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Flexibility Based Metrics at Diagnosis of New Technology Adoption

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Research-in-Progress

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Abstract

Nowadays, many corporate managers have great interest and expectation for the Internet of things (IoT) as a new technology. On the other hand, IT engineers became a captive of "me to desire" by cases of other companies that introduced new technologies. However, due to the shortage of insufficient building and using information technology (IT) skills and undeveloped information system architecture, many companies cannot appreciate the utility that the information system should bring. When deciding to adopt new technology, many corporations need a framework for considering the availability of new technology.

Therefore, this paper presents a diagnostic decision-making framework for answering whether to adopt a new technology just now. The scheme is consisted with balanced scorecard, IT infrastructure library and COBIT, and uses three indexes, defined by the penalty of change as a function of cost and time, such as MIS flexibility, meaning ease of change defined as a critical success factor, MIS reward as a key performance indicator, and MIS value as an important goal indicator. And, this framework presents a thinking process and criteria for deciding whether to develop information systems in-house, to purchase as a product, or to customize a ready-made software to the needs of the company. In order to make the discussion concrete, this paper uses IoT as an example of new technology.

Keywords: management information system (MIS), MIS flexibility, decision-making, Internet of things (IoT), IT infrastructure library, control objectives for information and related technology (COBIT).

Introduction

The possibilities of all aspects of the Internet of things (IoT) in human society and big changes by IoT are being discussed with great interest and expectation. However, the scope of its application is extremely huge, and attention to individual topics does not reveal the essence of IoT. Such kind of confusion and boom occurred frequently in the last 40 years. If many organizations have established a strategic framework for reviewing the introduction of new technologies, confusion in adopting new technologies can be avoided. Therefore, this paper examines the strategic framework of the decision and review procedure to introduce new technology.

In order to make this study concrete, IoT is taken as a new technology example, and the adoption is studied in the next context: What is the IoT? What will change with its implementation? What are the metrics for deciding whether to adopt it or not just now?

Changes by New Technology

The origin of this research is Furukawa (2000), and the previous studies are detailed in the papers of Furukawa and Minami (2013) and Furukawa (2014). And the research question of this paper is to clarify "How can we construct the strategic framework of the decision and review procedure to introduce new technology" Here, let's proceed with the story as simple as possible, because of the page limitation.

Why do we use ICT?

The computer can make judgments and branches such as human, and it is faster, cheaper and less mistakes than human. And the Internet freed our business from the constraints of time and space. And now, we expect to the IoT because it will free our business from the following constraints in remote places: e.g. Whereabouts unknown, Status Unknown and Inoperable condition. IoT eliminates these constraints by combining computer, telecommunication and sensor technologies. For example, various remote sensors can enable to confirm the location and the status of things. And more, the remote control of things can be realized by turning on/off the switch of drive devices based on the confirmed situation. Furthermore, brain computer interface enables computer operation from remote locations without physical contact.

How about human beings?

Our common sense insists that humans are not things and cannot be treated like things. This is a major limitation of human resource management. However, IoT is likely to change this constraint as well. Examples of deriving strategies and tactics from real-time collected data: e.g. athletes wearing sensors such as RFID (radio frequency identifier), GPS (global positioning system), gyroscope, acceleration, heart rate, and geomagnetism, are already at the practical stage. On the extension line of information exchange between nerve and computer, human beings are becoming a cyborg. If the cost and time are excluded from the constraints, the scope of ICT (information and communication technology) application will expand to such an extent that it can be considered technologically impossible.

What is the change in management area?

Management issues have been discussed in the three major schools, such as technical rationalism, behavioral science and cognitive science. Most of ICT utilization in the business so far is classified into the domain of technical rationalism originating from Taylor's scientific management method. If IoT can be used to monitor the state changes such as heart rate and/or blood flow at specific times, detailed analysis of human behavior becomes possible: e.g. When facing a specific person, the heart rate shows a remarkable change; Application of this monitoring to the marketing area is called brain marketing. Thus, the development and application possibilities of cognitive science are also spreading greatly. IoT, which can observe the state of human beings, is beginning to expand the possibility of ICT application into the domain of behavioral and cognitive science.

Change is Painful

The contents of management information systems (MIS) in this paper are based on transaction data, and includes subsystems of management information, decision support, executive support, office automation, and knowledge work in accordance with the definition of Laudon and Laudon (2000). And the expansion of the MIS area due to the IoT may further increase the demand for additional change of the MIS function to the IT department.

