

The Development of Shared-Question Based Technology Roadmapping for IT Engineers

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Abstract—In IT Industry, it is important for technology-based companies to make a flexible plan of technology development. Technology roadmapping which promotes to think of both Technology Push and Market Pull is one of the strategic tools for it. However, the following two engineer specific sets of values makes it difficult to practice: (i) a set of values to avoid forecasting technology based on doubtful (high uncertain) assumptions as illogic in terms of Technology Push and (ii) a set of values to have interests in verifications and validations of information for rationality in terms of Market Pull. To overcome it, there is a need to incorporate organizational management insight into technology roadmapping, thereby creating a new methodology for technology roadmapping in IT industry. In this study, we propose a Shared-Questions-Based Technology Roadmapping consists of future-oriented questions, situation based 3 layer structure, and rising shape. By doing an action research in Japanese IT service company, we found the methodology is effective for enhancing the cooperation behavior to achieve the future.

I. INTRODUCTION

In the IT Industry, technological shift happens frequently. It is important for technology-based companies to make a flexible plan for technology development including technology platform. IT companies which provide multi service, e.g. news, electronic commerce, finance, etc. need technological strategy based on the Market Pull, because the value of each service depends on the market trends.

Technology roadmapping is one of the tools for it. For example, T (Technology) –Plan of roadmapping is to support the understandings of how technological and commercial knowledge should combine to support strategy, innovation and operational process in the firm, in the context of both the internal and external [4]. The roadmapping as a communication tool, has three important aspects. The first is for the evaluation of various opportunities or threats at the business level. The second is for the identification of gaps between current situation and future visions. The last is for the exploration of strategic options to fill the gaps [5].

However, the following two IT engineer specific issues makes it difficult to practice: (i) there is a values to avoid forecasting Technology Push on doubtful assumptions and (ii) there is a values to have interests in verifications and validations of correctness in Market Pull [1][3]. As a limitation of roadmapping approach, Strauss and Radnor [8] insist that engineers tend to shift the focus from uncertainty future to certainty one, which will affect to their idea creation. These are relevant to organizational behavior theory including how to change employee mindset and actions. There is a need to incorporate organizational management

insight into technology roadmapping, thereby creating a new methodology for technology roadmapping in IT industry. In this study, we use cognitive model on motivation and propose a Shared-Questions-Based Technology Roadmapping (SQTR) consists of future-oriented questions, situation-imagined three Layer structures, and rising shape.

II. SHARED-QUESTION BASED TECHNOLOGY ROADMAPPING

A. Elements

This paper proposes a framework including following three components for covering IT engineer specific issues.

- a) Future-oriented question: This component is helpful to evoke the situation for the realization of the vision. Because a well-built question make participants' attentions focus on the vision [6][7]. Such as following questions create profound thinking and future oriented thinking: "What will you do?" "How will you do that?" [10]. In organizations, the share of the vision and the problem encourage the idea for organizational member. The future oriented question is the question recommending the vision and the problem, and evoking the idea for realization.
- b) Situation based three-layer structure: To understand the relationship among market conditions and technology development, the vertical axis of the roadmap is critical [5]. Three different types of layers on a chart are listed for supporting strategic planning and future-oriented thinking. The top layer indicates the situations of organizational stakeholders who have potentials to change business. The middle layer indicates the situations of organizational services that propose value for stakeholders' situations and needs. The bottom layer indicates the situations of organizational technological knowledge that need to be obtained to realize the contents of middle layer.
- c) Rising shape: To make participants can be easy to imagine a future goal, our roadmap has rising shape. The arrow in the rising chart can help to understand the relationship among elements on the situation-based three layers. Since the chart is rising shape, the arrows also will be rising, which evokes the participants' motivation for achieving goals and transform their mindset.

B. Chart

Based on the three main components that we mentioned above, Shared-Question Based Technology Roadmapping(SQTR) chart can be integrated as Fig. 1. To keep interests in making chart, the SQTR has three general

questions: i) "What our relationship is?", ii)"Why are we doing so?", and iii)"How do we build a relationship?" The structure of three questions is made in line with Deci's [2] basic elements of cognitive model on motivation: Energy source, Goals, and Behavior. Three general questions have three subsidiary questions. SQTR chart is made by answers of these questions.

