Value co-creation oriented strategic electronic roadmapping

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Doctoral Dissertation

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Abstract

Organizations are becoming increasingly aware of the importance of employee and performance in gaining and maintaining competitive advantage. Roadmapping is a human-centric strategic management technique to formulate organizational future planning. Typical roadmapping process is face-to-face workshop. There are research gaps need to be considered, while also focusing on the stakeholder value co-creation oriented and virtual approach with internet-based roadmapping that not only overcomes the limitation of space and time but also increases the degree of communication. There is need to overcome the limitation of space and time and the new approach of blending of human and electronic works in roadmapping process as well as the design of new perspective on roadmapping to create value co-creation oriented.

The research objectives are separated into three parts. The first part is to identify what stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process. The concept of stakeholder value co-creation oriented roadmapping is proposed. The second part is to design the blending of human and electronic works into strategic planning process with electronic roadmapping to overcome the space and time limitations and increase the degree of communication among multi-stakeholders. The comparative effectiveness of face-to-face and electronic roadmapping was experimented. The last objective aims to identify and weight the factors influencing for the adoption of e-Roadmapping in organization.

In terms of research methodology, the study 1, the concept of value co-creation (VCC) roadmapping is developed. The case study of VCC roadmapping process is illustrated and participant-centric approach in roadmapping is presented. The study 2, the conceptual model of e-Roadmapping approach with describing characteristics, approach, collaboration tools and procedure are presented. Then the comparative experimental case on face-to-face and electronic roadmapping approach with mixed method research approach of quantitative and qualitative was conducted.

Lastly, we conducted experts and participants panel check to identify the initial factors influencing the adoption of e-Roadmapping to answer the second objective. The study 3, from the results of study 1 and study 2, the factors influencing the adoption of e-Roadmapping in organization is considered. To answer the research objective, we use expert checks-AHP framework to identify and weight the factors.

This research contributes to the field of strategic roadmapping and identifies the new perspectives on roadmapping as follows: 1) Integration with service management concept: traditional strategic planning with roadmapping technique has limitations of information gathering, idea creation and implementation platform among stakeholders due to lack of value co-creation thinking. Service management concept is incorporated into roadmapping with value co-creation, resource integration, and collaboration platform to solve these limitations. The key behavioral factors affecting value co-creation oriented in strategic roadmapping are identified and can be encouraged for effective strategic roadmapping, 2) Blending and balancing with human and electronic embodiment of strategic roadmapping approach: the strategic electronic roadmapping conceptual model with electronic collaboration matrix makes the shifting from face-to-face to electronic roadmapping. It supports the value co-creation oriented in roadmapping with the superb coordination between face-to-face and electronic roadmapping process. The strategic electronic roadmapping can be conducted either real or cyberspace and enabled by electronic collaboration tools and platforms. The model allows roadmapping facilitator and participants to choose the approach and tools depending on the availability and appropriateness of workshops, organizations and participants, and 3) Implementing key factors of electronic roadmapping: the management implication of strategic electronic roadmapping can be exemplified with the influencing factors the adoption of electronic roadmapping in organization.

The synergies of factors among people, organizational culture, process and technology are measured. Executive and roadmapping team can further utilize these factors and weights for implementing electronic roadmapping in organization.

Keywords: Collaboration technology, Electronic roadmapping, Strategic electronic roadmapping, Strategic planning, Value co-creation

Dedicated to my beloved parents and family

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Content

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Chapter 1

Introduction

1.1 Background

The capability of organizations to create knowledge during the innovation process has been identified as a key resource in competitive advantage (Kazadi, Lievens, & Mahr, 2016). People's involvement during the innovation and strategic management process are also key factors (Kazadi et al., 2016; Kerr, Farrukh, Phaal, & Probert, 2013).

The term 'roadmap' is a graphic representation of routes or connections that show different developments over time and into the future; 'roadmapping' can be used to chart technologies or products, and to visualize complex operational strategies for a number of stakeholders in a standardized framework (Linnenluecke, Verreynne, Scheepers, & Venter, 2017).

For strategic planning, roadmapping is a technique that enables different groups to gain a consensus in organizational planning (Kerr, Phaal, & Thams, 2017). Many organizations have conducted roadmapping approaches to make better decisions for innovative technology development. The roadmap has been developed as a strategic tool to prepare for the uncertainty of technological innovation and social change.

Multiple people and stakeholders from different types of organizations have varying perspectives and potential to make contributions (Carayannis, Meissner, & Sokolov, 2016). Multi-stakeholders coming from multiple sectors/disciplines expect to plan and generate ideas for innovative technologies in the roadmapping process. This is due to roadmaps relying heavily on the knowledge, skill, experience, and insights that stakeholders bring into the process (Ho & O'Sullivan, 2017). Moreover, Freeman, Harrison, Wicks, Parmar, and Colle (2010) described a theory suggesting organizations must understand stakeholder behaviours, values, and backgrounds. Thus, organizations need to make an effort to understand stakeholder's knowledge and skill as well as values and backgrounds, thereby co-creating an improved roadmap for innovative technology planning.

Regarding the service concept with co-creation, service-dominant (S-D) logic has been suggested in service management, and can also be effective in technology management discipline. S-D logic views economic exchange as being based not on goods, but on the application of specialized knowledge and skills through needs, processes, and performances for the benefit of another entity or the entity itself (Ho & O'Sullivan, 2017; S. Vargo & Lusch, 2004), which based on the win-win relationship (Joiner & Lusch, 2016).

Value co-creation (VCC) under S-D logic is a predominant service concept that describes collaboration between multi-sector stakeholders that creates mutual benefits (Sukholthaman & Shirahada, 2016). Therefore we can synergize roadmapping as a knowledge creation process (Kamtsiou, Naeve, Stergioulas, & Koskinen, 2006) and value co-creation as a cooperative process (Romero & Molina, 2011) of innovation through stakeholder involvement. The service concept with VCC and resource integration among multi-stakeholders can effectively support efficient development, diffusion of innovation, and creation of innovative technologies, products, and services.

Incorporating stakeholder aspects for innovation is rapidly gaining momentum in organizations. There are always people behind new technology or innovation, and the role of people in competitiveness and collaboration for technology and service management is increasing (Jonas & Roth, 2017; Kazadi et al., 2016; Nardelli & Broumels, 2017; Pera, Occhiocupo, & Clarke, 2016; Romero & Molina, 2011; Stephen, Quan anh, Outi, & Gillian, 2016).

Strategic technology management toolkits play an important role in supporting a wide range of technology management decisions and processes. One of the key tools is roadmapping. Its importance as a strategic planning tool in industry and government is widely recognized and acknowledged (Ball et al., 2014; Geum, Kim, Son, & Park, 2013; Robert Phaal , Farrukh, & Probert, 2011; Robert Phaal et al., 2016; Vatananan & Gerdsri, 2012; Yonghee, Seong-Pil, & Karp-Soo, 2016).

The key factors leading to a successful roadmapping are the right process, data, and people (Vatananan & Gerdsri, 2012). Roadmapping can support underpinned principles of strategic management tools i.e. identified human-centric, workshop-based, and neutral facilitated and visual (Kerr et al., 2013). The roadmapping process runs as workshop-based whereby the key stakeholders and domain experts are brought together to capture, share and structure knowledge (Kerr, Phaal, & Probert, 2012). Roadmapping also promotes team interaction and participation; it improves communications, engagement and ownership within the process (Kerr et al., 2013; Toro-Jarrin, Idalia Estefania, & Güemes-Castorena, 2016; Yasunaga, Watanabe, & Korenaga, 2009; Yonghee et al., 2016). But in term of the applicable scope of the workshop-based approach, the default situation is a physical or face-to-face (F2F) meeting. There are limitations of space and time that decrease the degree of participation in the roadmapping process. The virtual setting and real-time online tools can support the process as mechanisms which allow participation from individuals who are not able to attend the meeting and need a chance to give their inputs and get involved in the roadmapping process (Kerr et al., 2013).

In the technology roadmapping and foresight research forum, there is a number of research opportunities mentioned. J. Lee, Kim, and Phaal (2012) suggested that the use of social networking and web-based forms of collaboration would serve and enhance the roadmap creditability. Information and Communication Technology (ICT)-based tools will be a driving force in the future development of foresight (Keller & von der Gracht, 2014) and ICT-based roadmapping would enhance the coordination and increase the productivity of planning activities (Rohrbeck, Thom, & Arnold, 2015). Raford (2015) suggested that the study of encouraging interactive socialization in F2F, online setting, form of blended workshops or online engagement should be conducted. Phaal (2018) also suggested that research and development should continue and link to work on application software and

digital technologies, which support roadmapping, and balance the blend of human and digital works.

In summary, this study focuses on the overlap between strategic roadmapping, Value co-creation and collaboration technology within the context of strategic management research as shown in Figure 1.1

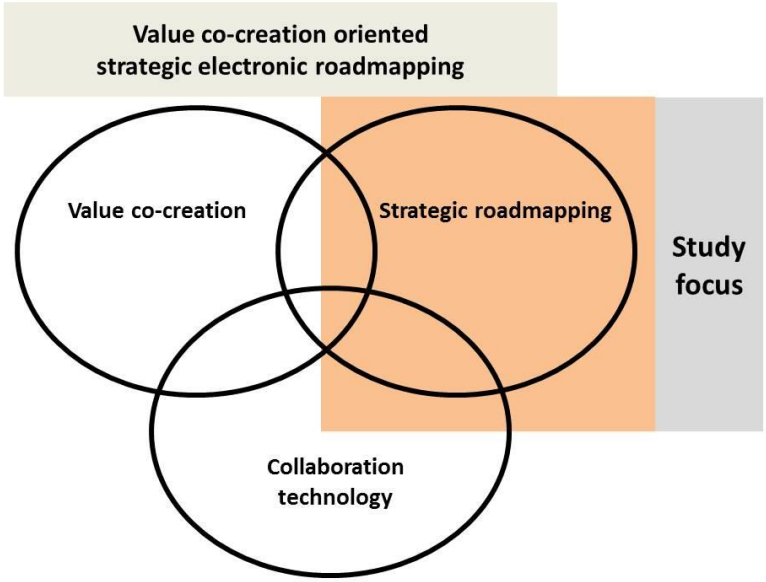

Figure 1.1 Focus of study

These highlighted research gaps need to be considered, while also focusing on the stakeholder value co-creation oriented and virtual approach with internet-based roadmapping that not only overcomes the limitation of space and time but also increases the degree of communication. There is need to overcome the limitation of space and time and the new approach of blending of human and electronic works in roadmapping process as well as the design of new perspective on roadmapping to create value co-creation oriented and uplifts the effective roadmapping stakeholders and organization.

1.2 Objectives

Based on the limitations on space and time and the degree of communication to support the organizational roadmapping process, there is a need to identify and develop a new perspective roadmapping model to organizational roadmapping for employee, stakeholder and organizational effectiveness through providing a flexible application.

Research objectives of this study is separated into three part based on research problems represented in Figure 1.2.

The first objective is to study what stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process. The concept of stakeholder value co-creation roadmapping is proposed.

The second objective is to design the blending of human and electronic into strategic planning process with electronic roadmapping to overcome the space and time and increase the degree of communication among stakeholders. The comparative effectiveness of face-to-face and electronics approach was experimented. The last objective aims to identify and weight the factors influencing the adoption of e-Roadmapping in organization.

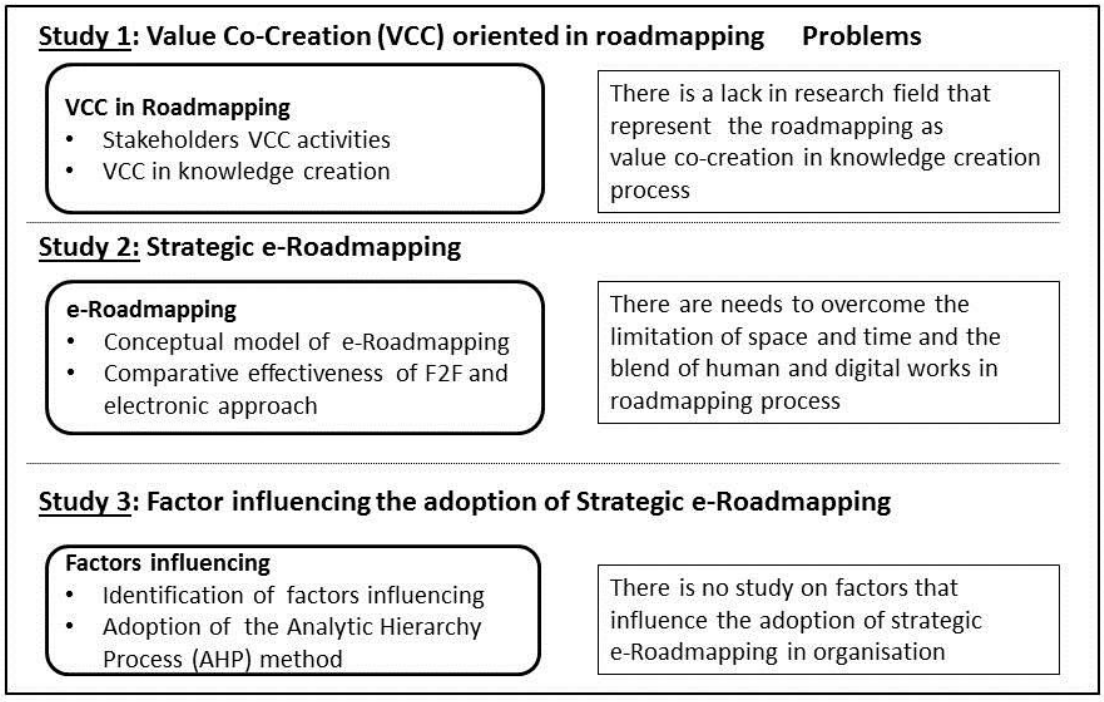

Figure 1.2 Research problems and studies

1.3 Research questions

Research questions in this research can be divided into two parts, as represented in Figure 1.3. As presented in the figure, it is necessary to understand the relationships of human and electronic works in roadmapping. This study focuses on how collaboration technology can overcome the limitation of space and time and degree of communication.

In the first stage of study, we need to find the answers for these following questions “What stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process”, “How to blend human and electronic into strategic roadmapping approach?”, and What are the key factors influencing to the adoption of e-Roadmapping in organization?.

After that, all findings from the first stage are incorporated to complete the process of the study, as represented on the right side of Figure 1.3 “How to conduct value co-creation oriented strategic electronic roadmapping?” which based on integrated concept of value co-creation, strategic roadmapping and collaboration technology.

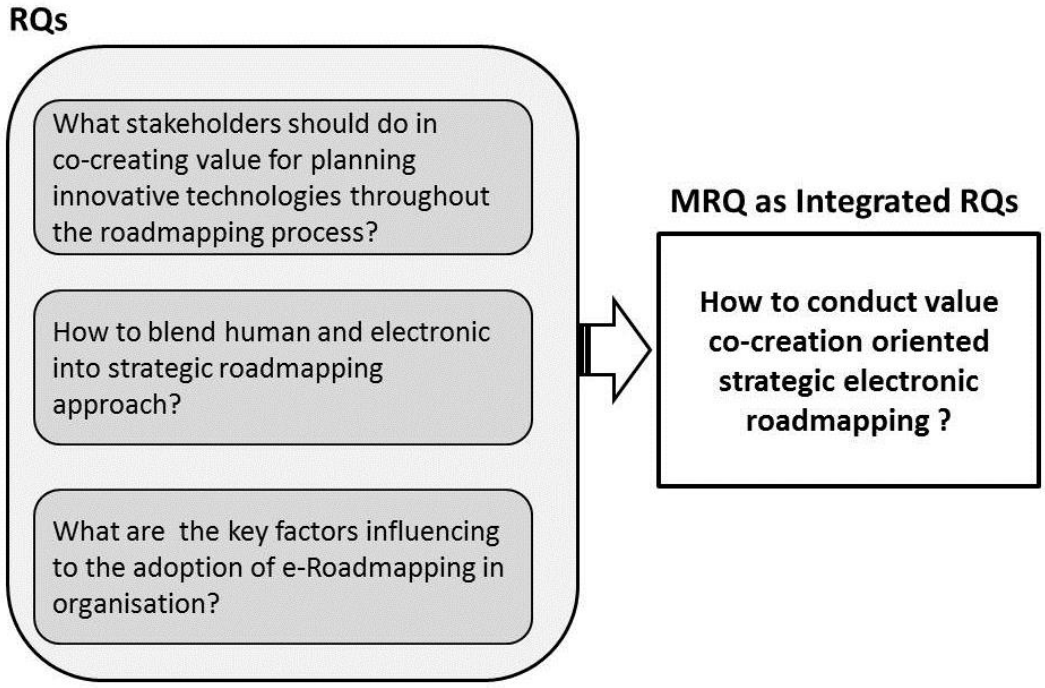

Figure 1.3 Overview of research questions

Major Research Question (MRQ):

How to conduct value co-creation oriented strategic electronic roadmapping?

Subsidiary Research Questions (SRQs):

1) What stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process?
2) How to blend human and electronic into strategic roadmapping approach?
3) What are the key factors influencing to the adoption of e-Roadmapping in organization?

1.4 Structure of study

Structure of this study is separated into six chapters, as demonstrated in Figure 1.4, namely Introduction, Literature reviews, Value co-creation oriented roadmapping, Strategic e-Roadmapping, Factors influencing the adoption of e-Roadmapping, and Conclusion.

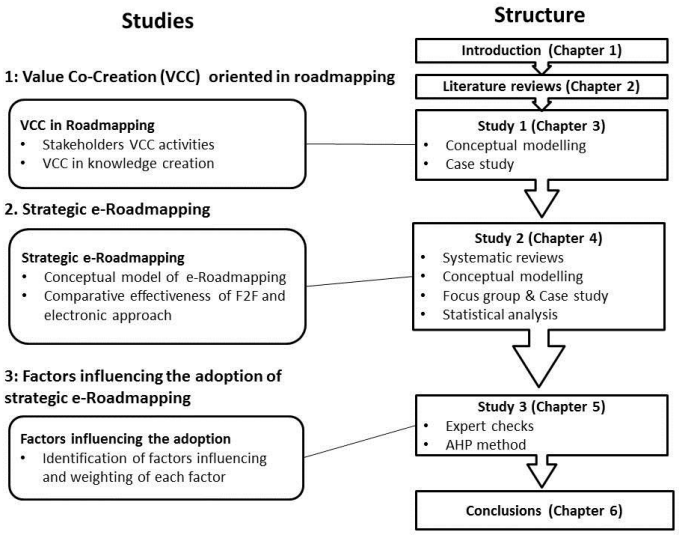

Figure 1.4 Structure of study

Details of Chapter 2 to 6 are briefly explained as follows;

'Chapter 2: Literature reviews' consists of details of related research and concepts, including Roadmapping, and collaborative technology. Related works and concepts discussed in this chapter are essential in supporting the modelling of value co-creation oriented roadmapping, and strategic e-Roadmapping.

'Chapter 3: Study 1 - Value co-creation oriented roadmapping' is the first phase that identifies related co-created activities in roadmapping process and concept of value co-creation oriented roadmapping as value co-creation in knowledge creation process.

'Chapter 4: Study 2 – Strategic e-Roadmapping' aims to develop the model of e-Roadmapping process and its effectiveness,

'Chapter 5: Study 3 – Factors influencing the adoption of strategic e-Roadmapping' focuses on the identification of factors influencing the adoption of e-Roadmapping in organization.

Chapter 6: Conclusions' includes answers for research questions, theoretical implications, management implications and limitations of the study and future research.

The summary of research methods is shown in Appendix A.

Chapter 2

Literature reviews

This chapter aims to provide a foundation for the research carried out and reported in this dissertation in subsequent chapters. It is split into four main sections; 1) Roadmap and roadmapping, 2) Collaboration technology and 3) Summary.

