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A Conceptual Framework of IoT Case Study*

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Abstract

With a prospective of rapid deployment of IOT, a systematic approach to derive a business strategy for various possible scenarios of IOT applications is in great demand. In this paper, a conceptual framework that can be utilized for the purpose of assessing the market potential and of setting up an initial business strategy for IOT deployment is suggested. The framework consists of utilization of well-known value curve analysis, ecosystem analysis and house of quality tools. The value curve analysis is utilized to identify value-enhancing components of consumers as well as relative strengths of suppliers. The ecosystem analysis is used to identify relevant players of the supply chain and their mutual relationships. The house of quality is suitable for developing the initial business strategy of the supplier by converting consumer requirements identified by value curve analysis into technical requirements for the supplier. In this paper, we applied our proposed framework to two services that have high potentiality of being benefited by IOT: car-sharing service and telehealth service.

Keywords : IoT(Internet of Things), House of Quality, Ecosystem, Case study

Ⅰ.Introduction

The size of the market for IoT(Internet of Things) will increase from 0.2 trillion dollars in 2013 to 1 trillion dollars in 2020(Machina Research, 2013). IoT has a potentiality that will increase total profit of global companies by 21% until 2020(Cisco, 2013). Many forecasts have appeared recently, predicting that IoT will be a promising paradigm. They have emphasized this paradigm will provide people with new, valuable experiences and also help companies to identify new business opportunities.

Atzori, L., Iera, A. and Morabito, G.(2010) highlighted that IoT will have a high impact on several aspects of the everyday life and behavior of potential users. From the point of view of a private user, domotics, assisted living, e-health, and enhanced learning are some examples of possible application scenarios in which the new paradigm will play a leading role in the near future. From the point of view of business users, the most apparent consequences will be visible in the fields such as automation and industrial manufacturing, logistics, business/process management, and intelligent transportation of people and goods. With these promising scenarios for a rapid growth of IoT, governments have been paying attention to developments of IoT. The US National Intelligence Council(2008) foresees that by 2025, internet nodes may reside in most everyday things - food packages, furniture, paper documents, and more. It highlights the idea that popular demand combined with technology advances could drive widespread diffusion of IoT that could contribute invaluably to economic development. The Korean government(Ministry of Science, ICT and Future Planning) announced a policy called the 'Master Plan for IoT' designed to increase Korean companies' competitiveness in IoT-related businesses. In spite of so many rosy market forecasts and governments' intention to support IoT related companies, a successful business model for IoT has not yet clearly demonstrated. Many global companies have tried to create their own IoT business models but thus far they have only been experimental. Therefore, we need case studies analyzing these attempts in order

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to get more insight about IoT business models. The objective of this paper is to present a framework of IoT case study and to show two sample case studies by using our framework.

Ⅱ.Framework of case study

Following key questions should be answered by IoT case studies.

(1) What values can be provided to the customers(buying side) through an IoT business model?

(2) What values(competitiveness) can the supplier side of an IoT business model benefit from?

(3) What are the relationship dynamics between players in an IoT business model?

(4) What functional and technical requirements are need to be prepared to provide the values both for the customers and the selling side?

In order to answer these questions, we propose a framework for an IoT case study. The value curve analysis suggested by Kim and Mauborgne(1997) can be used for finding answers to the first and second questions. The second question requires the introduction of an additional concept which can explain ‘supplier side-specific’ characteristics. We adopt ‘competitive priorities’(QCDF: Quality, Cost, Delivery, Flexibility) as that concept. The answer of the third question can be found by Kang, Hong, Kim and Park(2011)’s ecosystem approach. The concept for the fourth question is the house of quality suggested by Hauser and Clausing(1988).

