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Service innovation structure analysis for recognizing opportunities and difficulties of M2M businesses

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ABSTRACT

With the popularization of high-speed and high-capacity communication infrastructure, Machine-to-Machine (M2M) communication has received significant attention. However, even though the related technologies have been actively investigated, creating new businesses based on M2M communication is not easy. This study proposes a service innovation structure that visualizes the opportunities and difficulties of M2M service businesses. In our proposal, opportunities are classified as two types of value proposition (optimization and identification values) using the Sharing-Connecting-Analyzing-Identifying (SCAI) model. In addition, difficulties are discussed using a fishbone diagram. The SCAI model pays particular attention to the identification value, which tends to be ignored in other models. Opportunities and difficulties are structured as a map according to backcasting from a desired future M2M infrastructure. The backcasting approach is effective to untangle the intertwined difficulties. Using this opportunity-difficulty map, we can discuss and model M2M service businesses more clearly and strategically by recognizing the opportunities and the difficulties with stakeholders. A smart home case is used for explaining the effectiveness of our proposed model.

1. Introduction

Machine-to-Machine (M2M) communication means both wireless and wired systems to communicate among physical devices in the Internet of Things (IoT) world. M2M communication should be regarded as an infrastructure of services on it which we call “M2M service.” A M2M service forms a cyber-physical system (CPS) where data is gathered from sensors of physical machines and is analyzed, then converted to value in a cloud computing environment (a cyber space). The data consequently becomes “Big Data” and data analytics and optimization is one of hot issues in information technology and service science communities. Recently, M2M service has attracted increasing attention from business and innovation perspectives as well as from scientific and technological communities. A remote maintenance system using M2M communication is a typical and commercially successful application. Some market research said that the market size of global M2M communication is expected to grow from $17.18 Billion in 2014 to $35.16 Billion in 2020 [1]. However, a number of large-scale and innovative M2M service businesses are not as one would expect. In fact, many IT companies including authors' companies (Hitachi, NEC, and Toshiba) have prepared their M2M service solution, but they struggled to expand the market. This study presents a modeling method of M2M service businesses by determining their opportunities and difficulties.

We visualize opportunities and difficulties of M2M service businesses based on a survey of current M2M businesses. Two types of value proposition by M2M services are discussed: “optimization value” by big data analysis and “identification value” by

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big data search. In addition, we visualize difficulties using a fishbone diagram (one of the basic tools of quality control). Specifically, we focus on fragmentation of solution ("silo" solutions to address specific vertical application requirements) as a typical difficulty. These opportunities and difficulties are structured as a map by backcasting from a desired future M2M infrastructure. From this backcasting map (opportunity-difficulty map), we can visualize and discuss strategic paths to innovation in M2M businesses by identifying the opportunities and overcoming the difficulties.

In this paper, we address the research question: how to model innovative M2M service businesses. In order to answer this question, we clarify what are the opportunities and difficulties of M2M service businesses, then propose a framework to discuss the possible strategic paths to innovation that can be found by identifying opportunities and overcoming difficulties.

The remainder of the paper is organized as follows. Section 2 briefly reviews the literature on M2M service businesses. M2M service business opportunities and difficulties are described in Sections 3 and 4. We propose a backcasting analysis and discuss this using a smart home example in Sections 5 and 6, and present discussions and conclusions in Sections 7 and 8.

2. Literature review

In the literature review, we survey M2M technology, business model especially for IoT/M2M services, and service design.

Many studies have discussed the functional potential of M2M technologies. Lawton discussed the opportunities that M2M technology creates [2], and Wu et al. discussed key M2M application requirements and technology gaps [3]. Niyato, Xiao, and Wang noted the challenges of M2M technologies, including standardization, traffic characterization, protocol re-design, spectrum management, and optimal network design [4]. However, technological possibilities are not always implemented in successful businesses. In addition to technological possibilities, business models of M2M services should be more considered as Chesbrough said "Today, innovation must include business models, rather than just technology and R&D" [5] and Teece said "Not surprisingly, it is common to see great technological achievements fail commercially because little, if any, attention has been given to designing a business model to take them to market properly" [6]. Teece also pointed out that the emergence of the Internet is forcing traditional business model to change drastically.