IT/business strategy alignment

This paper focuses the procedure from the occurrence of change demands to MIS until the IT department responds to them. In other words, responding to changes in the business environment and improving work in-house within the organization aiming to improve productivity, etc. are the source of change demands of MIS as the business strategy and the organization strategy, respectively. These change demands are incorporated into the MIS plan, IT department must provide MIS services by the time the business and organization strategy intended. The mission of IT strategy is to provide MIS services by the intended time. The requirement of this strategy is to be able to respond to the

change demands easily and quickly. To this end, it is necessary to prepare an easy-to-change MIS structure (architecture) and enough skills of IT engineers.

However, in reality, there is a strategy gap between IT and business (Luftman, 1999; Luftman et Al. 2006; Kaplan et Al. 2006). The cause of the strategy gap is the chronic shortage of *staff-hours* that can be introduced into development due to the increase in maintenance work accompanying the expansion of the scale of MIS. If business and organization strategies seek to increase the IoT adoption system, further accelerate the IT department's overload situation. That is, this overload inhibits the organization's strategic behavior in the sense that it cannot provide service functions by the intended time. In order to be able to use the MIS service function by the intended time, it must be able to make additional changes of the MIS function in a short period and low cost (Furukawa, 2014).

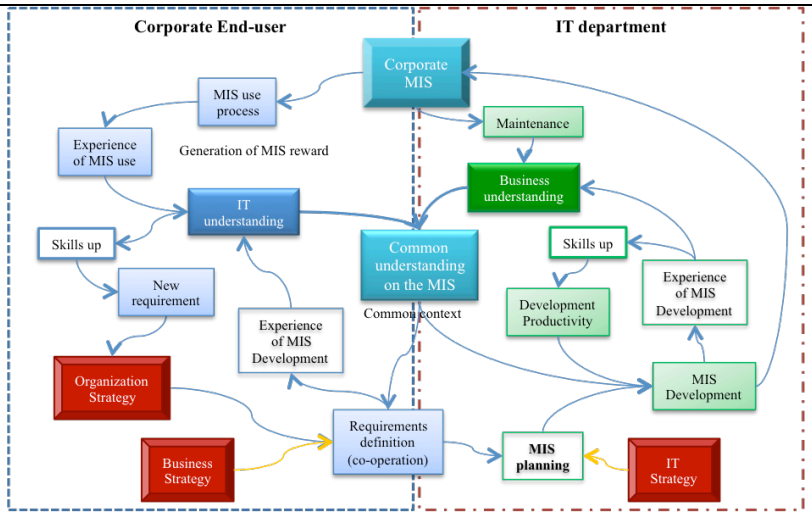

Figure 1. Development of IT Skilles [revised and adapted from Furukawa (2014)]

Skills development

The strategy gap between IT and business is caused by the shortage in all of the conceptual skill, human (communication) skill and technical skill of both IT department and end-users to build, to maintain and to utilize their MIS. These skills are nurtured only through experience.

Figure 1 details the process of accumulating MIS experience in a corporation. First, IT begins to be utilized in the corporation; the MIS department leads the development of its corporate MIS, and accumulates experience and an understanding of the business. Then, the initial MIS is provided to corporate end-users, and their MIS experience starts. This experience fosters the end-users' understanding of IT, resulting in them requesting the IT department as the source of MIS planning, in order to provide for their new requirements, which also calls for sufficient flexibility. Thus, both IT and business understandings develop a "common understanding on the MIS" and improves the maturity level of IT/business strategy alignment in the corporation. (Furukawa, 2014)

Definition of value and flexibility of MIS

Furukawa and Minami (2013) defines MIS flexibility as follows, and on which this paper is based.