The first question of "What our relationship is?" is to clarify current external and internal relationships of the organization. The answers of Q1-1: "What values do we exchange for whom?" shows the name of value that external and internal relationships can create. The answers of Q1-2: "How do we exchange values?" shows the organizational activity for the current strategy. The answer of Q1-3: "What technologies we have?" shows formal and informal technologies that engineers have. These answers represent the difference between stakeholders' values and organizational strategy as well as the gaps between actions and knowledge that organization has. These differences will lead to draw an interest to Question 3 of "How do we build relationship?"

The second question of "Why are we doing so?" is to deepen the understanding of the organizational aim. The answers of Q2-1: "What is the most important value for our stakeholders?" shows the sentence meaning the most important value that drives the needs of stakeholders. The answers of Q2-2: "What is our reason for doing?" shows the sentence meaning the most basic motive that participants keep serving the value. The answer of Q2-3: "What question is stimulate us for the future?" shows the question for discussion that participants generate the strategic options. To cultivate a shared understanding, these sentence of answers should be simple and friendly expression. These shared understanding will lead to enhance a motivation to solve Question 3 of "How do we build relationship?"

The third question of "How do we build a relationship?" is to explore the strategic options for achieving the organizational vision and mission. The answers of Q3-1: "How will we exchange values?" shows the characteristics of service that the organization should exchange the value. The answers of Q3-2: "What technologies should we get?" shows the name or the feature of technologies that the organization should get to develop the service. The answers of Q3-3: "What impact does our service have on our stakeholders?" shows the sentence meaning the situation of our stakeholders that exchange the value. The linkage with these answers is the strategic plan to fill the gaps between the future vision and the current position. This strategic plan that is expressed by own words drive participants behavior.

C. Shared-Question Based Technology Roadmapping

In order to generate novel technology solutions that may give rise to new product and market opportunities, the process of roadmapping is required to start by market pull [5]. However, there is a limitation to create ideas in the practice of traditional approach. Uncertain assumptions about future needs may shift the focus of the thought to verifications and validations of it [8]. Such behavior is driven by two engineer specific sets of values which are logical thinking and rational ones [1][3].

To solve these common issues that a roadmapping has, there is a need to acquire new factors to enhance the cooperative behavior to achieve the ideal future. There are structural orders that every participant acknowledge the uncertainty, think about the future, and explore the strategic options for achieving it. We propose a Shared-Questions-Based Technology Roadmapping as one of the solutions.