2.1 Roadmap and roadmapping

A roadmap is a graphical representation of objects, such as markets, technologies, products or resources, and their linkages over time (Cuhls, Vries, Li, & Li, 2015); it is a metaphor for a graphic representation of routes or connections that show different developments over time and into the future (Linnenluecke et al., 2017). A roadmap facilitates mutual understanding and visualizes complex operational strategies among multiple stakeholders and works as a strategic management tool for an organization to integrate technology into business strategy and requirements (Gerdsri, 2013; Gerdsri, Kongthon, & Vatananan, 2013; Li, Zhou, Xue, & Huang, 2016; Vatananan & Gerdsri, 2012).

Roadmapping is a human-centric strategic management technique that provides the opportunity to participate and engage with one another person or group aimed towards co-created solutions (Kerr et al., 2013). It is also one of the collaborative approaches for transforming organizational change reviewed by (Linnenluecke et al., 2017) and managing R&D planning as well as identifying the future of technological progress at government agencies and organizations (Yonghee et al., 2016). Roadmapping and related concepts are described in the following sub-section.

2.1.1 Framework

Roadmaps provide a framework within which various types of data and information can be stored, using the terms "know-why", - what, -how, -when, -who, and –where" (R. Phaal, Farrukh, & Probert, 2005, p. 109). The development of roadmaps is typically an iterative process, which involves periodic review and improvement based on human interaction through meetings and workshops. Regarding the roadmap architecture's visual dimension, it is in form of the generic roadmap framework presented in Figure 5.

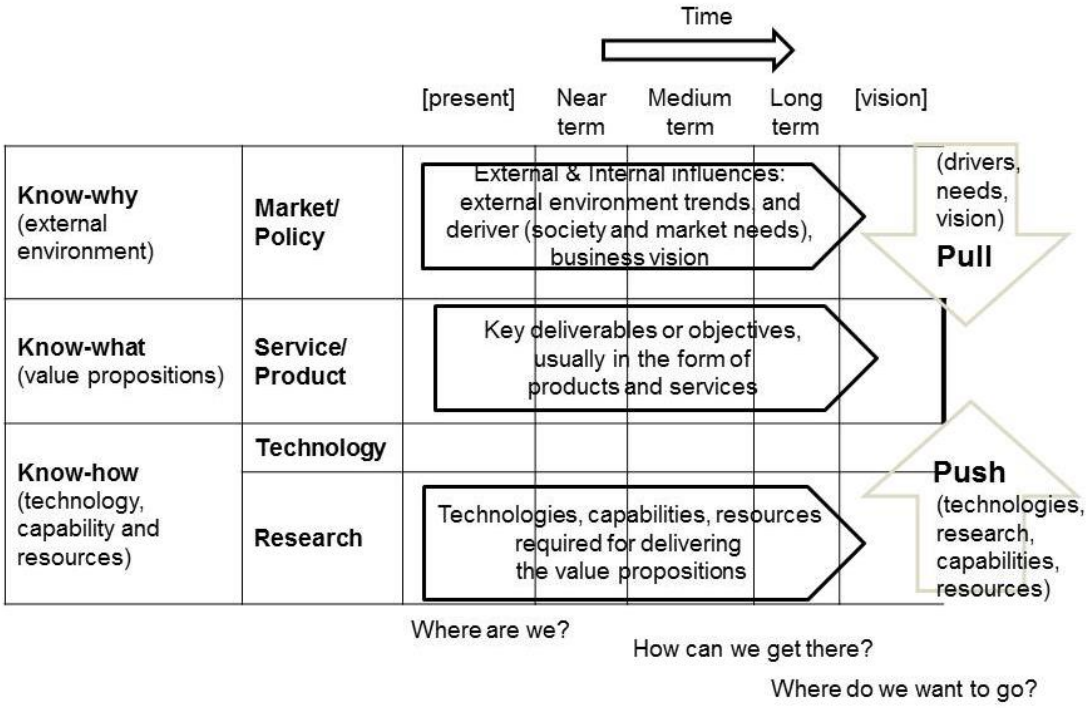

Figure 2.1 The generic roadmap architecture

(Adapted from (Cho & Lee, 2014; Ilevbare, Probert, & Phaal, 2014))

This time-based, multi-layered structure drives data gathering and analysis in line with three key questions: 1) Where are we? 2) Where do we want to go? and 3) How can we get there? (Ilevbare et al., 2014). The organization's value propositions (Toro-Jarrin et al., 2016) in format of innovation ideas, products, or services are the key focus in a roadmap's middle layer. The demand pull from social needs and technology push from research feeds are also considered due to the aim of generating new, innovative technology solutions for individuals and society.

2.1.2 Process

In the roadmapping process, there are four generic stages; initiation and planning, input and analysis, roadmap synthesis and output, and implementation of the roadmap (Gerdsri, Vatananan, & Dansamasatid, 2009; Ilevbare et al., 2014). The input and analysis stage is usually carried out in a workshop-based setting for capturing, sharing and creating knowledge from multiple stakeholders. There are two roadmapping workshop-based approaches (Gerdsri, 2013; R. Phaal, Farrukh, & Probert, 2001; Robert Phaal et al., 2011) which are S-Plan and T-Plan.

S-Plan focuses on general strategic challenges, typically at business, corporate, sector and policy level while T-Plan focuses on product-technology roadmapping. The roadmapping process can be customised to suit the particular application in terms of both architecture and process (Robert Phaal , Farrukh, Mills, & Probert, 2003)

2.1.3 Functions

In the context of supporting organizational activities, roadmapping acts as a focal point and promotes an organizational perspective. Roadmapping also enables different stakeholder groups to reach a consensus on how to appropriately move a creative idea and vision forward (Kerr et al., 2017). Roadmapping facilitates mutual understanding and visualizes complex operational strategies among multi-stakeholders, working as a strategic management tool for organizations to integrate technology into business strategy (Gerdsri, 2013; Li et al., 2016; Vatananan & Gerdsri, 2012) and changing business requirements (Gerdsri et al., 2013).

The roadmapping process focuses on the sharing of perspectives between people, leading to improved communication, new insights, creativity, learning, and knowledge (R. Phaal et al., 2005). Roadmapping is knowledge creation process. Organizational technology roadmapping also can influence innovation, as roadmapping mediates the indirect relationship between organization foresight and innovation, while perceived organizational support has a moderating effect on the relationship between technology roadmapping and innovation (Yoon, Kim, Vonortas, & Han, 2017).

The concept of value co-creation (VCC) has been emerged in multi-disciplines and getting attention from academics and practitioners as evidenced by numerous studies (Rahman, Toufiq, & Shirahada, 2017). For the organization’s view, VCC is a predominant service

concept that describes the collaboration between multisector stakeholders that creates mutual benefits (Sukholthaman & Shirahada, 2016). VCC refers to organizations and customers who are identified as resources integrators (McColl-Kennedy, Vargo, Dagger, Sweeney, & Kasteren, 2012). McColl-Kennedy et al. (2012) defined customer VCC as a ‘‘benefit realized from integration of resources through activities and interactions with collaborators in the customer’s service network’’ (p. 1).

In roadmapping’s view, VCC is practically evidenced in the theme of participant co-created activities which can be categorized as follows: 1) co-learning: participants come from different sectors and backgrounds but they are willing to learn new principles, new working styles, and tools; 2) co-operating: participants have a common interest and willing to join the roadmapping—the participants know what value they can share to create a benefit for other stakeholders; 3) co-production: participants are willing to discuss and/or debate in each workshop, 4) comparing: the information and knowledge from several sources (i.e. academic, government policy, and industry) are compared, and 5) connecting: participants build and maintain their relationship through face-to-face (F2F), online and/or social media tools on an individual and group level to keep in touch and keep working.

2.1.4 Stakeholder management

A stakeholder is “any group or individual that can affect or be affected by the realisation of an organization’s purpose” (Freeman et al., 2010, p. 31). Stakeholder theory is used in many areas such as supply chain management (Busse, Regelmann, & Wagner, 2017), the electric vehicle industry (Lu, Rong, You, & Shi, 2014), the healthcare industry (Jonas & Roth, 2017), and scenario planning (Freeman et al., 2010).

In terms of knowledge and innovation creation, Jonas and Roth (2017) determined that stakeholder integration is implemented in the mode of reactive integration throughout the stages of idea generation, implementation, and testing. Thus, organizations must increase their efforts in understand stakeholder knowledge, skill, and experience as well as values and backgrounds, thereby co-creating improved organizational technology that is innovative. However, no speculation has taken place concerning co-creation in stakeholder strategic planning, especially using the roadmapping technique.

Typically, the roadmapping process runs as workshop-based, whereby the key stakeholders and domain experts are brought together in order to capture, share, and structure knowledge (Kerr et al., 2012). Contributions from individuals and teams are necessary to assure the successful implementation of any project or process in an organization. Multi-stakeholders involved in roadmapping implementation come from different levels, expertise, and sub-groups both inter- and intra-organization. Gerdsri et al. (2009) identified the important and influential players: idea champions, champion team, roadmapping operation team, support team, and in-house facilitator or external roadmapping consulting team. For roadmapping in the government sector, the National Institute of Standards and Technology of USA, NIST (2010) identified different roles of government engagement in the roadmapping process: convener/coordinator, technical leader, participant, facilitator, implementer/adopter, funder/enabler, technical advisor, coordinator of federal agency needs, and interested observer (Ho & O'Sullivan, 2017).

Regarding multi-stakeholders' behavior, roadmapping is a human-centric strategic management technique that provides the opportunity to participate and engage with another person or group to co-create solutions (Kerr et al., 2013) and workshop-based whereby the key stakeholders and domain experts are brought together to capture, share and structure knowledge (Kerr et al., 2012). The process promotes team interaction and participation; it improves communication, engagement, and ownership (Kerr et al., 2013; Toro-Jarrin et al., 2016; Yasunaga et al., 2009; Yonghee et al., 2016).

Task-irrelevant behaviors are addressed primarily through active facilitation and group pressure to complete the task within time limits (Kerr et al., 2012). Petrick (2013) defined the interactive behaviors of stakeholders into three forms: coordination, collaboration, and cooperation that are included in organizational roadmapping. Activities in roadmapping need to be in co-creation form among multi-stakeholders. Then value co-creation of service concept should be applied.

2.2 Service management

2.2.1 Service-dominant logic (S-D logic)

At present, organizations have moved from manufacture to service sector as the global industry and business changed. The logic of service-dominant and value co-creation are moving forward.

The 'service-dominant logic (S-D logic)' perspective has recently emerged, focusing on intangible resources, the co-creation of value, and relationships (S. Vargo & Lusch, 2004). R. Lusch and Nambisan (2015) suggest that S-D logic transcends the tangible-intangible and producer-consumer perspective. They also emphasis the conceptualization of service innovation as: 1) innovation as a collaborative process through an actor-to-actor (A2A) network, 2) service as the application of specialized competences for the benefit of another actor or the self and as the basis of all exchange, 3) the generativity unlocked by increasing resource liquefaction and resource density, and 4) resource integration as a way to innovate. The integration of internal and external stakeholders is in line with resource integration in S-D logic. Stakeholder integration must be taken into account for innovative project and stakeholder management.

Regarding strategic and innovative thinking, S-D logic is a value creation process that is organizational, strategic, abductive (R. F. Lusch & Vargo, 2014). There are five ways in which S-D logic shapes an organization's strategic thinking through service ecosystems: collaboration, value proposing, designing, and configuring. Organizations can apply S-D logic as a strategy (R. F. Lusch & Vargo, 2014) by increasing of the effectiveness of the organization's roles as an integrator of resources and a co-creator of value through service, skill, and experience exchange while creating value, which involves the integration of multiple resources by multi-stakeholders simultaneously or as part of an integrative process.

Furthermore, value co-creation (VCC) is a central concept of S-D logic and is accomplished through resource integration (S. Vargo & Lusch, 2004; S. L. Vargo & Lusch, 2008; S. L. Vargo, Maglio, & Akaka, 2008). The concept of VCC has been extensively studied in service literature, VCC is defined as "benefit realized from integration of resources through activities and interactions with collaborators in the customer network" (McColl-Kennedy et al., 2012, p. 374).

For an organization, VCC refers to the collaboration of organization and customer, which are identified as resources integrators, implying mutual benefits from the service of the other through the integration of resources. Activities are defined as performing interactions on the ways individuals engage with others in their service network to integrate resources. VCC has emerged as multidisciplinary, receiving attention from both academics and practitioners, as evidenced by the number of VCC studies in many areas i.e. service ecosystems (Beirão, Patrício, & Fisk, 2016) , library and information services (Braun, Pereira, Sellitto, & Borchardt, 2015; Rahman et al., 2017), healthcare (McColl-Kennedy et al., 2012), service marketing (Plé, 2016) , stakeholder management (Jonas & Roth, 2017; Merrilees, Miller, & Yakimova, 2017; Nardelli & Broumels, 2017), social innovation (Polese, Botti, Grimaldi, Monda, & Vesci, 2018), service innovation (Fu, Wang, & Zhao, 2017), leadership (Nie, Shirahada, & Kosaka, 2013), and strategic partnerships (Dibley & Clark, 2011) .

In summary, the VCC process involves three elements: provider, receiver/user, and resources. The provider plays the role of arranging resources and proposes value through their skill, knowledge, experiences, thereby facilitating VCC through the integration and application of resources and offering the customer to engage in VCC activities. Stakeholder involvement or active interaction is important in the VCC process in order to enhance user value (Rahman et al., 2017). Stakeholder interaction with service provider resources may co-create value by utilising their competences. However, VCC in the roles of stakeholder, provider, and technology, as well as multi-stakeholders, networks, and collaborative contexts, still need a deeper level of understanding (Ostrom, A., David E., Lia, & Christopher A., 2015). Stakeholder VCC for organizational innovative technology creation remains open for study.

2.2.2 Roadmapping in S-D logic perspective

S-D logic concept is based on value co-creation and resource integration; it is in line with roadmapping as it needs resource which is knowledge, skill and experience from multi-participants. Value co-creation and resource integrator in service concepts can be described in roadmapping activities. Regarding service exchange platform of S-D logic, roadmapping also need collaboration platform to exchange, collaborate, communicated throughout the process. Roadmapping in S-D logic perspective is shown in Figure 2.2.

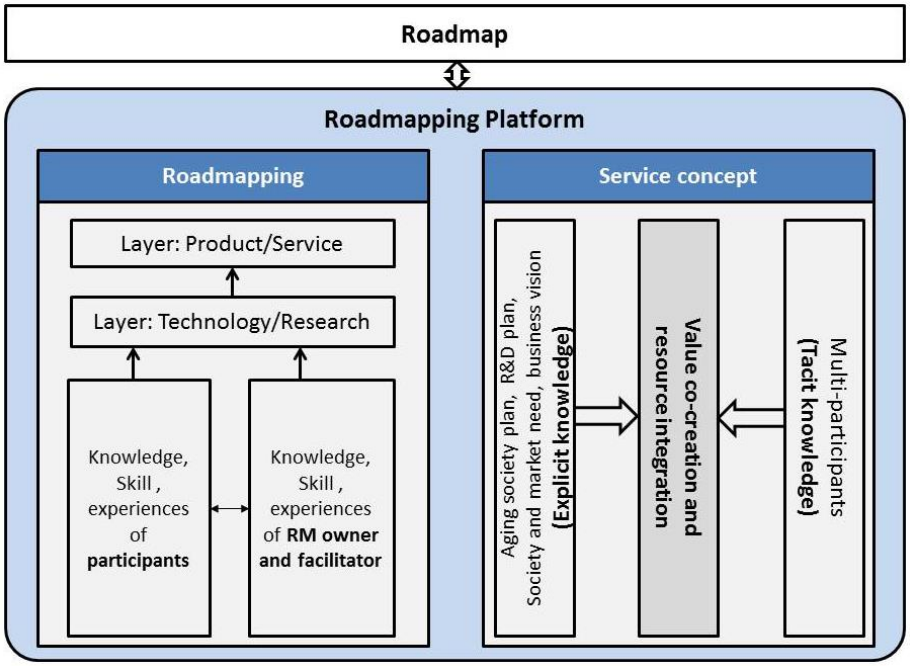

Figure 2.2 Roadmapping in S-D logic perspective

2.3 Collaboration technology

2.3.1 Information and Communication Technology (ICT)-based roadmapping

ICT has a critical role to support organizations to achieve their goals. Even though online settings and solutions do not cover every user's needs and cannot replace F2F interaction, they allow for addressing a large group of users with rich content and functionalities for search, recommendation, and interaction (Rohrbeck et al., 2015). In the roadmapping research forum, the scholars mentioned some research opportunities about ICT-enabled roadmapping. Lee et al. (2012) suggested that the use of social network service (SNS) and web-based forms of collaboration would enhance the roadmap creditability. ICT-based tools will be a driving force in the future development of foresight (Keller & von der Gracht, 2014). ICT-based roadmapping will enhance the coordination and increase the productivity of planning activities (Rohrbeck et al., 2015). Raford (2015) suggested that the study of encouraging interactive socialization in F2F, online settings, forms of blended workshops or online engagements should be conducted. Moreover, Phaal (2018) also suggested that works on application software and digital technologies which can support roadmapping and balance the blend of human and digital works are challenging. Wahl and Kitchel (2016) described the internet-based collaboration tools organized by asynchronous use (e.g. email, blogs, wikis, discussion boards), synchronous use (e.g. voice over internet protocol, web conferencing

systems, real-time collaboration), and hybrid use (e.g. shared spaces, text messaging, instant messages or chat). It is proven that ICT connects people across space and time in one common environment (González-Rojas, Correal, & Camargo, 2016) which is ubiquitous and accessible for anyone from any place at any time and any device.

The factors leading to adoption of ICT-based roadmapping in organizations are tools selection and supported software. Regarding roadmapping software, there is software on the market such as SharpCloud, Accolade, and Itonics (Abele, Hammann, et al., 2017; Abele, Schimpf, & Spielberger, 2017). In academia, there are a few roadmapping-supported software applications. S. Lee and Park (2005) and Tieju Ma, Yan, Nakamori, and Wierzbicki (2007) developed a web-based roadmapping support system and Lersmethasakul and Gerdsri (2015) designed a web-based application to determine the status of a roadmap. Finally, ICT, internet and software can be alternative supported tools to enable roadmapping in the organization and also need to be integrated with human aspects of roadmapping.

2.3.2 Computer-supported collaborative work (CSCW)

Regarding the co-working of humans and technology, the model of CSCW systems is made to consider the context of system usage. It is interdisciplinary research investigating collaborative work practices with the aim of designing collaborative technologies and examining the possibilities and effects of technological support for humans involved in collaborative group communication and work processes (Bowers & Benford, 1991). The CSCW Matrix created by (Johansen, 1988) is one conceptualization of CSCW which is categorized according to time and space and classified in four ways: synchronous (i.e. in the same place), synchronous (i.e.in different places), asynchronous (i.e. in the same place), asynchronous (i.e. in different places) (Penichet, Marin, Gallud, Lozano, & Tesoriero, 2007).

CSCW and internet-based tools as e-Collaboration has widely adapted to industry and academia to bring together individuals and groups to work in a common setting (Arinze, 2012; Wahl & Kitchel, 2016). There are past studies about CSCW in different aspects such as process and planning control, wastewater treatment, oil and gas production, vehicle control, security trading, diagnostic work, mobility work (Schmidt & Bannon, 2013), knowledge management (Ackerman, Dachtera, Pipek, & Wulf, 2013), multi-sited-design (Bjørn & Boulus-Rødje, 2015), social computing (Koch, Schwabe, & Briggs, 2015), and business process (González-Rojas et al., 2016).

