user, the platform offers an "IoT maturity Quickscan". This short and automated assessment gives the user an initial idea of the possible added value of the platform. At the same time, the answers are stored to enrich the user profile. *Demand articulation* describes the services in a more mature stage of the client. When an IoT strategy has taken shape, the creation of specific IoT propositions can be facilitated by advisory partners. In a later stage, online tools can be added to this part. Finally, *matchmaking* describes the service that connects firms on both sides of the platform with each other in order to create new value propositions. The partner search process is mainly supported through the online platform.

7.3.3 Channels

In order to reach potential customers, the platform has two different channels. Firstly, an online presence needs to be established. Therefore, the online platform needs to be findable through search engines such as Google. Websites of partners, trade unions an IoT blogs can play an important role in increasing visibility and credibility. Secondly, the platform's services can reach the customer through (offline) word of mouth and recommendations from partners. Especially this last method is important, since partners are seen as an important driver behind the adoption of the platform.

7.3.4 Customer relationships

The advantage of an online platform is that most interaction with clients can be automated, since this method is highly scalable. Interaction will take place through automated emails and software on the platform. To stimulate client-platform and client-client interaction, a platform moderator will be necessary, since this person can respond to specific situations. Finally, partners that make use of the platform's services (e.g. maturity assessment) in their advisory process, act as representatives of the platform. In the process, they will build and maintain customer relationships.

7.3.5 Revenue streams

As discussed before, the platform's basic functionality should be free of charge. This includes an IoT information section, basic partnership search features and an IoT readiness quick scan. The quick scan is an assessment of less than 30 questions, executed by a potential client. Completing the quick scan results in a score on several parameters. For a complete IoT maturity assessment, the client will pay a fee. The complete assessment is based on the same model and parameters as the quick scan, but consists of significantly more questions. Furthermore, the full assessment is conducted among multiple employees within a company. Related services, offered on the platform by advisory partners (complementors), will result in lead fees per assignment. Finally, the user can pay a recurring fee in order to use the platform's premium features (e.g. interaction with other users). For now, the platform will not make use of advertisements. The reason for this is twofold. Firstly, the platform benefits from an image that is as impartial as possible. Advertisements contribute to a more commercial image. Secondly, especially in the early stages, the number of visitors will be too low for advertisements to be lucrative. In that case, advertisements will only make the platform less attractive.

7.3.6 Key resources

The main resources of the platform are knowledge, data and software. Firstly, in order to offer an IoT maturity assessment, the platform uses an underlying IoT capability maturity model. This model contains the parameters (and relations) on which users score their firm, through answering related questions during the assessment. The model is initially constructed by practitioners, but develops and increases in value as it is applied to more firms (trained). Appendix XV further elaborates on the IoT capability maturity model and assessment. Secondly, the user and partner database is a key resource, as it is directly linked to the value of the matchmaking service. Due to network effects, the value of the matchmaking service increases exponentially with the growth of the user database. The user database needs to be built, since it does not yet exist. In order to generate a large database of company profiles, the platform requires partners with capabilities to do so. Thirdly, the algorithm that matches users with each other is an important asset, since it enables the fourth part of the value proposition. Also this asset needs to be developed, since it does not yet exist.

7.3.7 Key activities

In order to make the business model work, there are several activities that need to be performed. The first key activity is the development and maintenance of the platform and its assets (e.g. capability maturity model and matchmaking algorithm). Secondly, the growth of the client and partner network is vital to the platform's value. Therefore, a key activity is stimulating this growth. Thirdly, to stimulate client-platform and client-client interaction, a platform moderator needs to actively encourage this behavior. The moderation activities on the platform increase with the size of the user database. Therefore, the costs of these activities need to be weighed against the benefits.

7.3.8 Key partners

Key partners add value to the business in multiple ways. Firstly, key resources can be contributed by partners. The platform's IoT capability maturity model is developed by Inpaqt and Castermans Connected. Inpaqt can provide or develop the software necessary for the IoT assessment and the matchmaking service. Secondly, to apply the platform's services (e.g. maturity assessment) in practice, advisory partners are required in more complex cases. Thirdly, in order to create an initial database of firms, an ICT partner with web scraping tools is needed. Such a partner requires experience in creating software that searches company websites in order to extract information. Through this technology, it is possible to generate simple profiles of potential suppliers, which helps to overcome the chicken-and-egg problem that most platforms struggle with.

7.3.9 Cost streams

The last element of the business model is the cost structure of the platform. Due to its nature, the platform has a relatively high level of fixed costs, and low variable costs. Firstly, the biggest investment will be in the development of the platform and its services. Maintenance automatically follows this. Secondly, various variable labor costs are the consequence of running the platform. Examples are acquisition and moderation costs. Thirdly, the platform needs to be hosted on web servers. Especially in the early stages of the platform, it is lucrative to make use of cloud based hosting. This almost completely emiminates the fixt costs of purchasing hardware. Therefore, hosting can initially be very low cost. With a growing user base, the variable hosting costs will also increase.

7.3.10 Business model conclusions

We conclude that the business model of the platform revolves around four parts of the value proposition (Inform and inspire, situation analysis, demand articulation and matchmaking). Each of these parts influences the eight other elements of the business model. The four value proposition parts are designed in such a way that they can be developed relatively independently within the artifact. This independence reduces the need for high up front investments. We emphasize the tentativeness of the business model, as presented here. The development of a business model is an iterative process, that can even continue during exploitation of the platform. Therefore, the section above merely describes the first iteration in this process. In the next section, we further elaborate on the platform's value proposition, and the platform features that are required to deliver the proposition.

7.4 Key features

The previous section describes the business model behind the updated design of the platform. The business model emphasizes that the platform's value proposition distinguishes four parts: Inform and inspire, situation analysis, demand articulation and matchmaking. To further clarify the functionality behind these four parts, this section presents screenshots of a mockup, including further explanation. Below, we first discuss the structure of the platform, showing the relations between the platform's pages. Next, we describe the platform's general landing (home) page. Subsequently, we treat each of the parts of the platform's value proposition. For each of these sections we discuss the functionalities, the connection with the platform's value proposition and the relation to the updated requirements.

7.4.1 Platform structure

Before discussing the platform's segments, that each represent a part of the value proposition, this section discusses the structure of the platform. Figure 29 gives a rough overview of the relationships between each of the platform's sections.

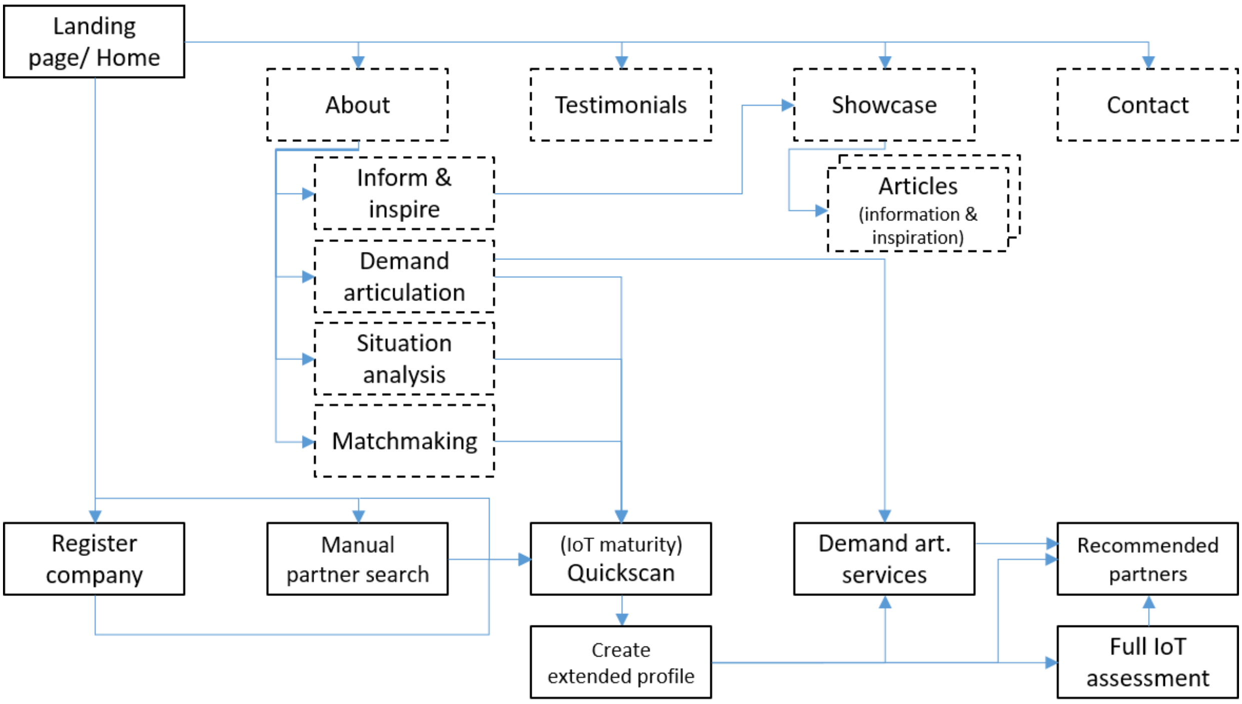


Figure 29: Site map of pages and sections (dashed) on the IoT-Match platform

The user arrives at the landing page. By either scrolling down or clicking, the user can reach the other main sections. The *about* section clarifies the four elements of the platform's value proposition. Subsequently, the *testimonials* section displays recommendations of current platform users in order to increase the platform's credibility. Next, the showcase section offers the user concise informative articles on IoT and healthcare related matters, such as trends, best practices and pitfalls. Finally, the contact section displays the platform's contact information. The following sections explicitly discuss the features of each of the sections related to the main value proposition.

7.4.2 Landing page – home section

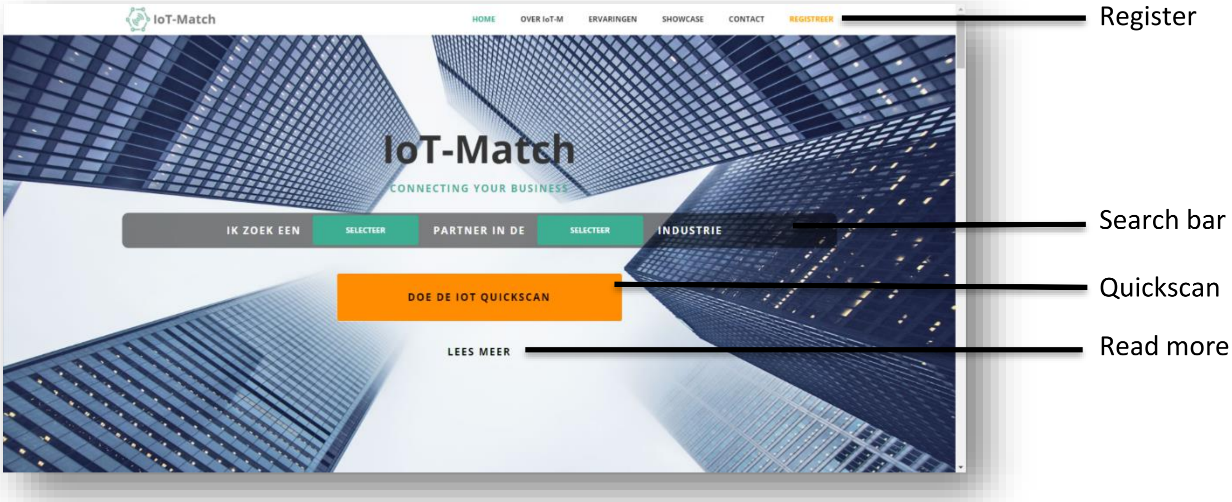


Figure 30: Screenshot of landing page

The first page that the user sees when visiting the platform's website is the landing page. It does not directly provide features from one of the four value proposition parts. Still, the landing page has two main functions. Firstly, the user should immediately be able to derive the platform's value proposition. This corresponds to the requirement (Table 18) of clearly communicating the added value of the platform. Secondly, it provides one or multiple calls to action (CTAs). A CTA, usually in the form of a button, evokes a user's action. These actions redirect the user to one of the four value proposition parts. As can be seen in Figure 30, the landing page has four CTAs. The *register* button enables the user to create a profile. The *partner search bar* allows the user to do a quick search for possible partners. The *Quickscan* button takes the user to the page where he can take the short and free version of the IoT maturity assessment (see appendix XV). Finally, the *Read more* button calls the user to read more about IoT, the platform and its added value.

7.4.3 Inform and inspire

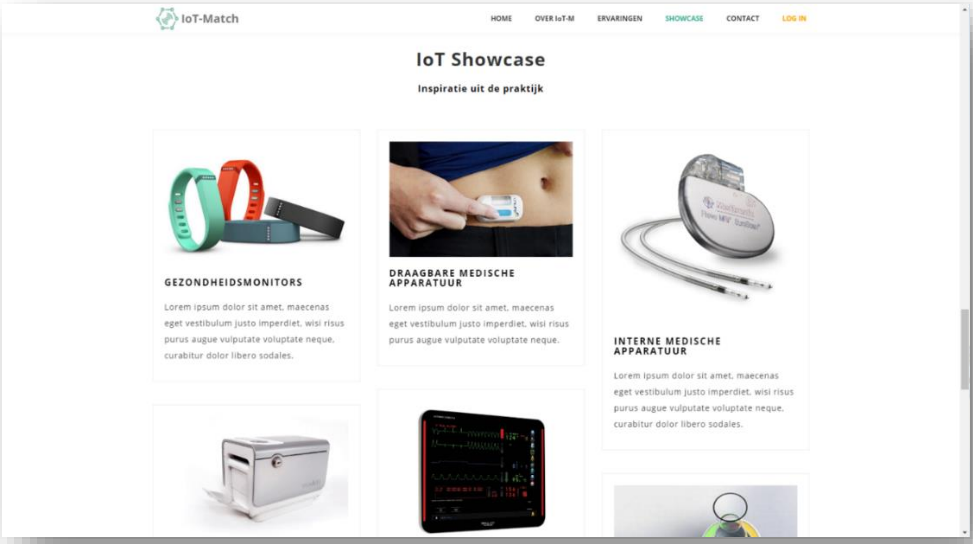


Figure 31: Screenshot of IoT showcase section (articles provide concise information on trends, best practices, pitfalls etc.)

By scrolling down from the initial section of the website, the user enters the showcase section. It is in this section that the platform aims to inform and inspire the user. Through different articles, this section shows trends, best practices, possibilities, implications and pitfalls of IoT and healthcare. Initially, the focus of the platform will be on the healthcare industry. However, as the platform expands, additional industries can be added, with each their own section. The showcase section corresponds to the first part of the platform's value proposition. In the list of updated requirements (Table 18), two requirements correspond to this section. The first requirement treats the inspirational aspect, which is fulfilled by presenting examples of IoT propositions. The second requirement treats the aspect of providing the user with brief and clear information. Figure 31 presents a graphical representation of the inform and inspire section.

7.4.4 Situation analysis

The situation analysis is the second part of the platform's value proposition. The main value in this section is the possibility for the user to assess his firm's IoT maturity through an online assessment. The target users for this assessment are firms that are new to the IoT domain, and are considering to develop an IoT proposition. Assessing the users' current situation is an important step in determining suitable advice.

For new users, the platform provides a free *Quickscan* that roughly determines the status and areas of improvement for the specific company. The data derived from this mini assessment will enrich the user profile. This enables more specific recommendations for partners or services in a later stage. One of the main goals of the Quickscan is to increase the user's awareness on (the benefit of) the platform's additional services. After completing the Quickscan, the user will be offered to take the (paid) full IoT maturity assessment. The full assessment will be completed by multiple employees within the firm, in order to bring any discrepancies to light. The assessment process can be supervised by one of the platform's advisory partners.