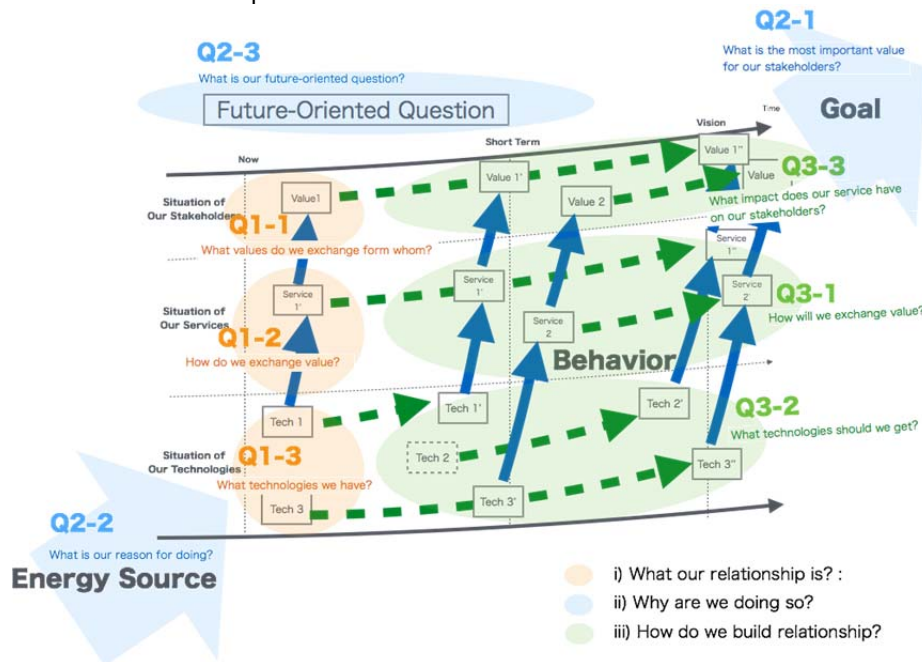


Fig.1 The Shared-Question Based Technology Roadmapping

The structure of SQTR is combination the coaching skill and the cognitive model on motivation. In the study of business coaching, it was the accepted theory that question increase the scope of client and the imagination of the future [6-7][10]. The future-oriented question which is related with cognition model on motivation is energizing in the participant's behavior to achieve the organizational goal. Moreover, three components, i.e., the future-oriented question, the situation based three-layer structure, and the rising shape, on the chart support to perceive their motivation.

III. IMPLIMENTATION OF SQTR IN IT-PLATFORM DEVELOPMENT ORGANIZATION

A. Target

A Japanese IT service company is slowing down growth in recent years. Technical board members thought that legacy platform was one of the factors. They decided to make a technological strategy for developing the new platform. There were following three conditions: to fill the needs of new environment, to be able to use existing users data, and to implement within one year.

A workshop of SQTR has been conducted at the platform development division of this company in mid-August, 2015. The number of the participants who wanted to discuss their

organizational vision was 13 persons among the 23 employees. Among the 13 participants, there was one division manager and two team leaders.

B. Practice

The SQTR consists of three workshops where participants are required to consider about three central questions in each time: the 1st workshop is about “What our relationship is?”, the 2nd workshop is about “Why are we doing so?”, and the 3rd workshop is about “How do we build a relationship?” as shown in Fig. 2.

Every workshop has 4 sessions by adding subsidiary questions that promote discussion of central questions. In each workshop, we assigned one participant as a facilitator for discussion to promote effective communication about subsidiary and central questions.

In both the 1st and 2nd workshops on the first day, we divided 13 participants into three groups as partly shown in Fig. 3, 4. Participants have to make an answer to a subsidiary question in one session. Then in the 4th session, each participant share their answers each other and complete to make chart based on the answers by three sessions.

Regarding the 3rd workshop on the second day, participants generate their ideas, share it, and check its feasibility, and charting to roadmap, as shown in Fig. 5.