2.3.3 Electronic (e)-Collaboration

Electronic collaboration or e-Collaboration is described by (N Kock, Davison, Ocker, & Wazlawick, 2001, p. 1) as "collaboration among individuals engaged in a common task using technologies" and not only limited to Computer Mediated Communication (CMC) or Computer Supported Cooperative Work (CSCW) but also online collaboration (Ned Kock & Nosek, 2005). E-Collaboration is about information sharing among individuals and organizations for the purposes of planning, coordinating, planning, improving efficiency and effectiveness. Organizations exchange information through people, process and technology, and increasingly rely on e-collaboration software to make it happen.

Ostrand et al. (2016) describe the significance of e-Collaboration software consists of (1) name recognition, (2) interpersonal facilitation, (3) clarity/simplicity, (4) cost consideration, and (5) mobile accessibility. Lomas, Burke, and Page (2008) state that good e-Collaboration tools should provide (1) strong communication capability, (2) easy-to-understand interface, (3) ambient communications, (4) document construction, and (5) sharing documents and files. The evolving area of ICT-supported collaboration represents a huge potential for organizations of all activities.

2.3.4 Collaboration platforms

Regarding service concept on value co-creation (VCC) refers to the collaboration of organization and stakeholders, which are identified as resource and knowledge integrators. A common collaboration platform to integrate resources is needed. This platform can be either a physical (face-to-face) or virtual (electronic) platform. In terms of knowledge management, knowledge creation represents a continual process and effective management and creation of new knowledge is an integral part of any organization (Sujatha & Krishnaveni, 2017).

Nonaka and Toyama (2003) defined 'ba' as a platform where information is given meaning through interpretation to become knowledge. Sujatha and Krishnaveni (2017) proposed 'Cyber ba' to configure this as a knowledge creation platform and enhance IT adaptability and work performance. Regarding value co-creation and co-innovation, Romero and Molina (2011) defined strategic networks such as collaborative network organizations and virtual communities as high-potential drivers. Mačiulienė and Skaržauskienė (2016) identified the

networked collaboration platforms as a source for improving and stimulating internal and external co-creation opportunities.

From the roadmapping aspect, a number of research opportunities mentioned (i.e. J. Lee et al. (2012) suggested that the use of social networking and web-based forms of collaboration would serve and enhance roadmap creditability. Information and communication technology (ICT)-based tools will become a driving forces in the future development of foresight (Keller & von der Gracht, 2014), and ICT-based roadmapping would enhance coordination, thereby increasing the productivity of planning activities (Rohrbeck et al., 2015). Raford (2015) suggested that the study of encouraging interactive socialization in face-to-face, online settings in the form of blended workshops or online engagement should be conducted. Additionally, Phaal (2018) suggests research and development linked to work on application software and digital technologies should continue, which can support roadmapping and balance the blend of human and digital works.

As above previous studies mentioned, VCC process in roadmapping can be implemented via collaboration platforms, i.e. online communities and social networks. Electronic (e)-Collaboration (Choi & Ko, 2012; Munkvold, 2018) with IT-enabled collaboration, can promote innovative co-creation by using seamless collaboration and communication through online real-time tools, mobile applications, devices, and environments in the organizational innovation process (Boling et al., 2014; Wong, Peko, Sundaram, & Piramuthu, 2016). Therefore, Cyber ba, e-Collaboration, and IT tools can enable collaborative planning for creating organizational knowledge and innovative technology. For additional, we conducted literature review of the factors of roadmapping in combination with collaboration technology as shown in Table 2.1.

2.4 Summary

2.4.1 Gaps in existing literature

Scholars have successfully developed stakeholder theory and strived to apply the theories primarily at an organization level in terms of service, technology, and strategic management. For collaborative strategic planning with roadmapping, the process of roadmapping is more valuable than the roadmap itself due to the communication, collaboration, and consensus generated among organizations and stakeholders (Lu et al., 2014). Moreover, roadmapping is

also searching for the integration of appropriate tools and concepts into the organizational roadmapping process and its operations (Vatananan & Gerdsri, 2012). However, the limitations of space and time decrease the degree of participation and need a mechanism to increase the degree of communication among stakeholders in the roadmapping process. Virtual settings and real-time online tools can support the process, as these mechanisms allow participation from individuals who are not able to attend meetings (Kerr et al., 2013), providing the chance for all parties to actively provide their input and become involved in a seamless roadmapping process.

The first research opportunities exist for studying stakeholder management, service concept, service design, and innovation in the seamless roadmapping process. Based on this gap, the first research question of this study is what stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process.

In another aspect with collaboration technology, the second research gaps need to be considered, while also focusing on the virtual approach with internet-based roadmapping that not only overcomes the limitation of space and time but also increases the degree of communication. There is a research opportunity on roadmapping for organizational strategic planning. Organizations can exchange information through participants, processes, and technologies, increasingly relying on CSCW and e-Collaboration tools to make strategic planning happen. This second study contributes to the development of ICT-enabled and internet-based strategic roadmapping, still an under-explored topic.

Lastly, the management implication of strategic electronic roadmapping can be exemplified with the influencing factors the adoption of electronic roadmapping in organization. The last key research question is how to conduct value co-creation oriented strategic electronic roadmapping.

2.4.2 Summary

This chapter has given an overview of strategic roadmapping, value co-creation and collaboration technology, and positioned these within the contexts of strategic planning. It has also identified a gap in knowledge, concerning how value co-creation oriented are addressed in strategic roadmapping, both in theory and practice. The conceptual approach will be discussed in detail in the following study by chapter.

Table 2.1 Factors influencing the adoption of roadmapping with collaboration technology

Factors/Authors	Counts	1 Yoon et al. (2017)	2 Godin et al. (2017)	3 Ostrand et al. (2016)	4 Graves and Doucet (2016)	5 R. Phaal (2015)	6 Raford (2015)	7 Rohrbeck et al. (2015)	8 Keller and von der Gracht (2014)	9 Robert Phaal , Farrukh, and Probert (2001)	10 Akhilesh (2014)	11 International Energy Agency (2014)	12 Faber (2014)	13 Soto-Acosta, Perez-Gonzalez, and Popa (2014)	14 Ikäläinen (2013)	15 J. Lee et al. (2012)	16 Vatananan and Gerdsri (2012)	17 Vaidy and Seetharaman (2011)	18 J. Lee, Phaal, and Lee (2011)	19 Gerdsri, Assakul, and Vatananan (2010)	20 Alsalem (2010)	21 Hou, Lu, Shi, Rong, and Lei (2010)	22 R. Phaal and Miles (2009)	23 Gerdsri et al. (2009)	24 Lomas et al. (2008)
1. Individual																									
1.1 Willingness																									
1) Mutual respect, understanding, and trust	3					●															●		●		
2) Willingness to adapt and accept the new technology	3				●							●			●										
3) Willingness to cooperate	2											●				●									
4) Willingness to reduce uncertainty	1															●									
5) Members see collaboration as in their self-interest																									
1.2 Openness																									
1) Spirit of openness	3					●														●			●		
2) Nature of individuals and work characteristics	1										●														
1.3 Leadership																									
1) Skill leadership	1																				●				
2) Ability to compromise	1																				●				
2. Organization																									
2.1 Organizational readiness																									
1) Organization/policy/senior management support	5	●								●		●							●				●		
2) Administrative/top management support and commitment	5				●	●							●	●										●	
3) Organizational readiness and IT Maturity	2												●					●							
4) Organizational culture	2									●								●							
2.2 Roadmapping team selection																									
1) Appropriate cross-section of members	6					●				●							●			●	●		●		
2) Group composition and characteristics	5					●					●	●										●	●		
3) Alignment with organizational objective	2																		●			●			
4) Organizational growth and sizes	1										●														
3. Process																									
3.1 Roadmapping process																									
1) Effective roadmap process	6									●		●					●		●	●		●			

Factors/Authors	Counts	1 Yoon et al. (2017)	2 Godin et al. (2017)	3 Ostrand et al. (2016)	4 Graves and Doucet (2016)	5 R. Phaal (2015)	6 Raford (2015)	7 Rohrbeck et al. (2015)	8 Keller and von der Gracht (2014)	9 Robert Phaal , Farrukh, and Probert (2001)	10 Akhilesh (2014)	11 International Energy Agency (2014)	12 Faber (2014)	13 Soto-Acosta, Perez-Gonzalez, and Popa (2014)	14 Ikäläinen (2013)	15 J. Lee et al. (2012)	16 Vatananan and Gerdsri (2012)	17 Vaidy and Seetharaman (2011)	18 J. Lee, Phaal, and Lee (2011)	19 Gerdsri, Assakul, and Vatananan (2010)	20 Alsalem (2010)	21 Hou, Lu, Shi, Rong, and Lei (2010)	22 R. Phaal and Miles (2009)	23 Gerdsri et al. (2009)	24 Lomas et al. (2008)
• Clear roles and policy guidelines	1																				●				
• Flexibility and adaptability	1																				●				
2) Effective tools/techniques/methods	3									●							●			●					
3) Effective training	1									●															
4) Clear business need	2									●												●			
3.2 Facilitation process																									
1) Role of facilitator, the idea champion, the champion team	4											●					●			●				●	
2) Effective facilitation	3									●							●			●					
3) Establishing good rapport and communication patterns	3				●												●			●					
4) Interpersonal facilitation	1			●																					
5) Strong communication capability	1																								●
4. Collaboration Technology																									
4.1 Accessibility	2							●	●																
1) Sharing documents and files	3																●			●					●
2) Software for development, storage, dissemination, and upkeep of roadmap	2									●									●						
3) Centralization/ Technology integration	4												●	●			●			●					
4) Document construction	1																								●
4.2 Usability	1							●																	
1) Easy-to-understand interface, Ease of use and usefulness, clarity/simplicity	3			●											●										●
2) ICT system supports/Expertise	3			●											●										●
3) Ambient communications, Mobile accessibility	2			●																					●
4) Training, planning, and resources	2		●		●																				
4.3 Cost efficiency and consideration	2			●					●																

Chapter 3

Value co-creation oriented roadmapping

3.1 Research design

3.1.1 Methodology

This study addresses the limitations of previous research on

1) the limitations of information gathering and idea creation among stakeholders due to lack of value co-creation thinking
2) the insufficient research exists regarding collaboration and value co-creation for innovative technology through strategic management techniques, including roadmapping
3) the limitations of space and time decrease the degree of participation and need a mechanism to increase the degree of communication among stakeholders in the roadmapping process

   By asking:

   What stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process?

The summary of workshops and activities is shown in Appendix B.

Regarding the aforementioned research question, we synergise the principle of service concept – value co-creation, and collaboration platforms into roadmapping to tackle issues presented by the literature. In this section, stakeholder value co-creation oriented roadmapping is presented in the following steps: concept and implementation procedure.

3.1.2 Concept

Stakeholder VCC roadmapping approach aims to capture and meet the requirements and to provide innovative ideas in a participant-centric approach. This means facing problems and identifying opportunities to provide understanding, service strategies, product features, and/or solutions to build better futures. We incorporated the VCC concept and a collaboration platform into the roadmapping process, thereby enabling the effective planning of innovative technologies

A process combining stakeholder co-creation activities with copoiesis (Ricarda Barbara Bouncken, Pesch, & Reuschl, 2016) as mutual knowledge creation among stakeholders in roadmapping process is applied. Kazadi et al. (2016) and Romero and Molina (2011) defined stakeholder co-creation as collaborative activities involving multiple external stakeholders contributing to an organizational innovation process. For practical customer value co-creation in S-D Logic, McColl-Kennedy et al. (2012) proposed customer value co-creation activities, while Botti, Grimaldi, and Vesci (2018); (Tommasetti, Troisi, & Vesci, 2017) proposed the framework of value co-creation measurement. Copoiesis facilitates the use and exchange of knowledge and its knowledge combination among organizations in way that encourage innovation (Ricarda Barbara Bouncken et al., 2016).

The collaboration between stakeholders that creates mutual benefits under the principles of VCC (Sukholthaman & Shirahada, 2016) can be applied to the roadmapping process. VCC and resource integration among stakeholders promotes the planning of innovative technologies, products, and services. Roadmapping requires the sharing of perspectives, knowledge, and expertise among stakeholders, leading to new creativity and knowledge (R. Phaal et al., 2005). Alegre, Sengupta, and Lapiedra (2013), defined roadmapping as a knowledge creation process for strategy and innovation that can serve as a method of knowledge management supporting scientific research, technology development, and creativity support (Tieju Ma, Liu, & Nakamori, 2006; Tieju Ma et al., 2007; Yan, Kobayashi, & Nakamori, 2005). Lastly, ICT, internet, software and social media tools can be alternative

supported tools to enable roadmapping in the organization and also need to be integrated with participant aspects of roadmapping.

3.1.3 Implementation

As Roadmapping is a human or participant-centric strategic management technique that provides the opportunity to engage with another person or group (Kerr et al., 2013) aimed towards co-created planning. Typically, the roadmapping process is workshop-based, whereby the participants are gathering in order to capture, share, and structure knowledge (Kerr et al., 2012).

To implement stakeholder VCC roadmapping, we propose conducting seven workshops. The workshops are based on the T-plan, fast-start, technology roadmapping approach (R. Phaal et al., 2001). They begin by bringing together stakeholders to form a cross-functional team to develop an initial roadmap that aligns with a five-layer (market/policy, service, product, technology, and research) roadmap structure implemented in the seven workshops. Each workshop has a specific purpose:

1) Discuss market/policy: External markets, social drivers, and internal business strategy drivers are identified, categorized, and prioritised for key market segments. Business strategy is reviewed.
2) Discuss value proposition: Value proposition among the stakeholders is defined, including the value proposition offered to the customer and the value the customer expects to receive.
3) Discuss service: Service solution concepts are defined. Potential service solutions, functions, and attributes are identified and prioritised with respect to how strongly they address the drivers.
4) Discuss product: Product concepts is defined. Potential product features, functions, and attributes are identified and prioritised with respect to how strongly they address the services.
5) Discuss technology: Technology capabilities are identified. Potential technological solutions for developing the product features are identified and prioritised.
6) Discuss research: Knowledge sources and strategic partners are identified. Necessary R&D, knowledge sources, and potential partners for R&D coopetition - R&D activities can be carried out in cooperation with a competitor (Bengtsson & Kock, 2000; Gnyawali & Park, 2011) and collaboration are identified.

7) Charting: Linkages among milestones, services, products, technologies, and partners are drawn. Initial roadmap linking markets, services, products, technologies, and resources is developed on basis of outputs from previous six workshops. A decision is made and actions are agreed upon.

3.2 Case study

The epistemological foundation of the example application discussed here is based on the interpretive paradigm. The example application is particularly suitable for interpretivist research. To answer our research question (what stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process), we observed the practices and operations in our example application (Eisenhardt & Graebner, 2007; Yu, Tsai, Wang, Lai, & Tajvidi, 2018) and generated useful findings to support our proposed roadmapping approach.

3.2.1 Research target

The government of Thailand is promoting Thailand 4.0 as a new economic model aimed at pulling Thailand out of the middle-income trap and pushing the country toward the high-income range. Science, technology, research, and innovation are important tools for driving the economy and improving life for Thais in the 4.0 era. Therefore, the government expects research and development centres to focus on national problems and challenges, responding to business, industry, and citizen needs by innovating for the future. A model of collaboration and co-creation among multiple stakeholders for implementing flexible network platforms is needed in Thailand to obtain stakeholders' knowledge and increase stakeholder involvement.

Roadmapping has been implemented in Thailand as a strategic management planning tool for constructing roadmaps at the industry, government, and R&D organization levels. We applied a stakeholder VCC roadmapping approach through an example application at a Thai technology-oriented organization in the context of technological innovation for improving well-being for the elderly.

This reflects the strong need to create innovative solutions for the elderly in line with Thailand's increasingly aging society. We collaborated with the Institute of Technology for persons with Disabilities and Elderly Persons (ITDE), a research unit in a government R&D institute in Thailand. ITDE's objectives are to promote R&D for the disabled and the elderly

towards commercialisation of value-added products, promotions, and support for new industries and services for Thailand's aging society. ITDE was tasked with formulating a strategic research agenda roadmap entitled 'Future services of assisted living technology for the elderly'. The objective for this roadmap was to represent the organization's R&D capabilities with respect to partners, technologies, products, and services. Each of these factors should respond to market needs, social drivers, and the elderly while linking to open collaboration among stakeholders.

3.2.2 Procedure

We collected data using various sources and research methods: 1) institutional research and development plans and internet sources; 2) roadmapping workshops with multiple stakeholders (both face-to-face and online); 3) a wrap-up and appraisal workshop; and 4) informal follow-up conducted using e-mails and phone calls. The procedure is described as below sub-sections.

A. Initiation

The initiation stage provides an opportunity to gather information needed in the later stages. Key stakeholders come together to form a team responsible for initiating the roadmapping process. The success of this stage's activities is evidenced by the acceptance of the roadmapping concept among stakeholders.

A total of 36 stakeholders were assembled: 1) eight advisory panels, 2) five government agencies dealing with elderly affairs, 3) two R&D organizations focusing on science, technology, and innovation, 4) five academics, 5) six technological service providers, 6) five healthcare service providers, and 7) five recipients (the elderly/family/informal caregiver). All parties are currently involved in elderly affairs from a policy, academic, economic, and social perspective.

We informed each potential stakeholder of our objectives, expected outcomes, and working procedures before asking them to join our roadmapping team. The co-created value in the roadmap was the result of collaboration among the stakeholders (providers and receivers).

B. Development: Idea generation from various perspectives for making a roadmap

The second stage, development, focuses on collecting and analysing data from internal and external sources. A series of seven workshops are organized to analyse the data and to present

the results in a visual roadmap. The success of this stage's activities is evidence by the content presented in the roadmap, the level of knowledge and expertise shared among the stakeholders, and the level of their communication throughout the process.

The procedures, collaboration tools, and outputs corresponding to each workshop are presented in Table 3.1. The seven workshops can be either face-to-face or real-time online workshops depending on team member availability. In our example application, workshops 1 to 6 were conducted online.

1) In the first workshop, Market/Policy, the team members discussed the market drivers. To identify the market drivers, the stakeholders and experts were surveyed, and priorities were calculated by response weight. This market driver analysis was conducted step-by-step:
    a) Roadmap facilitator presented a short list of potential market determinants.
    b) Stakeholders considered the potential determinants and provided brief opinions on each one.
    c) Stakeholders suggested additional market determinants.
    d) Facilitator presented revised list of potential market determinants.
    e) Stakeholders evaluated the relative importance of each potential determinant.
    f) Facilitator prioritised and assigned weights to market determinants on a normalised scale of 0–10.
    g) Facilitator presented the priorities of the market determinants in an online meeting using a Skype video call and/or a web conference.

    Collaborative Google Docs and Google Sheets were used as common documents in this analysis.

2) In the second workshop, Value proposition, the team members reviewed value proposition. The purpose of this workshop was to identify the potential co-created value among stakeholders. This value proposition identification was conducted step-by-step:
    a) Stakeholders identified their respective offerings.
    b) Facilitator consolidated and presented stakeholder co-created value matrix.
    c) Stakeholders discussed matrix.
    d) Facilitator proposed stakeholder descriptive value web.
    e) Stakeholders discussed web.

Collaborative Google Sheets were used for consolidating inputs from stakeholders. Outcomes were stakeholder co-created value matrix and stakeholder descriptive value web, which were then used to derive stakeholder value constellation diagram.