2.1 Buyer side (Value curve analysis)

It is important to find out consumers' needs and select technological application(Park & Jeong, 2012). Kim and Mauborgne(1997)’s value curve shows a company’s relative performance across its industry’s key success factors(e.g., hotel industry’s key success factors are something like eating facilities, bed quality, price, availability of receptionist, and so on.) in comparison to competitors or the industry average. In our value curve analysis of buyer side, Kim and Mauborgne (2000)’s value levers are replaced by industry’s key success factors. In order to measure level of buyers’ value from a business model both before and after IoT is applied to the model, we reorganize Kim and Mauborgne(2000)’s value levers and suggest new six value levers such as productivity, cost, time, simplicity, flexibility, and risk. Through this value curve analysis of buyer side, we can find out the values provided to customers by IoT business model.

2.2 Supplier side (Value curve analysis + competitive priorities)

In our value curve analysis of the supplier side, value levers for supplier side consist of five levers. Four levers are derived from ‘competitive priorities’(QCDF: Quality, Cost, Delivery, and Flexibility). The other one is ‘the image’ that measures the improvement of a supplier’s brand value by applying IoT to a business model in which the supplier participates. By draw a value curve, we can see the benefits which suppliers can get by applying IoT on their business.

2.3 Ecosystem

Kang, Hong, Kim and Park(2011)’s ecosystem approach helps in depicting relationships between players of the IoT business model. Based on this approach, we broaden the ecosystem of our framework that includes not only depiction of relationships among players but also description of each player’s role, costs, and benefits. Therefore, we can see the relationship dynamics between players in an IoT business model. In ecosystem, the presented model consists of nodes and arcs. A node is an entity which can be a product, service, and a participant. An arc represents a relationship between nodes. In this model, we show entities which will be presented a node as three types (product, service component, and player) in table 1.

<Table1>[1]

Entity	Description	Graphical notion
Product	A product component comprising an offering of an ecosystem. It can be owned by a player.	
Service component	It cannot be owned by a player.	
Player	A player participates in the ecosystem by producing, owning or using a component.	

2.4 House of Quality

Hauser and Clausing(1988)’s the house of quality is the approach that defines customer requirements (so called ‘What’) and then finds relationship between customer requirements and

1) modified Kang, Hong, Kim and Park(2011)'s representation of entities in an ecosystem.

functional/technical requirements(so called ‘How’) by using a relationship matrix. Interviews or surveys are commonly used to define customer requirements. However this paper presents a conceptual framework for defining customer requirements by using value curve analysis(Andrushevich, Copigneaux, Kistler, Kurbatski, Le Gall & Klapproth, 2013). In this paper, the concept of customer in house of quality approach is modified. And it contains both customer and supplier side. Drawing a house of quality table can detect functional and technical requirements, which are need to be prepared to provide the values both to the customers and the selling side.

Ⅲ. Sample case study

In this chapter we show two sample case studies on a car-sharing service and a telehealth service by using our IoT case study framework.

3.1 Car-sharing service Overview

3.1.1 Overview

Zipcar is a US car rental company, a subsidiary of Avis Budget Group. It provides automobile reservations to its members, billable by the hour or day. Zipcar members pay a monthly or annual membership fee in addition to car rental charges. It was founded in 2000 by Cambridge, Massachusetts residents Antje Danielson and Robin Chase. In recent years, we have seen the creation of a lot of Zipcar competitors. Traditional car rental companies have replicated Zipcar's short-term car rentals with programs including Hertz on Demand, Enterprise's WeCar, UHaul's Uhaul Car Share, and Daimler's Car2Go. After reviewing these cases, we used Daimler’s Car2Go service to analyze. By analyzing the case, we get the answers to preceding questions and get more insight about IoT business models. Daimler AG launched ‘Car2Go’, a new mobility concept, in Germany in 2008. It is an innovative car share program that places an emphasis on making things easier for customers. Small two-seater city cars can be hired at any time of day after a membership registration. Their use is charged on a minute-by-minute basis, including taxes, insurance, mileage, and fuel. While registering with Car2Go, the customer’s driving license is provided with an electronic chip that enables the car to be unlocked. The customer can unlock a car by holding his/her membership card against a reader in the windscreen. After the ride, the customer can return the car by parking it in any public parking space in the city. Since 2010, Daimler AG has also tested a ride-share community called ‘Car2gether’. After renting a Car2Go vehicle, the customer can offer a seat via Car2gether to other members. Available vehicles or seats can be located via internet in both Car2Go and Car2gether concepts(Leminen, S., Westerland, M., Rahajonka, M. & Siuruainen, R, 2012). Daimler AG has expanded Car2Go overseas since starting it in Austin, U.S. on May 2010(Wikepedia, 2015). As of May 2014, Car2Go operates over 10,000 vehicles, which serve eight countries and 26 cities worldwide with over 700,000 customers. The table 2 below shows the history of Car2Go’s expansion.[2)]