MIS brings reward (MIS reward) to end-users by using the function (Function) of MIS. MIS change to prepare this function is required as a penalty for the payment of both cost and time. This is a change penalty and is expressed as POC (penalty of change). The value of MIS (MIS value) is defined with this POC as the denominator and an MIS reward as a numerator. If MIS reward is large, and POC (cost and time) is small, MIS value will be large.

$$MIS\ reward = f(Function, Use)$$
$$POC = Penalty\ Of\ Change = g(Cost, Time)$$
$$MIS\ value = \frac{MIS\ reward}{POC} \qquad (1)$$

Equation (2) with this value (MIS value) as 1 is defined as MIS flexibility. The denominator POC is a function of cost and time, and if it is small, MIS can be changed in a short period with low cost. In short, MIS is flexible with respect to change demand.

$$MIS\ flexibility = \frac{1}{POC} \tag{2}$$

Individual MIS functions can be constructed in various ways, but it is preferable to construct them so that they are easy to change. Equation (3) is a mathematical expression for determining the optimal method from various methods requiring different POCs.

$$POC = \sum_{i=1}^{n} POC(X_i)\Pr(X_i) \tag{3}$$

What should be adopted is a method that minimizes future POC. Because the purpose of using a computer is “faster, cheaper and less mistake" than a human being.”

Flexibility based Metrics at Diagnosis

Diagnosis of IT/business strategy alignment

No matter how advanced technology is utilized, car, equipment and machinery are endurance materials. The important diagnostic indicator in this case would be an investment-to-benefit, because the purchase of merchandise goods does not require the in-house technology development process such as IT department of Figure 1.

However, in the case of using IoT for an information system where the IT department should be involved largely, it is necessary to consider the burden of maintenance associated with system operation. For this reason, the IoT adoption system should be positioned as an expansion of MIS. And the diagnostic indicator should include the MIS value, MIS reward and MIS flexibility.

Diagnosis of IoT adoption system is the judgment of whether IT/business strategy alignment is going well or not. This can be regarded as a problem of diagnosis whether the IoT adopted system can be used by the intended time.

Here, let's think about this argument in the context of the balanced scorecard (BSC) (Kaplan& Norton, 2000). The intended time is set by the business and organization strategies, and it becomes the due date of MIS change demand. These change demands, from the business perspective processes, are designed as the changes of MIS function. In order to complete the changes by the due date and achieve the strategic goal by the intended time, changeable MIS architecture and sufficient skills of IT engineers and end-users are indispensable. Then, these skills development, shown in Figure 1, must be prepared from the learning and growth perspective.

Indicators of BSC considering MIS flexibility

In BSC, a strategy map is drawn for linking the four perspectives and achieving the final goal. And, the indicators defining the causal relationship for quantitatively evaluating the goal achievement level at each perspective are defined as a critical success factor (CSF), a key performance indicator (KPI), and a key goal indicator (KGI). Then, associating these indicators with the concept of MIS flexibility is as follows:

- CSF = MIS flexibility = 1 / POC
- KPI = MIS reward
- KGI = MIS value

These can be valid evaluation indicators (judgment criteria) for diagnosing whether IT/business strategic alignment is well prepared or not.

Diagnosis of new technology adoption

The goals of business and organization strategy derive from strategic goals in the business process perspective. Diagnosis of the strategy alignment begins with identification of MIS change demand,

which is necessary for achieving the goals of business and organization strategy. Business and organization strategy intend to maximize MIS reward, and IT strategy contributes to the acquisition of optimum MIS value by aiming at minimizing mid-term POC.

Thus, the issues to be considered at this stage of business and organization strategy are as follows:

- What are the constraints that IoT as a new technology can remove?
- Would MIS value, which might be gained by removing constraints, recommend adopting IoT?
- Are IT skills of end-users sufficient to utilize the application system adopting IoT?

And, the issues to be considered at the stage of IT strategy are as follows:

- Can the IT department's current skills endure the adoption of IoT?
- Will the adoption of IoT have an unfavorable effect of increasing POC on the MIS architecture?
- Judging from current skills and human resource of IT department, which of the following is the best choice? 1) purchasing a product as stand-alone, 2) purchasing a product and integrating it with existing MIS or 3) building an IoT adopted MIS with the company.

In order to consider these issues appropriately, the maturity level of the IT strategy and MIS plan must be improving. Therefore, the PDCA cycle of MIS plan must be continued repeatedly. The objective of the maturity improvement is the qualitative improvement of IT service management. For this purpose, international best practices are compiled as IT infrastructure library (ITIL) (Davies, 2016). In addition, control objectives for information and related technology (COBIT) (COBIT5, 2012) can be used as a framework of governance and management for continuously providing high quality IT service management to end-users. Utilize ITIL, as best practices, to introduce concrete processes. Utilize the COBIT indicator and the maturity model to evaluate and improve the process introduced.