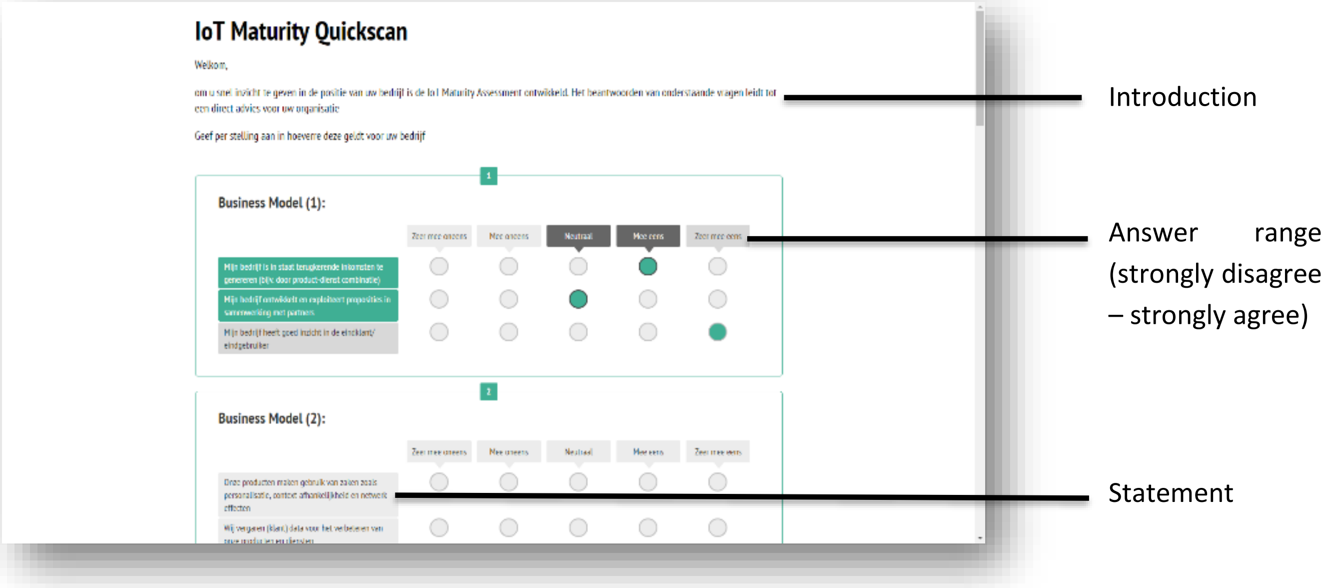


Figure 32: Screenshot of IoT maturity assessment

Figure 32 gives an idea of how the IoT maturity assessment and Quickscan will look like. In both assessments, the user is asked to score each of the statements, depending on how much it is valid for the company. The scores of the statements contribute to various parameters, such as competences and openness, within an IoT capability maturity model. By analyzing the data of multiple assessments, Inpaqt's software can train the capability maturity model by determining the weights of the relationships between parameters. By comparing the company score to the trained model, the software determines which actions need to be taken in order to reach desirable outputs. Appendix XV elaborates further on the IoT capability maturity model and assessment.

The situation analysis section corresponds to several requirements from the updated requirement list (Table 18). First of all, the Quickscan enriches the company profile and clarifies the company role within its ecosystem. The full assessment can further specify the firm's characteristics, in order to increase the value of the company profile. Secondly, both the Quickscan and the full assessment assess the current situation of a company, in order to better target the platform's future services. Finally, the full assessment also functions as a company identity confirmation and inspection, since a partnering advisor visits the company when executing the assessment. This both increases the platform's credibility and lowers the quality uncertainty.

7.4.5 Demand articulation

The services related to demand articulation, the third part of the platform's value proposition, are mostly executed offline. Especially in the early stages of the platform, the demand articulation process will be facilitated by one of the platform's advisory partners. During demand articulation, the learning process related to emerging technologies is guided. For the client, the goal of this process is the creation of a functional design of an IoT product-service combination.

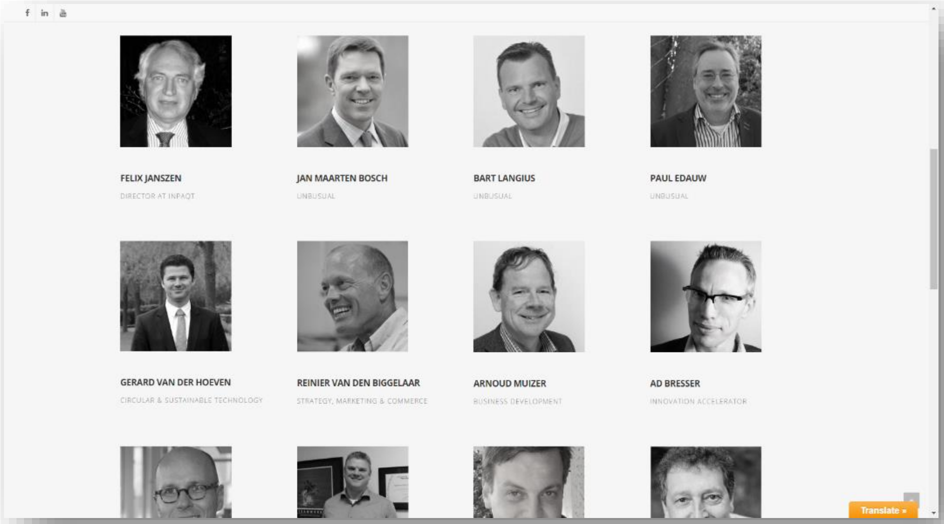


Figure 33: Screenshot of demand articulation partners section

Figure 33 displays an impression of the page that displays the platform's advisory partners, which offer demand articulation services. In order to request more detailed information, the user can contact the platform's service desk. After clarifying the client's need, an advisory partner is assigned to the firm.

The demand articulation section corresponds to two requirements from the updated requirements list (Table 18). The first requirement generically describes the section's goal: provide demand articulation services and tools. At this point, tools will be excluded from the design for feasibility reasons. In a more mature stage, it can be considered whether adding demand articulation tools adds significant value to the platform. The second requirement more specifically targets a single service: facilitation of IoT functional design creation. As discussed earlier in this section, this service will be provided offline by one of the platform's advisory partners. Since the majority of the demand articulation activities take place offline, the visualization of this section is limited.

7.4.6 Matchmaking

The final feature of the platform is its matchmaking service, referring to the fourth part of the platform's value proposition. The platform enables users (firms) to find a partner to complement their current ecosystem. Such a partner can be an IoT or healthcare related company in the Netherlands, but also providers of other relevant services, such as legal advice. On the basis of the eight matchmaking-related requirements (Table 18), we discuss the platform's features that are related to this subject.

In order to overcome startup problems, the platform requires a database with profiles of Dutch IoT and healthcare related firms. Currently, the database does not yet exist. Since the platform is subject to network effects, a lack of profiles is results in limited value. To overcome this chicken and egg complication, an initial database needs to be established. As discussed in section 7.3.8, a partnership with an IT firm is necessary to create such an initial database. On the landing page, supply side users are asked to create or supplement their company profile. This (complemented) profile will be included in the platform's supplier database.

When a (demand side) user arrives at the platform, there are two available methods for receiving partner recommendations. The user can either manually search the company database, or receive specific recommendations based on a company profile. The manual method makes use of the search engine, displayed in Figure 34. The user can choose a desired type of partner and a specific industry, which results in a selection of relevant companies. The main purpose of this method is to provoke interaction with the user, leading to interest in a Quickscan and the creation of a demand side profile. Specific partnership recommendations can be given after the user finishes the Quickscan. Upon completion of the scan, the user will be asked to perform a full IoT capability maturity assessment. This assessment results in an even more comprehensive company profile, leading to more specific partner recommendations.

Figure 34: Screenshot of manual partner search section

Some of the requirements (Table 18) have not been taken into account in the mockup. The mockup does not explicitly show the possible communication, network and word of mouth functionalities of the platform, including review mechanisms. These functionalities are expected to be a valuable addition, but are too detailed to take into account in this design phase.

7.5 Conclusions

This chapter discusses the thesis' final iteration in the platform design process. Using the outcomes of the interview phase, we formulate an updated goal [G_2], and pose updated sets of assumptions [A_2] and requirements [R_2]. Subsequently, we describe the platform's business model using the business model Canvas method. Finally, we dive into the key features of the platform by describing how the four elements of the value proposition are delivered.

The initial goal [G] of this platform is to reduce the user's partnership-related search costs by recommending suitable partners, based on company profiles. When interviewing potential users, these parties recognized the need for new partners when developing a new IoT proposition. Identification of a suitable partner is sometimes experienced as a problem, but not as a primary one. This is mainly due to the limited maturity of firms. A much more pressing issue is experienced in an earlier stage, namely in the awareness phase. When firms become aware of the relevance of IoT for their business, the lack of knowledge is identified on one of the most pressing problems. This finding results in a reformulation of the platform's goal. The updated goal [G_2] will therefore be: *Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition*. This goal can be divided into four parts: Inform and inspire, situation analysis, demand articulation and matchmaking.

As expected, the set of initial requirements and the list derived from the interview phase, showed both similarities and conflicts. First of all, since the goal of the platform changed, the focus of the requirements changed. The initial requirement list was primarily focused on matchmaking aspects of the platform. With the reformulation of the goal, the new set of requirements is expanded towards the four elements of the platform's value proposition. Conflicting requirements can be seen in the areas of confidentiality and online vs. offline facilitation. The confidentiality conflict is related to the idea of an online marketplace for partnership requests. This requires the user to publicly share sensitive data, which makes the marketplace an undesirable feature. The online vs. offline facilitation is related to the feasibility of providing services online. Interviewees indicated that some offline processes (e.g. assessing cultural compatibility, building trust, formulating an IoT proposition etc.) are highly unlikely to be replaceable by an online substitute. Therefore, at this point it is more realistic to facilitate some processes offline.

In the area of the platform's business model, several conclusions can be drawn. For simplicity reasons, the platform's focus is on two user groups. The two distinct user groups of the platform can best be described by a supply and a demand side. The supply side consists of firms of any size that are active in the field of IoT and/or healthcare. An addition to the supply side are firms that provide relevant, but more general services, such as legal advice. The demand side consists of firms that aim to enter the domain of IoT, whether as incumbent or as startup. The platform will focus mainly on SMEs, since interviews pointed out that this target group is most in need of guidance in the IoT domain. This guidance is offered through the four parts of the platform's value proposition (Inform and inspire, situation analysis, demand articulation and matchmaking). The four value proposition parts are designed in such a way that they can be developed relatively independently within the artifact. This independence reduces the need for high upfront investments. We emphasize the tentativeness of the business model, as presented here, since its development is an iterative process.

To further clarify the functionality behind the four value proposition parts, the last section of this chapter discusses the key features of the platform, accompanied by screenshots of a mockup. We first discuss the structure of the platform, showing the relations between the platform's pages. Next, we describe the platform's general landing (home) page. The main goal of this page is to clearly communicate the platform's value proposition and to persuade the user to act. Subsequently, we treat each of the parts of the platform's value proposition. For each section of these sections we discuss the functionalities, the connection with the platform's value proposition and the relation to the updated requirements. The *Inform and inspire* section makes use of brief articles to familiarize the user with the IoT domain. The *Situation analysis* section provides an IoT capability maturity Quickscan, which complements the user's profile. After this free mini assessment, the user can choose to perform a paid full assessment. This can be executed in cooperation with the platform's partnering advisory firms. The *Demand articulation* section displays services of partnering advisory firms. These services are aimed at firms in a more mature stage, and seek to support the process of creating an IoT proposition. Finally, the *Matchmaking* section helps firms find the right partner by comparing the client's needs with the platform's database of company profiles.

This chapter treats the final design stage of this thesis. In the following chapter, we discuss the evaluation of the design. This includes evaluation of the design plan and process. The evaluation of the product will be treated only briefly, since the product of this research is a mockup with very limited functionality.

8. Reflective evaluation of design

In the previous chapter, we establish an updated set of assumptions [A_2] and an updated goal [G_2] of the platform. Subsequently we discuss the updated requirements list [R_2], which results in a description of the platform's business model and key features. Due to the scope of this research, the previous chapter discusses the final stage in the design process. Throughout the process, we adhere to two design methods (Verschuren & Hartog, 2005; Sein et al, 2011) for guidance. Both methods emphasize the importance of evaluation of the design. This chapter treats the evaluation from both lenses. We choose to treat both methods separately, since each has a different approach of looking at the same process. We start by discussing the plan, process and product phases, according to the method of Verschuren & Hartog (2005). Next, we discuss the four stages of ADR: Problem formulation; Building, intervention and evaluation; Reflection and learning; Formalization of learning (Sein et al, 2011). Both methods of evaluation are applied in a reflective manner. Due to the limitations of this project, we are not able to include users in the evaluation process. Ideally, external validation should be obtained by involving users, which is recommended for subsequent iterations in the design process.

8.1 Evaluation in design-oriented research

Verschuren & Hartog (2005) argue that evaluation of the process of design asks for a highly systematic approach. Although evaluation is discussed at the end of the design process, they stress the importance of evaluation throughout the entire process. Furthermore, the design process should be highly iterative, although it is depicted linearly. Nevertheless, as shown in Figure 2, three rough stages can be distinguished in the design process: plan, process and product. The plan stage discusses the design on paper. This includes the goal, requirements and assumptions. The process stage discussed the realization of the plan, including the creation of a prototype (mockup in our case). Finally, the product stage discusses the effects that are involved with using the artifact. The evaluation of each of the three stages is treated below.

8.1.1 Evaluation of the design plan

Plan evaluation assesses the quality of the design on paper. The plan evaluation logically, ethically and empirically assesses the quality of the design plan. In this process, we assess the acceptability of the goal, the requirements, the assumptions and the relations between them. We start by assessing the artifact's goal.

The initial goal [G] of the platform is *to ease ecosystem creation and growth in the IoT (care) domain, by facilitating partnership formation*. This implies three things. (1) Ecosystem creation and growth in the IoT (care) domain is desirable, (2) and currently perceived as a problem; (3) The formation of partnerships causes ecosystem creation and growth. During this research, we conclude that the second implication of the initial goal [G] is overestimated. The devious problem perception of our interviewees results in a change of scope towards an updated goal [G_2]: *Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition*. This goal is then divided into four elements: Inform and inspire, situation analysis, demand articulation and matchmaking.

In line with the evaluation method, we first discuss the goal's clearness. A method to achieve consensus among stakeholders is to keep the planned goal vague, which is undesirable. The initial goal's [G] vagueness is one of the reasons of rephrasing the platform's goal. The updated goal [G_2] is aimed to more clearly convey the platform's purpose, and remove part of the initial ambiguity. Since the updated goal [G_2] is based on experiences from practice, the consensus of stakeholders is kept intact, even though the goal's vagueness has diminished. Due to less ambiguity, the feasibility and affordability of the updated goal [G_2] are easier to assess. In the context of this design, taking into account the commitment of current partners (Inpaqt, Castermans Connected), the updated goal [G_2] is highly feasible and affordable. Only the fourth aspect of the goal (matchmaking) poses feasibility and affordability risks, since external partners are required. Furthermore, there are no immediate ethical objections as long as the user's privacy and security are respected.

The updated requirements [R_2] match the goal [G_2]. Dividing the requirements into sections, that correspond to a specific part of the goal [G_2], is meant to further clarify the relationships. The level of detail of some requirements [R_2] is limited, which is the result of merely a single iteration with potential users. A similar case is that of operationalization of the requirements [R_2]. Several requirements [R_2] are not yet made operational (e.g. Database with profiles). Future improvements are possible by (1) connecting desirable scores to variables and (2) explicating actions that are required to reach certain criteria. Feasibility, affordability and ethical acceptability of the requirements [R_2] match those of the goal [G_2].

Many of the assumptions [A] related to the artifact are implicitly or explicitly discussed during the interview phase. In this manner, we are able to confirm or refute most assumptions [A]. This results in a limited amount of updated assumptions [A_2]. These remaining assumptions [A_2] are, for their purpose, sufficiently detailed. Future steps include the validation of these assumptions [A_2] by means of discussions with potential users. A possibility in a later stage is to test assumptions on the live platform, by means of gathering usage data.

8.1.2 Evaluation of the design process

Process evaluation discusses the realization of the artifact's prototype and implementation of the prototype. This thesis is limited to the visualization of the platform's key features. The focus of the process evaluation is therefore limited to this outcome. Generally, process evaluation is meant to identify possible improvements for the process. Next to that, a thorough evaluation can prevent costly defects in the future, since it compares the design process to a set of guidelines.

We start by discussing the actors involved in the design process, since these play an important role in this stage. Firstly, representatives from both Inpaqt and Castermans Connected have been closely involved in the process. Throughout the report referred to as practitioners, these actors bring significant expertise to the project. Knowledge and experience from the IoT domain was primarily added by Castermans Connected. Inpaqt is specialized in innovation management and building tools to support this process. The commitment of both firms has significantly contributed to the results of this thesis. Communication has mostly taken place in weekly meetings, which ensured continuous progress. The other important group of actors is the set of potential users. Communication with these actors has primarily taken place in the interview phase. The involvement of these actors was limited, but vital to the process. These actors are not only potential users, but also a valuable source of expertise on their specific domains.

The evaluation method also proposes a set of process criteria or guidelines. The first guideline is related to modular design. This corresponds to an artifact with relatively independent components. When looking at the platform, it has a clear structure of components, relating to the four parts of the value proposition (Inform and inspire, situation analysis, demand articulation and matchmaking). Each of these components is relatively independent. The main dependency is in the order of creation. Therefore, the four parts are mentioned in the order in which they should be developed. When following this order, it should pose few problems to have an incomplete platform. This is mainly because each part of the value proposition relates to a step in the development and partnership process. The second guideline argues that resources should be allocated proportionally to the importance of decisions. The most important decisions in this research (e.g. the amount of platform sides) have been backed up by literature or empirical analysis. The (at this point) less important decisions (e.g. graphical details) have been allocated a lot less time and effort. Another guideline is the distinction between strategic, tactical and operational decisions. This research does not explicitly distinguish these three types of decisions. However, we do aim to comply to the preferred order of treating these types. Essential decisions about the artifact as a whole (strategic) are the primary focus of the initial part of the design process. Subsequently, decisions about properties of parts of the artifact (tactical) are treated. Finally, we implicitly take into account the very detailed decisions (operational), by giving a graphical example of the platform's key features.