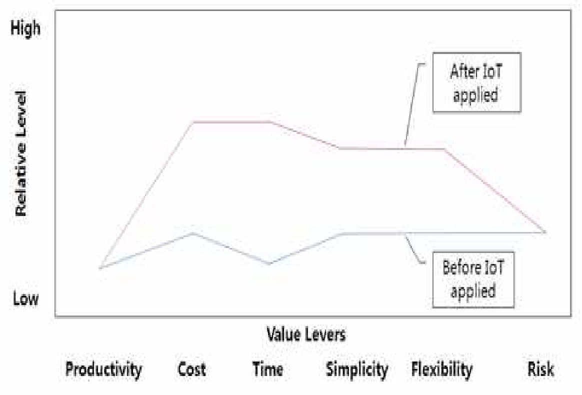
<Table2>

City	Country	Vehicles	Type	Start date
Ulm	Germany	300	Gasoline & Electric	October 2008
Austin	U.S.	300	Gasoline & Electric	May 2010
Düsseldorf	Germany	300	Gasoline	February 2011
Hamburg	Germany	700	Gasoline	April 2011
Vancouver	Canada	700	Gasoline & Electric	June 2011
San Diego	U.S.	300	Electric	November 2011
Amsterdam	Netherlands	300	Electric	November 2011
Vienna	Austria	600	Gasoline	December 2011
Lyon	France	suspended	Gasoline	February 2012
Washington, D.C.	U.S.	400	Gasoline	March 2012
Portland, Oregon	U.S.	375	Gasoline & Electric	March 2012
Berlin	Germany	1,200	Gasoline & Electric	April 2012
Toronto	Canada	375	Gasoline	June 2012
Calgary	Canada	550	Gasoline	July 2012
Miami	U.S.	240	Gasoline	July 2012
Cologne	Germany	350	Gasoline	September 2012
Stuttgart	Germany	500	Electric	November 2012
London	United Kingdom	suspended	Gasoline	December 2012
Seattle	U.S.	500	Gasoline	December 2012
Birmingham	United Kingdom	suspended	Gasoline	May 2013
South Bay, Los Angeles	U.S.	150	Gasoline	June 2014
Minneapolis	U.S.	300	Gasoline	September 2013
Columbus	U.S.	250	Gasoline	October 2013
Denver	U.S.	300	Gasoline	June 2013
Munich	Germany	300	Gasoline	June 2013
Milan	Italy	600	Gasoline	August 2013
Montreal	Canada	340	Gasoline	November 2013
Rome	Italy	500	Gasoline	March 2014
Florence	Italy	200	Gasoline	May 2014

2) http://en.wikipedia.org/wiki/Car2Go

3.1.2 Buyer Side Analysis

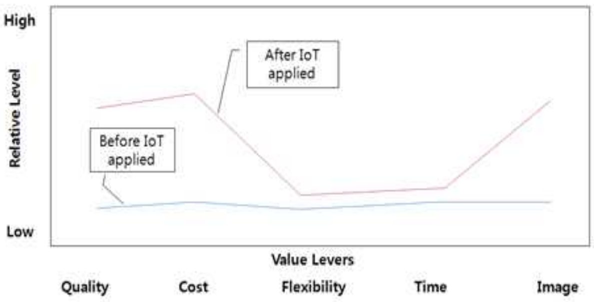
Because a customer can return a car in a place other than where the customer hired the car, or in any public parking space in the city, the customer can gain more value in time and flexibility from IoT car sharing (Car2Go). IoT chips which allow customers to hire and return cars without troublesome procedures provide customer value by saving time and allowing simplicity. Charging on a minute-to-minute basis enables customers to save on costs. The Ride-share system of Car2gether also allows customers to save their money and time. In figure 1, the blue line indicates the buyers' value before IoT is applied to the car share service and the red line indicates the buyers' value after IoT applied.