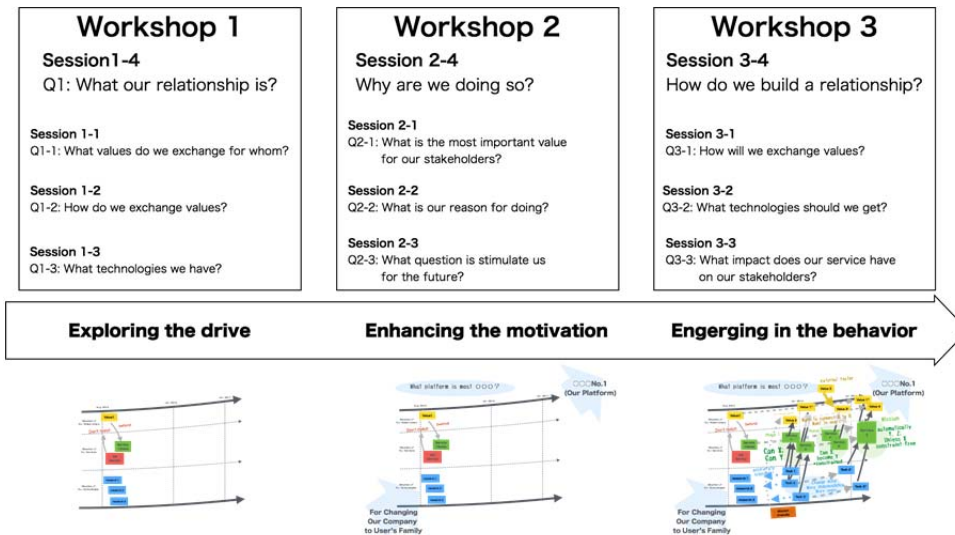


Fig 2. Process of SQTR workshop



Fig 3. SQTR workshop activity



Fig 4. Answer of Q1-1

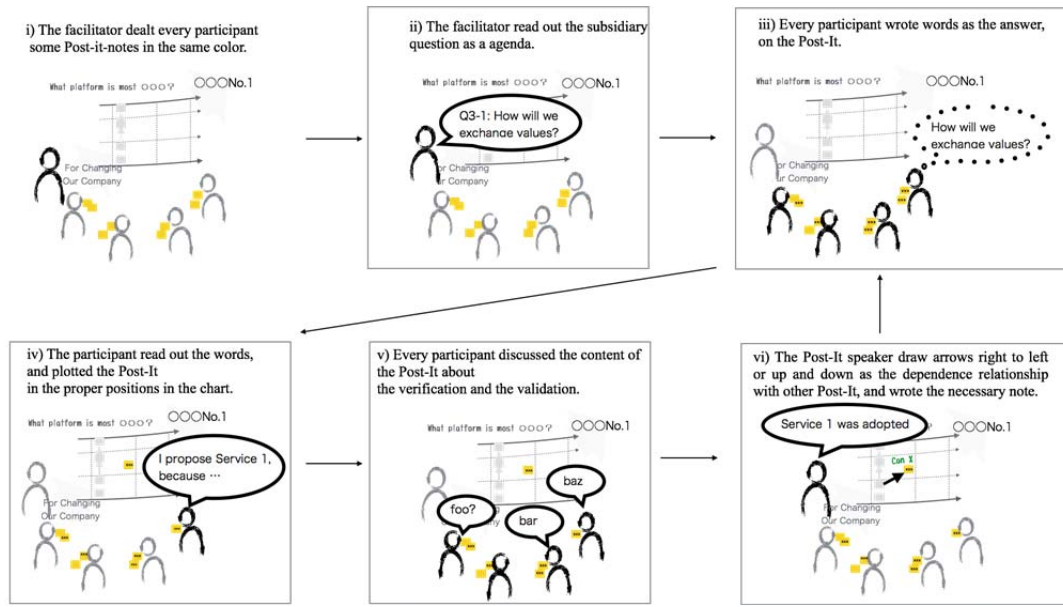


Fig 5. Process of Session in Workshop 3rd

C. Result

The Fig. 6 shows the final result of SQTR workshop. We simplify the contents of figure due to confidential issue. The roadmap is very flexible, in the terms of the inequality time span, frequent note, and protruded element from chart. There were following characteristics.

- Time Span: We decided that the end of period was Jan, 2017 and the halfway point was Jan, 2016. The goal should not over one year period, because we must keep on evolving the platform for an ever-changing market. A halfway point was the time that we wanted to release the pilot version.
- Clear phases: We clarified the mission and each phase. We considered the ideal state of service, and then considered pilot version and release version.
- Frequent note: Expression by arrow and post-it-notes has limitations. We wrote important contexts from discussion of characteristics of services and the meaning of elements.
- Cutting edge elements: The Value 3 in Fig. 4 is external new value that has been treated as not-important so far. We were not sure if that value was correct, however, this value was wonderful and had possibilities to change the other values. Such values are plotted outside the chart. Mission friendly is to pull the services 1 to value 2. This mission for achieving the strategy was found in the discussion of charting.
- To change and combine: The Value2 in Fig. 4 changes to value 4 by adding value 3. To fill needs with uncertainty, service Z is created by combined service 1' with service 2'.
- The emotional aim: “○○○” is most friendly and exciting words for us and stakeholders. Our emotional aim created our laugh and freewheeling thinking.

In this workshop, the following statements and behaviors of participants were confirmed by the observation.

- (Participant A) Increasing of the customer-oriented remark
- (Participant B) Take priority of consistency with the questions.
- (Participant C) Listen to other speakers without interruption
- (Participant D) Question to the technology that others has
- (Participant E) Speak about the technology in terms of own importance
- (Participant F) Condemn the un-logical statement rather than the illogical one
- (Participant G) Try to make correlation between elements of roadmap and his own work

According the participants, this roadmap has the following characteristics which has been not able to acquire by traditional roadmapping technique.

