A Lean Design Methodology for Business Models and Its Application to IoT Business Model Development

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***Abstract*— We propose a lean design methodology for business models, which repeatedly design business-model hypotheses in researching manner; moreover, with which corporate businesses can create new business value utilizing IT. Both analyzing business value that IT creates, and designing business models which repeatedly provide the business value will be possible. We applied the proposed method onto IoT utilizing sensing technology and GPS, and evaluated its effectiveness.**

Keywords- Business Model Design; Business Modeling; Business Model Canvas; Lean Startup; IoT

I. I INTRODUCTION

In today's business environment of rapid change, it is difficult to design a business model in the waterfall development process. We believe business model design requires a new value-leading approach, which is to specify a value-producible IT by conducting continuous evaluation and learn in a short period, and that business model to fit into the business environment and gradually get closer to the business goal. In this article, we propose a lean design method for business model as a new-value-creating business model design method, utilizing IT based on this approach. We apply the proposed methodology to IoT (Internet of Things) [5] business model design, and evaluate its effectiveness.

II. RELATED WORKS

A. BMG (Business Model Generation)

BMG is proposed as a business model development methodology [6,8]. As one of the BMG techniques, BMC (Business Model Canvas) is used. BMC is composed of nine blocks which covers four areas of customer, value proposal, infrastructure and funds. In BMC, however, it is difficult to conduct visualization and analysis in a concrete way.

B. Lean Startup

Lean Startup is a methodology to develop a business in phases; it repeats a cycle of building and verification in a short period [8]. It suggests to create an MVP (Minimum Viable Product) in order to conduct verification through the feed-backing loop of BML (Building, Measurement, and Learning); and repeats improvement. However, it does not provide a design method targeting a business model.

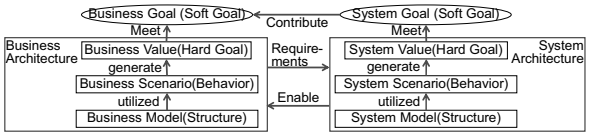

Fig. 1. Framework for IT-Driven Business Model Design Method

III. RESEARCH QUESTIONS

We set the following two research questions in developing a lean design methodology for business models.

- A method converting IT into business value
- Lean design method for business models based on a value converted from IT under the uncertainty.

IV. LEAN BUSINESS MODEL DESIGN METOHODOLOGY

A. Framework of Lean Design Method for Business Models

The business model in this article aims to create a new value utilizing IT, and to achieve a business goal which a corporation has set. Based on the principles of separating concerns, we classify the business model concerns into a business architecture and a system architecture, as illustrated in Fig. 1. This enables to grasp the requirements comprehensively.

B. XBMC and SMC

We proposed XBMC (eXtended BMC) and SMC, a set of visualization models for a business architecture and a system architecture, respectively [2]. XBMC extends the BMC, and specifies the business architecture concerns and relationship with the business goals (Fig. 2). The business goal can be resolved into the business value goal, profit goal, and cost goal [3]. And each goal will be related with XBMC.

As a counterpart of XBMC, we proposed SMC (System Model Canvas) which enable a relationship with the system goal (Fig. 3). The system goal can be resolved into the entities of the system-value goal, system-profit goal, system cost goal, and each goal will be related to the entities of SMC.

C. Lean Design Process for Business Models

To design a business model in the business environment of rapidly changing, it is difficult to predict a business model and its prospective value due to a lot of uncertain factors. It is inevitable to repeat trials and errors. As for business model design, we take an approach to extend the lean concept of repeating trials and

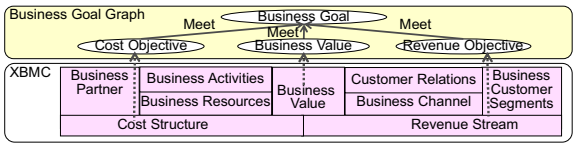

Fig. 2. XBMC

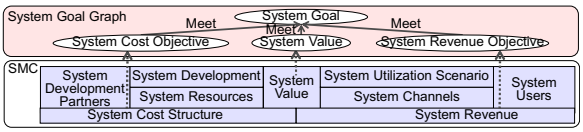

Fig. 3. SMC

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errors in the short period, and design a business model hypothesis which gets closer to the business goals, and refines the business model.