<Figure 1>

3.1.3 Supplier Side Analysis

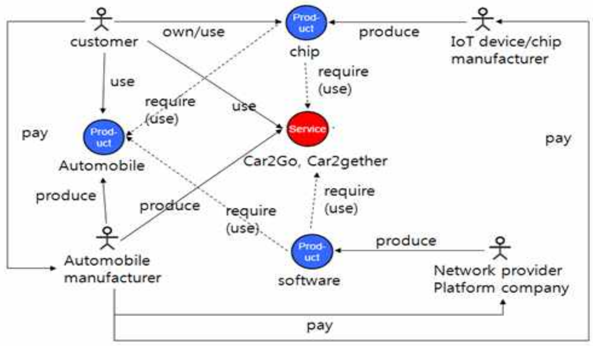
As IoT is applied to a conventional car rental service, IoT car sharing(Car2Go) can collect the information about customers'car usage in order to provide a more customized service. As a result, the supplier can be more competitive at a high service quality. This result carries over to build a better image, which improves the supplier's brand value. In addition, supplier can make higher performance in terms of cost because Car2gether can remove the car rental shop and reduce the effort of writing contracts every time. The benefits the company can get by applying IoT on the car sharing service are can be seen in figure 2.



<Figure 2>

3.1.4 Ecosystem

Figure 3 describes the relationships among players related to IoT applied car sharing business model. Each of the participants has their own role in IoT car sharing, paying costs and reaping benefits from the model. The products participated in IoT car sharing ecosystem are IoT related chips, automobiles, and the software. The IoT related chips are produced by IoT device and chip manufacturers. The software and infrastructure which makes the IoT applied car sharing service available is provided by network provider and platform related companies. These two nodes are required to the third product, an automobile to consist Car2Go and Car2gether service. The customer can use the rental car service by attaching an IoT chip on their membership card and pay the service charge to Daimler AG, an automobile manufacturer. In this business model, Daimler AG which used to be an automobile manufacturing company can broaden their business area to the service providing company.



<Figure 3>

Table 3 describes each player's role, costs, and benefits.

<Table3>

Player	Role	Costs	Benefits
Customer	Using IoT car sharing service	Service fee	Cost, Time, Simplicity, Flexibility
Automobile manufacturer	Organizing and operating IoT car sharing service	Infra using price, IoT chip purchasing cost	IoT car sharing service revenue
IoT device/chip manufacturer	Providing device/chip related to IoT car sharing service	Production cost	Revenue from selling device/chip
Software firm	Providing software related to IoT car sharing service	Software development cost	Revenue from selling software
Network firm	Providing infra related to IoT car sharing service	Infra set up cost	Network rental revenue

3.1.5 House of Quality

The value curve analyses which were done above make it possible to define customer(in this case customer means both buyer side and supplier side) requirements as follows. Buyer side requirements(benefits) are (1) returning a car in any public parking space, (2) convenient procedures of hiring and returning a car, (3) charging on a minute-to-minute basis, and (4) ride-share system. Supplier side requirements(benefits) are (1) creating a new business model, (2) utilizing the information about customers' usage, and (3) reducing the number of free seats by ride-share system.

Table 4 shows buyer/supplier requirements - functional requirements relationship. Functional requirements are the required functions to meet the request of buyer or supplier. For example, user identification is required to meet buyer/supplier requirements such as returning a car in any public parking space, utilizing the information about customers' usage and so on. Therefore, we can find relationships between customer/supplier requirements and functional/technical requirements by using a relationship matrix.