8.1.3 Evaluation of the design product

Product evaluation treats the results of the design process, the value of the results and the effects of using the artifact. This summative evaluation assesses whether the use of the artifact fits the artifact's goal. Furthermore, the satisfaction of the designers and important stakeholders concerning the artifact is evaluated. One of the goals of product evaluation is to substantiate the decision to continue or stop the design process. Stopping the process can be the result of a lack of progress, but also because the design goal can be achieved in a different manner.

This thesis aims to produce a mockup, with limited functionality, that displays the artifact's key features. Due to the confined scope of this research, the evaluation of the product is limited to the artifact's mockup. This results in exclusion of the effects of using the artifact. We therefore focus on the value of the results of the design process.

We argue that this design process adds value in two distinct ways. Firstly, by explicating the needs of the target user, we redefine the platform's initial goal [G]. The updated goal [G_2], and corresponding requirements [R_2] and assumptions [A_2], provide valuable knowledge to several important stakeholders. This knowledge lays the foundation for the development and improvement of future products and services. Secondly, we propose an example of translating the found requirements into an artifact (Chapter 7). Due to the time limitations of this project, we were not able to execute another iteration in the design process. However, the resulting mockup gives a structured overview of the four value proposition parts (Inform and inspire, situation analysis, demand articulation and matchmaking), which can be further developed in additional design cycles. An additional benefit of the current design is its modular structure. Each of the four value proposition parts is relatively independent. This enables the stakeholders to focus further development on the parts that are deemed most interesting.

Castermans Connected and Inpaqt have shown special interest in the situation analysis part of the platform. The further development of an IoT capability maturity model and assessment has received first priority (Appendix XV). This is mainly because of Inpaqt's experience in creating similar models and assessments. Furthermore, the channels necessary for deploying assessments are already established.

8.2 Action Design Research

Sein et al (2011) propose a method that goes beyond traditional design science, by recognizing the importance of organizational context. The Action Design Research (ADR) method is specifically used to design IT artifacts in an organizational environment. The method is aimed to build, intervene and evaluate in a specific problem situation. Four stages are distinguished in ADR. However, these stages are tackled in a more iterative way than traditional stage-gate models would. The method draws on a total of seven principles, which will be evaluated in the appropriate stages. An overview of the ADR stages and principles can be seen in Figure 3. Below we briefly discuss each of the four design stages in hindsight.

8.2.1 Stage 1: Problem formulation

In ADR stage one, the *perceived problem* is formulated, which corresponds to the initial goal [G] of the artifact (Chapter 5). The input for this formulation comes from practitioners, combined with literature research. This meets the first two principles of ADR (Practice-Inspired Research, Theory-Ingrained Artifact). We start the research with the view that ecosystem creation within the IoT domain is a problem. In line with the ADR method, we first position the problem as an instance of a class of problems. We argue that ecosystem creation in IoT is an instance of general ecosystem creation, which is in its turn an instance of business model innovation (Figure 1). Subsequently, we create an IoT matchmaking requirements framework, which is the theoretical basis of the artifact.

8.2.2 Stage 2: Building, Intervention and Evaluation

The second stage in ADR is *Building, Intervention and Evaluation* (BIE). The problem description from stage one provides input for the initial design of the IT artifact. Since the focus of this research is on organizational intervention, the organizational-dominant BIE cycle is used (Figure 4). Because of the limited time available, the focus of this research is on the first half of the cycle.

The ADR method emphasizes the importance of stakeholder involvement. The dominant stakeholders in this process are the owners of the companies Inpaqt and Castermans Connected. These stakeholders are involved though weekly meetings. The first half of the BIE cycle also requires end user involvement. This is done through interviews with five companies.

The second ADR stage rests on three principles. Firstly, Sein et al (2011) mention *Reciprocal Shaping*, which stresses the importance of the mutual influences of the IT artifact and the organizational context. The perspective of the organizational context is initially guaranteed by the practitioners in this project. In a later stage, potential end users contribute to this principle as well. Secondly, the importance of mutual learning is pointed out. This is described as *Mutually Influential Roles*. The practical knowledge from practitioners is complemented by the theoretical knowledge of action design researchers. The basis for this principle lies in the IoT matchmaking requirements framework (Figure 17), and is later complemented by multi-sided platform literature (Chapter 4). The third and final principle in this stage is *Authentic and Concurrent Evaluation*. The key message of this principle is that evaluation should be considered a continuous process. The continuous evaluation during this research is supported by the method of Verschuren & Hartog (2005), as discussed in section 8.1.

8.2.3 Stage 3: Reflection and Learning

ADR stage three is *Reflection and Learning*. This stage is continuously present in parallel with the first two stages. It aims at generating knowledge that can be applied to a broader class of problems than merely this single case. A single principle is dominant in this stage: *Guided Emergence*. This attempts to merge the seemingly contradicting terms *design* and *emergence*. ADR aims at creating an ensemble artifact that reflects not only the initial design, but also the continuous input of stakeholder perspectives.

When reflecting on the design process discussed in this thesis, we argue that guided emergence is clearly visible. Ideally, the use of an artifact generates continuous feedback for further improvement. This is not the case for this thesis. However, during this thesis, design and practice are constantly taken into account. The most visible example is related to reformulating the platform's goal and requirements. This change is fully based on stakeholder input, increasing the chance of the final artifact's adoption.

8.2.4 Stage 4: Formalization of learning

The last stage in the ADR process is stage four: *Formalization of Learning*. In this stage, knowledge gained in the previous stages is aggregated into general concepts for a field of similar problems. The last principle, *Generalized Outcomes*, explains that the result of ADR is an IT artifact combined with organizational changes. Together, these are the solution to a problem. Both the solution and the problem can be generalized. Finally, from the research outcomes we can derive design principles.

In chapter 1 we already generalize the problem of IoT ecosystem creation as an instance in a class of problems. This class of problems is the creation of business ecosystems in general, which is one of many possible business model innovations. The solution to the problem, as proposed by this thesis, is an online (B2B matchmaking) platform that provides tools and services, which familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition. Several lessons learned during the design process, and takeaways from the final result, can be generalized, making them applicable to other domains. We treat these learnings more comprehensively in chapter 9.

8.3 Conclusions

Throughout the process, we adhere to two design methods for guidance. Both methods emphasize the importance of evaluation of the design. This chapter treats the evaluation from both lenses. We start by discussing the plan, process and product phases, according to the method of Verschuren & Hartog (2005). They argue that evaluation of the process of design asks for a highly systematic approach.

The plan stage discusses the design on paper. This includes the goal, requirements and assumptions. The initial goal [G] of the platform is *to ease ecosystem creation and growth in the IoT (care) domain, by facilitating partnership formation*. During the design process, we identify two main flaws in the initial goal [G]. Firstly, the sole focus on ecosystem creation is undesirable, since firms experience larger problems in an earlier stage, already while exploring the possibilities and implications of IoT. Secondly, the initial goal is formulated too vague. The devious problem perception of our interviewees results in a change of scope towards an updated goal [G_2]: *Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition*. This goal is then divided into four elements: Inform and inspire, situation analysis, demand articulation and matchmaking.

The process stage discussed the realization of the plan, including the creation of a prototype (mockup of the platform's key features). In this stage, stakeholders play an important role. Representatives from both Inpaqt and Castermans Connected have been closely involved in the process, bringing significant expertise to the project. Communication with potential end users has primarily taken place in the interview phase. The interviews provide a valuable source of expertise on the interviewees' specific domains. Furthermore, the evaluation method also proposes a set of process criteria or guidelines. Although not always explicit, these guidelines have been taken into account during the process.

Finally, the product stage assesses the added value of the results of the design process. We argue that this design process adds value in two distinct ways. Firstly, the updated goal [G_2], and corresponding requirements [R_2] and assumptions [A_2], provide valuable knowledge to several important stakeholders. This knowledge lays the foundation for the development and improvement of future products and services. Secondly, we propose an example of translating the found requirements into an artifact (Chapter 7).

Next, we discuss the four stages of ADR: Problem formulation; Building, intervention and evaluation (BIE); Reflection and learning; Formalization of learning (Sein et al, 2011). In the problem formulation stage, we first position the problem as an instance of a class of problems. We argue that ecosystem creation in IoT is an instance of general ecosystem creation, which is in its turn an instance of business model innovation (Figure 1). Subsequently, we create an IoT matchmaking requirements framework (Figure 17), which is the theoretical basis of the artifact. In the BIE stage, again the practical knowledge from practitioners is complemented by the theoretical knowledge of action design researchers. This is primarily done by discussing multi-sided platform literature (Chapter 4). In the reflection and learning stage, we argue that guided emergence is clearly visible. During this thesis, design and practice are constantly taken into account. The most visible example is related to reformulating the platform's goal and requirements. Finally, in the formalization of learning stage, we also generalize the solution (IoT matchmaking platform) as an instance in a class of solutions (B2B matchmaking platforms. The generalized design principles for B2B matchmaking platforms are summarized in Table 11. Several lessons learned during the design process, and takeaways from the final result, can be generalized, making them applicable to other domains. We treat these learnings more comprehensively in chapter 9.

9. Conclusions, discussion and reflection

Previous chapter specifically evaluates the design process. In this last chapter look back at the complete research process. We start by answering each of the sub questions that were posed in the first chapter. The answers of these questions lead to the answer to the main research question. The second part of this chapter discusses the contributions of this study and the implications of its results. The final part of this chapter reflects on the methods used in this thesis and the limitations of the design process and results.

9.1 Conclusions

In this section, we answer the main question of this research: *What are the requirements for a matchmaking platform that enables to develop and grow an ecosystem of (SME) companies that develop IoT solutions?* We do this by following the structure of the report. We therefore first answer each of the five sub questions, which each represent a phase in the design process, and end with the conclusion of the main research question.

9.1.1 Requirement categories for matchmaking in the IoT domain

In chapter 2 and 3 we aim to answer the first sub question of this research: What requirement categories for matchmaking in the IoT domain can be derived from literature? Due to the importance of business models in IoT, we introduce the business model as an organizing principle for analyzing the IoT domain. To structure characteristics of IoT, we discuss the Service related, Technological, Organizational and Financial aspects of the IoT domain. These domains provide the structure for our first requirement category: IoT business models. In the service domain, we discuss the methods of value creation in IoT. The technology domain is described using the IoT technology stack. In the organization domain, we emphasize the importance of ecosystems and show generic roles of firms within an IoT ecosystem. The finance domain mainly discusses methods to capture value.

In chapter 3 we discuss matchmaking. Selecting the right partner is crucial in gathering the necessary resources to deliver a service. Partnering in new product development is seen as a maturation process instead of a discrete event. The findings from this literature research are combined with the IoT business model findings from chapter 2. We argue that requirements related to matchmaking in the IoT domain can be divided into seven categories. Therefore, we propose an IoT matchmaking requirements framework that divides our findings into seven requirement areas: Complementarity, Trust, Compatibility, Communication, Agreements, Commitment and IoT Business models. These requirement areas are plotted along three phases of the partnership maturation process (Awareness, Exploration, Expansion) (Figure 17).

9.1.2 Design principles for B2B matchmaking platforms

In chapter 4 we aim to answer the second sub question of this research: What design principles can be derived from multi-sided platform literature and analyzing existing matchmaking platforms? We define multi-sided platforms (MSPs) as software creating value by serving as a facilitator for interaction between multiple distinct user groups. From the analysis of three existing B2B matchmaking platforms, we draw conclusions on how these current platforms try to overcome common obstacles. We summarize the conclusions from literature and the MSP analysis in design principles for B2B matchmaking platforms, which are shown in Table 11. These principles can help MSP designers to make deliberate choices related to the amount of distinct user groups, primary and secondary features, pricing structures, governance mechanisms etc.

The design principles aim to convey knowledge about the creation of other artifacts with similar properties. Therefore, these principles should be applicable to a class of platforms. Since the analysis was not specifically related to IoT platform, we argue that our design principles are applicable to all platforms that facilitate interaction between distinct groups of business users (B2B matchmaking).

9.1.3 First hunch platform requirements

In chapter 5 we aim to answer the third sub question of this research: What (first hunch) platform requirements can be derived from previous sections? We describe the platform's goal [G] as to ease ecosystem creation and growth in the IoT (care) domain, by facilitating partnership formation. This is done by facilitating interaction between two or more firms. At this point, we introduce the platform's working title: 'IoT-Match'. We propose the following value proposition for the platform: *IoT-Match reduces partnership-related search costs for SMEs in the care domain, by recommending suitable partners.*

Based on the platform's goal, we propose the platform's initial characteristics. These characteristics are structured using the MSP analysis framework, as described in chapter 4. We bring together these characteristics with the categories from the IoT matchmaking requirement framework (Figure 17) and the views of practitioners, in order to create a list of first hunch requirements [R], as shown in Table 13. This list is followed by a list of assumptions [A]. Both lists can be divided into functional, user-related and contextual aspects. Emphasis should be placed on the fact that the requirements and assumptions are mainly focused on the functional aspects of the platform. Non-functional requirements (e.g. quality, privacy, security, sustainability, scalability etc.) are of such importance, that at this point they are assumed to be fulfilled.

9.1.4 Additional platform requirements from interviews

In chapter 6 we aim to answer the fourth sub question of this research: What additional platform requirements can be derived from practices and problems of IoT-related firms in the healthcare domain? By means of interviews we aim to (1) validate the list of first hunch requirements [R] for the platform; (2) Complement the initial requirement list with a list of additional requirements derived from the interviews [R_i] (Table 16); (3) Validate or refute the assumptions [A] made for the first hunch design.

One of the main conclusions is that only three of the seven initial requirement categories (IoT business models, complementarity and communication), as presented in Figure 27, are perceived as pressing problems. Other requirement categories are perceived as important, but they are not perceived as direct problems. Furthermore, the awareness phase is deemed much more important by interviewees than our initial estimation. This is mainly since users already face difficulties in estimating the implications of IoT on their firms. These difficulties already play a role before the explicit need for partnerships arises.

9.1.5 Key functionalities and characteristics of the artifact

Chapter 7 discusses the final phase of the design process, in which we aim to answer the fifth sub question: What are the key functionalities and characteristics of an online B2B matchmaking platform, and how do these relate to its requirements? Using the outcomes of the interview phase, we formulate an updated goal [G_2], and pose updated sets of assumptions [A_2] (Table 17) and requirements [R_2] (Table 18). Subsequently, we describe the platform's business model using the business model Canvas method. Finally, we dive into the key features of the platform by describing how the four elements of the value proposition are delivered.

The initial goal [G] of this platform is to reduce the user's partnership-related search costs by recommending suitable partners, based on company profiles. Interviews indicated that identification of a suitable partner is sometimes experienced as a problem, but not as a primary one. This is mainly due to the limited (IoT) maturity of firms. A much more pressing issue is experienced in an earlier stage, namely in the awareness phase. When firms become aware of the relevance of IoT for their business, the lack of knowledge is identified as one of the most pressing problems. This finding results in a reformulation of the platform's goal. The updated goal [G_2] will therefore be: *Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition*. This goal can be divided into four parts: *Inform and inspire, situation analysis, demand articulation and matchmaking*.

With the reformulation of the goal, the set of requirements is expanded and divided using the four elements of the platform's value proposition. Conflicting requirements can be seen in the areas of confidentiality and online vs. offline facilitation. The confidentiality conflict is related to the idea of an online marketplace for partnership requests. This requires the user to publicly share sensitive data, which makes the marketplace an undesirable feature. The online vs. offline facilitation is related to the feasibility of providing services online. Interviewees indicated that some offline processes (e.g. assessing cultural compatibility, building trust, formulating an IoT proposition etc.) are highly unlikely to be replaceable by an online substitute. Therefore, (at this point) it is more realistic to facilitate some processes offline.

In the area of the platform's business model, several conclusions can be drawn. For simplicity reasons, the platform's focus is on two user groups. The two distinct user groups of the platform can best be described by a supply and a demand side. The supply side consists of firms of any size that are active in the field of IoT and/or healthcare. An addition to the supply side are firms that provide relevant, but more general services, such as legal advice. The demand side consists of firms that aim to enter the domain of IoT, whether as incumbent or as startup. The platform will focus mainly on SMEs, since interviews pointed out that this target group is most in need of guidance in the IoT domain. This guidance is offered through the four parts of the platform's value proposition (Inform and inspire, situation analysis, demand articulation and matchmaking). The four value proposition parts are designed in such a way that they can be developed relatively independently within the artifact. This independence reduces the need for high upfront investments. We emphasize the tentativeness of the business model, as presented here, since its development is an iterative process.

To further clarify the functionality behind the four value proposition parts, the last section of chapter 7 discusses the key features of the platform, accompanied by screenshots of a mockup. The main goal of the platform's general landing (home) page is to clearly communicate the platform's value proposition and to persuade the user to act. The *Inform and inspire* section makes use of brief informative articles to familiarize the user with the IoT domain. The *Situation analysis* section provides an IoT capability maturity Quickscan, which complements the user's profile. After this free mini assessment, the user can choose to perform a paid full assessment. This can be executed in cooperation with the platform's partnering advisory firms. The *Demand articulation* section displays services of partnering advisory firms. These services are aimed at firms in a more mature stage, and seek to support the process of creating an IoT proposition. Finally, the *Matchmaking* section helps firms find the right partner by comparing the client's needs with the platform's database of company profiles.

