



Business models for the Internet of Things



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ABSTRACT

The Internet of Things is the connection – via the internet – of objects from the physical world that are equipped with sensors, actuators and communication technology. This technology is looked at by a large variety of domains, such as manufacturing, healthcare and energy, to facilitate the development of new applications and the improvement of existing applications. To also enable the commercial exploitation of these applications, new types of business models must be developed. Frameworks exist to facilitate the development of business models. These frameworks define the building blocks that a business model address. This paper presents a business model framework specifically for Internet of Things applications. Through a literature survey, interviews and a survey among practitioners, it identifies the building blocks that are relevant in an Internet of Things business model, types of options that can be focused on within these building blocks and the relative importance of these building blocks and types. The framework can be used by developers as a starting point for creating business models for Internet of Things applications.

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1. Introduction

The Internet of Things (IoT) refers to the interconnection of physical objects, by equipping them with sensors, actuators and a means to connect to the Internet. By technologically enabling this, the goal is to develop new applications and to improve existing applications. Famous examples of IoT applications include monitoring of personal health through wearables, washing machines that enable you to pay per load instead of for the machine, greenhouses that adapt their internal climate to the monitored properties of the crops that grow inside, and stables that adapt feeding and milking schedules to monitored properties of individual cows.

The IoT is currently going through a phase of rapid growth. The number of connected ‘things’ has increased threefold over the past five years (Digitimes, 2013) and is estimated to be 4.9 billion in 2015 (Gartner, 2014). As a consequence, organizations expect the IoT to become an important source of revenue. Cisco estimated that the global IoT market will generate \$14 trillion in profit over the next decade (Bort, 2013) and Gartner (2013) predicts that the total global economic added value for the IoT market will be \$1.9 trillion dollars in 2020.

The Economist Intelligence Unit (2013) stated that the biggest incentive for businesses to move ahead with the IoT are arguably the potential financial returns from its “productisation”. In other words, for the Internet of Things to be fully adopted by businesses, financial returns are key. Therefore, business models and ways to create value for IoT technology are needed. However, in spite of the thought that along with the introduction of the Internet of Things new revenue opportunities will rise and old business models will not be applicable to do so, the question what business models will be applicable remains (The Economist Intelligence Unit, 2013). Moreover, as our literature review in Section 2 of this paper will show, there currently exists little academic knowledge on how business models for IoT applications differ from business models for other application and how they should be constructed.

This paper aims to fill that gap, by presenting a framework for developing business models for IoT applications. The framework is created based on a literature survey into existing business model frameworks and subsequently adapting these frameworks based on interviews in 11 companies that develop IoT applications. Finally, the relative importance of the different parts of the framework for IoT applications are determined through a survey with 300 respondents resulting in 72 observations. By doing so, the contribution of this paper is a novel business model framework for IoT applications that is both grounded in literature and in interviews and a survey among IoT professionals.

Against this background the rest of this paper is structured as follows. Section 2 presents existing business models for IoT

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applications from literature. Section 3 presents our research method, Section 4 the data analysis, Section 5 the results, Section 6 a discussion of the results and Section 7 the conclusions.

2. Existing business models for the Internet of Things

A business model is an overview of the manner in which a company does its business. *“It is a description of the value a company offers to one or several segments of customers and of the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams”* (Osterwalder, Pigneur, & Tucci, 2005). Business models are usually split into various components (Chesbrough & Rosenbloom, 2002; Morris, Schindehutte, & Allen, 2005). The most widely used components in the business model literature are customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure (Osterwalder et al., 2005).

A business model framework is a tool that helps a company to develop its business models, by providing an overview of these components. To develop a framework for business models for IoT applications, we initially searched for existing business models for IoT in literature with the aim of generalizing them into a framework. To conduct this search, we used the keywords “Internet of Things” AND “business model*”; searching the ACM Digital Library; IEEE Explore; Science Direct; Springer and Web of Science. With these search terms; we only found 20 papers. From these papers; we selected the ones that contained an actual business model; which led to only 5 papers. Two of these papers developed their business model; based on a business model framework called the Business Model Canvas (Osterwalder & Pigneur, 2010); which; in turn; is synthesized from a large number of similar frameworks (Osterwalder, 2004).