<Table 4>

			Functional Requirements						
			User Identification	Vehicle Location	Driving Pattern Recognition	Billing	Security (Lock/Unlock/Surveillance)	CRM	Connectivity
Buyer/Supplier Requirements	Buyer Side	Returning a car in any public parking space	●	●	○	○	○		○
		Convenient procedures of hiring and returning a car	●	●	△	●			○
		Charging on a minute-to-minute basis	●	●	●	●			○
		Ride-share system	●	●	△	●			○
	Supplier Side	Creating a new Biz. Model						●	
		Utilizing the information about customers' usage	●	●	●			●	○
		Reducing the number of free seats by ride-share system	●	●					○

●Very Strong Relationship
○Strong Relationship
△Weak Relationship

Table 5 shows functional requirements - technical requirements relationship. For example, communication chipset/module supports functional requirements such as user identification, vehicle location, driving pattern recognition, security and connectivity. By analyzing this table, we can find which technology is needed to be prepared to meet the functional requirement.

<Table 5>

		Technical Requirements					
		Communication chipset/module (NFC, GPS, 3G/LTE)	Sensor (Image, Pressure)	Capability of constructing billing system	Capability of constructing CRM system	Capability of constructing monitoring system	Capability of constructing SI/Platform
Functional Requirements	User Identification	●	●		●		○
	Vehicle Location	●	●			○	
	Driving Pattern Recognition	△				●	○
	Billing			●	●		
	Security (Lock/Unlock/Surveillance)	○				●	
	CRM				●		
	Connectivity	●	△				●

●Very Strong Relationship
○Strong Relationship
△Weak Relationship

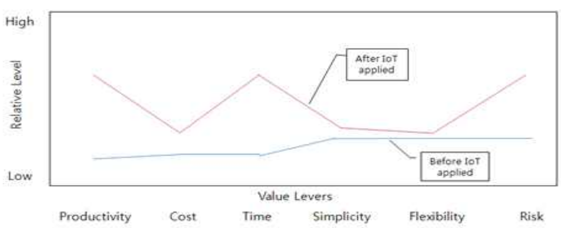
3.2 Telehealth service

3.2.1 Overview

Telehealth is the delivery of health-related services and information via telecommunication technologies. Telehealth could be as simple as two health professionals discussing a case over the telephone or as sophisticated as doing robotic surgery between facilities at different ends of the globe. Telehealth is an expansion of telemedicine, and unlike telemedicine(which more narrowly focuses on the curative aspect) it encompasses preventative, promotive and curative aspects. Originally telemedicine used to describe administrative or educational functions related to it, today telehealth stresses a myriad of technology solutions(Wikipedia, 2015). For example, physicians use email to communicate with patients, order drug prescriptions and provide other health services. One of the most significant increases in telehealth usage is the home monitoring of conditions by patients whose clinical trials in the UK have shown to improve mortality by around 47%, however the case for telehealth is still being actively debated, with a study on a separate US project showed remote telemonitoring was associated with increased mortality in vulnerable patients(Zerwekh, J. & Zerwekh Garneau, A., 2015). Intel and GE Healthcare launched the telehealth joint venture called Care Innovations on January 2011(Care Innovations, 2011). Care Innovations has concentrated on developing monitoring and information technologies to allow people with serious health conditions to live independently rather than be institutionalized in nursing homes or assisted-living facilities. By adopting IoT, Care Innovations has also helped hospitals and healthcare service companies to provide better telehealth or telemedicine for their customers.

3.2.2 Buyer Side Analysis

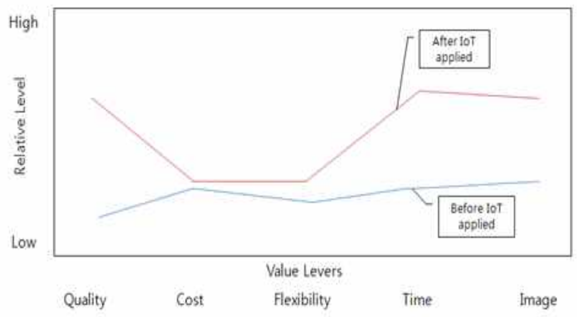
Because a customer can receive appropriate services without going to hospitals or healthcare service companies, the customer can get advantage of time and money. When a customer has an emergency, the system automatically sends notification to doctors or the person in charge of healthcare service companies can reduce customers' risk. As the customers can lessen worries about health disorder or occurrence of accident, they can improve their productivity in everyday life. In figure 4, we can see the benefits customers can get by using IoT applied healthcare service.