3) In the third workshop, Service, the team members identified potential service solutions by conducting literature reviews, speaking to experts, holding virtual meetings for brainstorming, and then identifying solutions with the potential to become useful services for the elderly. The relationships among service solutions and market drivers were evaluated using the market drivers and a service solution analysis grid. The effect of each solution on each market driver was ranked using a linking grid. Collaborative Google Docs and Google Sheets were again used.
4) In the fourth workshop, Product, the team members identified potential product features by conducting literature reviews, speaking to experts, holding virtual meeting for brainstorming, and then identifying solutions with the potential to become useful products for the elderly. The relationships among product features and service solutions were evaluated using the analysis grid. The effect of each feature on each service solution was ranked using the linking grid. Collaborative Google Docs and Google Sheets were again used.
5) In the fifth workshop, Technology, the team members used the linking grid to identify and rank the relationships among technologies and products.
   This was done online using Collaborative Google Docs.
6) In the sixth workshop, Research, the team members considered potential resources such as R&D, knowledge, and partners. To identify key resources including skills, competences, alliances, knowledge, and capital investment, they met face-to-face to conclude them and to identify potential partners for coopetition, co-creation, and resource integration by means of open innovation. This was done online using Collaborative Google Docs.

C. Integration: Idea convergence by charting

In the seventh and final workshop, Charting, the team members integrated the roadmapping into everyday business activities. The success of this stage's activities is evidenced by the continuation of 1) roadmapping in everyday business activities and 2) stakeholder involvement in keeping the roadmap functional. In this face-to-face meeting with the stakeholders, we delivered the first draft of the roadmap.

Table 3.1 Workshop topics, activities, collaboration tools and outputs

Workshop Topics	Activities	Collaboration tools	Outputs
1. Market/Policy	・ Identify and prioritise market segments ・ Prioritise market and business drivers ・ Focus on most important market segments and competitors ・ Consider competitors' strengths and weaknesses ・ Consider strategic implications for business, products, and technologies	・ Web conference ・ Facebook group ・ Line (SNS) ・ Google Docs/Sheets	・ Business strategy ・ Market drivers
2. Value proposition	・ Segment possible stakeholders ・ Create empathy map ・ Formulate value propositions	・ Web conference ・ Facebook group ・ Line (SNS) ・ Google Sheets	・ Value propositions
3. Service	・ Brainstorm service feature concepts ・ Group concepts ・ Ranking to the groups on basis of potential impact	・ Facebook group ・ Line group ・ Google Docs/Sheets	・ Service strategy ・ Service solutions ・ Service attributes
4. Product	・ Brainstorm product feature concepts ・ Group concepts ・ Ranking to the groups on basis of potential impact	・ Facebook group ・ Line (SNS) ・ Google Docs/Sheets	・ Product strategy ・ Product features ・ Attribute of products
5. Technology	・ Brainstorm possible technology solutions ・ Group solutions into technology areas/routes	・ Google Docs	・ Technology trends ・ Technology features
6. Research	・ Identify key resources (skills, competences, alliances, knowledge, and capital investment)	・ Google Docs ・ Face-to-face workshop	・ Key R&D areas ・ Target partners for open innovation/ collaboration
7. Charting	・ Define focus and format of route map ・ Chart market milestones ・ Chart evolution of product features ・ Chart preferred technology solutions ・ Chart other resources ・ Draw linkage between levels	・ Face-to-face workshop	・ The first draft of roadmap

3.3 Evaluation

We evaluated the results of this example application of stakeholder VCC roadmapping by 1) observing the stakeholder VCC activities in the face-to-face and online workshops throughout the roadmapping process at which the co-created activities were presented and 2) observing the team members in a face-to-face wrap-up workshop with seven representative participants at which the roadmapping process was summarized and evaluated.

3.4 Results

3.4.1 Observation of stakeholder VCC activities

From our observations of stakeholder VCC activities, we grouped stakeholder VCC activities from the example application with ITDE/NECTEC into three major themes and nine activities, which are shown along with examples in Table 3.2. The activities exemplify how the stakeholders proposed, shared, and co-created value for innovation throughout the roadmapping.

Table 3.2 Examples of stakeholder value co-creation activities

Theme	Activity	Examples
Co-initiation	1. Contract commitment	▪ *Assembling a team from across multidisciplinary sectors*: Identifying suitable stakeholders from relevant sectors who are willing to join. ▪ *Obtaining policy support and time dedication:* Strong policy support from roadmap owner – ITDE/NECTEC and top management was needed to recruit key researchers who were willing to join and dedicate their time to the roadmapping workshops.
	2. Information Collation	▪ *Sharing information and expertise among stakeholders:* Stakeholders share information and express ideas for formulating roadmap. ▪ *Comparing:* Stakeholders collect and compare information from various sources, i.e. academia, government, and industry.
	3. Activity Combination	▪ *Developing and communicating objective, scope, and plan:* Kick-off meeting between top management, roadmapping team, and key stakeholders is conducted to communicate rational, project's scope and objective, and roadmapping approach. ▪ *Designing a series of workshops:* The roadmap facilitator designs a series of face-to-face or online workshops in which team members develop a roadmap using selected e-collaboration tools.

Theme	Activity	Examples
Co-acting	4. Co-learning	▪ *Willing to learn new approach:* Stakeholders learn new principles, working styles, and tools even they come from different sectors and no IT backgrounds. They use new tools to share knowledge and information related to their specific domains.
	5. Co-production	▪ *Co-delivery:* Stakeholders assist with fulfilling required and additional activities in either a face-to-face or online setting, making use of questionnaire, online forum, or debate for each roadmapping workshop.
	6. Cooperation	▪ *Willing to cooperate:* Stakeholders from healthcare service provider shares lesson learnt to researcher from R&D institutions to create more benefit for them. They have a common interest and are willing to join the roadmapping process.
	7. Coopetition	▪ *Turn competitor into partner:* Stakeholders from different healthcare providers found a way to collaborate, thereby changing competitors into partners.
	8. Connection	▪ *Keep in touch:* Stakeholders built and maintained relationships among team members through online social media tools on individual and group levels to keep in touch and continue working. Face-to-face meetings are no longer required as process is supported by e-collaboration tools.
Co-evolving	9. Collaboration change	▪ *Change management*: Stakeholders select alternative ways of overcoming space and time limitations in roadmapping process with adoption of e-collaboration tools. ▪ *Continuous improvement*: ITDE/NECTEC as roadmap owner continues using roadmapping approach to update roadmap.

The stages and activities in stakeholder VCC in the roadmapping process are summarised in Figure 3.1 by dimension. The dimensions of stakeholder VCC activities in roadmapping are co-initiating, co-acting, and co-evolving in correspondence with 1) the stage of roadmapping (Gerdsri, 2013; Gerdsri et al., 2010; Gerdsri et al., 2009), i.e. initiation, development, and integration, 2) stakeholder integration in the service innovation process (Jonas & Roth, 2017), i.e. idea generation, development, and testing, and customer value co-creation activities (Botti et al., 2018; Tommasetti et al., 2017).

The first dimension, co-initiating, refers to getting an organization ready to implement the roadmapping process. It is composed of three sub-dimensions: 1) Contract commitment, 2) information Collation, and 3) activity Combination. Commitment and policy support from senior management in the organization are needed in the first stage (initiation). The search for and collation of information involves a set of information-related actions carried out by stakeholders. This information is needed in later stages and includes information and knowledge obtained from various sources, i.e. academia, government, and industry.

The combination of activities is related to stakeholder in further activities. A ground rule for team participation is set.

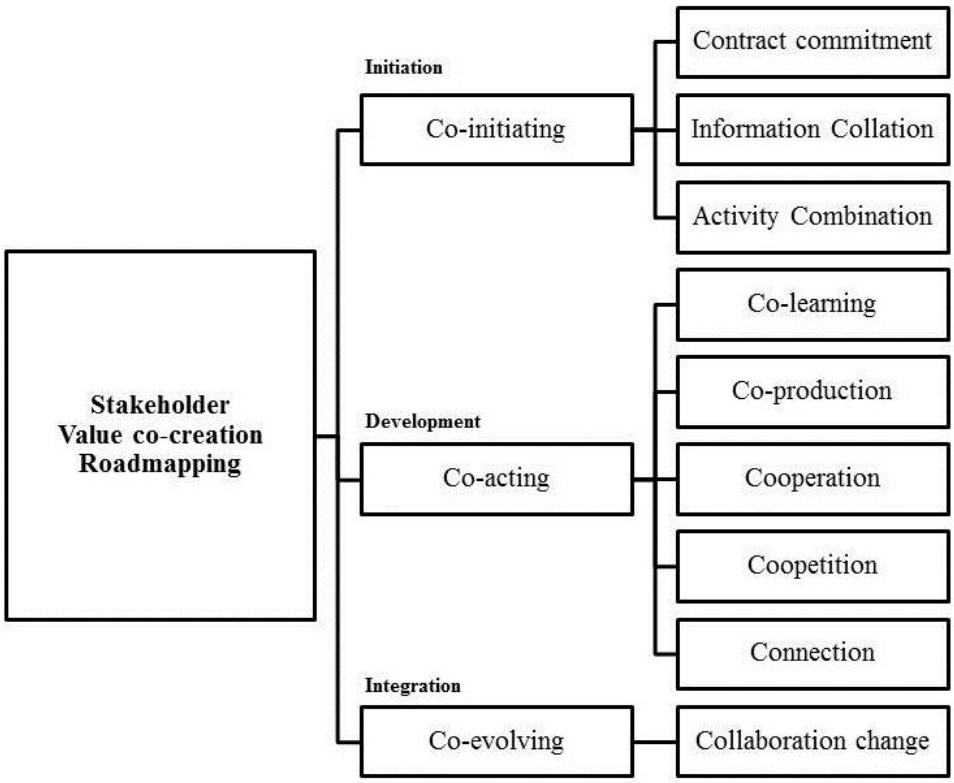

Figure 3.1 Stages and activities in stakeholder value co-creation in roadmapping process

The second dimension, co-acting, refers to developing a roadmap by engaging with appropriate stakeholders and conducting step-by-step roadmapping workshops that combine 1) co-learning, 2) co-production, 3) cooperation, 4) coopetition, and 5) connection.

In co-learning, commitment is a directly variable affects co-learning (Benavides-Espinosa & Ribeiro-Soriano, 2014). The stakeholders, who are from different sectors and backgrounds, are willing to learn new principles, working styles, and tools as well to share knowledge, information, and expertise related to their respective domains of expertise.

In co-production, the stakeholders assist with fulfilling the required and additional activities in either a face-to-face or online setting. These activities can make use of a questionnaire, an online forum, or an online debate for each roadmapping workshop. In cooperation, the stakeholders have a common interest and are willing to join the roadmapping process.

In coopetition, the stakeholders co-create as simultaneously combines cooperation and competition between competitors (Ricarda B. Bouncken, Gast, Kraus, & Bogers, 2015; Kraus, Gast, Klimas, & Stephan, 2018). Coopetition works as a strategy in innovation processes (Ricarda B. Bouncken & Fredrich, 2012; Ricarda B. Bouncken et al., 2015) by promoting value creation and value appropriation (Ritala & Hurmelinna-Laukkanen, 2009). Empirical research has shown a positive relationship between coopetition, innovativeness, and competitiveness (Gast, Filser, Gundolf, & Kraus, 2015; Gnyawali, He, & Madhavan, 2006). Organizations intending to increase coopetition can achieve goals through the use of an alliance strategy and an alliance function (Ricarda B. Bouncken and Fredrich (2012). For roadmapping, the dual technology roadmap for open innovation (Geum et al., 2013) conforms to coopetition strategy. Stakeholders are willing to turn competitor to business or research partner.

In connection, the stakeholders build and maintain relationships among all team members through online social media tools on individual and group levels to keep in touch and continue working. The final dimension, co-evolving, refers to integrating the roadmapping process into on-going planning activities so that a roadmap can be regularly reviewed and updated. It involves changing the collaboration methods so that the stakeholders' routines and practices are driven by creative and planning activities. The stakeholders contribute their knowledge, skills, and expertise through participant-centric approach to create innovative ideas through the three major themes and nine activities as evidences shown in Table 2 in combination with the roadmapping process.

3.4.2 Observation of team members in face-to-face wrap-up workshop

The results obtained from the wrap-up workshop with seven representative participants revealed other aspects for implementing VCC roadmapping: 1) organization, 2) facilitator, 3) participant, and 4) collaboration platform and tools.

From the organizational aspect, there are two key requirements: 1) a strong commitment and organizational policy support from senior management and 2) a supportive organizational working culture. The second requirement presents a challenge to the facilitator. The facilitator needs to promote a collective learning and facilitation process and to create a relaxed and productive atmosphere that facilitates knowledge creation and transfer during the roadmapping process, especially for the face-to-face approach.

For the e-Roadmapping approach, the facilitator not only has to be an expert on the roadmapping process but also needs to be highly digital literate to support the collaboration tools.

From the participant aspect, the right combination of participants and their willingness to co-create in roadmap development are important factors in addition to their being digital literate. From the collaboration platform and tools aspect, the participants need 1) ubiquitous access to the roadmapping work anytime, from anywhere, and from any device and 2) simple, easy-to-use and familiar tools to participant have to be considered for utilisation and expansion.

3.5 Discussion

The focus of this study was the role of stakeholders in value co-creation roadmapping as embodied in the research question: what stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process. Our aim was to identify key behavioural activities affecting value co-creation roadmapping.

Here we describe the adoption of a concept of stakeholder VCC roadmapping in a technology-oriented organization, lesson learned from stakeholder VCC roadmapping, and the role of the roadmapping facilitator and that of an online real-time social media platform supporting the integration of resources.

3.5.1 Adoption of the concept of stakeholder VCC oriented roadmapping in technology-oriented organization

Regarding the proposed concept described in section 3.1.2, the example application described in section 3.2.1 sheds light on the nature of the relationship between stakeholder involvement, roadmapping as a knowledge creation process, and value co-creation as a cooperative process. In terms of people, we acknowledge the contribution of the stakeholders who participated in the roadmapping process and the political will and support from the senior management stakeholders. In the combined process of roadmapping, value co-creation, and design, we worked on roadmapping principles (Kerr et al., 2013; More, Gungor, Phaal, & Probert, 2015) in human-centric, workshop-based, neutrally facilitated, and visual terms. We describe the activities throughout the process in the following sub-section.

3.5.2 Lesson learned from stakeholder VCC oriented roadmapping

Three lessons were learned from the example application: 1) when recruiting an appropriate combination of stakeholders with different backgrounds and from different levels in various organizations and sectors, strong consideration should be given to ensuring that their contributions and perspectives are balanced. Moreover, the stakeholders themselves should be encouraged to recommend candidate stakeholders from their networks, 2) the willingness of stakeholders to join the roadmapping process as well as political will and support from senior management and the roadmap owner are important, and 3) value co-creation among the stakeholders is accomplished through the activities shown in Figure 1. Table 3.2 shows that stakeholders collaborate under the 9C's co-created activities for planning innovative technologies throughout the roadmapping process.

3.5.3 Role of roadmapping facilitator and online real-time social media platform supporting integration of resources

The roadmapping facilitator must actively provide additional information to the stakeholders to facilitate their face-to-face and/or e-collaboration discussions that will guide them through the roadmapping process. Regarding the online and social media tools listed in Table 1, the findings from the stakeholder aspect are as follows: 1) from the e-collaboration perspective, the synergy of online social media tools can help overcome the limitations of stakeholder participation in terms of space and time, as described in Table 3.1, 3.2) the stakeholders had diverse digital literacies, so the e-collaboration approach should be adjusted appropriately, and 3) Organizations can adapt the e-collaboration approach to their strategic planning.

3.6 Summary

We investigated how stakeholders work to co-create value for planning innovative technologies during the roadmapping process. The 9C's activities in stakeholder VCC roadmapping under the proposed roadmapping approach were implemented and observed for an example application. The 9C's are 1) Contract commitment, 2) information Collation, 3) activity Combination, 4) Co-learning, 5) Co-production, 6) Cooperation, 7) Coopetition, 8) Connection, and 9) Collaboration change as described in Section 3.4.1.

Stakeholders collaborate through the 9C's under the VCC concept using a combination of face-to-face workshops and online workshops conducted on a collaboration technology platform. The findings from an example application, analysed using our proposed stakeholder VCC roadmapping approach built upon existing literature contribute to our understanding of value co-creation by suggesting that stakeholder VCC in roadmapping can extend beyond face-to-face workshops to e-Collaboration supported by online real-time social media tools as a collaboration platform and collaboration tools. This approach improves organizational performance in strategic planning and stakeholder communication and collaboration. Altogether, the findings of this study support the existing literature, and clarify the needs and expectations of value co-creation in roadmapping. They show that the concept of stakeholder VCC roadmapping can be used to create innovative technologies through a strategic roadmapping process with stakeholders in the context of a participant-centric approach supported by technology.

This proposed approach incorporating a combination of face-to-face workshops and online workshops supported by collaborative platform can also be used in strategic planning to increase the degree of communication and collaboration among stakeholders in the roadmapping process. This roadmapping approach constitutes a mechanism for organizations needing to 1) do planning of innovative technologies through roadmapping by blending a human and digital approach, 2) overcome the obstacles of roadmapping workshop arrangements, and 3) use online social media tools for facilitating the roadmapping process.

The example application led to Thailand applying technological innovation planning to their problem of an aging society in the context of Thailand's 4.0 policy. Governments need to synergise interdisciplinary policies, strategies, and innovation. Stakeholder value co-creation roadmapping supports innovation strategies, people collaboration, and a co-creation approach that can serve as a tool for strategic planning while strengthening open collaboration and value co-creation among stakeholders.

Chapter 4

Strategic e-Roadmapping

4.1 Research design

4.1.1 Methodology

This study highlighted the research gap on virtual or electronic roadmapping approach that not only overcomes the limitation of space and time but also increases the degree of communication and collaboration of stakeholders.

The aim of study was threefold. First, we aimed to develop the conceptual model of an e-Roadmapping approach. Second, we asked what about the effectiveness of the typical F2F and e-Approach. Third, we investigated the feedbacks on concerning issues of e-Roadmapping from experts.

To answer the above-mentioned three aims, this study investigates the ‘state-of-the-art’ of roadmapping process, stakeholder management and collaboration technology. To answer the first aim, we develop the conceptual model of e-Roadmapping approach with describing characteristics, approach, collaboration tools and procedure. The experimental case on face-to-face and electronic roadmapping approach with mixed method research approach of quantitative and qualitative was conducted to answer the second question. Finally, we conducted experts and participant panel check to identify concerning issues of e-Roadmapping

The summary of workshops and activities is shown in Appendix B.

4.1.2 Conceptualizing model of e-Roadmapping

Based on the factors i.e. roadmap and roadmapping, stakeholder management and collaboration technology that we mentioned in the literature review, we propose a conceptual model of e-Roadmapping approach as presented in Figure 5.

e-Roadmapping is the fusion between a typical F2F and online setting which achieves features through an alignment with CSCW and e-Collaboration tools to serve the shift from face-to-face to electronic.pro

Figure 4.1 presents the conceptual model of e-Roadmapping by using a collaboration matrix. The matrix considers work contexts along two dimensions: the first is whether collaboration is co-located or geographically scattered, and the second, whether individuals collaborate synchronously (same time) or asynchronously (different time). It is categorized into four types of approaches. Type 1 is a F2F approach and type 2, 3 and 4 are electronic approaches.