Based on this approach, we propose a lean design method for business models with the Lean Startup [7] as the basis. Fig. 4 shows the process for the lean design method for business models. It is composed of two-layer design processes; the initial business model design elevating the business model hypothesis, and a detailed business model design which refines the business model hypothesis in phases for actual construction. These phases are conducted by repeating business value extraction utilizing the targeted IT; hypothesis creation which creates the business value; and evaluation. The design process reduces the design cost, and enables to design a business model with agility, which achieves the business goal.

D. IT Value Conversion by Initial Value Analysis

The initial value analysis of initial business model design is a process which converts an IT into value (Fig. 5). It is conducted by extracting a targeted IT in a business model, and by specifying a system value and a business value for utilizing the IT. This initial value analysis enables to analyze the IT which a business model to be input for business model design, and the business value created by utilizing the IT.

1) Framework Converting Value from IT

As a converting method of a business model utilizing IT into business value, we extend the idea of SN matrix (Seeds Needs matrix which is a technique of the SN conversion method for drawing ideas in product development. The SN conversion method converts the seeds of the product engineering characteristics into the merits and/or functions to make it value for customers, and extracts new needs of customers, in a repeated way. As for the converting seeds to needs in the SN conversion method, we set IT as seeds and needs as a business value. Thus, we applied the SN conversion method as a value conversion method from IT to the value of the lean design

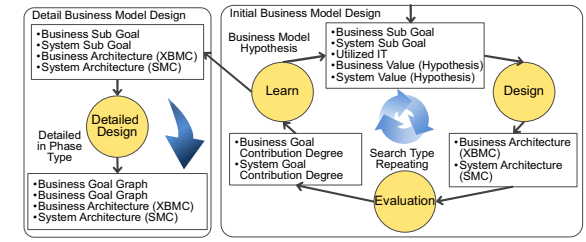

Fig. 4. Two Layered Lean Design Process of Business Models

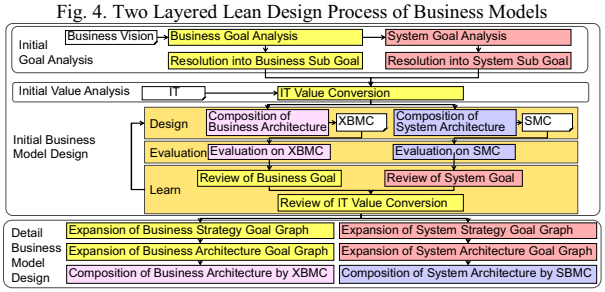

Fig. 5. Lean Design Process for Business Models

method for business models. The SN (Seeds-Needs) matrix is a basis for the SN conversion method. Therefore, in lean business model design, we call it IT value matrix. As illustrated in Fig. 6, it presents a chain formed by IT, IT-providing function, system value created by the function, and business value created by the system value.

IT value matrix can analyze functions from the extracted IT, extract system value from the structural analysis of the functions, and business value from structural analysis of the system value.

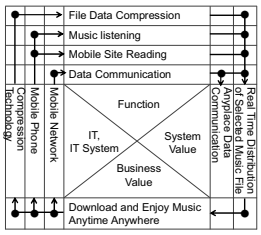

Fig. 6. IT Value Matrix

2) Value Conversion Process from IT

Fig. 7 shows IT value conversion process using IT value matrix. It converts IT into value by repeating tasks shown in the figure. It repeatedly converts IT into value by extending IT value matrix. In order to terminate the conversion process, we evaluate the contribution level of both system goals and business goals.

3) Design of Business Model Hypothesis

Design a business model hypothesis so that it can create and provide system value and business value, extracted in IT value matrix during the IT value conversion process.

a) Design of Business Model Hypothesis: Based on the system value extracted in IT value matrix, it designs a system architecture using SMC.

b) Design of Business Architecture: Based on the business value extracted in IT value matrix, it deigns a business architecture using XBMC.

V. Application to IoT Business Model Design

A. Outline of Application

We applied the proposed methodology to designing a business model using IoT [5] in a machinery manufacturer company in Japan. From this experience, we demonstrate the effectiveness of the proposed methodology.

First, we applied the initial business model design process to the business models, and, designed a IoT business model hypothesis for after-sales services of machines.

The machinery manufacturer company is intended to create a new business model utilizing IoT in after-sales services which

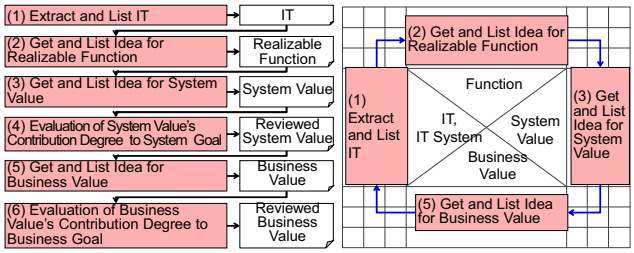

Fig. 7. IT Value Conversion Process

provides value for a customer using the machines. For staffs in charge of the after-sales services, the new business model is expected to utilize IT including GPS, sensing, mobile network, and data analyzing technique. The after-sales services aim to realize the business vision of the company; "total value chain support for the customers who buy and use the machineries". The following five points highlight this case.