Like BSC, both ITIL and COBIT use CSF, KPI and KGI as the evaluation indicators. In short, the concept of MIS flexibility can be and must be used in these frameworks. Diagnosis is the "judgment of good or bad". Best practices can be used as a goal to be aimed at. By comparing the broke down IT strategy and MIS plan with the frameworks and cases of the ITIL and COBIT, it becomes possible to construct an appropriate diagnostic metrics of new technology adoption.

Multistage decision-making based on the MIS flexibility

IoT adoption system must provide the essential functions to achieve the goal of the BSC. With this premise, let's think about the MIS value evaluation process.

Now, the MIS reward, which is the numerator of MIS value, is positioned on the BSC strategy map as an indicator of contributing to achieving the goal. On the other hand, the POC, which is the denominator of the MIS value, has the same characteristics as the human month, so its estimate will be similar.

MIS flexibility is the reciprocal of POC, which is a function of Cost and Time same as human month. In other words, it is simpler to compare Cost and Time than the POC itself, and by plotting the estimated value of the alternatives on the Cost and Time coordinate axes; it is possible to specify the approach closest to the origin of the coordinates (the lower right of Figure 2).

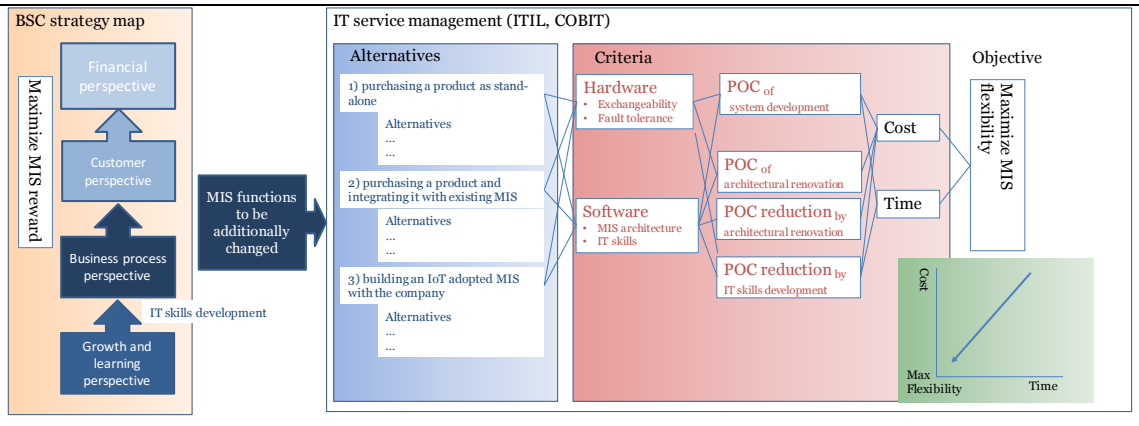

Figure 2. Problem definition via Analytic Hierarchy Process

However, method of information system development is diverse. And the IoT adoption system is one of its alternatives.

Furukawa (2013) theoretically detailed that IT strategy must include medium-term IT skills development and renovation of MIS architecture in order to reduce POC in the medium term. The volume on MIS value, MIS reward and POC, are largely dependent on IT skills of individual organizations. So, it is difficult to estimate accurate values as well as general estimates. In order to build the basis for estimating the diagnostic indicators; it is essential to accumulate experiences as in Figure 1. Ultimately, the diagnosis using these indicators will be a multistage decision-making process like Analytic Hierarchy Process (AHP) in which Cost and Time were used as judgment indicators (Figure 2).

The alternatives are 1) purchasing a product as stand-alone, 2) purchasing a product and integrating it with existing MIS or 3) building an IoT adopted MIS with the company. And the criteria of AHP consist of hardware and software. The former should include Exchangeability and Fault-tolerance, and the latter should include MIS Architecture and IT skills (Figure 1) of the organization, and they must be considered from a medium-term perspective.

Conclusion

This paper examines the strategic framework of the decision and review procedure logically to introduce new technology with IoT as an example, and presented the concept of MIS flexibility as a metric at diagnosis of new technology adoption. The concept of MIS flexibility (Furukawa and Minami, 2013) can integrate BSC, ITIL and COBIT as a common evaluation indicator.

The remaining challenges to make this paper a Completed Research Paper is to demonstrate the diagnostic metrics based on actual cases and data of MIS flexibility. The next challenge will base on the scheme of Furukawa (2013) and it might adopt a decision scheme of selecting the optimum solution from a plurality of choices.

Acknowledgment

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