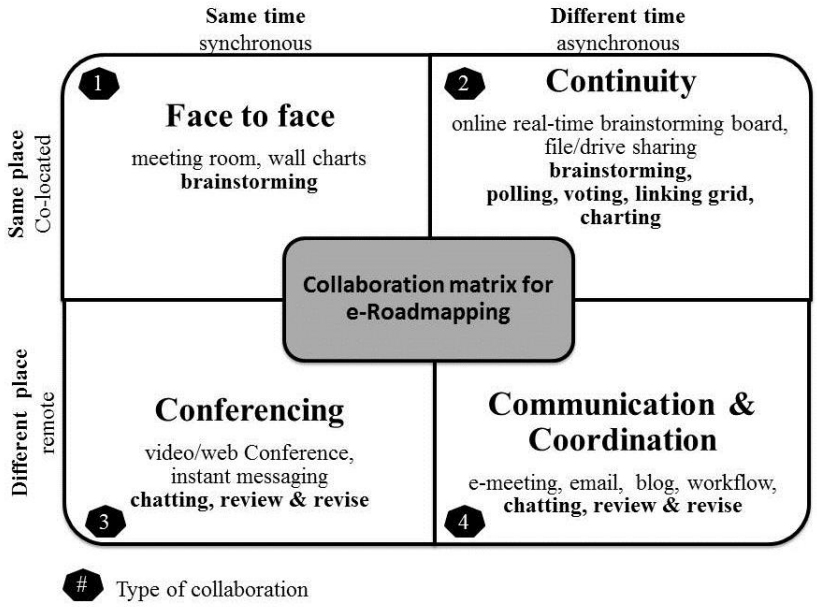

Figure 4.1 The conceptual model of e-Roadmapping

(adapted from (Johansen, 1988))

Type 1: Face-to-face

This is the typical roadmapping approach. Workshop participants have to gather at the same time and the same place, known as being 'Synchronous/co-located'. The brainstorming method as roadmapping facilitation is the key approach to capture, create and share knowledge.

Type 2: Continuity

The roadmapping process can be run even in the mode of different time and same place or 'Synchronous/co-located'. The continuous task can be conducted by using a common working place and participants can work there anytime. It consists of an online real-time brainstorming board, file/drive sharing (Mansor, 2012; Ostrand et al., 2016), and a method of polling and voting. A linking grid (Ball et al., 2014; R. Phaal et al., 2001) and charting can be applied.

Type 3: Conferencing

ICT-enable tools support this type of collaboration to solve a geographical limitation. Same time and different plane or 'Synchronous/remote' among workshop participants is solved with remote interactions by video conference application (Keary & Redfern, 2012; Larsen, 2015), online social networks (Franchi, Poggi, & Tomaiuolo, 2013), instant messaging through team chatting, and online documentation reviewing and revising.

Type 4: Communication & Coordination

In the supreme condition with ubiquitous access, roadmapping can be run under different time and different place or 'Asynchronous/remote'. Virtual collaboration tools (Ostrand et al., 2016) can be adapted for this type for seamless communicating and coordinating among participants.

The conceptual model of e-Roadmapping is described into characteristics, approach, e-Collaboration tools, and procedures as follows.

1) Characteristics

e-Roadmapping possesses the following characteristics:

- Enhancements of e-Collaboration facilitation: CSCW and Internet-based collaboration tools assist the roadmapping facilitation and communication.
- Flexibility of workshop facilitation: the workshop format can be either F2F or online workshop depending on the availability and appropriateness for participants.

2) Approach

The roadmapping approach can be customized in different contexts (Phaal et al., 2003) . As of Figure 4.1, it represents the superb coordination between F2F and online setting in

roadmapping process. E-roadmapping is defined as collaborative planning, which is conducted either in real- or cyberspace and enabled by ICT in roadmapping workshops. The roadmap owner, team, and participant can choose the roadmapping approach and tools depending on the availability and appropriateness for the workshop and participants.

3) e-Collaboration tools

The potential e-Collaboration tools of each collaboration type for building e-Roadmapping are illustrated in Table 4.1.

Table 4.1 Tools of e-Collaboration in e-Roadmapping

Type	Purpose	Tools	Definition
Face-to-face	Brainstorming	IdeaFlip	Real-time and offline brainstorming and collaboration
		Sticky notes	
Continuity	Brainstorming	IdeaFlip	Real-time and online brainstorming and collaboration
	Voting and Linking grid	Google Sheets	Spreadsheet application in Google's suite (G Suite)
	File sharing	Google Docs	Participants can easily review and revise a document from their computer with ubiquitous access
		Dropbox	Tools for file sharing and cloud storage
	Charting	SharpCloud	Software for roadmapping and strategic planning
		Lets-focus	Drawing software for a visual think and communication bench to optimize meetings and workshops
		Accolade	Software for roadmapping and vision strategist
		iObeya	Digital visual management platform and virtual meeting
Conferencing	Video/Audio/ Web Conference	Skype	A telecommunication application software product that specializes in providing video chat and voice calls between computers, tablets, mobile devices
		Zoom	Organizational video communications on a cloud platform for video, audio conferencing, chat, and webinars across mobile and desktop
	Instant Messaging	Slack	A real-time cloud-based set of team collaboration tools and services
		Line	A freeware app for instant communications on e-Devices.
Communication & Coordination	Website & Blog	Wordpress	A free and open-source Content Management System (CMS) which easily build a blog or website.
		Joomla	A free and open-source CMS for publishing web content.
	Organizational social media portal	Yammer	A private organizational social media which provides real-time communication and file sharing that is only accessible by employees who have a valid organizational email address or approved Internet Protocol address.

4) Procedure

The procedure of e-Roadmapping can be a simple five-step process:

1) Convene a team from across the multidisciplinary sectors. Key players come together to form a core team responsible for initiating the roadmapping process. It is important for the roadmapping team to prepare themselves by learning, understanding, and customizing the roadmapping process.
2) Check what online, social media and roadmapping tools participants have experienced. Roadmapping facilitator explores what e-Collaboration tools, according to collaboration matrix of e-Roadmapping that the participants have experienced and are familiar.
3) Design roadmap architecture, workshop, and approach. Roadmapping owner and facilitator design the architecture of the roadmap and decide which roadmap layers will be included. They align the sequence of roadmapping workshops and decide which workshops will be conducted in F2F or a real-time online setting.
4) Select e-Collaboration tools for each workshop. Roadmapping facilitator considers the information from process steps 2) and 3) and then selects the most appropriate e-Collaboration tools for each workshop.
5) Conduct and observe the workshop. Roadmapping facilitator prioritizes a F2F setting for the kick-off workshop since a F2F meeting can trigger participants' innovative thinking through an atmosphere of excitement, including eye-contact and tone of voice. So, it is appropriate for the first team meeting.

4.1.3 Experimental design

The characteristics, approach, e-Collaboration tools and procedures are considering when conducting the experiment. The conceptual model and procedure of e-Roadmapping using data from the roadmapping class of a Japanese institute specializing in advanced graduate education and research was illustrated. This class used roadmapping as a tool for creativity and total capability development. The experiment aimed to compare the effectiveness of F2F and electronic roadmapping approach and recommended the further adoption of electronic approach.

We used a mixed method research approach of quantitative (e.g. a feedback questionnaire) and qualitative (e.g. a focus group meeting and individual interview). The first phase of the roadmapping workshop was conducted in a F2F setting and the second phase was conducted

in an electronic setting. The third phase was conducted in via a focus group and individual interviews of the workshop participants using a brainstorming technique in both online and F2F forms.

The experiment section is organized as follows. First, in the sub-section 'sample and data collection procedure' we explained how we collected data. Second, we explained the experimental approaches of quantitative and qualitative as well as the analysis method used. Third, the data analysis was described. Finally, expert checks on e-Roadmapping approach and factors influencing the adoption of e-Roadmapping are described.

1) Sample and data collection

We collected data by using a purposive sampling technique from ninety graduate students who had enrolled in a roadmapping workshop of innovation theory and methodology class. The participants were well-educated graduate students, had a basic knowledge of roadmapping and the equivalent in terms of multi-disciplinary knowledge, information science, knowledge science, material science, and other advanced sciences and technology areas as judged by the professor.

2) Experimental approaches of quantitative and qualitative

Quantitative approach

In the first phase with a F2F setting, participants were divided into 15 groups, consisting of 5-6 participants and worked on the product roadmap. We invited 7 of 15 groups with 43 participants to join the experiment with approval from the professor. During the F2F roadmapping process, the well-educated teaching assistants (TAs) were assigned to be roadmapping facilitators and the study authors took into account fieldwork observations and participant feedback. After the completion of the first phase, we called for participation in the second phase. Since we were concerned about the participant combinations, selections, and the volunteer nature of participants, we needed ones who willing to join without coercion. At last, we finalized on ten volunteer participants willing to join the electronic experimental phase. The group size and facilitation approach were in self-organizing facilitation due to a small group size (R. Phaal, 2017). The participants had backgrounds in industrial engineering, computer engineering, material sciences, biomedical engineering, ICT/engineering management, humanities and business administration with working

experience and equivalent technical and commercial knowledge. For the comparison of the effectiveness of the two approaches, we used the measures from T-Plan which are usefulness, functionality, and usability (R. Phaal et al., 2001); we added value-oriented creation and application of e-Collaboration tools. We started with the F2F roadmapping approach. The front-end of the roadmapping workshop typically consists of a brainstorming activity (Kerr et al., 2012) and T-Plan (R. Phaal et al., 2001) approach was selected as a roadmapping process. The structure of roadmap was defined as a market driver, product, and technology layer. The comparative flow of the roadmap workshop between the F2F face and electronic approached is shown in Figure 4.2. The type of collaboration from collaboration matrix for an e-Roadmapping is designed for each workshop.

A F2F workshop-based setting and graphical templates in the form of paper wall charts were used to support workshop facilitation. Linking grids between the market drivers and product features, product features and technology capabilities were applied to determine the linkages among them. For the e-Roadmapping approach, we deployed the same workshops as the F2F approach by starting with a F2F kick-off meeting, then we conducted the remaining workshops in an online setting by using real-time online and social media tools.

At the kick-off F2F meeting, we gave a brief experiment plan and also discussed the topic of the roadmap. Members discussed and agreed to work on the new topic since it is opened new creativity on new roadmap topic and made it more interactive among the members. As a result, we changed the roadmap topic to one that generated more inspiration and creativity.

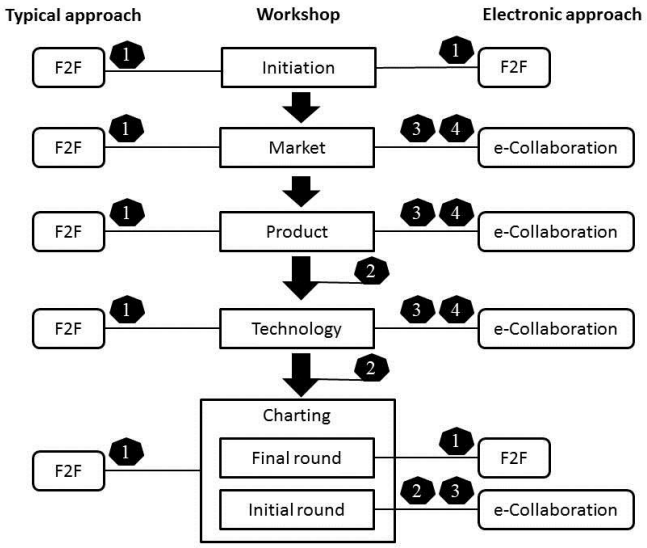

Figure 4.2 Flow of roadmapping workshops

The e-Collaboration tools were selected based on name recognition, interpersonal facilitation, simplicity, cost, and mobile accessibility (Ostrand et al., 2016). The roadmapping landing page for communication and collaboration was developed with 'Wordpress' as a portal for participants and facilitator collaboration. For identifying the market driver, product features, and technology capabilities, we applied 'IdeaFlip' instead of 'Post-it' and used 'Google Sheets' to analyze the relationship of the market-product-technology via a linking grid approach. Since participants and facilitator worked in a virtual environment and on a virtual team, we selected 'Slack' for communicating and discussing and used 'Skype' for providing video chat and voice call for online team meetings. At the last workshop, for charting the roadmap, we conducted two rounds: the initial round was conducted in an online setting and the final round was conducted in the F2F setting for reviewing and concluding the roadmap. We use 'SharpCloud' in an online setting for charting, visualizing, and communicating the roadmap. All of the selected tools supported ubiquitous access. After the completion of the second phase, e-Roadmapping, we provided participants with a questionnaire as shown in Appendix C to assess the effectiveness of the F2F and e-Roadmapping process. The five criteria of effectiveness were assessed by using a five-point Likert scale, together with an opportunity to add specific comments on the associated process: 1) usefulness, 2) functionality, 3) usability, 4) value-oriented creation, and 5) e-Collaboration tools.

Qualitative approach

The focus group and individual interviews of the workshop participants via brainstorming in the form of F2F and online were conducted with 'IdeaFlip' to identify the challenging issues affecting the adoption of an electronic approach.

3) Data analysis

To compare the two roadmapping approaches, we selected the paired t-test statistics because it is a method of analysis of matched data points and is based on the assumption that the differences or interventions between the paired observations are normally distributed (Daya, 2003; Hedberg & Ayers, 2015; Pandis, 2015). Paired t-tests on the F2F and e-Approaches were calculated using SPSS version 17.

4) Expert checks

Expert validation on e-Roadmapping approach

One common method for validating the accuracy of research findings is the use of expert checking (Wendelken, Danzinger, Rau, & Moeslein, 2014). For this check, we selected seven experts and members consist of five strategy management experts from academic and professional organizations who are responsible for organizational strategic planning and another two participants who joined the experimental workshops. Table 4.2 presents the demographic profile of the experts and participants for validation.

We shared the summaries of the findings and conclusions with them. Then, the experts were asked to return to the author's results and to provide feedback based on their own experiences. The experts recommended some changes and indicated that the results overall reflected their own experiences with the organizations.

Table 4.2 Experts demographic profile - Expert validation on e-Roadmapping approach

Reviewers	Expert field	Experience	Position/Organization
Expert: E			
E1	Service science and business innovation	22 years in Research and Development (R&D) of Japanese ICT corporate and 10 years in advanced science and technology university	Japanese university professor
E2	Knowledge/innovation management and roadmapping	15 years in research, consulting, training on roadmapping.	Thai university assistant professor
E3	Policy research and development	12 years of science and technology policy development.	Director of policy research division in Thailand national R&D center on science and technology
E4	Science, Technology, Innovation master plan formulation	17 years in ICT, Science, Technology, and Innovation master plan formulation	Policy researcher and director of platform technology management division of Thailand national R&D center for electronics and computer technology
E5	Technology transfer and management	10 years in industrial technology transfer and technology roadmap development project in a sensor cluster	Manager of Industrial analysis and technology transfer evaluation section, Thailand national R&D center for electronics and computer
Participant: P			
P1	Engineering management and supply chain management	6 years working experience in formulating an organizational master plan	Ph.D. student and policy researcher in transportation research centre of a Thai university.
P2	Industrial engineering management	9 years working experience in operation and planning.	Ph.D. student and supervisor of production planning division of multinational corporation in automation technology industries.

4.2 Results

The results are presented in four parts. The first part is the results from an experiment in quantitative and qualitative analysis part, which focuses on the comparative effectiveness of F2F and electronic approaches. The second part is the summary of feedback from the expert check. The final part is the result of the two-round expert checks on factor influencing the adoption of e-Roadmapping in organization.

4.2.1 Conceptual model of e-Roadmapping and its effectiveness of experiment

1) Quantitative analysis

The results of the experiment, focusing on the comparative effectiveness of F2F and e-Roadmapping process are shown in Table 4.3. Compared to a typical F2F approach, the e-Approach performed better in overall measures including usefulness, functionality, usability, value-oriented creation and e-Collaboration. The effectiveness of each measurement from the experiment is prioritized and assigned weight on a normalized scale of 0-100.

The e-Approach performed better overall, measuring 89.27 percent and the F2F measured at 77.87 percent. In term of usability, there was a large difference in the scores on sufficient materials and workshop facilitation since participants can easily capture, share data and materials through e-Collaboration tools as well as the workshop facilitation. The roadmapping facilitator kept the off-line and on-line dialogue moving steadily and productively, making sure everyone could fully participate, enabling participants to follow the process even if they could not attend some F2F or online workshops.

Regarding value-oriented creation, co-learning had the highest score and presented the electronic approach as promoting their willingness to learn new principles, working styles, and tools. For connecting, participants could maintain their relationships through F2F, online and social media tools on both the individual and group level to keep working collaboratively.

Table 4.3 Results from experiment

Category	Average score F2F (%)	Electronic (%)
Effectiveness of Roadmapping approach	77.87	89.27
Usefulness	86.00	92.00
[rm] Roadmap method supports the aim	86	92
Functionality	78.67	90.67
[stru] Roadmapping provides a structured framework for mapping and exploring the key linkages between the technological resources and business objectives of the organization.	80	90
[sup] Roadmapping supports strategic technology management initiatives in the organizations.	80	88
[suptech] Roadmapping process supports the communication between technological and commercial functions of the business	76	94
Usability	71.60	88.40
[suff] Roadmapping materials were sufficient for conducting the process.	74	94
[aim] The aims of each process were clear.	78	90
[work] The workshops were facilitated well.	66	94
[discuss] The time in the workshops to discuss important issues was sufficient.	62	76
[part] The combination of background and sectors of workshop participants was appropriate.	78	88
Value-oriented creation	75.20	86.00
[colearn] Co-learning	80	94
[cooper] Co-operating	76	82
[copro] Co-production	68	86
[compa] Comparing	78	88
[connect] Connecting	74	80
e-Collaboration tools	72.33	87.67
[brain] Brainstorming	84	88
[draw] Drawing up each layer	68	96
[link] Linking grids	62	88
[chart] Charting	76	86
[review] Reviewing	76	82
[commu] Communication	68	86
[confi] Confident to apply in future	68.00	94.00
[rmtsr] Roadmapping can be a strategic tool to develop product/service aiming for increasing the participant's quality of life and well-being regarding Transformative service research (TSR)	80.00	88.00

The selection of appropriate e-Collaboration tools was important. We obtained the participants' opinions from the first phase on F2F roadmapping; they stated that the process of linking the relationship between the layers and drawing on each layer were the critical process to be improved. Therefore, we applied 'IdeaFlip' real-time brainstorming tools instead of post-it paper tools and used 'Google Sheets' for linking grids analysis (market-product-technology).

During the e-Approach, the communication was done via 'Slack', a cloud-based team collaboration tool for communicating and discussing, and we used 'Skype' for an online team meeting for the review session. Finally, for charting the roadmap, we used 'SharpCloud'

visual communication for visualizing the roadmap. SharpCloud supported moving from a static diagram to a visual and automatically updated it and kept it alive and useful after the workshops ended. It helped participants to see the ongoing roadmapping in each layer, at every step, and they could relate and draw the relation of each element of the roadmap easily by themselves. In our experiment, we worked on free open source software (FOSS) except for 'SharpCloud'. It is commercial software, but we used the 1-year student premium license from SharpCloud.

Finally, the participants decided to use the electronic approach in the future and also trust that an electronic approach process can be a strategic tool to develop product/service to increase the participant's quality of life and well-being regarding TSR (Anderson et al., 2013).

Table 4.4 provides a detailed view of participant perceptions of 1) the degree of usefulness, functionality, usability, value-oriented creation, 2) the alignment of roadmapping and TSR for well-being, 3) the effects of collaboration tools and 4) the degree of confidence to apply roadmapping process in the future using either a F2F or electronic approach. Paired t-test statistics were calculated using SPSS version 17.

Table 4.4 Results from Paired T-test statistic with SPSS.