9.1.6 Matchmaking platform requirements (main research question)

The answers to the sub questions of this research can be used to answer the main question: *What are the requirements for a matchmaking platform that enables to develop and grow an ecosystem of (SME) companies that develop IoT solutions?* Since the objective of this research has two separate aspects, we distinguish functional requirements from business model requirements.

Functional requirements describe the functions or tasks that the artifact (platform) needs to fulfill in order to achieve its goal. The goal [G_2] that we propose is the following: *Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition*. We divide this goals into four parts: *Inform and inspire, situation analysis, demand articulation and matchmaking*. These parts correspond to the platform's four main sections. As seen in Table 18, we also divide the platform's requirements [R_2] into these four parts, and an additional general part.

We clarify the business model requirements by means of the Canvas method (Figure 28). The platform focuses on two distinct customer segments or user groups. The two user groups can best be described by a supply and a demand side, with a focus on SMEs. The platform's four value proposition parts are designed in such a way that they can be developed relatively independently within the artifact. This independence reduces the need for high upfront investments. Although the basic functionality of the platform needs to be available free of charge, the platform also offers premium subscriptions in exchange for extra features. Advisory partners, or complementors, play an important role in the platform's business model. These firms directly contribute to the platform's value proposition, but also maintain customer relationships and act as (sales) channel. The full business model description can be found in section 7.3.

9.2 Contributions and implications from an MoT perspective

This section discusses the main contributions of this study, including recommendations for future research. Subsequently, we treat the implications of our findings for practitioners.

9.2.1 Contributions and recommendations

In this section we discuss the importance of our findings, in relation to both literature and practice. Below, we present our three major contributions. For each of the contributions we also present our recommendations for further actions.

By examining literature on partnerships, ecosystems, governance mechanisms and IoT business models, we are able to propose an IoT matchmaking requirement framework (Figure 17). This framework groups our findings from literature in seven requirement categories: Complementarity, Trust, Compatibility, Communication, Agreements, Commitment and IoT Business models. We argue that requirements related to finding a suitable business partner can be placed in one of these categories. According to our knowledge, no such framework currently exists. Therefore, our framework poses a new perspective that can serve both practice and science. For practitioners, this framework can serve as a guideline on important factors when considering new partnerships. In a scientific scope, the framework can serve as a basis for future research on requirements for collaboration in multidisciplinary domain. We propose two recommendations for further research related to this framework. Firstly, the framework should be further validated in various industries related to the IoT domain (e.g. smart homes, automotive etc.). Secondly, we propose that further research related to this framework focuses on validation in different domains (non-IoT). In Figure 27 we already indicate that not all requirement categories are perceived as equally important. A follow-up study could focus on the importance of requirement categories per domain.

In chapter 4 of this thesis, we establish a set of design principles for B2B matchmaking platforms. These principles are partly based on existing multi-sided platform (MSP) literature. The other principles are based on an analysis of existing B2B matchmaking platforms. Our analysis of existing platforms contributes to MSP literature, although further validation is desired. The set of design principles can aid designers of MSPs to systematically and deliberately address important design decisions. We propose two recommendations for further research related to these design principles. Firstly, the list of design principles can be expanded using other sources from literature. A possible addition then is to explicitly group the principles into strategic, tactical and operational categories. This clarifies the order in which the design principles should be addressed by designers. Secondly, we plead for testing the principles in practice. Results from these tests can be used to refine or restructure the principles

One of the most obvious contribution of this research is the tentative design of a specific IT artifact, a B2B matchmaking platform for firms in the IoT domain. We describe the artifact using its primary goal [G_2], and corresponding assumptions [A_2] and requirements [R_2]. Furthermore, we propose a business model for the platform, and discuss the platform's main features by means of a mockup. These contributions are mostly practical in nature, and should thus appeal especially to practitioners. For designers of MSPs, we provide an example of applying methods from literature to structure the design process. For Inpaqt and Castermans Connected we propose a tentative list of platform requirements, a business model and a graphic representation (mockup) of the platform's main functionalities. We recommend that the design process is continued in an iterative fashion. The platform's value proposition is deliberately divided into four parts. This division enables a sequential development of the platform, which reduces the initial investment and therefore the risk. In particular, we recommend further development of the IoT capability maturity assessment. Furthermore, in a later stage of the design process, we recommend to explicitly take into account non-functional requirements of the artifact.

9.2.2 Management implications

Since this report is a thesis for the Management of technology (MoT) program, we aim to explicate the MoT perspective of this project. We do this by discussing the implications of this research for both the IoT domain and multi-sided platform (MSP) designers.

The study takes place in the IoT domain, which is highly multidisciplinary. We argue that, for companies in this domain, technology should be perceived as an important resource. For most companies, the technological knowledge necessary for cutting edge IoT propositions is too costly and time consuming to generate fully in-house. Therefore, we argue that the formation of partnerships, which share the necessary resources to develop an IoT proposition, are required to reduce the risk and time to market of new proposition. New partnerships can also lead to the creation of new and creative business models. In order to help companies to find suitable partners, we propose a framework of partnership requirement categories (Figure 17). Furthermore, the artifact and services as proposed by this thesis are meant to facilitate the process of proposition development and partnership formation.

For designers of MSPs, we also discuss some of the implications related to platforms. Developing a MSP based business model is fundamentally different from developing a traditional value chain. Since MSPs are subject to (cross-side) network effects, the value of an MSP is largely dependent on proportional growth of its distinct user groups. Due to the network effects and development costs, increasing returns to scale are common for platforms. In winner-takes-all industries, developing an MSP involves significant risk, since large investments are often required to overcome the chicken-and-egg problem. We argue that designing an MSP requires a different mentality than traditional business models do. Firstly, acquiring users in an MSP business model requires more than a traditional conversion to transaction. The platform should deliver value to all user groups from the start, in order to get all sides to participate. Furthermore, the designer should ensure that users create additional value for the platform, which is required for the platform's growth. Secondly, when the platform is designed, not only the consumer should be kept in mind. Since an MSP also caters to producers, also these users' needs are to be incorporated. Often, this is done by offering tools that add value to producers. Thirdly, a new monetization mindset is required for platforms. Conventional products are priced by adding a margin to the product's costs. In contrast to this, MSPs often incur costs for subsidizing one side of the platform, in order to create more value for the other side.

9.3 Reflection

In this section we reflect on the execution of this research. We first reflect on the methods used in this research. Next, we discuss research process and results, including their limitations.

9.3.1 Methods

Verschuren & Hartog (2005) argue that a highly systematic approach is required for the evaluation of a design process. They formulate a design cycle that helps structure the design process. Furthermore, the method poses guidelines that help guarantee quality. One of the biggest concerns related to this method is the fact that it tries to structure any design process. Therefore, it does not specifically address issues related to designing an IT artifact. In order to complement the rather generic design method, we turn to Action Design Research (ADR) by Sein et al (2011). This method goes beyond traditional design science by recognizing the importance of organizational context. ADR explicitly takes into account opinions from a variety of stakeholders. Apart from their seven principles, Sein et al give the designer a lot of freedom in the design process. Both methods emphasize the importance of an iterative approach. The systematic approach of Verschuren & Hartog complements the freedom of the ADR method well.

During the literature research, the business model proved a useful organizing principle. Firstly, it served as a structure for discussing the various findings from literature. Secondly, it fits well in the philosophy of this research, since we emphasize the important influence of IoT on contemporary business models. When designing the platform's business model, the business model Canvas provided a helpful tool for structuring thoughts. However, the business model Canvas does not explicitly take into account the possibility of two-sided business models. This leads to a sub-ideal visualization of the platform's business model. The limitations of the Canvas method can be compensated by using a more detailed method (e.g. STOF) in future iterations.

9.3.2 Process and product

One of the limitations of the literature research is related to its scope. Although the interview phase treats cases in the healthcare industry, we do not comprehensively treat this industry in the literature phase, since the scope of the research is already perceived as broad. Another limitation is seen in chapter 4. There we treat multi-sided platform literature, which fully leans on the work of a single author. However, we compensate this with an empirical research on existing B2B matchmaking platforms.

Related to the interview phase, we recognize several limitations. Due to the low number of interviews in this phase, both reliability and validity can be questioned. For validation of the platform requirements, we rely largely on five interviews. However, the interviewees are not only potential users of the platform, but they also have significant expertise in their domains. Nevertheless, more validation with other potential users is advisable in future iterations. Furthermore, reliability is increased by introducing structure into the interviews. This is done to some extent, by making use of fixed interview topics (Table 15). The validity of the interview results is limited, since the interviews have been interpreted by a single researcher. However, since both summaries and sound recordings of the interviews are available, the results can be confirmed by others. The final limitation related to the interview phase that we discuss is the domain influence. The five examined cases are all related to healthcare, but the results show few healthcare specific conclusions. The added value of choosing these specific cases is therefore questionable.

We also recognize several limitations during the design phase. Firstly, the most important findings in the first four research phases led to a rephrased goal [G_2]. This updated goal has a big influence on the final design stage. However, due to a change in scope, the initial literature research does not fully cover all aspects of the final design. Furthermore, we do not explicitly discuss literature on aspects such as mockup design. Secondly, the platform requirements evolve over time. Since the early stages of the design process are limited to descriptions of the platform, the evolving requirements pose no significant problem. As discussed above, the final set of requirements [R_2] is validated only by a limited number of interviews. Also, the level of detail of the requirements is limited and further operationalization is required in future research. Furthermore, in the final mockup, we do not take into account all requirements. Some functionalities are expected to be a valuable addition, but are too detailed to take into account in this design phase. Thirdly, we did not explicitly take into account non-functional requirements. We argue that these can best be taken into account in subsequent phases of the design process. Fourthly, the amount of iterations made in the design process is limited. Especially the business model is fairly global and has not yet been tested. Further specification of the business model, taking into account all relevant stakeholders, is a valuable next step. The limited amount of iterations is partly due to an emphasis on reporting, which proved to be time consuming. Fifthly, we do discuss other cases of design research, but do not explicitly compare our results to existing literature. Finally, we are not able to prove causality in this research. One of the most important reasons for evaluating design research is to assess if the artifact contributes to the desired goal. Since we did not produce a functioning artifact, we are not able to measure the results of use. Therefore, the evaluation phase is limited to a reflective evaluation.

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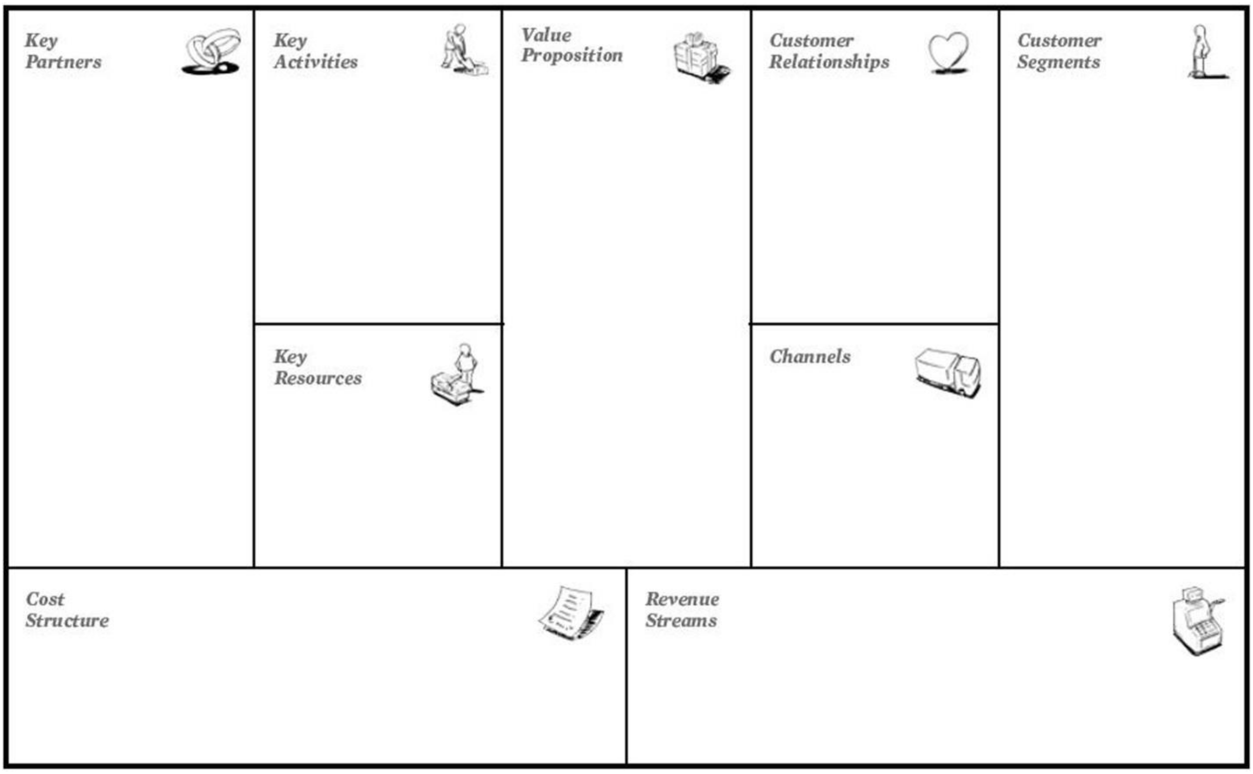
Appendix:

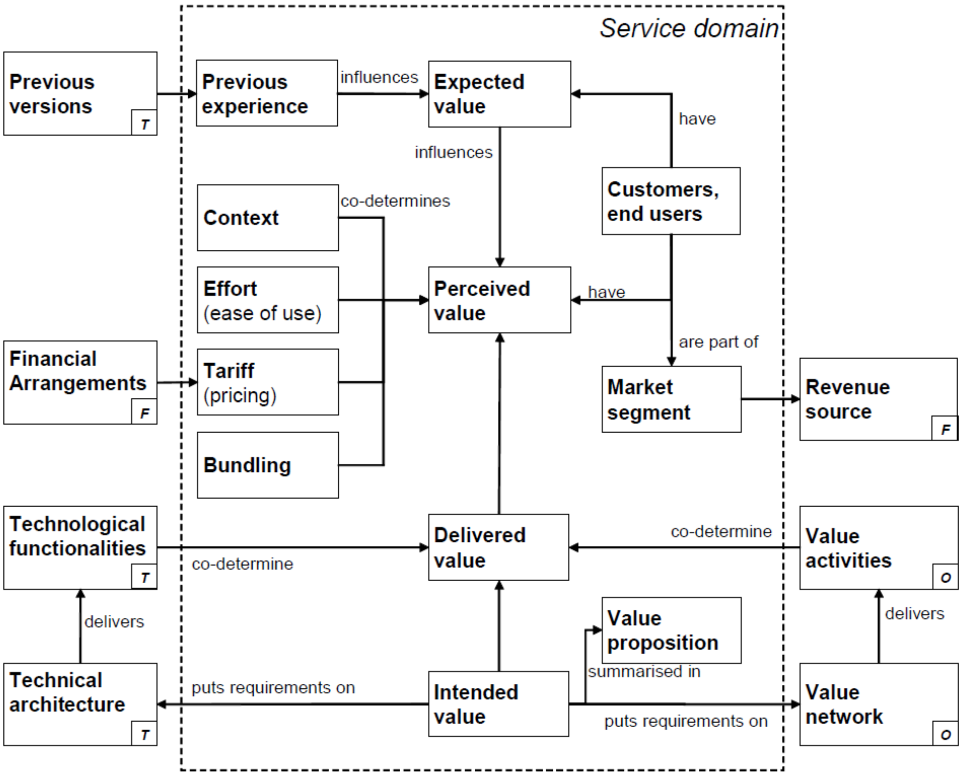
I. Business model Canvas

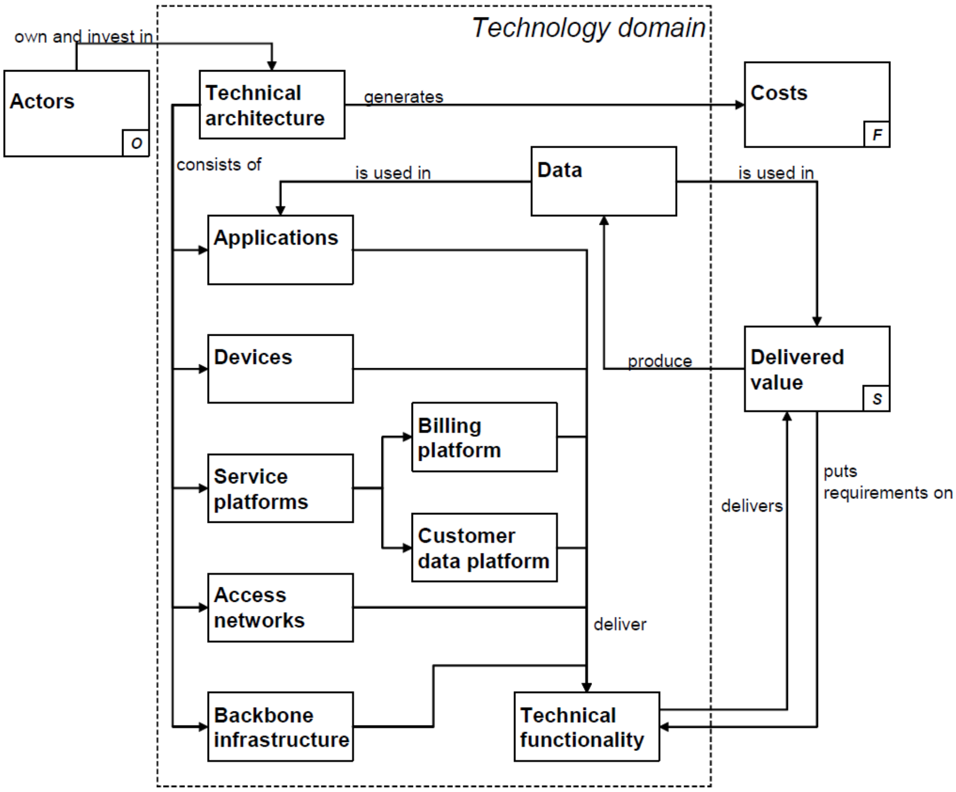
(Osterwalder & Pigneur, 2010)