1) The refinement of business goal and system goal which the business model must achieve out of the business vision

2) Extract IT candidates, and extract system value and business value that can be created by the IT

3) Design a system architecture which can continuously create and provide the extracted system value

4) Design a business architecture which can continuously create and provide the extracted business value

5) Evaluate the business architecture and system architecture on the designed business model hypothesis

B. Business Model Design

1) Business Model Design Method

As for IT utilized in business model design using the IT value matrix, we applied a brainstorming technique at the beginning. It was limited only for getting initial ideas. We thought it would be important to provide a place for discussions and collaboration among stakeholders in order to extend the idea, and to produce innovative ideas. In this case, the business design team consisted of five people, including one facilitator and four stakeholders (Fig. 8).

2) Refinement of Business Goals and System Goals from the Business Vision

To define a business goal, we resolve the business vision of a machinery manufacturer company using goal analysis. First, we set the machinery manufacturer's business vision, "support customers' value chain in total," as the top strategic business goal (Fig. 9). Then, we defined the business goal, "extend the service business sales value, and bring up service sales ratio". We further refined the business goal into three sub-goals:

a) Profit goal: "bring up the service sales",

b) Cost goal: "bring up the service profit ratio", and

c) Business value goal: "bring up the service quality for customers".

Fig. 8. Business Model Design Workshop

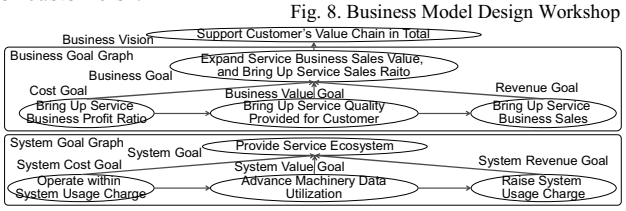

Fig. 9. Business Goal Graph and System Goal Graph

Next, in parallel with business goal refinement, we defined the system goal "provide ecosystem for the service," which contributes to the business goal. We refined the system goal into three sub-goals:

a) System profit goal: "bring up the system usage charge",

b) System cost goal: "operate within the system usage charge", and

c) System value goal: "advance machinery data utilization".

3) Analysis of System and Business Value utilizing IT

With IT value matrix, we analyzed the system value and business value utilizing IT extracted on IoT business.

a) Listing and Extracting IT Utilized

We listed the prospective IT candidates on the IT value matrix. As illustrated in Fig. 10, we extracted GPS, sensing, mobile network, smart device, and cloud which could contribute to "advance machinery data utilization".

b) Analysis of IT Realization Function

Based on the extracted IT candidates, we elicited the functions which each IT would realize, and list them on the IT value matrix. As illustrated in Fig. 10, the functions include that collecting the location data of the machine in a remote place, and that collecting sensing data from IoT and mobile network. We also elicited the data confirming function out of office/home by smart device.

c) Analysis of System Value

We analyzed system value generated by the elicited functions with respect to the system value goal. We listed the system value on IT value matrix. As illustrated in Fig. 10, we extracted two system values for achieving the system value goal of "advance machinery data utilization".

d) Analysis of Business Value

We analyzed the business value generated by the elicited system value in order to achieve the business value goal; and list the business value effect on IT value matrix. As illustrated in Fig. 10, we elicited two business values which can be generated by the system value, and contribute to achieving the business value goal of "bring up the service quality for customers". By IT value conversion, we elicited business value for "theft deterrence" including

i) "Visualization of remotely operated machinery's location and condition" on system value, and

ii) "Detecting and notifying abnormality and the location of the machine, and prevent theft".

e) Evaluation of Contribution Degree to Business Goal

Upon designing a business model hypothesis, we

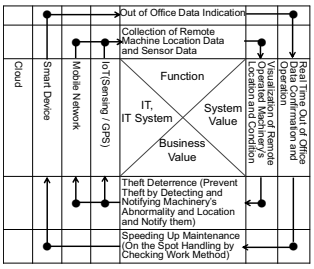

Fig. 10. After-Sales Service IT Value Matrix

evaluated the contribution degree of the extracted business value of theft prevention and maintenance speeding up to the business goal. The contribution degree is the one contributes to the business value goal, and is evaluated in three phases shown by the formula below.