Topic	Paired Samples Test		SD	t	n	p	
Usefulness	Pair 1	Frm - Erm	.82327	-1.152	10	.279	
Functionality	Pair 2	Fstru - Estru	.70711	-2.236	10	.052	*
	Pair 3	Fsup - Esup	.69921	-1.809	10	.104	
	Pair 4	FsupTech - EsupTech	.99443	-2.862	10	.019	*
Usability	Pair 5	Fsuff - Esuff	.81650	-3.873	10	.004	***
	Pair 6	Faim - Eaim	.84327	-2.250	10	.051	*
	Pair 7	Fwork - Ework	.96609	-4.583	10	.001	***
	Pair 8	Fdiss - Ediss	1.25167	-1.769	10	.111	
	Pair 9	Fpart - Epart	.70711	-2.236	10	.052	*
Value-oriented creation	Pair 10	Fcolearn - Ecolearn	.94868	-2.333	10	.045	*
	Pair 11	Fcooper - Ecooper	1.05935	-.896	10	.394	
	Pair 12	Fcopro - Ecopro	1.37032	-2.077	10	.068	
	Pair 13	Fcompa - Ecompa	1.26930	-1.246	10	.244	
	Pair 14	Fconnect - Econnect	1.49443	-.635	10	.541	
e-Collaboration tools	Pair 15	Fbrain - Ebrain	1.03280	-.612	10	.555	
	Pair 16	Fdraw - Edraw	.96609	-4.583	10	.001	***
	Pair 17	Flink - Elink	.88192	-4.914	9	.001	***
	Pair 18	Fchart - Echart	1.17851	-1.342	10	.213	
	Pair 19	Freview - Ereview	1.25167	-.758	10	.468	
	Pair 20	Fcommu - Ecommu	.84327	-3.375	10	.008	***
Confident to apply in future	Pair 21	Fconfi - Econfi	1.05935	-3.881	10	.004	***
Roadmapping & TSR	Pair 22	Frmtsr - Ermtsr	.51640	-2.449	10	.037	*
**: p<0.05, **: p<0.01, ***: p<0.001*							

Referring Table 4.4, there are twenty–two pairs based on a number of questions in the questionnaires. The first character of the variable name in column of paired samples test which begins with ‘F’ or ‘E’ stands for ‘Face-to-face’ and ‘Electronic’ respectively. In addition, the characters followed by ‘F’ or ‘E’ represent the topic under the category. Furthermore, ‘*’ represents the $p < 0.05$ or 95% confidence level, ‘**’ represents the $p < 0.01$ or 99% confidence level, and ‘***’ represents the $p < 0.001$ or 99.99% confidence level,

For usefulness, the roadmapping process method supports the aim (Frm - Erm). This difference is non-significant, p-value = 0.279. In terms of functionality, a roadmapping process can support the communication between technological and commercial functions of the business (FsupTech – EsupTech) with significance at p-value = 0.019 and provide a structured framework for mapping and exploring the key linkages between the technological resources and business objectives of the organization (Fstru – Estru) with significance at 0.052 which is a bit higher than a significant value at 0.05.

In terms of usability, there are two out of five features that have the significance which are sufficient of materials and instructions (Fsuff – Esuff) at p-value = 0.004 and the workshop facilitation (Fwork - Ework) at p-value = 0.001.We also consider another two features which are a clear process (Faim – Eaim) and the appropriateness of a combination of workshop participants’ background are significant (Fpart – Epart) even though the p-values = 0.051 and 0.052 with adaptable. Regarding value co-creation in a roadmapping process, only co-learning (Fcolearn – Ecolearn) is significant at p-value = 0.045. In terms of e-Collaboration tools, there are three out of the six tools that have the most significance, i.e. IdeaFlip as drawing each layer (Fdraw – Edraw) at p-value = 0.001, Google Sheets for linking grids analysis (Flink – Elink) at p-value = 0.001 with df = 8 because there is one missing value and Slack as communication tool (Fcommu – Ecommu) at p-value = 0.008.

Regarding the question of the way forward, participants rated that they will use an e-Approach in the future (Fconfi – Econfi). This difference was significant at p-value = 0.004. Finally, participants were confident that e-Approach can be a strategic tool to develop product/service aimed at increasing the quality of life and well-being (Frmtsr – Ermtsr) with significance at p-value = 0.037.

2) Qualitative analysis

Qualitative data was obtained from the focus group and individual interviews of participants. It presented other challenges for adopting e-Roadmapping, beyond those measures covered in

the questionnaire. Regarding an e-Brainstorming session at the end of the F2F phase, participants indicated the challenges for the adoption of e-Roadmapping in organizations. Qualitative results revealed the significance of the following context: 1) organization, 2) facilitator, 3) process, 4) participant and 5) e-Collaboration tools.

For the organizational aspect, there are two key challenges: 1) the strong commitment and organizational political will from management level and 2) an understanding of the organization's working culture is needed.

The second challenge is the role of facilitator. The facilitator is needed for the collective learning and facilitation process, to create a relaxed and productive atmosphere for participants which smooths the progress of knowledge creation and transfer during the roadmapping process (Gerdsri et al., 2009) especially in a F2F approach. But in the e-Roadmapping approach, the facilitator not only has to be keen on the roadmapping technique but also needs to be strongly digital literate on e-Collaboration tools. The task of the facilitator is shifted from traditional to e-Facilitator which needs to have both hard and soft or technology and artistic skills. The facilitator has to give priority to the selection of the most appropriate e-Collaboration tools for every stage and workshop for the roadmapping process to reflect the effectiveness.

The roadmapping process is the third issue; a clear business need, process and instruction for each step was strongly raised. In terms of the participants, the right combination of participants and the willingness to co-create in roadmap development are the important issues as well as the digital literacy of the participants.

The last challenge is e-Collaboration tools. In the e-Approach, participants pay attention to the ability of this following issues: 1) ubiquitous access: the representation of the ability for an internet-based service to be widely accessible (establishing ubiquitous access for a cloud service can require support from anytime, anywhere and any device); 2) economical and effective software selection; the roadmap owner should be concerned about cost considerations and use FOSS and SNS when feasible; 3) ICT infrastructure: an e-Approach relies on internet, stable and appropriate computer network and internet bandwidths are needed; and 4) digital literacy: knowledge, skills, and behaviors involving the effective use of digital devices such as desktop PCs, laptops, tablets, and smartphones for purposes of ubiquitous access and collaboration. Simple, easy to use and familiar tools to participant have to be considered for utilization and expansion.

4.2.2 Feedbacks on concerning issues of e-Roadmapping from experts

We increased the validity of findings by asking five experts and two participants for feedback on the overall findings of the e-Roadmapping approach, conceptual model, and implications.

1) Overall e-Roadmapping approach

The e-Roadmapping approach is a good idea to solve organizational strategic planning's pain which is the operating cost of roadmapping. As E4, P1 and P2 pointed out:

> The e-Roadmapping can decrease 1) time cost – experts may have time cost higher than normal participants either travel cost or brainstorming time cost, 2) roadmap implementation cost – if roadmapping start fast, the loss of opportunity cost of roadmap owner could be decreased. (E4, director of platform technology management division)

> e-Roadmapping can solve the problem of space and time for conducting the roadmap. I think it is a good approach to employ with the organization since the participants are unavailable due to the time and place difference. (P1, policy researcher)

> Some of roadmapping workshops may not be conducted in F2F and plenary meetings. They can be in online setting to save operating cost, administrative cost and travel cost. (P2, supervisor of production and planning division)

2) Conceptual model

A conceptual model of e-Roadmapping approach is designed with the collaboration matrix in the context of roadmapping and presented for each of the four quadrants. The model made use of tools to facilitate online collaboration among participants. Here are opinions from E2, P1 and P2.

> This conceptual model is a very good idea, a valid contribution to the roadmapping community and clearly describe the collaboration type, easy to understand and usable for implementation in the organization. (E2, university assistant professor)

> The tools of roadmapping could be in various types of technology and they support the roadmapping process. Authors also identify the potential tools and procedure for conducting e-Roadmapping. (P1, policy researcher)

The conceptual model presents the clearly collaboration type and procedure which easy to understand and implement in an organization. (P2, supervisor of production and planning division)

3) Usability

The e-Roadmapping approach works well on blending human and electronic, which can support roadmapping as experts/participants mentioned below.

e-Roadmapping approach can be a guideline for creating a roadmap in any organization. (P1, Policy researcher)

The selective e-Collaboration tools are easy to learn and use even though I need to switch them regularly. (P2, supervisor of production and planning division)

The usability of e-Collaboration tools has been dramatically improved due to an exponential improvement of computing processing power and internet bandwidth. This helps us to create complex diagrams at more ease than before, e.g., roadmaps with other participants remotely and asynchronously and can enhance people's satisfaction but it may not guarantee the resulting usability of roadmaps. (E1, university professor)

e-Roadmapping could work well in idea collection and co-creation with a big number of participants then synthesizing in F2F meeting. (E3, director of policy research division)

e-Roadmapping helps the consensus among participants and roadmapping facilitations both of content and F2F or electronic method. (E4, director of platform technology management division)

e-Collaboration tools are currently effectively used in different environments. (E5, manager of Industrial analysis and technology transfer evaluation)

4) Concerning issues of e-Roadmapping

Experts raised some additional issues which consist of 1) technology acceptance, 2) technology readiness, 3) learning capability of participants, 4) level of openness and 5) ICT security as P2, E1, E4 and E5 mentioned below.

Role of facilitator and motivation of participants are more important than tools. (E1, university professor)

The success factor of e-Roadmapping adoption is the strong support from a top executive of organization and technology acceptance from participants (P2, supervisor of production and planning division)

The balancing of the online and offline workshop and ICT literacy of participants are needed. (E4, director of platform technology management division)

The additional concerned issues should be 1) ICT security, 2) level of openness, and 3) learning capability of stakeholders. (E5, manager of Industrial analysis and technology transfer evaluation)

5) Implications

The combination of a F2F and online meeting with electronic tools works as a hybrid approach and could be considered to implement as appropriate to each organization's readiness.

e-Roadmapping could be greater to traditional F2F roadmapping in term of limitation of space and time as well as the decreasing the dominating discussion from the senior participants, especially for east Asian working culture. (E3, director of policy research division)

e-Roadmapping is applicable to organizational strategic planning and could be a working trend especially for an organization which is 1) IT-familiar or oriented, 2) appointed to work among multi-stakeholders from scattered places. (E4, director of platform technology management division)

e-Roadmapping is fit to T-plan; product-technology development, but for S-plan; corporate level planning, F2F can trigger participants' innovative thinking, through the excitement atmosphere including eye-contacts and tone of voice. (E1, university professor)

e-Roadmapping is applicable for an organization which is open-minded, contemporary and non-vertical management style. (E5, manager of Industrial analysis and technology transfer evaluation)

The development of integrated solution should be further studied to maintain roadmap repository, i.e. documents, diagrams, the current status of the roadmap. The success

factors of e-Roadmapping adoption should be studied. (E4, director of platform technology management division)

6) Challenging issues for the adoption of e-Roadmapping in organization

Three key challenging issues affecting the adoption of e-Roadmapping are noteworthy on the proposed conceptual model and experimental results which are categorized by 1) motivation and leadership: the strong commitment from management level, organizational working culture and the motivation to co-create in roadmapping from participants; 2) effective process and facilitation: a clear business need, clear process and clear instruction for each process is strongly recommended as well as the roadmapping efficiency of the facilitator in roadmapping knowledge and technique, participant member selection and digital literacy; and 3) ICT and e-Collaboration: ubiquitous access, trusted and stable infrastructure, secured computer network, stable internet bandwidths and economical and effective software selection are needed.

4.3 Discussion

The aim of our study was threefold. First, we aimed to develop the conceptual model of an e-Roadmapping approach. Second, we asked what about the effectiveness of the typical F2F and e-Approach. Third, we investigated the concerning issues of e-Roadmapping approach.

Referring to results from quantitative and qualitative analysis and feedback from experts, the following sub-sections discuss the effectiveness and benefit of an e-Roadmapping approach and challenging issues for the adoption of e-Roadmapping in the organization as well as the blending of human and electronic works into roadmapping.

4.3.1 The comparative effectiveness of face-to-face (F2F) and e-Roadmapping approach and its benefits

Regarding the roadmapping approach, compared to the typical approach of being physically present, the electronic approach performs better on a measure of the usefulness, functionality, usability and value-oriented creation. By the adopting e-Roadmapping, the workshop format is re-arranged and flexible. It is also connected to the comfort of participants and facilitators due to the decrease in administrative tasks, and an increase in work productivity, communication and improved team performance.

The electronic approach is synergizing collaborative planning and e-Collaboration tools which indicate the individual and organizational benefits of e-Roadmapping: 1) increasing performance by accelerating the effectiveness of roadmapping for strategic planning activities; 2) improving team communication by enhancing the coordination and collaboration through ubiquitous access; and 3) improving organizational well-being in terms of worker well-being (Edgar, Geare, Saunders, Beacker, & Faanunu, 2017) by flexible working which does not depend on time and financial well-being by reducing the operating and travel cost of a roadmap implementation project.

4.3.2 The blending of human and electronic works into roadmapping

ICT and software can support roadmapping with the features of storage, dissemination, representing graphics, brainstorming, and upkeep of roadmaps. The selection of software is needed to fit in with the human behavior and process. The participant also should not expect that software will deliver good roadmaps. The software is not the heart of roadmapping process; it is only to support the roadmapping process. Furthermore, the e-Facilitator has a big role in the e-Roadmapping approach.

It is important to highlight the importance of humans in the process, especially regarding the participant's motivation to join the roadmapping workshop, and the new role of roadmapping facilitator which extends from off-line to online facilitating in ubiquitous access mode. E-Roadmapping facilitators have to realize that the selection of the most appropriate e-Collaboration tools for every stage or workshop of the roadmapping process and digital literacy of participants must reflect the effectiveness. The e-Approach needs to kick-off with a F2F meeting and then be followed by an e-Approach as appropriate. The evidenced-based applications in our study follow. First, an internet-based brainstorming tool is helpful for enabling the free expression of ideas; it makes it seem like participants work in front of a wall chart as well as avoiding 1) domination of a debate by senior participants during sessions and 2) directly colliding with other participants. Second, the shared spaces supporting open communication are required, so that information is shared freely among multiple stakeholders and the content is also verified by them. Regarding utilization and expansion of e-Roadmapping, the selection of Free Open Source Software (FOSS) and Social Networking Service (SNS) service need to be continually explored. The tools that are simple and familiar to participant have to be considered.

The e-Roadmapping approach and its selective e-Collaboration tools are integrated with human aspects of roadmapping based on value-oriented creation which are the 5Cs' activities (co-learning, co-operating, co-production, comparing, connecting) throughout the roadmapping process. Our findings suggest that with proper design and attention, a fusion approach between a typical F2F and online setting could be developed that would leverage the benefits of both virtual and in-person collaboration more effectively. The approach could be extended to adopt an organizational strategic planning tool and to enhance communication, collaboration and increase the productivity of planning activities.

4.4 Summary

This chapter constructs a conceptual model of an e-Roadmapping approach which represents the superb coordination between the F2F and online electronic roadmapping processed, conducted either in real- or cyberspace and enabled by e-Collaboration tools. This approach overcomes the limitations of space and time and increases the degree of participants' communication. The roadmap owner, facilitator, and participants can blend human and electronic into strategic roadmapping by using the electronic approach and tools depending on the availability and appropriateness of workshops and participants.

We illustrated the conceptual model and experimented to compare the effectiveness of the Face-to-face and electronic approaches. The results indicate that, compared to a typical F2F, and E-approach performed significantly better on all measures: usefulness, functionality, usability, and value-oriented creation. The selected e-Collaboration tools effectively and can be used instead of typical workshop tools.

There is a limitation of experimental roadmapping participants, since we collected data by using a purposive sampling technique from ninety graduate students who had enrolled in a roadmapping workshop of innovation theory and methodology class. They involved in face-to-face roadmapping workshop and ten students of them joined us in electronic roadmapping workshop.

The further challenges and issues for the adoption of an e-Roadmapping approach in an organization and the blending of human and electronic works were discussed. Lastly, the e-Roadmapping approach could be an additional supported approach to F2F for increasing the flexibility and comfort of the process. The participant is one of the most important influencers throughout the roadmapping process, especially their attitude and ability.

The study overcomes the limitations of space, time and communication with a more concerted notion of ‘Connect and Catalyst' in the context of participant-led roadmapping practices. An e-Roadmapping approach improves communication across teams and organizations and improves efficient time management and planning. The concepts and procedures described in this paper can be applied to a customized roadmapping process used in strategic planning workshops and could be used as a guideline for an individual or teams who are responsible for implementing an organizational e-Roadmapping project.

Chapter 5

Factors influencing the adoption of e-Roadmapping

5.1 Research design

5.1.1 Methodology

The study is aim to identify and rank the factors influencing the adoption of e-Roadmapping in organization. The expert checks method is used to determine key factors selected by reviewing the related literature and identifying the evaluation criteria. Moreover, AHP method, together with the data from expert questionnaire surveys, is applied for selecting and prioritizing factors influencing the adoption of e-Roadmapping. The expert checks-AHP methodology is introduced in Figure 5.1.

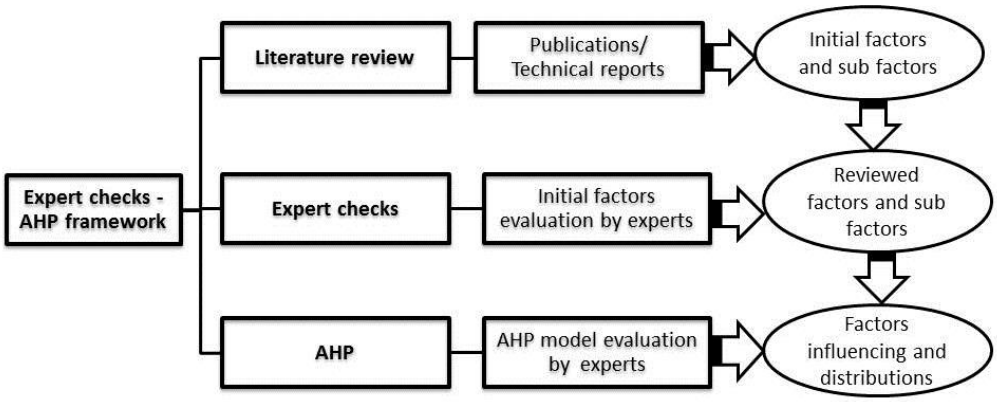

Figure 5.1 Expert checks-AHP methodology

The summary of activities is shown in Appendix B.

5.1.2 Expert checks

The knowledge and experience of roadmapping expert is essential for making scientific decisions (Tang, Sun, Yao, & Wang, 2014; Wendelken et al., 2014). For this check, five experts, who work in academic institute, management level and roadmapping practitioner, are selected to complete a questionnaire survey on the assumption that they held senior positions which leads to ability to capture all perspectives of roadmapping. Table 5.1 presents the demographic profile of all experts.

All experts received the summaries of literature reviews which are the combination of roadmapping and collaboration technology and were introduced about the initial factor influencing the adoption of e-Roadmapping as in Table 5.2. The experts, then, were asked to review, comment, and return feedback, based on their experiences. Afterwards, the expert checks were conducted. The questionnaire is shown in Appendix D.

Table 5.1 Experts demographic profile - Expert checks on factor influencing

Reviewers	Expert field	Experience	Position/Organization
Academic: A			
A1	Technology management and Transformative service research	10 years in advanced science and technology university	Japanese university professor
A2	Knowledge/innovation management and roadmapping	15 years in research, consulting, training on roadmapping	Thai university professor
Management: M			
M1	Policy research and development	15 years in science, technology and innovation policy development	Senior policy research and team leader in Thailand national science, technology, innovation policy
Roadmapping practitioner: R			
R1	Science, Technology, Innovation master plan formulation	17 years in ICT, Science, Technology, and Innovation master plan formulation	Policy researcher and director of platform technology management division of Thailand national R&D centre for electronics and computer technology
R2	Policy research and development	12 years of science and technology policy development.	Director of policy research division in Thailand national R&D centre on science and technology

Table 5.2 The definition of each factor

Factors/Sub-factors	Definition
Motivation	
Mutual respect and trust	The respect and trust among roadmapping team.
Willingness to cooperate	A roadmapping team's willingness to cooperate with stakeholders.
Willingness to adapt and accept the new normal	A roadmapping team's willingness to adapt and accept the new tools.
Leadership	
Openness	The openness spirit of senior management.
Supporting policy from top management	The strong support from senior management and organizational policy support.
Characteristics of organizational working culture	Organizations working culture represents a positive working environment.
Effective process	
Appropriate team composition and selection	The appropriate of roadmapping team members from several sectors and expertise.
Clear role, responsibility and guideline	The roadmapping process is clear. Guideline is prepared for each member's role.
Simplify, adaptability, and flexibility process	The roadmapping process is easy and flexible to run.
Effective facilitation	
Well-trained rapport and interpersonal skills	Roadmapping facilitator needs strong interpersonal skill.
Well-understood roadmapping technique	Roadmapping facilitator needs in-depth roadmapping technique.
Mature digital literacy	Roadmapping facilitator needs digital literacy expertise.
Collaborative technology	
Ubiquity	Support work from any device, any place, anytime, and any platform.
Usability	Easy to understand interface and easy to use.
Cost efficiency	Price is reasonable or would be open source software.