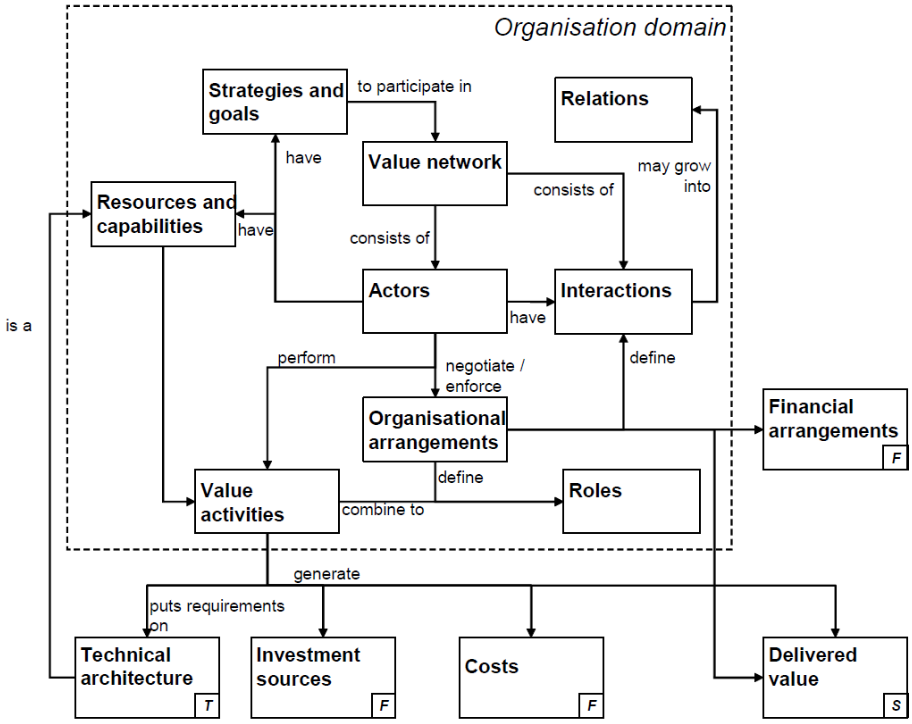


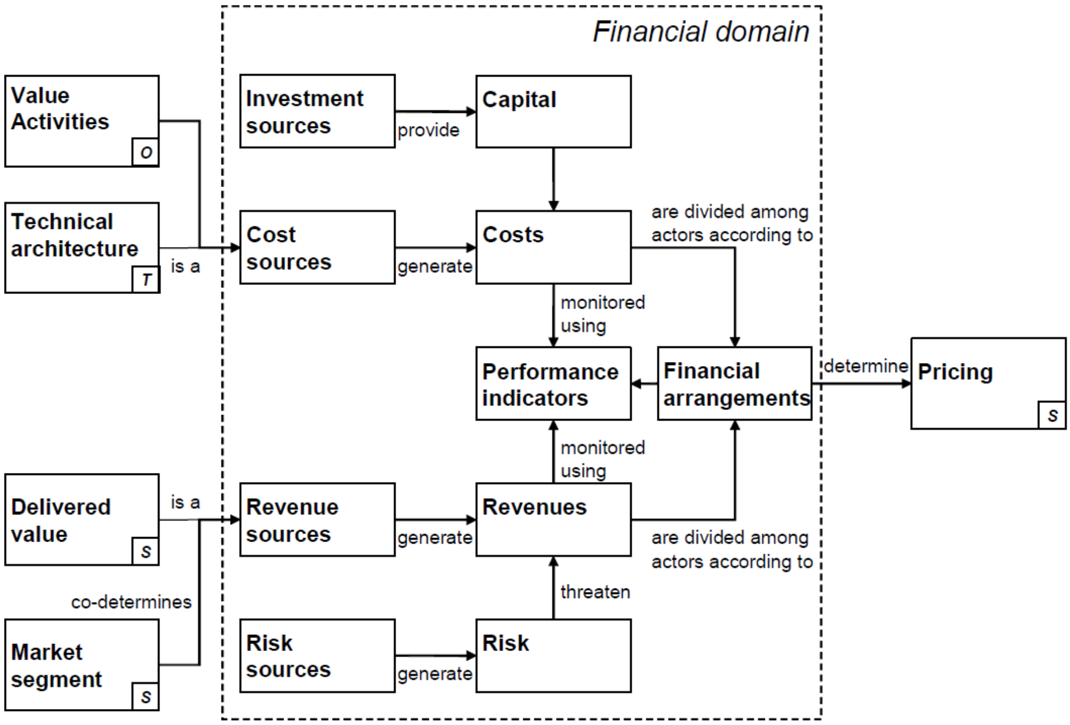
II. STOF – Descriptive model for four domains

(Bouwman, De Vos & Haaker, 2008)






Organisation domain
Strategies and goals
to participate in
Relations
Value network
have
may grow into
Resources and capabilities
consists of
have
consists of
Actors
Interactions
have
is a
perform
negotiate / enforce
define
Organisational arrangements
Financial arrangements
F
define
Value activities
combine to
Roles
generate
puts requirements on
Technical architecture
T
Investment sources
F
Costs
F
Delivered value
S


Financial domain
Value Activities
O
Investment sources
provide
Capital
Technical architecture
T
is a
Cost sources
generate
Costs
are divided among actors according to
monitored using
Performance indicators
Financial arrangements
determine
Pricing
S
monitored using
Delivered value
S
is a
Revenue sources
generate
Revenues
are divided among actors according to
co-determines
threaten
Market segment
S
Risk sources
generate
Risk

III. Capability areas

Porter & Heppelmann (2014) identify four capability areas of smart products: monitoring, control, optimization and autonomy. Each of these capabilities rests on the previous one, as can be seen in Figure 35. The most basic form of a smart product senses and monitors its condition and environment. Through remote commands, algorithms and actuators, this data can lead to response. The large amount of data generated by smart products can be analyzed and used to optimize processes. Ultimately, devices can become autonomous, practically ruling out human intervention. In this state for example, instead of monitoring every single device, operators can monitor an entire fleet at once.

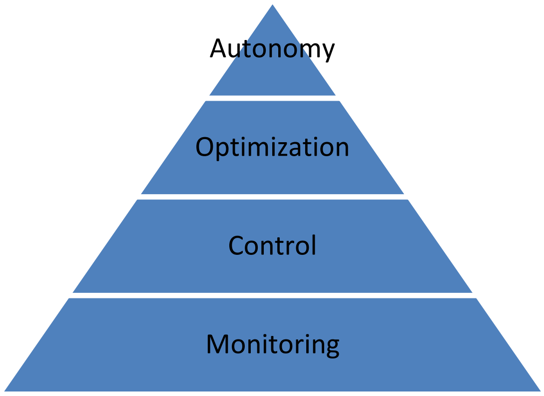


Figure 35: Four capability areas of smart products

IV. 6C framework for analyzing IoT ecosystems

Source: (Rong et al, 2015)

A total of six dimensions are used to analyze companies within an IoT-related ecosystem (Figure 36): context, cooperation, construct, configuration, capability and change. Context refers to environmental factors of a network, like barriers and driving forces, and explains among other things why a certain network develops. Cooperation relates to interaction (collaboration and governance) mechanisms between partners. Construct describes the core structure and the enabling infrastructure of a network. Configuration refers to identifying patterns in the ecosystem and external relationships among partners. Capability relates to the beneficial features of an ecosystem, such as communication, synergy and learning ability. The final dimension, change, reflects the degree of renewal and (co-)evolution of an ecosystem. By analyzing six cases in various IoT-related domains, using the 6C framework, Rong et al (2015) identify three ecosystem patterns. The division is based on openness of the network. In highly open networks, data can be obtained by various stakeholders, which leads to collaboration and enhanced products. Semi-open systems allow for customers to receive feedback and alter the product. The product interface can also be opened to other firms within the network. In the case of a less-open ecosystem, the focal firm receives feedback from customers and internally continues R&D and product development. No other parties are directly engaged in this process. This last pattern is more common in mature industries that are dominated by a single firm.

6C

1. **Context**
From the view of the lifecycle, different stages of the business ecosystem have different missions, drivers and barriers.
   - lifecycle stages Moore (1993)
   - missions
   - drivers
   - barriers

2. **Cooperation**
Reflects the mechanisms by which partners interact in order to reach common strategic objectives
   - coordination mechanism
   - governance system

3. **Construct** Hayes and Wheelwright (1984), Shi and Gregory (1998), Zhang et al. (2007)
   - structure
   - infrastructure

4. **Configuration** Bertalanffy (1950), Lin et al. (2009)
   - pattern
   - external relationship

5. **Capability** Shi and Gregory (1998), Zhang et al. (2007)
The key success features of the IoT-based business ecosystem:
   - communication and accessibility
   - integration and synergy
   - learning ability
   - adaption and mobility

6. **Change**
Reflects the pattern renewal and evolution of the business ecosystem (how it evolves in regard to its business environment from one pattern to another at the ending stage of lifecycle; pattern shift also reflects from the dimensions of configuration and cooperation of a business ecosystem respectively)
   - renewal
   - co-evolution

Figure 36: 6C framework (Rong et al, 2015)

V. Common IoT ecosystem roles

Table 19: IoT Ecosystem roles and descriptions (Mazhelis et al, 2013)

Role	Description
Chip manufacturer	Designs and manufactures integrated circuits for module and device manufacturers
Module provider	Manufactures components such as sensors of modems and supplies them to OEM/ODM (Original equipment/design manufacturer)
OEM/ODM	Integrates components to produce the device or other piece of equipment.
SIM provider	Manufactures SIM cards for network operators
WSAN operator and service provider	Operates and delivers services/information from wireless sensor and actuator networks (WSANs) under its responsibility
Network operator	Provides connectivity between WSAN and the IoT applications; it may encompass the access (mobile or landline) network, the core network, and the transmission network.
Network equipment provider	Manufactures network elements and provides related services and offers them to network operators
Subscription management	A third party that manages SIMs and contracts on behalf of M2M user; is responsible for the roaming and switching of networks
M2M service provider	Manages the M2M service platform
M2M platform vendor	Produces the M2M service platform which handles device-specific tasks, including fault detection, management of SIM cards etc.
Integrator	Ensures seamless inter-operation between the devices and the M2M platform
M2M user	Is an organization that is formally in charge of the sensor and actuator devices/network
Sensor and actuation service broker	Acts as a broker between the providers and consumers of the sensor and actuator services.
Application service provider (ASP)	Builds the application/service from the components (own or made by other service providers) and delivers it to the user
Complementary service provider	Provides the services complementary to those of ASP
Cloud infra provider	Provides cloud computing infrastructure services, on top of which the ASP can deploy and run the applications
(Application) developer	Designs and develops IoT applications and services
Distributor	Retails physical or digital goods and services
Provisioning service provider	Deploys the application/service
Assurance	Carries out maintenance to ensure the availability of the services and guarantee that these services perform in line with SLA (Service level agreement) or QoS (Quality of service) performance levels
Billing service provider	Provides billing services to a service operator, serving as a financial intermediary between the operator and customers.
Ad agency	Provides ads and manages ad campaigns for advertisers, acting as intermediary between the advertiser and a service provider
Advertiser	Orders advertisements (individual or campaigns)
Content aggregator	Distributes content from different content providers to different SPs, acting as an intermediary between them
Content provider	Provides user-generated or professionally created content
End user	Uses the application/service provided by the ASP
Subscriber	Negotiates and commits to the agreement with the ASP on the service and its qualities
Standard development organization	Develops standards in the form of an official organization, industrial alliance or a special interest group
Regulatory body	Controls the processes, as mandated by a legislative body
Legislative body	Makes, amends or repeals laws

VI. IoT Value drivers

According to Fleisch (2010) it is nearly impossible to structure IoT applications, since they are almost as diverse as the physical world itself. Instead, he poses a total of seven origins of value of IoT applications. He claims that all of the nearly 100 IoT applications that were investigated are based on one or more of these value drivers. Value drivers one to four are based on M2M communication, while drivers five, six and seven find their basis in the integration of users.

The first and second driver of value are related to *manual* and *automatic proximity triggers* respectively. IoT applications can simplify proximity verification like access control and payment. Smart objects crate business value due to the fact that they can communicate their unique ID in a fast and easy way, which increases perceived convenience. The automation aspect is added when the proximity of a smart object automatically causes a series of reactions, often in business processes and supply chain. The benefit of this use is most seen in increased process speed and reliability. The data that is generated by applying smart objects in processes can lead to continuous improvements in those processes. The third value driver is closely related to the first two, and revolves around *automatic sensor triggering*. Where driver one and two only communicate a unique ID, the third driver adds data that are collected by a sensor. There are various types of data, like location, brightness and acceleration. Based on these data and preprogrammed rules, event-based actions can be initiated. This can lead to increased process quality. The fourth value driver is based on *automatic product security*. In high-value-high-risk scenarios, a minicomputer fitted with security technology can be used for security measures like anti-counterfeiting. This resembles the technology already used in car keys and debit cards, which is relatively costly. A cheaper solution is to automatically identify a device by leveraging the network. The chance of the device being counterfeit is calculated using its unique log, which is updated by all triggered actions of that specific device.

Driver five is the first value driver on the basis of user integration. Connected devices are often characterized by *simple and direct user feedback*. When an interaction takes place, such a device often gives an energy-efficient feedback signal. This can be haptic signal like a vibration, an audio signal in the form of a beep, or a visual signal like an LED that flashes. The sixth value driver is *extensive user feedback* which enables rich services. A user-friendly computer, often a smartphone, can compensate for the limitations of simple smart objects by linking the object to a software application and sources on the Internet. Examples of services related to consumer products can include price comparison, shopping advice, health warnings etc. For businesses, these applications often provide a new channel to reach potential customers. The last value driver is described as *mind-changing feedback*. It covers technology which can influence user behavior by combining the physical and digital worlds. Examples of these applications are very diverse. A smart meter can make consumers aware of their real-time energy and water use in comparison to their friends, in an endeavor to diminish waste. Also, a car insurance provider can induce desirable behavior by providing discounts to customers that install a crash recorder in their car.

VII. IoT Business model builder

According to Mazhelis et al (2013), automatically collected data is the driver for development of new services and revenue models. They state that the exchange of data and mutual beneficial information between stakeholders are key issues for IoT. For implementation, a value-centric approach is advised over a cost-focused approach. Bilgeri et al (2015) emphasize the importance using a right approach when building a business model. Their approach, "The IoT Business Model Builder", addresses four issues in the business model design process, specifically related to IoT.

- Extended scope: The focus of a business model should shift from the company to the ecosystem level, since value flows in multiple directions across various stakeholders.
- Visualization: When visualizing complex value streams, traditional methods that assume linear value chains can fall short. This business model builder supports visualization of complex networks.
- Value proposition: For a sustainable stakeholder network, the value proposition of each key stakeholder should explicitly be considered.
- Data: In IoT business models, large amounts of data are an important asset. Data can be monetized directly, but can also be reused as an asset within the business model.

VIII. Trends in IoT

In his work, Jurvansuu (2011) presents a future vision towards a ubiquitous world by describing several IoT-related trends. These trends partly overlap with the three main markets as mentioned in Chapter 3. Several of those trends are discussed below, organized per market.

The automotive domain has already seen a wide adoption of IoT technologies. Several cars can already detect objects and people in their immediate surroundings. Based on these detections, such cars can take action to reduce speed. Driver habits and alertness can be monitored and GPS systems provide real-time traffic information. There are also developments in (mutual) communication between vehicles and infrastructure. More recently, cars have been connected to the internet, which enables a variety of new services, like automatic monitoring. Hybrid and electric cars are gaining market share, which supports this trend. The vision presented for this domain is one where cars communicate mutually to optimize traffic flow, and ultimately becoming autonomous.