- The vision and the pass point was clearly charted.
- Delivery time of technology development has been brought forward.
- Elements were evenly plotted for the duration.
- The roadmap was not obtrusive.
- The roadmap contain elements beyond their expectation

This development division decided to adopt this roadmap as the technological strategy. Then, they were opening technological meetings for discussion to achieve their strategy, in September, October, and November 2015. With the repeating the technological meeting, participants were increased. In three times meeting, they assigned their role, and decided rough technical specification.

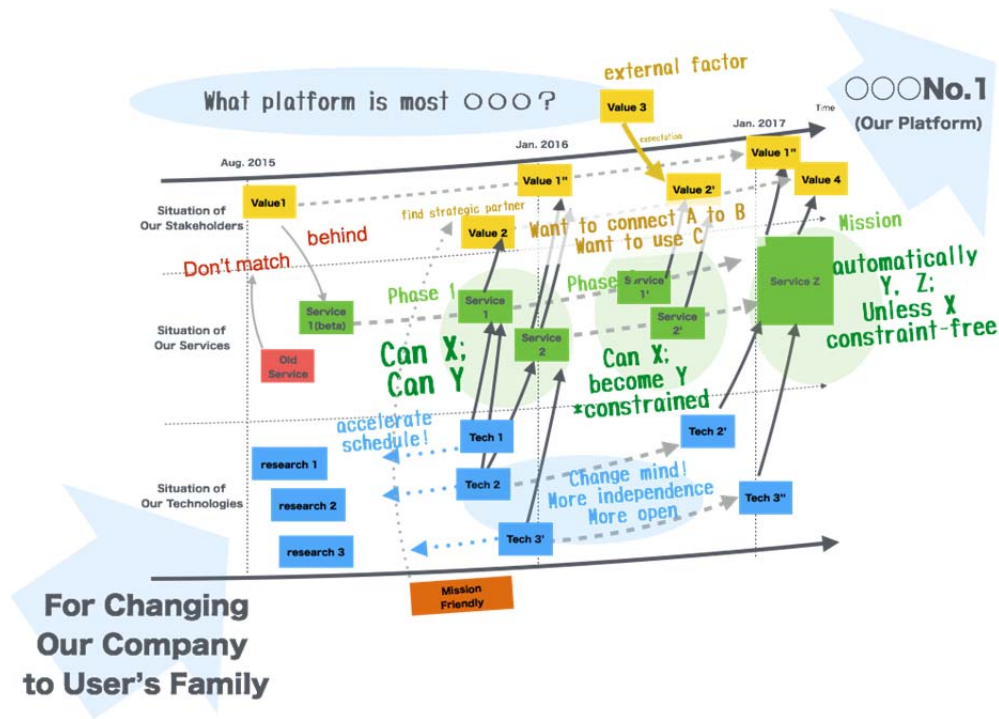


Fig. 6 An example of SQTR output

IV. EFFECTIVENESS MEASUREMENT

A. Sample and Data collection procedure

To identify the effects of the SQTR, we conducted an action research in a platform development department at Japanese IT service company during the period from May 21st, 2015 to November 17th, 2015. In 1st October, 2015, the number of participants changed from 25 to 17 by employee movement (10 left, 2 added).

We analyzed before and after effects of the Roadmapping implementation to identify the effects to organizational culture and employees' satisfaction. To evaluate the effectiveness of the roadmapping, we used corporate moral survey which was conducted on May and November to all employee.

B. Measurements

Regarding corporate moral survey, the survey has mainly four topics: job satisfaction, organizational culture, relationship with boss, and company. In table 1 shows the question items that are answered by 5 Likert-scale. In this paper, we use the results of questions about job satisfaction, organizational culture, and relationship with boss, thereby describing how much the engineers who made the roadmap change their mindset.

C. Analysis

To identify the effects of the roadmapping, we conducted t-test and descriptive statistics to identify the effect of before and after of roadmapping . The statistical analyses were used by SPSS.