<Figure 4>

3.2.3 Supplier Side Analysis

Thanks to Care Innovations, hospitals and healthcare service companies are able to make the level of their service quality higher. Care Innovations supports hospitals and healthcare service companies to make their service timelier when their customers have an emergency. Hospitals and healthcare service companies can also expect to have a competitive advantage by providing a differentiated service from the others. The benefits suppliers can get by applying IoT on their business model are shown in figure 5.

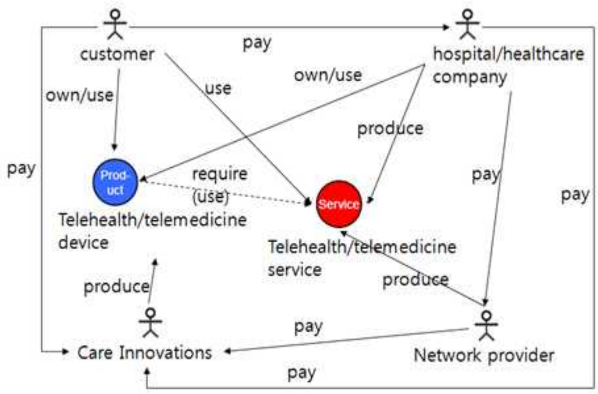


<Figure 5>

3.2.4 Ecosystem

Figure 6 describes the relationships among players of the health care business model which adopted IoT. Each participant has their own role in IoT telehealth/telemedicine, paying costs and reaping benefits from the model. The table below shows each player's role, costs, and benefits.

In this case, the product is relatively simple compared to the prior IoT applied car sharing service case. IoT applied Telehealth/telemedicine device is produced by Care Innovations Company. And the Telehealth/telemedicine service is produced by both hospital/healthcare company and the network provider. The customer owns the IoT applied device and uses it for their healthcare. The service providing hospital/healthcare company gets payment from customers.



<Figure 6>

In table 6, each ecosystem player's role is described. And relating costs and benefits are summarized.

<Table 6>

Player	Role	Costs	Benefits
Customer	Using telehealth/telemedicine service	Service fee	Productivity, Time, Risk
Care Innovations	Producing device and consulting telehealth/telemedicine service	Production cost	Revenue from selling device and consulting
Hospital/healthcare service company	Providing telehealth/telemedicine service	Consulting fee, network usage fee	telehealth/telemedicine service revenue
Network firm	Providing infra related to telehealth/telemedicine service	Infra set up cost	Network rental revenue

3.2.5 House of Quality

The above value curve analyses make it possible to define customer(in this case customer means both buyer side and supplier side) requirements as follows. Buyer side requirements are (1) receiving service at home, (2) appropriate service in emergency, and (3) real time data(body temperature, blood pressure) transmission. Supplier side requirements are (1) making level of service quality higher, (2) providing immediate service in emergency, and (3) collecting and managing customer data(body temperature, blood pressure). Table 7 shows buyer/supplier requirements - functional requirements relationship. For example, user identification is required to meet buyer/supplier requirements such as receiving service at home, making level of service quality higher and so on. Therefore, we can find relationships between customer/supplier requirements and functional/technical requirements through a relationship matrix.

<Table 7>

			Functional Requirements				
			User Identification	Customer's data analyzing	Diagnosis	Prescription	Connectivity
Buyer/Supplier Requirements	Buyer Side	Receiving service at home	●	●	●	●	●
		Appropriate service in emergency	●	●	○	●	●
		Real time data(body temperature, blood pressure) transmission	●		○	○	○
	Supplier Side	Making level of service quality higher	●	●	○	○	
		Providing immediately service in emergency	●	●	●	○	
		Collecting and managing customer data(body temperature, blood pressure)	●	△	○		●

●Very Strong Relationship
○Strong Relationship
△Weak Relationship

Table 8 shows functional requirements - technical requirements relationship. For example, communication chipset/module supports functional requirements such as user identification, customer's data analyzing, and connectivity.