Several consumer devices in the home setting already possess the ability to connect to the Internet. The smart home consists of appliances like smart TVs, connected set-top boxes and entertainment systems. The decreasing costs of hardware, and continuously improving software, will contribute to a growing amount of connected devices in the smart home. Because of the long lifecycle of home and office environments, manufacturers can focus on electronics and software with a long lifespan. Products like furniture and home appliances will be fitted with embedded electronics, which will all exchange information. Sensors in these products will ensure quality during the entire lifecycle of the products. Challenges in this domain can be expected in the form of limited added value and security risks. The first can lead to difficulties in creating favorable business cases for extensive use of these applications. The second is related to interoperability of the devices and consumer privacy and safety.

In the healthcare sector, there is a shift towards care and treatment at home, facilitated by various instruments to monitor the patient's status. Personal 'wearables', like clothing and accessories, can enhance abilities like vision and hearing through embedded electronics. Personal devices will extend beyond context awareness. By sensing the user's behavior, these devices will become intention aware, better understanding the user's current situation in relation to the past. Constant monitoring of the user's physical condition can influence insurance premiums and claims.

IX. Summary interview: Handicare Stairlifts

Jeroen Nuijten – Product Planning Innovation Specialist

Introduction

Handicare is a globally operating company that produces mobility and safety solutions for elderly and disabled people. The company was founded in 1986 in Norway and currently employs around 1300 people in worldwide. In 2007, Handicare acquired the Dutch stair lift manufacturer Freelift, which employed around 200 people. Since 2010, Freelift carries the name Handicare Stairlifts, which currently still operates from Heerhugowaard. The company offers a range of built-to-order stair lifts, including some connectivity features ("Over handicare – handicare," 2016)

Ecosystem

The development and manufacturing processes of Handicare's stair lifts are executed in-house. Handicare has a total of three production facilities, based in China, the Netherlands and the United Kingdom. Mechanical and electrical components and intermediate products are provided by a network of suppliers. For this, Handicare Stairlifts makes use of the procurement organization of Handicare. The stair lifts are sold through a worldwide network of dealers. In some cases, external consultants or experts can be consulted. A simplified overview of the core ecosystem is seen in Figure 37.

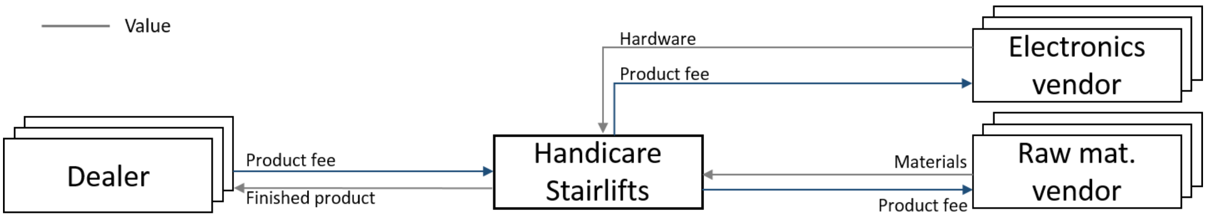


Figure 37: Handicare Stairlifts - VIP diagram of the core ecosystem

Partnership process and bottlenecks

The regular approach of finding a new partner starts with consulting Handicare's procurement organization. From the existing database, a shortlist of potential partners is generated. Then, a selection procedure is initiated. Several potential partners are invited to hear the proposition. Subsequently, from each of the potential partners, a plan of action is requested. After judging the proposed plans, the firms are visited. Finally, the most favorable partner is chosen. This process meets most of the needs of Handicare Stairlifts. Finding the right supplier or partner is thus not seen as a bottleneck.

The most effective innovation projects have proven to be those in cooperation with long-term partners. These partners often already have 10 to 20 years of collaboration with Handicare Stairlifts. In hindsight, a development partner should preferably be based in the Netherlands. Cultural differences play a negligible role, since Handicare is an international organization and knows how to deal with those. Physical distance however, has proven to be a bottleneck. When cooperating, a lot of time is spent in communication. In case of issues during the development process, visiting a partner is required on a regular basis. The barrier for visiting a partner increases greatly with distance.

When developing a new product proposition, one of the biggest bottlenecks is the absence of specific knowledge (e.g. on communication technology). Also implications of adding new technology on factors such as assembly, installation, customer contact and personnel training play a part in this.

Requirements for matchmaking platform

The stair lift business is highly competitive. Constant innovation contributes to a sustained competitive advantage. Information on current or future innovation projects is regarded as sensitive, and should therefore not be disclosed to competitors. A matchmaking platform should respect the sensitivity of this information. Being required to publically post a partnership request will not be well received by Handicare Stairlifts. On the other hand, a platform that only compares and displays potential partners will be received skeptically, since information can be subjective. To counteract this quality uncertainty, the platform can provide certificates after assessing a firm. However, these certificates will only be valued when the platform has enough credibility. In any case, the platform should fit into the company's current processes. Furthermore, such a platform is not expected to identify long-term partners. Since identifying the right partner for an innovation is not seen as the major bottleneck, such a matchmaking platform is expected to provide limited benefits.

Much more beneficial would be a platform that aids in creating a functional design of an IoT proposition. Since specific knowledge on technologies and implications of IoT lacks, such a platform could indicate which factors a company should take into account when designing an IoT proposition. Examples of such factors are signal coverage, compatibility, pitfalls and general requirements. If the platform would showcase examples of other projects, it could help employees convince their management to execute similar projects.

X. Summary interview: Faber Electronics

Martijn Matena – Account manager

Introduction

Faber Electronics is a manufacturer based in Velp, the Netherlands. The company started as producer of emergency lighting and developed its business into PCB (printed circuit board) assembly, product tests and repairs and full product assembly. The company also provides its clients with global component sourcing services and logistics services. Faber Electronics is active in several markets, including automotive, traffic engineering, audio and healthcare. Ideally, Faber Electronics is involved early in its clients' design process. This way, Faber Electronics can execute a feasibility analysis and optimize the design though a DfM (design for manufacturing) process (Faber Electronics, 2016).

Ecosystem

Faber Electronics is specialized in the assembly of PCBs. The circuit board and the components that need to be assembled are supplied by various suppliers. Since the board is a critical component, the relationship with the supplier of these boards is close and long-term. In the case of low production numbers (<250.000 pcs), most other components are supplied by a handful of distributers. In the case of custom components, the firm is often required to approach new supplier. However, these suppliers are often specified by the client. Often, the client also specifies other components, such as the product casing. Faber Electronics appeals to its supplier networks to manufacture such components. In that case, Faber Electronics assembles the components into a finished product and even offers logistics services. Since there is a clear difference between development and manufacturing, the firm's clients often make use of third parties to develop a product. Faber Electronics temporarily collaborates with such product developers in order to review the product design. In this Design for Manufacturing (DfM) process, Faber Electronics critically assesses the choice of components and factors like testability of the design. For certification purposes, Faber Electronics only refers its clients to the appropriate agencies, since manufacturing and certification are strictly separated. Both Faber Electronics' clients and suppliers vary from SME to larger corporations. However, the bulk of both consists of SMEs. A simplified overview of the core ecosystem is seen in Figure 38.

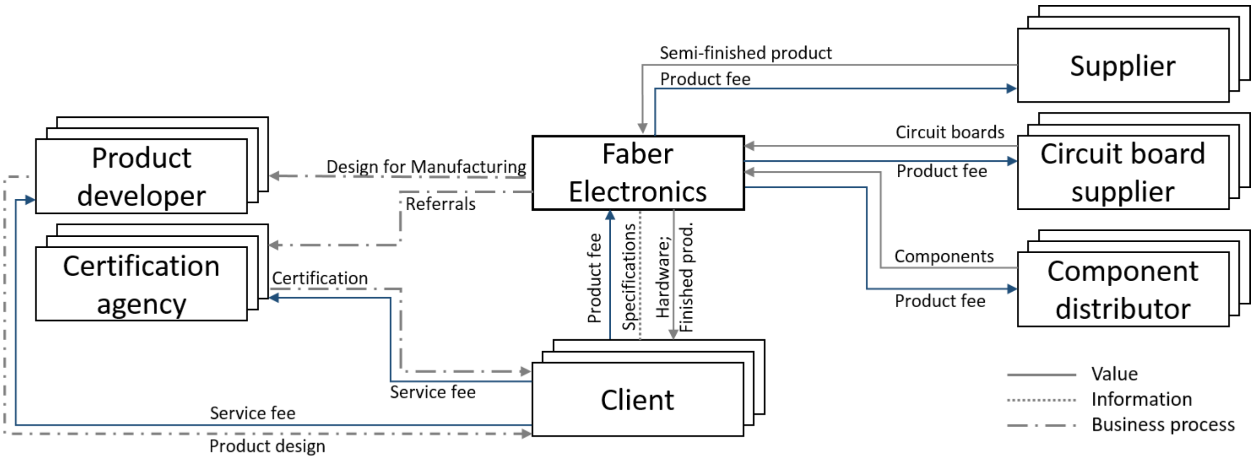


Figure 38: Faber Electronics - VIP diagram of the core ecosystem

Healthcare sector

Operating in the healthcare sector has several implications for manufacturing companies such as Faber Electronics. Self-evidently, certification plays an important role for healthcare products. Specifically, for healthcare products, it is mandatory to track and trace the origin of each component throughout the value chain. As a result, specific production series can be recalled in case of malfunctions. The track and trace process is handled internally by Faber Electronics and does not pose any additional problems.

Partnership process and bottlenecks

Faber Electronics establishes two types of new relationships on a regular basis. They either cooperate with a new supplier, or with a new client. In the case of a new supplier, the conditions are often predetermined by the client. Since the client specifies all required part numbers, Faber Electronics sources those components from either their existing supplier base or (often) prescribed new suppliers. New clients are acquired in various ways, i.a. through word of mouth (WOM) and cold calling. Especially the latter method requires significant effort and could be improved. Faber Electronics prefers to be involved in the product development process from an early stage, although that is not always the case at this point. Early involvement can result in a timely feasibility check of the product and a more cost effective result. Early establishment of trust between the client and Faber Electronics is seen as essential in the product development process. Because of factors like intellectual property, clients can act reserved in the initial stages of cooperation. The preferred type of cooperation is long term (at least multiple production series), since this simplifies communication and is financially more viable. Factors such as compatible company vision, goals and culture are not essential to Faber Electronics, as long as communication and commitment are sufficient.

Problems that the firm notices among clients are often related to finance in the case of startups. These companies often lack the funds for production. Because of this, Faber Electronics is sometimes requested to invest in kind in such a firm. In most cases, Faber Electronics does not share the risk of their clients. Another problem that Faber Electronics encounters is the lack of technical knowledge at the side of the client, especially in the area of IoT. As a result, clients often tend to look for proven or off-the-shelf solutions. These components are often not cost effective in larger production series, especially since IoT products often require low production costs.

Requirements for matchmaking platform

Currently, Faber Electronics does not make use of matchmaking or similar services, both for supplier search and client acquisition. The impression of the firm is that marketing campaigns are more suitable for the B2C segment then for B2B relations. Although the firm sees few bottlenecks in the client acquisition process, it does prefer an earlier involvement in its client’s product design process. This involvement is suitable to close the technical knowledge gap between the firm and its client. A matchmaking platform should facilitate client acquisition in order to be interesting for Faber Electronics. The focus needs to be on long term cooperation, since investment in one-off production series is not viable for the firm. If the platform features supplier rankings and reviews, this would be received with limited credibility. However, if company reviews were to come from a firm’s own professional network, the credibility of these reviews would increase dramatically. An addition to the client profile would be a quality guarantee, such as a credit rating. Additional services that the platform van offer, such as consultancy, are perceived as of limited value.

XI. Summary interview: Aspider M2M / Wyless

Michel Zwijnenberg – Founder Aspider M2M

Introduction

Aspider M2M is a mobile virtual network enabler (MVNE) based in Woerden, the Netherlands. The firm provides connectivity solutions to companies such as Stedin (smart meters), Philips (citytouch) and Wyless, i.a for applications in the healthcare sector. Due to its license as mobile virtual network operator (MVNO), Aspider M2M is able to provide complete connectivity solutions and greater control to its clients. In 2014, Aspider M2M was acquired by Wyless. Wyless is a mobile (virtual) network operator, active in the IoT domain. The company was founded in 2003 and is headquartered in Boston, Massachusetts. Other offices are located in Brazil, Germany, the UK, Switzerland and the Netherlands. Next to providing connectivity solutions for IoT-related applications, the company offers i.a. engineering services and a software platform for remote management of IoT solutions. (Wyless, 2016).

Origin of Aspider M2M

The origin of Aspider M2M lies in MEC Solutions. MEC solutions was the first mobile virtual network enabler (MVNE) in the Netherlands. As an MVNE, the company provided enabling services to mobile virtual network operators (MVNOs). These MVNOs provide mobile services to customers without owning the mobile infrastructure. After about three years, MEC Solutions fused with Aspider Communications, their first customer. The newly formed company, named Aspider Solutions, still served MVNOs as MVNE. The company soon added mobile network operators (MNO) to their customer groups. The first large assignment was concentrated on Ben, a sub-brand of T-Mobile. After several years, Aspider M2M was founded. Most other M2M companies serve as a reseller for products of existing operators. Aspider distinguished itself by applying for an MVNO registration in the Netherlands. The company also owned its own service delivery platform (SDP). In 2014, Aspider M2M was acquired by Wyless, mainly for its existing client base and unique approach. The SDP has not been integrated in Wyless' service platform, although this was the initial plan.

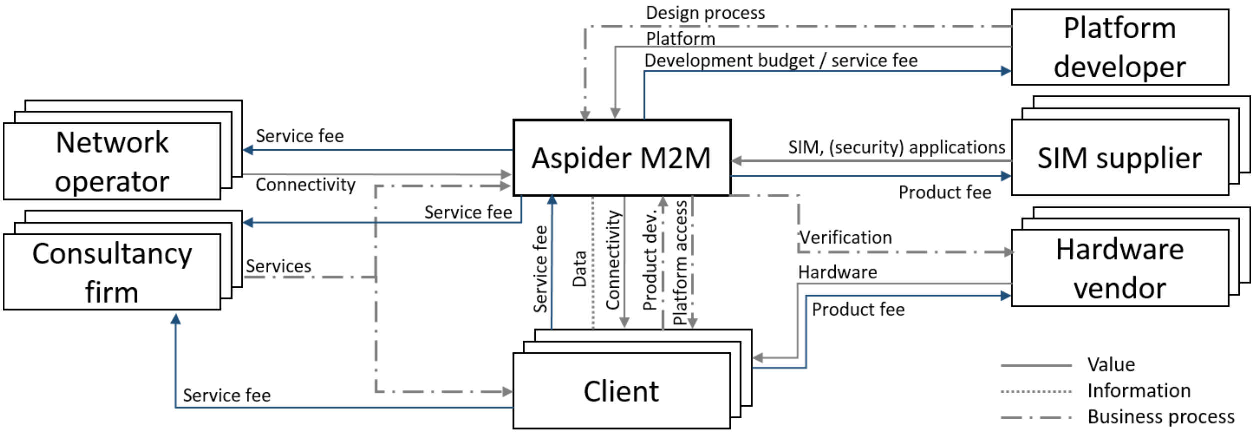


Figure 39: Aspider M2M – VIP diagram of the core ecosystem

Ecosystem

Aspider M2M has various long-term partners that contribute to the company's value propositions. First of all, access to the mobile infrastructure is provided by network operators. SIM cards are provided by SIM suppliers. These suppliers also provide services, such as security applications. Hardware is supplied by a hardware vendor, directly to a client. However, Aspider M2M has close contact with preferred suppliers, mainly based in Asia. The vendor's products (e.g. gateways), are tested and verified by Aspider's consultancy network. These consultants also deliver services directly to Aspider's clients. Aspider's SDP is developed and maintained by an external ICT firm. An overview of the core ecosystem can be seen in Figure 24. Next to these firms, Aspider M2M also regularly consults parties like ACM (Authority for Consumers and Markets) and the Ministry of Economic Affairs for topics like legislation. A simplified overview of the core ecosystem is seen in Figure 39.

Wyless

Wyless' value proposition is divided into three areas: Hardware, connectivity only and platform. Through the Wyless store, (value added) resellers or end users are able to buy hardware (gateways) including connectivity and device management. Clients are also able to only purchase connectivity. Wyless' unique selling point is its scale, since it is able to resell connectivity of various MNOs worldwide. Finally, Wyless' IoT management platform is also sold white labeled. This enables other companies to offer i.a. device and connectivity management services which carry their own brand.

Partnership process

The main bottlenecks that Aspider M2M identifies in the IoT partnership process are related to uncertainties. Since the discipline is relatively new and fragmented, it is often unclear what IoT can contribute to a company. Questions as "Where do I begin and what/who do I need?" are common, even after years of experience.