Contribution degree ={+,++,+++} +(1)<++(2)<+++(3)

The contribution degree has three grades of:

+ : poor, ++ : nominal/marginal, +++ : good

As illustrated in Fig. 11, we designed a business model for theft prevention, by selecting a business value of "theft prevention".

4) System Architecture Design

Using SMC, we designed a system architecture which can create and provide a system value needed for theft prevention business of i) "Visualization of remote operated machinery's location and condition".

First, we selected a machinery user who is also a user of the system-value-providing system, as well as a staff from a machinery manufacturer. Then for the system user, we selected a cell phone and Internet provider as a system channel for providing system value. Through the system channel, in order to provide the system value to the user, we selected a system utilizing scenario which the user can operate. As a system profit structure which is the price for the system value, we can charge system usage fee to the machinery user.

Next, we decided to develop a machinery location-condition indicating system consisting of the following sub-systems:

a) A system indicating the machine's location and condition,

b) A system accumulating data of location and operation data from the machines, and

c) An indicating system.

As the system development partner, we selected a network provider who provides a data-communication environment in order to collect machine's location and condition data. As for the system cost structure, we extracted data for the development and operation cost of the information systems, as well as the cost

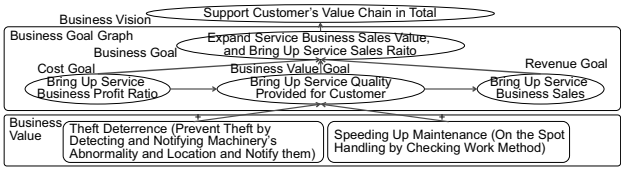

Fig. 11. Evaluation of Business Value's Contribution Degree to Business Goal

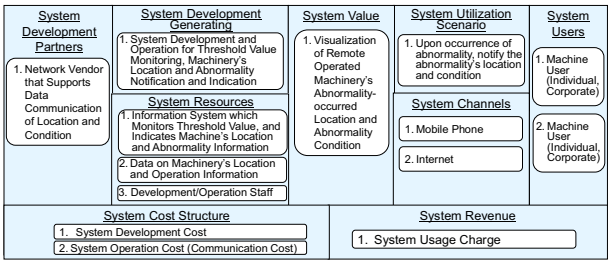

Fig. 12. System Architecture for Theft Deterrence Business

of data communication environment which the partner provides for data collection on machine's location and condition. By identifying these SMC components, we can design a system architecture for the theft-prevention business (Fig. 12).

5) Business Architecture Design

Using XBMC, we designed a business architecture which creates and provides the business value of "notify the machine's abnormality and its location, and prevent theft" which is necessary for theft-prevention business.

First, we selected an individual and/or corporate user who concerned theft as a customer segment to whom the business value of theft prevention provided. To the customer segment, we extracted an e-mail provider, Internet service provider, and a monitoring center as a business channel which will be necessary for business value provision. In order to make the business customer segment to enjoy the business value, we elicited a monitoring service; and notification to the customer via the business channel when an abnormal incident happens. As for the profit structure, we will collect the monitoring service charge from the business customer segment.

Next, in order to provide a business value; we elicited business activities including

a) Monitoring on the machinery's abnormalities, reporting to the user upon an abnormal occurrence on the machine,

b) Emergency visit to the spot the machine is located, and

c) Follow up maintenance to the machine on the abnormalities.

As a business resource necessary for carrying out the business activity, we elicited a 24-hour monitoring center for possible abnormalities on the machinery, and staffs for the service center, who would notify the customer on such incident and take necessary actions. By identifying the XBMC components, we crate the business architecture for theft prevention business as illustrated in Fig. 13.

6) Evaluation of Business Model

We evaluated the system architecture and business architecture with the value, feasibility, and sustainability, which will be used in the business design, and utilized in the system-design process [1]. We set the metrics for the each evaluation of the business and system architecture. The value, feasibility, and sustainability are respectively measured by formulas (2), (3), and (4).