5.1.3 Analytic Hierarchy Process (AHP)

For a multi-criteria analysis, AHP is employed to help prioritize very complex decision alternatives involving multiple stakeholders and multiple goals. Pair-wise comparisons are the fundamental concept of AHP.

As AHP has been adapted for group decisions, the number of experts should be six to twelve participants (Melón, Aragonés Beltran, & Carmen González Cruz, 2008; Tansakul, Suanmali, & Ammarapala, 2018). In this study, the collected data are from twelve experts. There are three groups of experts which are 1) academician who teach or do research on roadmapping, or have publications on roadmapping which indexed in JCR or SCOPUS, 2) management executive who involved or experienced in roadmapping projects, and 3) roadmapping practitioner who have experiences in roadmapping projects as a roadmapping facilitator or participant. Table 5.3 presents the demographic profile of AHP experts.

The collected comments and feedbacks from expert checks were, then, used to set up the hierarchy structural model of factors influencing the adoption of e-Roadmapping. Accordingly, the obtained data were used to develop AHP questionnaire to seven factors by obtaining the opinions of twelve experts. The questionnaire is shown in Appendix E. The experts compare the relative importance of the decision alternatives of pair-wise with respect to factor and sub-factors. Each expert is requested to enter his/her judgements and makes a distinct and identifiable contribution to the issue.

In this study, the Super Decisions version 2.8 was used for calculating and synthesizing the relative weight within the AHP model. Saaty (2008) recommended that a consistency ratio of 0.1000 or less is considered as an acceptable value. Responses that did not meet the consistency ratio requirement were asked to adjust from expert until they are valid.

Table 5.3 AHP Experts demographic profile

Reviewers	Expert field	Experience	Position/Organization
Academic: A			
A1	Service science, business innovation and roadmapping	22 years in R&D of Japanese ICT Corporate and 12 years in advanced science and technology university	Japanese university professor
A2	Knowledge/innovation management and roadmapping	15 years in research, consulting, training on roadmapping	Thai university professor
A3	Strategic roadmapping and strategic technology management	21 years in strategic roadmapping	UK university principal research associate
A4	Technology and engineering management	20 years in technology and engineering management	USA university professor
A5	Business, technology and strategic management	25 years in business, technology and strategic management	Korean university professor
Management: M			
M1	Policy research and development	15 years in Science (S), Technology (T) and Innovation (I) policy development	Thai senior policy research and team leader in Thailand national STI policy
M2	ICT, Knowledge and innovation management	15 years in ICT, Knowledge and innovation management	Thai university Chief Information Officer
M3	Information system development and roadmapping	12 years in Information system development	Japanese technical director of IT Services company
Roadmapping practitioner: R			
R1	Science, Technology, Innovation master plan formulation	17 years in ICT, STI master plan formulation	Thai policy researcher and director of platform technology management division of Thailand national R&D center for electronics and computer technology
R2	Policy research and development	12 years of science and technology policy development.	Thai director of policy research division in Thailand national R&D center on S&T
R3	Strategic technology planning	10 years of strategic technologies development	Japanese LCD monitor company
R4	Innovation management	15 years in management consultancy services	UK managing director of management consulting firm

5.2 Results

5.2.1 Expert checks

We asked five experts for feedback on the appropriateness of initial factors. Their feedbacks are describing below and Table 5.4 Overall feedbacks and Table 5.5 feedback categorized by factor and sub-factors.

Table 5.4 Overall feedbacks - Expert checks

Expert	Overall feedback
Academic	
A1	The e-Roadmapping is gradually increasing attention. It is important in every organization. To come up ideas effectively, it is important to think about the better questions. Good question can draw better ideas from participants. Therefore, facilitator/moderator needs to have good questioning skills. In the near future, the artificial intelligence should play such a role.
A2	Classifying the model into three categories (i.e. People, Process and Technology) makes sense! The model seems to be simple yet comprehensive enough to be adopted easily.
Management	
M1	I understand that the adoption of e-Roadmapping is 'adoption of innovation' for roadmapping. I would like to propose that 1) The process should begin with understanding of e-Roadmapping for considering and decide to use. E-Roadmapping should be tailored to the context of the content and culture of users and participants 2) In e-Roadmapping process, it should have a feedback system between the facilitator and the participant for optimizing the process to the maximum effectiveness and reduce the failure. 3) The learning mechanism should be added. 4) The feedback and learning process may be embedded in collaborative technology. 5) The ability to understand can be inserted in the category of people.
Roadmapping practitioner	
R1	For category of people, I propose to insert one more factor which is 'Personal background'; education level, technology usage level in daily life, technology usage experience, and digital literacy. For motivation factor, I propose to insert one sub-factor which is 'cost and benefit' of each roadmapping workshop's participant/stakeholder In case of operation cost of face-to-face is high, it will have potential opportunity to run workshop in electronic mode. Cost in economic way, it does not mean only travel cost or opportunity (time) cost but may means the cost of confront too. In some sensitive matter, debating without confront may make more comfortable and make operation cost is lower than fact to face workshop.
R2	By considering the initial factors, I agree with all the initial factors. There may be some sub-factors that were at the first read. It might not be immediately understood. Such as characteristics of organizational working culture. I am not sure whether it will affect to the AHP calculation or not, it is understood that the leader has an effect to organizational culture, so that I do not recommend moving to category 1: motivation.

Table 5.5 Comments from experts categorized by factors and sub-factors

Factors/Sub-factors	Experts' comment	
	A1	A2
1. Motivation		
1.1 Mutual respect and trust	Since we cannot see other participants in e-Roadmapping (e-RM) system, mutual respect will be very important especially in generating ideas.	-
1.2 Willingness to cooperate	This factor is, of course, important, but to improve such willingness, moderator needs to incentivize participants.	
1.3 Willingness to adapt and accept the new normal	Yes, however, new technology will generate digital isolation, moderators need to consider about it too.	
2. Leadership		
2.1 Openness	I'm not sure the meaning of senior management, but to make productive environment that enables participants freely to say something as well as promoting this way of future planning.	-
2.2 Supporting policy from top management	In general, participants take cost in joining these activities, it is very important to approve their activities in terms of organization they work.	
2.3 Characteristics of organizational working culture	The e-RM promotes people to envision in an ubiquitive way, so it is more person-oriented not corporate culture orientation. *I'm not agreeing with this aspect.*	I think *Organizational Culture* should have a more prominent role. *Would it make sense to add it as a separate factor under the People category?* An Organizational Culture develops itself whether or not management tries to influence it. Often in SMEs management does not actively try to manage or form the culture of their organization and the culture evolves through the action of leadership. So the question is • "What kind of culture would best support the eRoadmapping initiative?" • What criteria should be met in order to create such a working culture? • Can we influence and build at least a team culture that will support and facilitate the eRoadmapping initiative?

Factors/Sub-factors	Experts' comment	
	A1	A2
		In your description, you mention "Positive Working Environment" what exactly do you mean by that? Please define what kind of positive working environment is necessary for a successful eRoadmapping project.
3. Effective process		
3.1 Appropriate team composition and selection	This factor is relevant to "Motivation" factors, so this is important.	-
3.2 Clear role, responsibility and guideline	Role and responsibility can work effectively, but sometimes reduce mindsets to overarch (break the border) activities. An appropriate management should be needed.	
3.3 Simplify, adaptability, and flexibility process	Flexibility is very important in terms of the nature of e-RM.	
4. Effective facilitation		
4.1 Well-trained rapport and interpersonal skills	To make trust among participants, it is very important of facilitator's work.	Interpersonal Skills can remain under 4.
4.2 Well-understood roadmapping technique	Of course!	The sub-criteria 4.1 and 4.2 could be combined. Well trained facilitators could be defined as well trained in facilitation techniques and the roadmapping process. Effective facilitation or could be made part of the People Category under 1. Motivation.
4.3 Mature digital literacy	Same above!	-
5. Collaborative technology		
5.1 Ubiquity	Very important	-
5.2 Usability	Minimum function is enough such as "easy to input ideas", "easy to see other participants' ideas", etc. No need to complex functions.	
5.3 Cost efficiency	To introduce e-RM concept into organization, it is important to think about cost. Organization should introduce this e-RM as a groupware of internal communication.	

5.2.2 AHP model

The collected comments and feedbacks from expert checks were, then, used to set up the hierarchy structural model of factors influencing the adoption of e-Roadmapping as shown in Figure 5.2 and Table 5.6. Accordingly, the obtained data were used to develop AHP questionnaire to evaluate seven factors by obtaining the opinions of twelve experts. The experts compare the relative importance of the decision alternatives of pair-wise with respect to factor and sub-factors as shown in Figure 5.2. Each expert is requested to enter his/her judgements and makes a distinct and identifiable contribution to the issue.

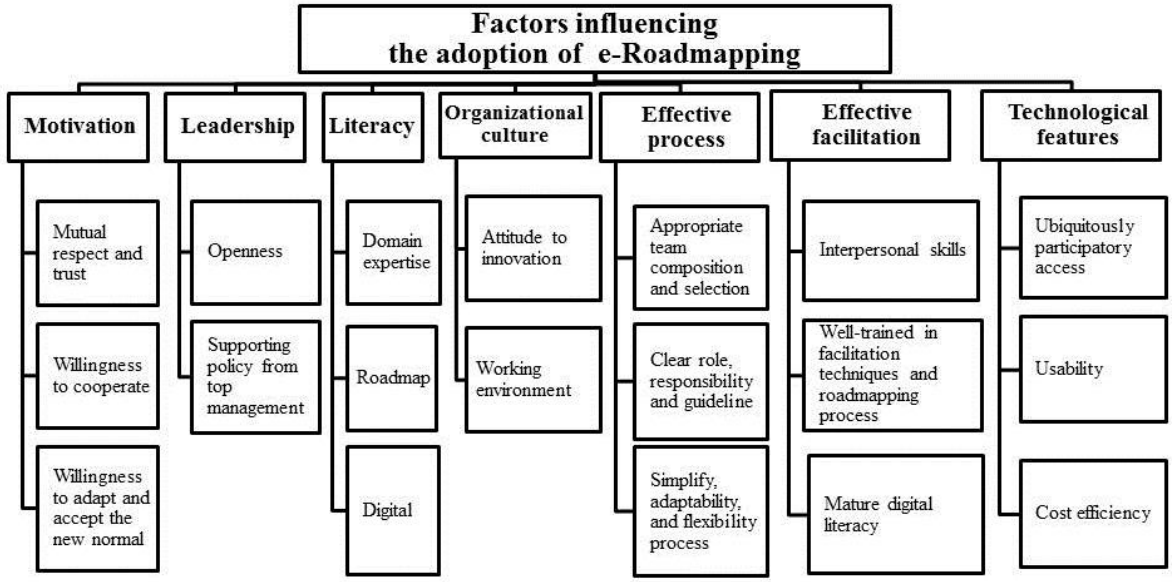

Figure 5.2 Hierarchy structure of the AHP model

Table 5.6 The revision of the definition of each factor

Factors/Sub-factors	Definition
Motivation	
Mutual respect and trust	The respect and trust among roadmapping team.
Willingness to cooperate	A roadmapping team's willingness to cooperate with stakeholders.
Willingness to adapt and accept the new normal	A roadmapping team's willingness to adapt and accept the new tools and processes for increasing benefit and decreasing cost.
Leadership	
Openness	The openness spirit of senior management.
Supporting policy from top management	The strong support from senior management and organizational policy support.
Characteristics of organizational working culture	Organizations working culture represents a positive working environment.
Literacy	
Domain expert	Literacy on a particular topic of multi-stakeholders
Roadmapping	Literacy on roadmap and roadmapping
Digital	Literacy on digital and ICT

Factors/Sub-factors	Definition
Organizational culture	
Attitude to innovation	Positive attitude in creativity and innovation process
Working environment	Flexible work either physical or virtual environment.
Effective process	
Appropriate team composition and selection	The appropriate of roadmapping team members from several sectors and expertise.
Clear role, responsibility and guideline	The roadmapping process is clear. Guideline is prepared for each member's role.
Simplify, adaptability, and flexibility process	The roadmapping process is easy and flexible to run.
Effective facilitation	
Interpersonal skills	Roadmapping facilitator needs strong interpersonal skill.
Well-trained in facilitation techniques and roadmapping process	Roadmapping facilitator needs in-depth roadmapping and facilitation technique.
Mature digital literacy	Roadmapping facilitator needs digital literacy expertise.
Technological features	
Ubiquitously participatory access	Support participatory work from any device, any place, anytime, and any platform. Support sharing documents, files, and centralization/integrated platform. Promote feedback and learning.
Usability	Easy to understand interface and easy to use.
Cost efficiency	Price is reasonable. Groupware would be open source software.

5.2.3 AHP analysis

Based on the input related to experts' judgement, Table 5.7 shows the weights computed by Super Decisions software for all factors and sub-factors.

Table 5.7 The weights of all factors and sub-factors in the hierarchy

Main factor Area	Weight	Sub-factor Area	Weight
Motivation	0.1288	Mutual respect and trust	0.3194
		Willingness to cooperate	0.3014
		Willingness to adapt and accept the new normal	0.3792
Leadership	0.1944	Openness	0.4549
		Supporting policy from top management	0.5451
Literacy	0.1682	Domain expert	0.5441
		Roadmap	0.2868
		Digital	0.1691
Organizational culture	0.1661	Attitude to innovation	0.5793
		Working environment	0.4207
Effective process	0.1389	Appropriate team composition and selection	0.4042
		Clear role, responsibility and guideline	0.3105
		Simplify, adaptability, and flexibility process	0.2853
Effective facilitation	0.1247	Interpersonal skills	0.2908
		Well trained in facilitation techniques and roadmapping process	0.4782
		Mature digital literacy	0.2310
Technological features	0.0788	Ubiquitously participatory access	0.3333
		Usability	0.5686
		Cost efficiency	0.0981

The AHP results reveal that ‘Leadership’ is the most important factor with the importance weight of 0.1944, following by the ‘Literacy’ and ‘Organizational culture’ with the importance weights of 0.1682 and 0.1661, respectively. Moreover, ‘Effective process’ and ‘Motivation’ should be considered to fulfill the successful adoption of e-Roadmapping in organization, with the importance weight of 0.1389 and 0.1288 respectively. Apart from that, ‘Effective facilitation’ and ‘Technological features’ must also be encouraged.

Regarding sub-factors of ‘Motivation’, ‘Willingness to adapt and accept the new normal’ has been assigned as the most important issue with the highest importance weight of 0.3792. The second sub-factor is ‘Mutual respect and trust’ following by ‘The willingness to cooperate’. According to ‘Leadership’, it is proven that the ‘Supporting policy from top management’ has been deemed as the most crucial factor following by the ‘Openness.’ With respect to ‘Literacy’, the most important factor is ‘Domain expert’ with the highest weight at 0.5441 following by ‘Roadmap’. ‘Digital’ has the lowest priority, with a value of just 0.1691 since digital literacy is not quite be constraint in organization. According to ‘Organizational culture’, it is confirmed that the ‘Attitude to innovation’ has been judged as the most essential factor with a relative weight of 0.5793 following by ‘Working environment’ which organizational culture helps characterize the quality of a working environment.

In accordance with ‘Effective process’, it is evidenced that the ‘Appropriate team and composition and selection’ has been referred as the most important factor with the importance weight of 0.4042 following by ‘Clear role, responsibility and guideline’ and ‘Simplify, adaptability, and flexibility processes’. With a focus on ‘Effective facilitation’, it shines the light to the role of roadmapping facilitator. Facilitator in the next roadmapping era needs to have ‘Well-trained in facilitation techniques and roadmapping processes’ with the evidenced weight at 0.4782. The second and third issues are ‘Interpersonal skill’ and ‘mature digital literacy’ which can be considered as supporting factors to achieve effective facilitation.

Lastly, according to ‘Technological features’, the most obvious evidence is ‘Usability’ with the weight more than 0.5000 among three sub-factors. The second important is ‘Ubiquitously participatory access’ and the least important sub-factor is ‘Cost efficiency’.

5.3 Discussion

e-Roadmapping approach represents the synergy of people, process and technology in roadmapping. Referring to the seven key factors, the motivation, leadership, literacy and organization culture can be grouped into ‘People’, effective process and facilitation can be grouped into ‘Process’, and technological features can be considered as ‘Technology’. This synergy presents the blending and balancing of human and electronic works in roadmapping.

The AHP results from twelve experts show the managerial implication of the adoption of e-Roadmapping in organization. In terms of people, roadmapping team must concern on ‘Willingness to adapt and accept the new normal’ and ‘Appropriate literacy of domain expert’. In organizational aspect, ‘Supporting policy from top management’ and ‘Attitude to innovation’ is highly suggested as major concern. Regarding ‘Process’, ‘Appropriate team composition and selection’ and ‘Well-trained in facilitation techniques and roadmapping process’ are the most highlighted constraints. Lastly, in ‘Technology’ aspect, the ‘Usability’ is the most important to persuade participant in adopting e-Roadmapping approach.

With respect to digitalization of roadmapping processes, there are obviously trends in digital technology that will open up new chances to enhance the collaboration and communication in roadmapping. E-Collaboration tools, internet or software are not the center of roadmapping process as summarized from the result, people is still the main factor with the assist of technology to enable the seamless and efficiency of process. On the other hand, digital literacy of roadmapping participants is not a major problem since the software is easy to use, and participants are also familiar with software and digital tools as new normal applications.

5.4 Summary

The objective of this study is to identify the factors influencing the adoption of e-Roadmapping in organization and measured the influential weight of each factor. The roadmap owner or roadmapping facilitator who responds in organizational roadmapping project can better know the way to conduct and improve roadmapping approach. The management implication of e-Roadmapping can be exemplified with these influencing factors.

For future research, the factors and sub-factors can be lead to the development of e-Roadmapping maturity model. The indicator of each sub-factor should be further discovered then the organizational e-roadmapping maturity can be assessed.

Chapter 6
Conclusions

6.1 Answer for research questions

6.1.1 SRQ1: What stakeholders should do in co-creating value for planning innovative technologies throughout the roadmapping process?

Chapter 3 Value co-creation (VCC) roadmapping investigated this SRQ1. The concept of VCC roadmapping is design based on the involvement of stakeholder and organization as well as the value co-creation in knowledge creation of roadmapping process which implemented on collaboration platforms.

The 9C's roadmapping activities (committing contract, collation, combination of activities, co-learning, co-production, cooperation, coopetition, connection and changing collaboration methods) in VCC roadmapping under the conceptual model were implemented and observed with case study. This approach incorporates a combination of face-to-face and online workshop with supported by collaborative platforms. It can be served as a roadmapping tool for strategic planning while strengthening open collaboration and value co-creation among multi-stakeholders.

6.1.2 SRQ2: How to blend human and electronic into strategic roadmapping approach?

Chapter 4 e-Roadmapping investigated this SRQ2.