Currently, when the existing partner network is insufficient to serve a client, a new partner is sought. The approach that is taken differs per partner type. In case that an MNO is required, the approach is relatively straightforward. Since the Netherlands only has four MNOs, they are contacted directly. When various suppliers are available, usually the company's and personal networks are consulted. A common approach is posting a message on networking sites like LinkedIn.

Requirements for matchmaking platform

Several websites, platforms and consultants that aim to clarify the domain of IoT already exist. Also MNOs often fulfill such roles, but these firms are perceived as biased. Information on IoT is widely available online, but the information is scattered, often biased and simply too much to process. A new platform should thus aim for a neutral, unbiased image. This image can be compromised by a too commercial approach. Credibility is one of the essential requirements for such a platform. Perceived credibility is influenced by factors such as:

- Recommendations by other parties (Chamber of Commerce, Ministry of Economic Affairs)
- Contact with large providers (Microsoft, Amazon)
- Topicality of content
- Findability
- Name (e.g. www.IoT.nl)
- Large user base

The value of such a platform for Aspider M2M is perceived as limited. Only when the above requirements (credibility, neutrality etc.) are met, would the company consider to invest time in the platform. The expected result should be higher than the effort. Also, the platform should compete with the ease of social networks like LinkedIn. A possibility to lower the threshold of such a platform is to integrate it in existing services like LinkedIn. The company profile is then directly available, making the platform more approachable.

According to Aspider M2M, the target audience of the platform should be SMEs. This user group is still underserved in a landscape where multinationals are often the main focus.

XII. Summary interview: Giant Leap Technologies

John Versmissen - Director

Introduction

As an M2M systems integrator, Giant Leap develops complete custom solutions to monitor, control and manage machines. This is done through offering a variety of software and hardware. The company is active in the areas of M2M consulting, development, implementation and operations, mainly for the SME market. Specific services are remote monitoring and control, access control, automated meter reading and development of web based applications. The Amsterdam-based company is active in the M2M field for around 10 years (Giant Leap, 2016).

Ecosystem

Giant leap currently operates in four main markets: industrial machines, access control, indoor fleet management and healthcare. The company aims to serve as a one-stop-shop for their clients, which are mainly finished product producers. Due to the creation of custom solutions, Giant Leap often becomes a long-term partner for their clients. While offering a complete range of M2M solutions with the aid of multiple partners, Giant Leap is specialized in communication between devices and their proprietary cloud platform. Applications, including business logic and dashboards, are developed internally. Gateways, the common hardware in IoT-related products, are preferably supplied by one of several hardware vendors. The type of hardware vendor used partly depends on the protocol required in a specific situation (e.g. GPRS, Wi-Fi, Bluetooth, ZigBee, SIGFOX). In the case that custom solutions need to be designed, hardware components can be ordered and assembled. In some cases, development and production partners design and produce a custom solution, according to Giant Leap's requirements. Also, if necessary, technical specialists from Giant Leap's personal network can be involved in a project. A simplified overview of the core ecosystem is seen in Figure 40Figure 39.

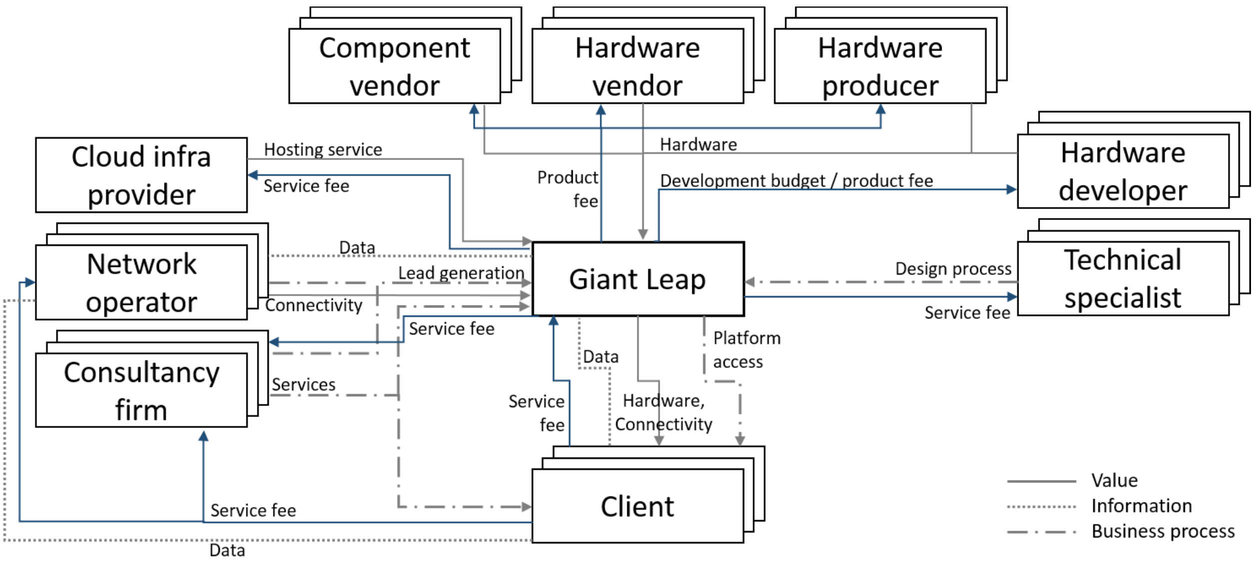


Figure 40: Giant Leap – VIP diagram of the core ecosystem

In the initial phase of contact with a client, Giant Leap often fulfills the role of (project management) consultant. In some cases, external consultancy firms generate leads for Giant Leap. These firms can also be involved in such a project, often depending on the available capacity within Giant Leap. Other possible scenarios are when Giant Leap supplies only its software services, or a combination of hardware and software. The web applications of Giant leap are hosted by a hosting provider. In cases where GPRS connectivity is required, a mobile network operator is involved in the project. The existing web environment of such a provider is then used to manage connection. Giant Leap frequently cooperates with most large mobile network operators in the Netherlands, which regularly generate leads for the company. Next to leads from network operators, hardware providers and consultants, Giant Leap also approaches prospects that might benefit from its services.

Healthcare

In the (health)care industry, there are two main obstacles for IoT propositions. Firstly, products in this industry need to be certified before entering the market. Secondly, stakeholders (e.g. government, insurance companies, municipalities) often disagree on a distribution of costs. This is one of the factors that hampers innovation in this industry. An interesting development is seen in the area of health insurance. Insurance companies are willing to compensate for expensive equipment for patients, provided that the patient can prove regular use. IoT has shown to play an important role in this demand.

Developments

Several developments in the IoT domain pose both threats and opportunities for Giant Leap. Firstly, multiple IoT-related platforms have been established (e.g. IBM Bluemix, ThingWorx, Comgate, EVRYTHNG). Secondly, ever more intelligent hardware enters the market. Thirdly, this hardware can often easily connect to applications through APIs. Partly because of these developments, OEMs are now able to produce IoT propositions. Next to possible threats, these developments can also create opportunities for Giant Leap. It is expected that hardware vendors will increasingly require Giant Leap as a partner in creating value propositions for their clients. Giant Leap does not rule out the future use of other existing platforms, but recognizes its added value in its customizable solutions.

Partnership process

Currently, when the existing partner network is insufficient to serve a client, a new partner is sought. In most cases, such a partner is a technology provider. The search process starts with consulting the existing connections and browsing the Internet. Identification and selection of a suitable partner is a relatively difficult process. Technical complementarity, reliability and compatibility of a potential partner are indicated as key issues during this process. Factors related to cooperation during the beginning phase of the partnership (expansion phase) require less attention. Most partners of Giant Leap are SMEs. Since both parties have a commercial interest in the creation of a new partnership, the method of cooperation evolves naturally. This is especially the case when there is a capacity surplus within both parties. Partnering with larger parties can sometimes be difficult due to a certain inequality. This can be seen in a limited extendedness by the larger party.

Requirements for matchmaking platform

When trying to identify a technology partner, capabilities and track record are of vital importance. An explicit categorization difference between (verified) experience, and industries in which a company is able to operate, is thus desired. Furthermore, such a platform could offer an overview of available (cloud) platforms.

When presenting Giant Leap on a platform in order to generate leads, the platform should distinguish itself from existing company databases. Disappointing experiences with existing company databases result in some skepticism. Trying to find one's own company, while behaving like a prospect, is the first test that helps to assess the platform's value. Search results should then accurately display a company's experience/suitability over another company's 'ability to develop a solution'.

Experience in the M2M market learns that is it very difficult for prospects to find the right solution. However, consultancy firms often already fulfill this networking role. Actually monetizing this role could prove to be difficult, since project management is subsequently done by Giant Leap itself.

XIII. Summary interview: Innospense

Thijs van Nuenen – Founder

Introduction

Innospense is Dutch company in the pharmaceutical telecare, founded in 2006. They are known for their automatic medication dispenser Medido, which is currently also sold by Philips in the Benelux area. The product is mainly used among independently living elderly people. Currently, these people are assisted several times per day by a district nurse, i.a. for medication use. In the case that at least one visit per day can be replaced by use of the Medido device, placement of the dispenser is cost effective. Until recently, placement of the dispenser was possible under the Dutch general law on exceptional medical expenses (AWBZ). Since early 2015, reimbursement is provided by health insurance companies (Innospense, 2016). Innospense's software platform facilitates information exchange between several stakeholders (e.g. pharmacists, caregivers, doctors).

Ecosystem

Innospense is a relatively small company that developed the Medido medication dispenser. Its ecosystem is increasingly complex due to the nature of the healthcare sector. The basis of the ecosystem is briefly described and a simplification of the relations can also be seen in Figure 41. Hardware is developed in house. Software development and optimization is done in collaboration with external developers. Currently, hardware developments are mainly focused on quality increase and cost reduction. Software developments are focused on the web portal, device firmware and connections with other firms. Production and assembly of the device is fully outsourced to a manufacturer. Connectivity (2G, 3G), including SIM card is provided by a mobile network operator. Innospense's web portal is hosted on their own servers, located at a cloud infra provider. On the other side of the network are parties that benefit directly from the product. Examples of such parties are pharmacies, medication packaging firms, health insurance companies and home care organizations. A simplified overview of the core ecosystem is seen in Figure 41Figure 39.

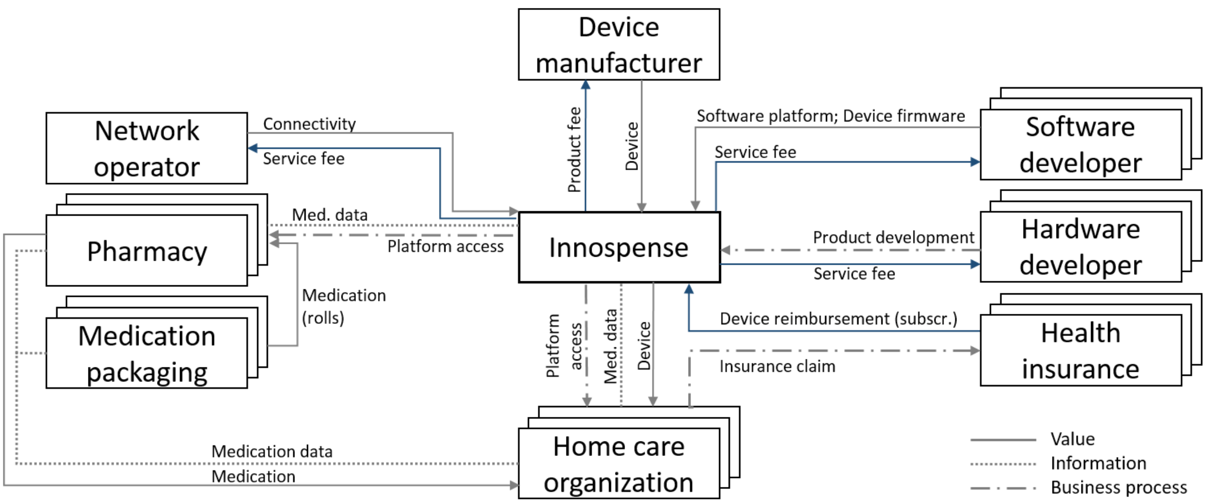


Figure 41: Innospense – VIP diagram of the core ecosystem

Healthcare sector

The healthcare sector is complex, which is easy to overlook as a startup. Innospense depends on insurance companies, since these reimburse the devices. However, the healthcare sector is strongly subject to changing regulations and insurance companies change their policies regularly. This instable environment creates a high degree of insecurity and risk for a company that develops healthcare products. Due to the high risks, Innospense notices distrust from parties in this sector. Establishing long term commitment proves difficult, which hinders innovative solutions.

Also characteristic for the healthcare sector is a returning struggle about responsibility, especially financially. Opinions on 'who should pay the bill' differ between stakeholders. Some plead that financial responsibility lies with the end user, while others prefer the government or insurance companies to take responsibility. Disagreement on this matter strongly delays innovation.

Partnership process and bottlenecks

When developing an innovative proposition, partners are indispensable. Hiring large development firms is too expensive for a startup, even with significant investments. As a result, Innospense mainly cooperates with SMEs. Finding a suitable new partner is not seen as a large problem. In previous cases, the existing network was always able to put forward suitable candidates. During cooperation however, issues occur on a continuous basis. These issues are mostly related to the insecurity that innovation brings. As a result, most often the issues are budget related. As a startup, Innospense is hesitant to share risks and benefits with partners, except for investors. The reason for this is related to commitment and focus. For a startup like Innospense, the innovation project is the core business on which everything depends. For a partner, contributing to such a project is often only one of multiple interests. When setbacks occur, the project should not be dependent on such a partner. Collaborating with an investor is seen as more straightforward, since clear agreements are established upfront.

Requirements for matchmaking platform

Entrepreneurship is an adventure in which intuition plays a large role. An entrepreneur musters people that are willing to take the risk of being in a startup. Making sure you have the right network to get things done is essential, even if this means driving thousands of kilometers to build such a network. A platform could be able to save time in this process, but making mistakes is necessary for the development of the company.

Although a platform can provide firms with a place where they can offer their services, there are not many firms willing to actually take a large amount of risk. This commitment however, is required when developing an innovative proposition.

During collaboration, facilitation of a regular reflection on the partnership is a valuable addition. Previously, Syntens provided support on this matter. Since the merger of Syntens and the chamber of commerce, this service is discontinued.

XIV. Overview B2B matchmaking issues and platform requirements from interviews

Category	Description	Giant Leap	Aspider M2M	Handicare Stairlifts	Innospense	Faber Electronics	Platform req. conclusions
Current ecosystem							
Firm role	Type of firm	M2M SP	MVNO	ASP (large)	ASP (small)	OEM, ODM	
Most important partners	Roles in core ecosystem	Hardware/component vendors, development and production partners, cloud infra provider, MNO, consultancy firms, technical specialists	MNOs; SIM suppliers; Hardware vendor; Consultancy firms; Platform developer	Suppliers (electronical, mechanical); Dealers; Internal organizations (e.g. procurement)	Home care organizations; Pharmacies; Medication packaging; Healthcare insurance; Production company; MNO; Cloud infra provider; Developers; Philips	Component distributor; Suppliers (mechanical, electrical); PCB developer; Client	Supply side contains at least core ecosystem partner roles (clearly distinguished)
Preferred partner size	SME, large	SME (equality)	Large firms (scale)		SME		Supply side contains firms of all sizes
Type of collaboration	E.g. Risk-sharing, long-term, one-off	Long-term and project based	Long-term	Long-term	Long-term, explicitly no risk sharing (except investors)	Long-term, one-off	Focus on long-term relationship development
Challenges	Issues in current ecosystem				Increasingly complex network; Large partners too expensive	Openness and collaboration	Aim to reduce perceived network complexity
IoT BM							
Current value proposition	Firm's main proposition	Custom solutions to monitor, control and manage machines.	Connectivity solutions	Stairlift witch voice connection	Automatic medication dispenser (Medido)	PCB production	
Clients	Common client type	Mainly OEM (end-product producer)	Large firms (e.g. Philips, Stedin, Wyless)	Dealers	Home care organizations	Mainly OEM (final product producer)	Demand side focus on SME
Type of client relationship	E.g. Risk-sharing, long-term, one-off	Long-term supplier	Long-term supplier; Product development	Long-term	Long-term	Long-term (at least multiple production series)	Focus on long-term relationship development
Value creation	Actions that make and improve a firm's offering	M2M consulting, development, implementation and operations	Connectivity solutions; Roaming	Mobility and safety solutions for elderly and disabled people	Increase home care efficiency	Production; Assembly; Sourcing; Testing; Service/repair	
Value capture	Monetization of customer value	Service fee	Subscription	Product fee (possibly reimbursed by insurance)	Subscription (reimbursed by insurance)	Product fee	
Challenges	IoT-related issues	Changing markets; Emerging alternatives; Specific technological requirements	Uncertainty on what IoT can offer, where to start, which partners needed etc.; Information overload	Determining technical properties of product (Limited technical IoT knowledge); Implications of innovation on assembly, installation, customer contact and personnel training	Constant budget issues; System interoperability (data exchange)	Client's technical knowledge level; Clients only choose proven solutions (low risk); Low cost requirements; Being involved from the start of design	Provide guidance on possibilities, implications and pitfalls of IoT