Up to now, business model has been defined and discussed by many scholars and practitioners [7]. Shafer et al. classified components of business model into four primary categories: strategic choices (including value proposition), the value network, creating value, and capturing value [7]. In the business circles, business model canvas proposed by Osterwalder and Pigneur [8] becomes popular. They defined "A business model describes the rationale of how an organization creates, delivers and captures value." Value proposition takes a center position of the business model canvas. Business models relating to the Internet had been discussed from the e-commerce boom around 2000. For example, Amit and Zott developed a business model suggesting value creation of e-businesses [9]. Recently, the Internet has been evolving to Internet of Things (IoT) and a business of IoT comprise many stakeholders, where business model as a business ecosystem becomes important. Rong et al. proposed the 6C framework to understand business ecosystem, where "6C" means "Contest," "Cooperation," "Construct," "Configuration," "Capability" and "Change" [10].

Some studies have tackled M2M service business analysis and have proposed M2M business models. Morrish took a general view of M2M business model [11]. Laya and Markendahl compared typical M2M cases—including smart cities, smart houses, e-home care, and smart energy systems—and analyzed the key factors of success and failure of M2M businesses [12,13]. Goncalves and Dobbelaere presented 11 roles and the value chain among these roles. They extracted three M2M business scenarios, i.e., application stream, mobile stream, and CE (Consumer Electronics) device stream scenarios [14]. Leminen et al. proposed a framework for "Internet of Things" businesses, including M2M businesses. They analyzed several concrete cases from the automotive industry [15]. Glova et al. applied a requirement engineering method, called e3-value, to business modeling of a healthcare service based on IoT [16].

Although those analyses revealed some aspects of M2M service businesses, many did not go beyond an analysis of currently implemented businesses and few proposed a concrete business modeling method for future M2M businesses. Thus, major gaps remain between current M2M businesses and future M2M businesses. This study visualizes opportunities and difficulties of future M2M businesses and analyzes opportunities and difficulties using a backcasting approach from the desired future M2M infrastructure. While many business modeling methods focus on value proposition (opportunities), few focus on difficulties to overcome for realizing future M2M businesses.

Service business modeling methods have been studied in an upstream part of a new service development. Cooper & Edgett [17] and Edvardsson & Gustafsson [18] have presented new service development methods. These approaches seem somewhat analytic since they provide no specific design charts and tools. Several useful and general service modeling tools have been developed, including molecular modeling and service blueprint by Shostack [19]. We have also proposed a concrete service design method (called "DFACE-SI") for product-based services [20] which featured recognition of their opportunities and difficulties. However, these methods did not consider characteristic features of M2M service businesses. This study focuses on opportunities and difficulties of M2M service businesses.

3. M2M service business opportunities

First, we analyze M2M service business opportunities according to a case survey conducted by a research project of the Joint Forum for Strategic Software Research[1] (SSR-M2M project). Table 1 lists typical M2M service cases and their created values, which are derived from our literature survey, interviews, and discussion in the SSR-M2M project.

By carefully assessing values in these cases, we find that the value (e.g., I-1, I-3, II-2, and III-1 in Table 1) created by "big data" analysis, including statistics, data mining, and operations research, which we refer to as the "optimization value," is not the only important value even though the M2M business is a typical target of "big data" analysis. Another important value (e.g., I-2, II-1, and III-2 in Table 1) is the "identification value," in which specific objects and states are searched and detected from exhaustive data. A machine location monitoring in the construction tracking system is a typical identification value which can detect abnormal movement by theft. Fig. 1 indicates that M2M values comprise the connection, optimization, and identification values, which can be expressed as a 2-dimensional map (covering ratio × volume). Here, "big data" is "big" in the sense of "volume" and "covering ratio." The connection value is primitive one and created by M2M connections without "big data," which includes one-to-one device monitoring. This

[1] Joint Forum for Strategic Software Research (SSR) is a private funding agency established and managed by electrical industries, including Hitachi, NEC, Tome, and Toshiba, and supervised by academics.