TABLE 1. EMPLOYEE SURVEY QUESTIONS

No	Questions
Job Satisfaction	
1	My job gives me a feeling of personal accomplishment
2	My job makes good use of Table 1. Employee Survey Questions my skills and abilities
3	I am working positively
4	My job contributes our organization goal
5	My job makes me grow
Organizational Culture	
6	We are listening to understand the different opinions
7	We are interested in each other's work, and helping each other
8	We are trying as many new things as we can
9	We make a customer oriented decision
10	We have good relationships both inside and outside partners
11	We share tough feedbacks each others to achieve the corporate goal
Relationship with boss	
12	My boss has understandings of our skills and our abilities
13	My boss assigns us works that are relation to career development

V. RESULTS AND CONCLUDING REMARKS

We acquired 22 valid respondents among 25 employees before SQTR. After the SQTR, there were 17 valid respondents among 17 participants. The Table 1 shows Means, standard deviation, t-value of variables.

Regarding employee satisfactions before and after the SQTR, the Table 2 shows that the SQTR has enhanced the cognition of the engineering personnel such as job satisfaction item #4 ($t=2.74, p<0.01$) and item #5 ($t=2.75, p<0.05$), organizational culture items #6 ($t=4.91, p<0.001$), #7 ($t=2.55, p<0.05$), #8 ($t=5.73, p<0.001$), and #11 ($t=2.43, p<0.05$), and relationship with boss items #12 ($t=3, p<0.01$) and #13 ($t=3.59, p<0.01$).

The behavior of participants of SQTR showed that the question that we set created the shared interests among participants in the discussion. Through observation, we found that they communicated emotional conversation when participants realized that the answer of questions are important.

The effect of the shared question was helpful to expression of vision and aims, and to propose the challenging plan. The roadmap that has been brought forward and the result item #8 of survey showed this fact.

According to the results of item #6, #8, and #11, SQTR contributed to improving participants' motivation to achieve organizational goals. The dialogue of participant D and participant E and quantitative results of item #7 and #12

represent that the discussion through SQTR deepen human relationship with their bosses through recognition from bosses.

The results of item #4 and #13 shows that SQTR enables participants to promote the understanding between their own contribution and organizational goals. The planning their own strategic options gave the understanding of relationship between their growth and their job for organizational goal. As a conclusion, SQTR creates understanding their organizational aim, and acknowledging organizational vision and uncertainty situation.

The roadmapping approach will contribute to improving cooperation behavior to achieve the uncertain future as the organizational goal.

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TABLE 2. MEANS, STANDARD DEVIATION, T-VALUE OF VARIABLES

No	Question	Before the RM			After the RM			t
		N	M	SD	N	M	SD	
Job satisfaction								
1	My job gives me a feeling of personal accomplishment.	22	2.91	1.15	17	3	0.94	
2	My job makes good use of my skills and abilities.	22	3.05	1	17	2.53	0.87	
3	My job shows at my individuality.	22	2.73	1.12	17	3.18	1.01	
4	My job contributes our organization goal.	22	2.68	1.17	17	3.59	0.8	2.74 **
5	My job gives my growth.	22	2.77	1.15	17	3.53	0.51	2.75 *
Organizational culture								
6	We are listening to understand the different opinions.	22	2.32	0.99	17	3.71	0.69	4.91 ***
7	We are interested in each other's work, helping each other.	22	2.86	0.99	17	3.59	0.71	2.55 *
8	We are trying as many new things as we can.	22	2.5	1.01	17	4	0.61	5.73 ***
9	We have a customer oriented decision	22	3	1.02	17	3.18	0.73	
10	We have good relationships both with relevant organization and internal partner.	22	3	0.82	17	3.12	0.86	
11	We are each other giving the tough feedbacks to achieve the goal.	22	2.95	0.95	17	3.65	0.79	2.43 *
Relationship with boss								
12	My boss has understanding of our skills and our abilities.	22	2.55	0.96	17	3.41	0.8	3 **
13	My boss assigns me with a relation to my career development.	22	2.59	0.91	17	3.59	1	3.59 **

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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