Category	Description	Giant Leap	Aspider M2M	Handicare Stairlifts	Innospense	Faber Electronics	Platform req.
Healthcare							
Involvement	How much the firm is involved in the domain	Healthcare is one of four markets	Many care clients	Full care focus	Full care focus	One of multiple markets	Include both healthcare-specific and generic partners in database
Developments	Remarkable trends	Increased interest in IoT solutions from insurance companies		Growing amount IoT innovations	Shrinking budgets		
Challenges	Healthcare-related issues	Certification, disagreement on cost distribution and responsibility		Highly competitive (prudence in disclosure)	Innovation hindered due to distrust; High degree of risk and insecurity (changing regulations and policies); Disagreement on cost distribution and responsibility	Traceability of components	Provide guidance on possibilities, implications and pitfalls of healthcare
Partnership process							
Type of new partner	Roles in core ecosystem	Often technology provider	Client, technology provider	Supplier		Client	Distinguish demand side (finding providers) and supply side (finding clients)
Search methods	Current approach	Consulting existing connections, browsing the Internet	Direct contact; Consulting existing network; Post on LinkedIn	Current partner network; Consult internal procurement organization	Consulting existing connections	Cold calling; Word of mouth (WOM)	Resemble ease of use of current search methods (e.g. LinkedIn); Include network/ WOM functionalities
Awareness phase	Important factors in this phase (E.g. IoT BM generation)		Uncertainty on what IoT can offer, where to start, which partners needed etc.	Implications of IoT on the firm		Lack of technical knowledge at client side	Provide guidance on possibilities, implications and pitfalls of IoT; Provide demand articulation; Distinguish firm phase
Exploration Phase	Important factors in this phase (E.g. complementarity, trust, compatibility)	Mostly technical complementarity, also reliability (trust) and compatibility		Complementarity (knowledge and experience)	Intuition	Trust (early involvement, IP)	Primary focus on (technical) complementarity and reliability of partners
Expansion phase	Important factors in this phase (E.g. communication, agreements, extendedness)	Evolves naturally		Communication	Agreements and commitment (budget, reflection)	Communication	Stimulate inter-firm communication
Challenges	Partnership-related issues			Innovate effectively with new partner; Physical distance to partner	Insecurity; Commitment; Focus: IP		Guide partnership process beyond initial search

Category	Description	Giant Leap	Aspider M2M	Handicare Stairlifts	Innospense	Faber Electronics	Platform req.
Current matchmaking platforms							
Usage	Current use of matchmaking services	Limited	Limited	None	None	None	
Positive elements	Beneficial properties		Ease of use when profile already exists (LInkedIn)				Integrate with existing services (e.g. LinkedIn)
Negative elements	Disappointing properties	Unverified, biased information	Most services are biased (e.g. Vodafone); Limited credibility				Warrant credibility and neutrality of platform; Clearly communicate added value
Substitute services	Alternative partner search methods	Consultancy (networking role)	Especially social media (LinkedIn)	Internal procurement organization			Assure fit in current search process; Provide added value above existing methods
Platform requirements							
Expectations	Desires for new matchmaking platform	Accurate and verified information	Neutral, unbiased image; Findable; Focus on SME (underserved)	Discreet / anonymous; Objective information; Fit in current search process;	Facilitation of a regular reflection on the partnership	Client acquisition; Long-term relations; Quality assurance (client solvency);	Warrant credibility and neutrality of platform; Be findable; Respect sensitive information or warrant anonymity; Assure fit in current search process; Focus on long-term relationship development
Features	Desirable functionalities	Show capabilities and track record; Filter/sort on experience; Provide overviews of e.g. available cloud platforms	Plugin for existing services (e.g. LinkedIn)	No detailed public partnership requests; Guide creation of functional IoT design; Checklist of important factors and pitfalls for IoT innovations; Showcase projects (convince users of IoT benefits)		Review mechanism (see if current partners have experience with new party)	Register and verify firm capabilities and experience; Integrate with existing services (e.g. LinkedIn); Respect sensitive information or warrant anonymity; Provide guide on possibilities, implications and pitfalls of IoT; Provide review mechanism
Quality uncertainty	Measures to reduce quality uncertainty	Verify experience and capabilities	Recommended by trustworthy parties; Topical content; Credible name; Large user base	Provide certificates after assessments		Credit check	Register and verify firm capabilities and experience; Warrant credibility and neutrality of platform;
Concerns	Worries related to matchmaking platform	Monetizing the platform (clients' willingness to pay)	Commercial approach compromises neutrality	Certifications only credible when platform is credible; Not able to guarantee long-term partnerships, thus limited benefits	Substitutability of trial and error process; Finding people that really want to take a risk	Higher chance of interaction with platform when recommended by current network	Provide added value above existing methods; Low/no financial threshold; Warrant credibility and neutrality of platform; Include network/ WOM functionalities

XV. IoT capability maturity model and assessment

The fourth aspect of the platform’s business model, the situation analysis, is regarded as the most interesting short-term opportunity for Inpaqt and Castermans Connected. The main reason for this is that Inpaqt already has the tools and experience to develop (capability maturity) assessments. The development of an IoT capability maturity assessment starts with creating an IoT capability maturity model. This graphical model, which is a Bayesian network (see Figure 42 for example), represents a set of variables (nodes) and their interdependencies. The initial model is based on literature and expert opinions. The nodes in the model are represented by questions in the assessment. With the data of multiple executed assessments, the model can be ‘trained’ by means of machine learning. Training the model results in updated conditional probabilities of the nodes. A trained model can be used for predicting outputs of interest and aiding decision making.

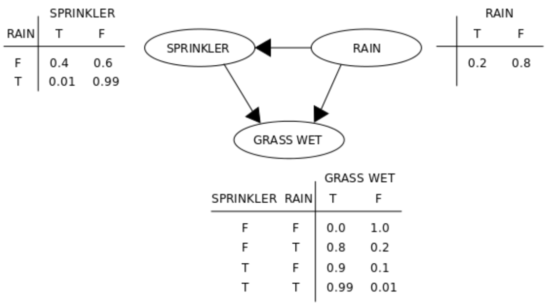


Figure 42: Example of Bayesian network with conditional probability tables (wikipedia.org)

The IoT capability maturity model is based on the four stages in the business cycle (Business model, Delivery model, Human and social capital, Governance) as used by Inpaqt. Each of the four stages represents a category in the model. Because of the importance of partnerships in the IoT domain, a fifth category (Ecosystems) is added to the model (Figure 43). Each of the categories consists of one or more sub categories, which contain variables (e.g. customer engagement, data collection etc.). Each variable is represented by a question in the assessment. The questions are derived from literature, previous assessments of Inpaqt and similar online assessments.

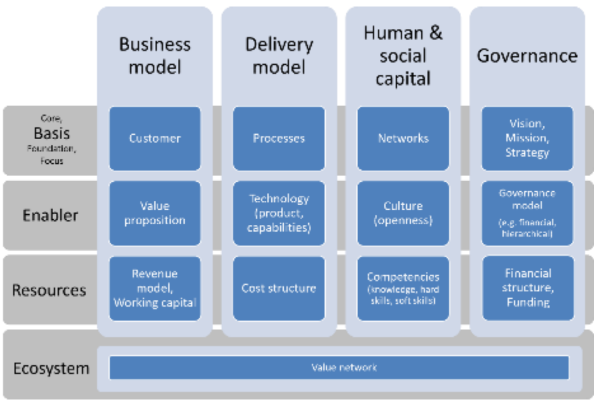


Figure 43: High-level representation of IoT capability maturity model

The model is used in combination with two types of assessments: The IoT Quickscan and the full IoT capability maturity assessment. The Quickscan has a total of 26 questions, and serves as an approachable first impression of the full assessment. The full assessment consists of 78 questions, divided into five categories. After completion, both assessments show the user a two-dimensional score as in Figure 44. The horizontal axis represents the company’s generic competitive strengths, while the vertical axis represents the digital/IoT capabilities of the firm. The colored circles indicate the sub score of each category. The black dot depicts the total score.

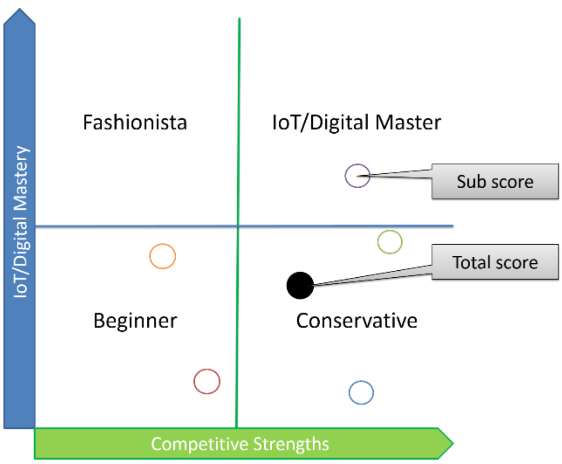


Figure 44: IoT capability maturity score

XVI. Envision Case Study Protocol – IoT-Match report

ENVISION

Empowering SME business model Innovation

Case contact data	
Case number	
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Document information	
Document number	
Name of the document	IoT-Match case report standard format
Version	V1.0
Date	03-08-2016
Description	IoT-Match is a design of an online B2B matchmaking platform, and is a collaborative effort between the firms Inpaqt and Castermans Connected. The platform aims to provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition. The value proposition is divided into four parts (Inform and inspire, Situation analysis, Demand articulation, Matchmaking). These services are provided to the two distinct user groups (sides) of the platform: (1: Demand side) SMEs and startups related to IoT, and (2: Supply side) suppliers of IoT/healthcare related products/services and various advisors (e.g. legal, innovation management etc.). The most important characteristics of the BMI are related to (1) offering a range of services, depending on the user's stage in the partnership process, and (2) the use of IT to automate services and derive knowledge from large amounts of data.
Author	M.J.D. Frijns
Language	English

Confidentiality of data	
Case use rights	Researchers only
Document access rights	Researchers only
Restrictions	
Willing to participate in ADR case study	

Collection of empirical data	
Responsible researcher	M.J.D. Frijns
Research period	08-02-2016 to 25-08-2016
Research approach	ADR
Data collection phases	Desk research; Interviews; Evaluation
Main theories used	Action Design Research (Sein et al, 2011); Business model CANVAS (Osterwalder & Pigneur, 2002); Evaluation in design research (Verschuren & Hartog, 2005)
Data-analyses; use of codes etc.	N/A
Software used for analyses	N/A

Validation and review of case report	
Validated by contact person	Yes
Validated by co-researchers	No
Reviewed by ENVISION researchers	W.A.G.A. Bouwman
Reviewed by external reviewers	M.F.W.H.A Janssen; M.E Warnier

Background information	
	Case on B2B matchmaking platform
Background characteristics	IoT-Match started as a concept for a new business model in 2015. The initial idea was a collaborative effort between the firms Inpaqt and Castermans Connected. To further develop the business concept, a graduation assignment was started in 2016, in association with Delft University of Technology. The goal of this project was to apply design and business model theories in order to develop a service concept and business model for an online B2B matchmaking platform. In August 2016, the project resulted in a description and a mockup (visual representation) of the platform's key features and a proposed business model. The intention of the two initiating companies is to commercialize, at least part of, the proposed platform. At the time of writing, no separate business entity has been formed yet.
Established in	N/A (No separate business entity yet)
Number of employees	2 co-founders
Turnover	N/A
Location	Delft (NL)
Industry	IT
Market area	Initial target area is the Netherlands
Market segment	The two sided platform focuses on (1: Demand side) SMEs and startups related to IoT, and (2: Supply side) suppliers of IoT/healthcare related products/services and various advisors (e.g. legal, innovation management etc.)
BtoB/BtoC/BtoG	B2B
Value offering	Provide tools and services that familiarize SMEs with the implications of IoT, and identify necessary actions and partners for the development of an IoT proposition
Legal ownership	N/A
Management team	Professor Emeritus in Management of Technology and Innovation; Consultant in the Internet of Things domain
Lifecycle phase of SME	Startup
Lifecycle phase of the product	Startup
Family business	Not a family business
Female business / involvement	Currently there are no female owners
Value network / Partner reliance	The double sided platform aims to facilitate interaction between its demand and supply side, which both consist of companies. Therefore, the platform's value proposition largely relies on it's user network

Company culture	
Strategy	Aims to fulfill a platform function, facilitating interaction between firms in the IoT domain, eventually becoming a hub for IoT related business.
Entrepreneurial orientation	Innovative, tolerance for risk. Risk is limited by applying for grants/subsidies.
Market orientation	The platform is a response to the growing but fragmented IoT market
Learning orientation	Strongly believes in feedback loops, especially in contact with partners and users
Technology level	High-tech, primarily software based
Innovativeness of the firm	Open to new ideas. Flexibility to adopt new ideas quickly. Limited financial and human resources to innovate more, while focus is on growth and operations.

Description of the environment of the company in the terms of:	
Market dynamics	IoT is a prominent trend which affects many industries. Since many firms are still not completely aware of the benefits of IoT, the market is relatively turbulent.
Competitor behavior	The importance of a guiding and connecting role within the IoT domain is acknowledged by multiple firms, resulting in substitute products and services (e.g. advisory services and end to end solution providers)
Regulation	Relevant regulation is mainly related to user privacy and data security
Driving technologies	Predominantly low power communication protocols (Bluetooth, ZigBee etc.)

Business model innovation	
Driver behind BMI	Chance to position the company as a key player in a relatively immature and growing industry
Focus of the BMI	Focus on scalability and efficiency, resulting in reduced transaction costs for the user
Phase of BMI	The business model innovation is now in the test phase. Prototype with key functionalities needs to be built
BM ontology used	Canvas was used in the design process (as a brainstorming tool), because it is widely known and easy to interact with.
BM tooling used	See above
BM metrics used	N/A
Management of the BMI process	Since the firm is small, internally the process was iteratively managed in weekly meetings. External stakeholders and users were involved in relevant phases of the process.
Changes in BM elements	The business model was designed to be a new entity. The most important elements are discussed below: *Customer segments*: Two distinct user groups (platform sides) that represent supply and demand *Value proposition*: Four separate parts that complement each other (Inform and inspire, Situation analysis, Demand articulation, Matchmaking) *Key activities*: Platform development, maintenance and moderation *Key resources*: IoT capability maturity model and assessment (in development); Database of company profiles (not yet acquired); Matchmaking algorithm (not yet developed) *Key partners*: Complementors (advisory partners); ICT partner (web scraping technology for initial profile creation; not yet acquired)

Evaluation of effects	
Level of radicalness of the BMI	For the company, the BMI is a radical change. The platform allows the firm to grow a large network of users compared to current services
Level of disruptiveness of the BMI	Online platforms are fairly common, and can be seen in many industries. The complementary services of the platform (e.g. situation analysis) are based on unique models and technology, providing novelty to the business model.
Key performance metrics	• Daily website visits • Company database size • Number of users • Number of assessments executed
Is the BMI initiative considered as successful	Since the business is not yet in operation, it can not yet be considered as successful. Interviews with potential users suggest skepticism towards a matchmaking platform. The situation analysis (IoT capability maturity assessment) is expected to show the best short term results.
What is the expected outcome	The platform and its services are an extension of the current activities of Inpaqt and Castermans Connected. The platform should be self-sustainable but can also produce cross-sales.
Operational /Organizational changes	N/A
Impacts to strategy	The firm's strategy will be formed by the results of the BMI (Iterative process).
Did BMI process lead to improved -understanding of BM? - communicability of BM? - finding blank spots or loopholes in BM? - strategic flexibility?	Inpaqt is specialized in management of technology and innovation. Business models are therefore already a well known and frequently applied concept in this firm. However, the matchmaking platform could provide additional strategic flexibility to the company, since it provides an additional area in which innovation opportunities can be identified.

Keywords	IoT, Matchmaking, Ecosystem, Multi-sided platform, ADR, Design
Main message towards SMEs	Firms should be aware of the benefits and risks of establishing a multi-sided platform. These platforms provide interesting business opportunities, because of their scalability. However, a critical mass of users needs to be activated in order to overcome the inherent network effects. The platform should be designed using an iterative design approach that emphasizes stakeholder involvement (e.g. Action Design Research). During the design process, the firm should take into account that its decisions affect an entire ecosystem. BM tooling can guide the process of brainstorming and communication with stakeholders.
Suggestions for usage of the case material	An E-learning platform which offers a visualized step by step guidance in BM design and BMI. This would require an abstraction of the current BMI case study repository.
Lessons learned	Establishing a (multi-sided) platform can be a promising opportunity, especially when aiming to become a key player in an immature industry. However, in order to profit from this highly scalable business model type, the platform's inherent network effects need to be overcome. In order to design the platform's services and business model, we advise to use an iterative process that includes the important stakeholders. The platform's services should fit in its users' current (business) processes, in order to provide an interesting addition/substitution. The Business Model Canvas is a useful tool for brainstorming and communication purposes, but provides limited detail. Especially the multi-sided nature of a platform is difficult to fully describe with this method.