Value={+,++,+++} +(1)<++(2)<+++(3) (2)

Feasibility={+,++,+++} +(1)<++(2)<+++(3) (3)

Sustainability={+,++,+++} +(1)<++(2) <+++(3) (4)

The business value evaluation is based on the contribution degree to the business value goal, while the system value

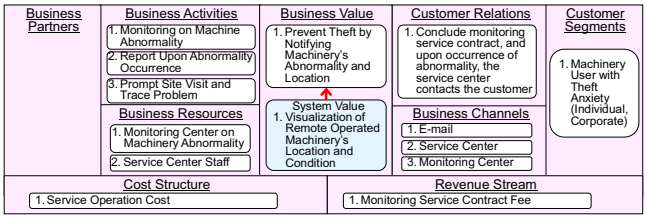

Fig. 13. Business Architecture for Theft Deterrence Business

evaluation is based on the system value goal. Each is evaluated by one (1) degree of "+" (Fig. 14). The feasibility and the sustainability were evaluated by the designed XBMC and SMC. The business activities designed by XBMC, i.e. an emergency visit by the staffs to the site of an abnormal occurrence, and realization of follow up are evaluated difficult to implement on a daily basis. Therefore, they are evaluated "+" as indicated in "Before Learn" of the feasibility and sustainability.

7) Learning and Improvement of Business Model

Based on the evaluation of the business model, we analyzed possible improvement in the business model to meet the business goal. Regarding to the emergency visit and following up, which were evaluated difficult for both feasibility and sustainability, we could improve it by a partnership with a security company with some extra cost. From this learning, as illustrated in Fig. 15, we re-designed the business architecture by reviewing the business partner in XBMC.

VI. Evaluation

A. Evaluation of the Proposed Methodology

From the application, we evaluated that the two learn subjects in this article are resoluble.

1) Method of Converting IT into Value

By IT value matrix and IT value-converting process, we extracted sensing, GPS, mobile networks, and data analysis as IT used in IoT business. By analyzing the functions of these technologies, we specified the structure of the SMC and extracted the system value and business value in order to prevent theft, in a systematic way. The proposed method can smoothly convert IT into the system and business value.

2) Business Model Design Method

We can continuously improve the initial business model design with respect to the business and system value extracted in the IT-value-converting process. We can also design each business model of theft prevention by the business architecture and system architecture. Therefore, the proposed methodology is feasible and useful when the initial design of the business model cannot fully accommodate the diverse aspects of the business in a rapid change of business environment.

Business	Value		Feasibility		Sustainability	
	Business	System	Business	System	Business	System
Theft Deterrence (Before Learn)	+	+	+	+++	+	+++
Theft Deterrence (After Learn)	+	+	++	+++	++	+++

Fig. 14. Evaluation of Theft Deterrence Business Model

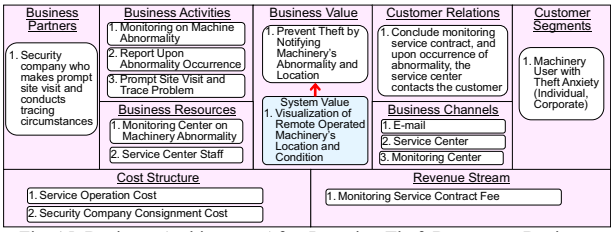

Fig. 15. Business Architecture After Learning Theft Deterrence Business

B. Comparison with Related Works

Among the related works; BMC provides a business model visualization method [5], and the Lean Startup provides a business development method [7]. However, they do not provide any business model design methodology which can create IT-utilized value. On the other hand, our proposed methodology provides a method of continuously designing a business hypothesis in an incremental manner; with IT value matrix and IT value conversion process. The proposed methodology contributes to the design techniques of business model in today's rapidly changing environment.

VII. Discussions

We examined the proposed method from the views of business model designer and corporate management.

A. Discussions from the View of Business Model Designer

There are few business model designers who have knowledge of both business and IT. For this reason, especially in business model design utilizing IT, they will end up doing trials and errors. However, the proposed methodology enables to create IT which can be utilized in a business model, and clearly and logically analyze and induce the business and system value. Moreover, it will be possible to design a business model which has higher feasibility based on the value.

B. Discussions from the View of Corporate Manager

The critical interest of a corporate management is how the designed business model contributes to the business goal. The proposed methodology can evaluate the value with the goal graph, which is the business goal's contribution degree to the designed business model. This helps the corporate management to make more accurate decisions than usual cases in the business model implementation.

VIII. Conclusion

We proposed a lean design methodology for business models which creates a new value utilizing IT, which plays an important role in corporate management. The proposed design methodology enables to design a business model by repeating a value-leading design in searching manner, evaluation, learning, and by evolving it in phases. We applied the proposed methodology to the IoT business model design of a machinery after-sales services, and evaluated its effectiveness.

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