Table 1 shows the components that are covered by the various business models. These components are the partners, activities and resources that are key to produce and sell the product, the value that the product brings, the way in which the relation with the customer is built, the channel through which the product is sold, the types of customers that the product targets, the way in which costs are incurred and the way in which revenue is made. The table shows that the two models that are based on the Business Model Canvas cover all components of that framework. The models by Fan and Zhou (2011) and Liu and Jia (2010) cover a subset of these components. Li and Xu (2013) use different terminology to introduce their business model and primarily focus on the different stakeholders in developing an IoT platform and the activities that these stakeholders should perform. When developing the business model framework for IoT applications in this paper, we take the Business Model Canvas as a starting point, because two of the five business models for IoT applications that we found in the literature are based on the Business Model Canvas and because the Business Model Canvas itself is based on a meta-analysis of business model framework literature. We also apply the Business Model Canvas terminology by labelling the business model components ‘building blocks’. A business model is constructed by choosing one or multiple specific ‘types’ for each building block. For example, ‘Asset Sale’ is a type of the building block ‘Revenue Stream’ that can be used to construct a business model.

3. Empirical research methodology

The overall goal of this research is to create a framework for developing business models for IoT applications and considering the literature survey described in the previous section shows that a

business model framework has building blocks that are developed by specific building block types. Therefore, we use an empirical research methodology to identify the building blocks and building block types for business models for IoT applications. Subsequently, we determine which building blocks and specific types are considered significantly more important than others for developing business models for IoT applications.

The literature survey from the previous section shows that the research area of IoT business models is relatively unexplored; five IoT business models exist in literature and these have not been empirically validated. Therefore, we choose a sequential exploratory research design, based on the approach proposed by Teddlie and Tashakkori (2006), that is useful for exploring relationships when study variables are not known (Hanson, Creswell, Clark, Petska, & Creswell, 2005). In a sequential exploratory research approach qualitative data are collected and analyzed first, followed by collection and analysis of quantitative data. Afterwards, the inferences of both strands are integrated in one discussion. The sequential use of two different methods increases construct validity (Greene, Caracelli, & Graham, 1989), and ultimately leads to stronger conclusions (Teddlie & Tashakkori, 2006).

In particular, we continue as follows. First, we identify building blocks and specific building block types using literature and interviews with professionals who work on IoT business models. Subsequently, we determine the relative importance of the identified building blocks and types using the results of a survey contrasted with the results of the interviews.

4. Data and analysis

This section analyses the data that is collected to determine the building blocks and specific building block types for business models for IoT and to determine their relative importance.

4.1. Interviews

In line with the motivation for using the Business Model Canvas as a starting point for developing a framework for IoT business models, we develop an interview protocol based on the Business Model Canvas. The interview is semi-structured and aims to ask practitioners working on IoT business models about the completeness and correctness of the building blocks and types for IoT business models identified in the Business Model Canvas. The questions are based on the questionnaire developed by Osterwalder and Pigneur (2010, p. 19–42). Appendix A shows the complete interview protocol.

Participants were searched in the following ways:

- A. Referrals from business network
- B. Referrals from IoT specialists
- C. Contact for IoT company found on the internet
- D. Referrals from prior interviewees

As a result, 11 interviews were planned as shown in Table 2.

Table 3 shows the descriptive statistics of the interviews. It shows the sector in which the company of the interviewee operates, the size of the company, the type of clients of the company, whether the IoT offering that is considered in the interview (see Table 2) is primarily a product, a service, or both, and the number of years that the company is offering the product or service. The interviews were transcribed, sent back to the interviewees for verification, and coded. The interviews were used to complete and adapt the types of an IoT business model, by adding, removing, splitting or merging types, or by proposing an alternative classification for a type. Appendix B shows how these changes were made. It also

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