<Table 8>

		Technical Requirements					
		Communication chipset/module (NFC, GPS, 3G/LTE)	Sensor (Image, Pressure)	Capability of constructing billing system	Capability of constructing CRM system	Capability of constructing monitoring system	Capability of constructing SI/Platform
Functional Requirements	User Identification	●	●	○	●	●	○
	Customer's data analyzing	●	○			○	
	Diagnosis		●				○
	Prescription			●	●		
	Connectivity	●	△				●

●Very Strong Relationship
○Strong Relationship
△Weak Relationship

Ⅴ. Conclusion

As IoT is still in the early stage of development and its application is so diverse that no framework has appeared yet to explain IoT cases generally. Therefore we try to present a general framework which can embrace unique characteristics of IoT cases by adapting widely adopted frameworks such as value curve, ecosystem, and house of quality.

The first objective of our framework is to find the values provided to both buyer side and supplier side through an IoT business model. In order to achieve the first objective, we applied the value curve analysis suggested by Kim and Mauborgne(1997) to our framework. Its second objective is to define functional and technical requirements which are needed to provide the values to both buyer side and supplier side through an IoT business model. It could be achieved by adopting the house of quality suggested by Hauser and Clausing(1988). This paper introduces two sample case studies, a car-sharing service and a telehealth service. And we analysed these by using our IoT case study framework. The case study on a car-sharing service revealed that IoT car sharing allowed not only the customer(buyer side) to gain more value in time, flexibility, simplicity, and cost but also the company(supplier side) to benefit from service quality level, cost, and image. Based on this result, we define buyer/supplier requirements and show functional/technical requirements by using the house of quality.

The case study on a telehealth service manifests almost similar result of the case study on a car-sharing service. But the two case studies' results of the value curve analysis are different from each other due to the difference of two services' own characteristics. Thus, the two case studies' functional requirements are also different from each other.

We hope that further case studies adopting our framework will appear more and more as IoT accelerates its growth by widening its application across industries. Recent studies consider enjoyment as an category of customers needs. And the results show enjoyment positively affect perceived usefulness and convenience of customers. Therefore, enjoyment is also an important factor and it should be considered in future studies(Huang, Chang & Cho, 2011).

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IoT 사례분석을 위한 개념적 틀 제시*

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국문요약

빠르게 발전하는 IoT 시대에 발맞추어, IoT 적용과 관련하여 다양한 시나리오에 이용할 수 있는 경영 전략을 이끌어내기 위한 체계적인 접근이 요구된다. 본 논문에서는, IOT를 적용할 때 시장 잠재력을 평가하고 초기 경영 전략을 세울 때 사용할 수 있는 개념적 틀을 제시한다. 개념적 틀은 널리 알려진 가치곡선분석, 생태계 분석 그리고 품질의 집을 이용하여 구성하였다. 가치곡선 분석은 소비자에게 가치를 주는 항목을 파악하는 부분과 이와 관계된 공급자의 강점을 분석하는데 이용된다. 생태계 분석은 공급사슬 상의 참가자들과 그들의 관계를 파악하는데 이용된다. 품질의 집은 공급자에게 소비자의 요구사항을 파악하고 그것을 공급자의 기술적인 요구 조건과 비교하여 초기 사업 전략을 구축하는데 적합한 분석도구이다. 본 논문에서는 우리가 제시한 개념적 틀을 IoT를 적용하였을 때 큰 발전 가능성이 있는 Car-sharing 서비스와 telehealth 서비스 이렇게 두 가지 서비스에 적용하여 분석하였다.

핵심주제어 : 사물인터넷, 품질의 집, 생태계 분석, 사례 분석

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