1) The conceptual model of e-Roadmapping

e-Roadmapping approach represents the superb coordination between the F2F and online electronic roadmapping processed, conducted either in real- or cyberspace and enabled by e-Collaboration tools. This approach overcomes the limitations of space and time and increases the degree of participants' communication.

The key characteristics of e-Roadmapping are 1) enhancements of e-Collaboration facilitation: CSCW and Internet-based collaboration tools assist the roadmapping facilitation and communication and 2) flexibility of workshop facilitation: the workshop format can be either F2F or online workshop depending on the availability and appropriateness for participants.

2) The effectiveness of the face-to-face and electronic approach

Regarding the roadmapping approach, compared to the typical approach of being physically present, the electronic approach performs better on a measure of the usefulness, functionality, usability and value-oriented creation. By the adopting e-Roadmapping, the workshop format is re-arranged and flexible. It is also connected to the comfort of participants and facilitators due to the decrease in administrative tasks, and an increase in work productivity, communication and improved team performance.

The e-Roadmapping approach is synergizing collaborative planning and e-Collaboration tools which indicate the individual and organizational benefits of e-Roadmapping:

1) increasing performance by accelerating the effectiveness of roadmapping for strategic planning activities;
2) improving team communication by enhancing the coordination and collaboration through ubiquitous access;
3) improving organizational well-being in terms of worker well-being by flexible working which does not depend on time and financial well-being by reducing the operating and travel cost of a roadmap implementation project.

6.1.3 SRQ3: What are the key factors influencing to the adoption of e-Roadmapping in organization?

Chapter 5 Factors influencing the adoption of e-Roadmapping investigated this SRQ3. According to the results of expert checks-AHP methodology, which were derived from the experts' opinions, the three main groups (people, process, and technology) are identified.

Referring to the seven key factors, the motivation, leadership, literacy and organization culture can be grouped into 'People', effective process and facilitation can be grouped into 'Process', and technological features can be considered as 'Technology'. This synergy presents the blending and balancing of human and electronic works in roadmapping. Table 6.1 shows the combination of factors into group of people, process and technology.

Table 6.1 The combination of factors into group of people, process and technology

People	Process	Technology
Motivation	**Effective process**	**Technological features**
• Mutual respect and trust • Willingness to cooperate • Willingness to adapt and accept the new normal	• Appropriate team composition and selection • Clear role, responsibility, and guideline • Simplify, adaptable, and flexible process	• Ubiquitously participatory access • Usability • Cost efficiency
Leadership	**Effective facilitation**	
• Openness • Supporting policy from top management	• Interpersonal skills • Well-trained in facilitation techniques and roadmapping process • Mature digital literacy	
Literacy		
• Domain expertise • Roadmapping • Digital		
Organizational culture		
• Attitude to innovation • Working environment		

6.1.4 MRQ: How to conduct value co-creation oriented strategic electronic roadmapping?

Firstly, this study presents the activities which stakeholders should do in co-creating value for innovative planning throughout the roadmapping process. The 9C's co-created activities are recommended and can be implemented either on face-to-face or online platform. Secondly, this study proposes the model and procedure of strategic e-Roadmapping approach which blending human and electronic works with 9C's involvement in to strategic roadmapping. Lastly, the factors influencing the adoption e-Roadmapping in organization are identified. Roadmap owner and roadmapping facilitator can apply the factors and sub-factors for conducting their organizational roadmapping project.

6.2 Theoretical implications

Value co-creation oriented strategic e-Roadmapping is the first roadmapping approach which

1) Integration with service management concept

Traditional strategic planning with roadmapping technique has limitations of information gathering, idea creation and implementation platform among stakeholders due to lack of value co-creation thinking. Service management concept is incorporated into roadmapping with value co-creation, resource integration, and collaboration platform to solve these limitations. The key behavioral factors affecting value co-creation oriented in strategic roadmapping are identified and can be encouraged for effective strategic roadmapping.

2) Blending and balancing with human and electronic embodiment of strategic roadmapping approach

The strategic electronic roadmapping conceptual model with electronic collaboration matrix makes the shifting from face-to-face to electronic roadmapping. It supports the value co-creation oriented in roadmapping with the superb coordination between face-to-face and electronic roadmapping process. The strategic electronic roadmapping can be conducted either real or cyberspace and enabled by electronic collaboration tools and platforms. The model allows roadmapping facilitator and participants to choose the approach and tools depending on the availability and appropriateness of workshops, organizations and participants.

3) Implementing key factors of electronic roadmapping

The management implication of strategic electronic roadmapping can be exemplified with the influencing factors the adoption of electronic roadmapping in organization. The synergies of factors among people, organizational culture, process and technology are measured. Executive and roadmapping team can further utilize these factors and weights for implementing electronic roadmapping in organization.

6.3 Management implications

For management implications, this study can be presented in two perspectives which are organization and individual

1) Implication to organization

   This study shows that the leadership with strong policy support from top management is key factor of the adoption of e-Roadmapping approach as well as the organisational with the attitude to innovation. Organisational executives should concern on these issues.

2) Implication to individual

   For roadmapping teams and participants, they can apply the combination of a face-to-face and online workshop with e-Collaboration tools works as a hybrid approach and could be considered to implement as appropriate to each organizational and participants' readiness. e-Roadmapping could be greater to traditional face-to-face roadmapping in term of limitation of space and time as well as the decreasing of the dominating discussion from the senior participants, especially for east asian working culture. On another hand, roadmapping facilitator can urge or motivate the participants on each value co-creation activity with 9C's activities.

6.4 Directions for future research

This study has made some significant contributions and shows the potential directions for future research. First, the case studies were conducted in Japan and Thailand. We therefore suggest that further studies of value co-creation oriented strategic e-Roadmapping are carried out in other countries to add to our knowledge about strategic planning process. Second, the factors and sub-factors of e-Roadmapping adoption can be lead to the development of

e-Roadmapping maturity model. The indicator of each sub-factor should be further discovered then the organizational e-Roadmapping maturity can be assessed. Lastly, the adoption of an e-Roadmapping in an organization as the blending of human and electronic works can move forward to the study of organizational digital transformation. Since e-Roadmapping is already adopt the synergies of mindset, people, process and technology which are the foundation of digital transformation.

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Appendix

Appendix A:
Summary of research methods

Summary of research methods

Topic	Study 1 Value creation oriented (VC) in RM	Study 2 Electronic (E)-RM	Study 3 Factors influencing the adoption of e-RM
1) Objective	To examine what activities participants should do in co-creating value for planning innovative technologies throughout the roadmapping process	To blend human and electronic into strategic roadmapping approach	To identify appropriate factors and weights for the adoption of e-RM in organization
2) Method	1) Conceptualizing value co-creation oriented roadmapping approach 2) Conducting example application in a multi-stakeholder context in organization 3) Observing and interpreting stakeholder behavior in roadmapping workshops	1) Observe F2F-RM and apply e-RM approach 2) Feedback questionnaire, focus group and individual interview 3) Experts and participants check	Expert checks-AHP methodology
3) Data collection	We collected data using various sources and research methods: 1) roadmapping workshops with multiple stakeholders (both face-to-face and online) 2) a wrap-up and appraisal workshop 3) informal follow-up conducted using e-mails and phone calls.	1) Purposive sampling technique from graduate students who had enrolled in a RM workshop of JAIST class – F2F: 43 participants, – Electronic: 10 participants 2) Expert checks – For validate e-RM: 5 experts and 2 participants	There are three groups of respondent 1) Academician who teach or research on RM or have RM publications which indexed in JCR or SCOPUS. 2) Management executive in organization who involve or experience in RM project 3) Roadmapping practitioner who have experiences in RM project as RM facilitator or participant There are 12 AHP respondents from 5 countries which are Japan, Korea, Thailand, UK and USA.
4) Data analysis	1) Observing the stakeholder VCC activities in the face-to-face and online workshops throughout the roadmapping process at which the co-created activities were presented 2) Observing the team members in a face-to-face wrap-up workshop with seven representative stakeholders at which the roadmapping process was summarized and evaluated.	Paired t-test statistics using SPSS version 17	Super Decisions AHP Software Version 2.8

Appendix B:
Summary of studies, workshops, and activities

Summary of the studies, workshops, and activities

Studies	Activities	Conducted place	2016						2017		2018				
			Jun	Jul	Aug	Sep	Oct	Nov	Nov	Dec	Mar	Apr	May	Jun	Jul
Study 1: Value creation (VC) oriented in RM https://serviceroadmap.wordpress.com/	1. Call for participation	JAIST, Japan (JP)	25 jun – 3 july												
	2. Virtual workshop			4 jul – 2 aug											
	3. F2F workshop	Bangkok, Thailand (TH)			3										
	4. Follow up #1	JAIST, JP				☑									
	5. Follow up #2	Bangkok, TH					☑								
	6. Wrap-up & Appraisal workshop	Bangkok, TH						17							
Study 2: Electronic (e)-RM https://hybridroadmapping.wordpress.com/	1. Observed roadmapping class	JAIST, JP	-						17			-			
	2. Call for participation to Hybrid roadmapping pilot research project and Registration form was launched.									7					
	3. F2F Kick off session									11					
	4. Conducted e-RM workshops														
	4.1 Market layer									12					
	4.2 Product layer									14					
	4.3Technology layer									15					
	4.4 Charting									18-19					
	5. F2F Wrap up session									20& 23					
	6. Expert checks										12-30				
Study 3: Factors influencing the adoption of e-RM	1. Review factors for RM with collaboration tools	JAIST, JP	-						☑						
	2. Expert checks the factors and sub-factors – Round 1		-										1-15		
	3. Finalize AHP model												16 may – 16 jun		
	4. Establish AHP model													17-20	
	5. Design AHP questionnaire													17-20	
	6. Experts do AHP questionnaire													20 jun-9 jul	
	7. AHP analysis													21 jun-13 jul	

Appendix C:

Questionnaire for the comparative effectiveness of face-to-face and e-Roadmapping process

The comparative of Roadmapping process between Face-to-face and Hybrid: Post-Process Questionnaire

Background

This questionnaire is conducted under the partial of Transformative roadmapping research project of Mr. Pornprom ATEETANAN, D3, Shirahada Lab, and School of KS. It is designed to assess the roadmapping method which used in S101, S102, and S503 class, in term of 4 key measures: usefulness, functionality, usability and value co-creation for capturing learning process and improving further adoptions.

Respondent's info

School: ☐ IS ☐ KS ☐ MS

Status: ☐ M1 ☐ M2 ☐ D1 ☐ D2 ☐ D3

Working experience: ☐ no working experience ☐ 1-3 years ☐ 4-6 years ☐ more than 6 years

Please indicate (☑) the level of your agreement with the following statements and include any comments you may have that relate to the statements.

Face-to-face approach	Hybrid approach
1. Usefulness The declared aim of the roadmap is given here: **To think about new product/service in the 10 years later.**	
1.1) the roadmapping process method is supported the aim.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
1.2) Comment on area of particular 'Strength' for the method …… ……	1.2) Comment on area of particular 'Strength' for the method …… ……
1.3) Comment on area of particular 'Weakness' for the method …… ……	1.3) Comment on area of particular 'Weakness' for the method …… ……
2. Functionality The generic aims of the techniques used in the process are given below. Rate how well these aims were met.	
2.1) To provide a structured framework for mapping and exploring the key linkages between the technological resources and business objectives of the organization	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Comments: …… ……	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Comments: …… … …… …
2.2) To support strategic technology management initiatives in the organizations, such as product planning, technology strategy, and planning, technology selection, etc.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Comments: …… ……	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Comments: …… ……

Face-to-face approach	Hybrid approach
2.3) To support communication between technological and commercial functions of the business	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
Comments: …… ……	Comments: …… ……
2.4) Open comments for 'Functionality' …… ……	…… ……
3. Usability	
3.1) The roadmapping materials and/or instructions were sufficient for conducting the process.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
3.2) The aims of each process were clear.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
3.3) The workshops were facilitated well.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
3.4) The time in workshop to discuss important issues were sufficient.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
3.5) The combination of background and sectors of workshop participants was appropriated.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
3.6) Open Comments for **'Usability'** …… ……	…… ……
4. Value Co-Creation	
4.1) **Co-learning:** You are willing to learn new approaches.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
4.2) **Co-Operating:** You know what value from them which can share and create more benefit to other participants.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
4.3) **Co-Production**: You are willing to discuss in each workshop	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
4.4) **Comparing:** The comparative of information and knowledge from several sources i.e. academic, government policy, and industry are applied.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree

Face-to-face approach	Hybrid approach
4.5) **Connecting:** You built and maintain your relationship with other participants through face-to-face, online and/or social media tools on individual and group level to keep in touch and keep working.	
Strongly disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly agree	Strongly disagree ☐1 ☐2 ☐3 ☐4 ☐5 Strongly agree
4.6) Open Comments for **'Value Co-Creation'**	
…… ……	…… ……
5. Roadmapping approach (You can choose more than one item)	
5.1) what parts of the process were particularly useful?	
☐ 1 Process briefing ☐ 2 Drawing up market layer ☐ 3 Drawing up product layer ☐ 4 Drawing up technology layer ☐ 5 Connecting and prioritizing relative layers with linking grid (Market & Product layer and Product & Technology layer) ☐ 6 Drawing up a roadmap ☐ 7 Review session at the end of every layer ☐ 8 None	☐ 1 Kick-off Face-to-face Meeting ☐ 2 Drawing up market layer ☐ 3 Drawing up product layer ☐ 4 Drawing up technology layer ☐ 5 Connecting and prioritizing relative layers with linking grid (Market & Product layer and Product & Technology layer) ☐ 6 Drawing up a roadmap ☐ 7 Review session at the end of every layer by Skype VDO call ☐ 8 Face-to-face summarize and evaluation ☐ 9 None
5.2) what parts of the process could be improved?	
☐ 1 Process briefing ☐ 2 Drawing up market layer ☐ 3 Drawing up product layer ☐ 4 Drawing up technology layer ☐ 5 Connecting and prioritizing relative layers with linking grid (Market & Product layer and Product & Technology layer) ☐ 6 Drawing up a roadmap ☐ 7 Review session at the end of every layer ☐ 8 None Comments: …… ……	☐ 1 Kick-off Face-to-face Meeting ☐ 2 Drawing up market layer ☐ 3 Drawing up product layer ☐ 4 Drawing up technology layer ☐ 5 Connecting and prioritizing relative layers with linking grid (Market & Product layer and Product & Technology layer) ☐ 6 Drawing up a roadmap ☐ 7 Review session at the end of every layer by Skype VDO call ☐ 8 Face-to-face summarize and evaluation ☐ 9 None Comments: …… ……
5.3) What parts of the process should be in '**Online approach'**	
☐ 1 Process briefing ☐ 2 Drawing up market layer ☐ 3 Drawing up product layer ☐ 4 Drawing up technology layer ☐ 5 Connecting and prioritizing relative layers with linking grid (Market & Product layer and Product & Technology layer) ☐ 6 Drawing up a roadmap ☐ 7 Review session at the end of every layer	
Comments: …… ……	
5.4) the roadmapping process can be a strategic tool to develop product/service aiming for increasing the customer's quality of life and well-being.	

Face-to-face approach	Hybrid approach
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
5.5) other comments (if any) ……	……
6. Collaboration tools – The method/tool was supported well.	
1) Process briefing: **Brainstorming meeting**	1) Kick-off Face-to-face Meeting: **Focus group meeting**
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
Other recommended tools……	Other recommended tools……
2) Drawing up market/product/technology: **Sticky notes**	2) Drawing up market/product/technology: **IdeaFlip**
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……
3) Connecting and prioritizing relative layers with linking grid: **Sticky notes**	3) Connecting and prioritizing relative layers with linking grid: **Google spreadsheet**
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……
4) Drawing up a roadmap: **Charting on paper**	4) Drawing up a roadmap: **SharpCloud software**
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……
5) Review session at the end of every layer: **Brainstorming meeting**	5) Review session at the end of every layer: **Skype VDO Call meeting**
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……
	6) Summarize and evaluation: **Focus group meeting**
	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools…… ……
6) Communication tools: **Announcement**	7) Communication tools**: (1) Landing page** (http://hybridroadmapping.wordpress.com)
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree Other recommended tools……
	Communication tools: **(2) Slack**
	1 2 3 4 5

Face-to-face approach	Hybrid approach
	Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
Other recommended tools……	Other recommended tools……
7. The way forward	
7.1) You confident to apply this process in the future.	
1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree	1 2 3 4 5 Strongly ☐ ☐ ☐ ☐ ☐ Strongly disagree agree
7.2) Will you use **'Hybrid approach'** for your organizational strategic planning	
☐ Yes ☐ No	
8. General comments/suggestions	
…… …… ……	

Thank you very much for your kind co-creation.

Pornprom ATEETANAN pornprom@jaist.ac.jp

Appendix D:

Expert checks questionnaire

Expert checks questionnaire (May 2018)

A study of factors influencing the adoption of e-Roadmapping in organization

Dear Expert,

The present study is part of the Ph.D. dissertation, aiming to identify and rank the factors influencing the adoption of e-Roadmapping in organization. The goal of this two-round written expert checks is to develop recommendations for the adoption of e-Roadmapping and we kindly ask you, as a roadmapping expert, to help us by giving your opinion on the different issues address on e-Roadmapping.

Research method is shown in Figure 1. The initial factors diagram and briefly definition are presented in Figure 2 and Table 1 respectively. It is derived from literature review, participant and expert checks in e-Roadmapping workshop project.

We would like to ask you to review and answer the questions as instructions provided below.

Instructions

1. Please make comments on any issue you wish. You may suggest inserting, updating, deleting or moving factor as you wish.
2. Please send your comments to us by May 15, 2018 or make an online meeting as your preferable date and time.
3. For further information, please contact: Pornprom Ateetanan

   E-Mail: pornprom@jaist.ac.jp,

   Skype ID: nong.ateetanan@outlook.com

   Line ID: nong.pornprom

Background

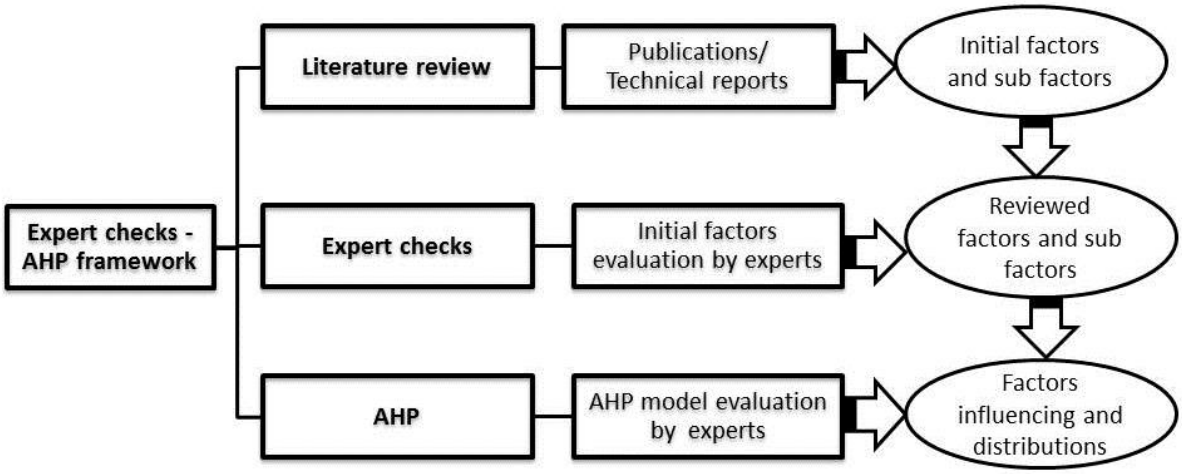

Figure 1 Research method

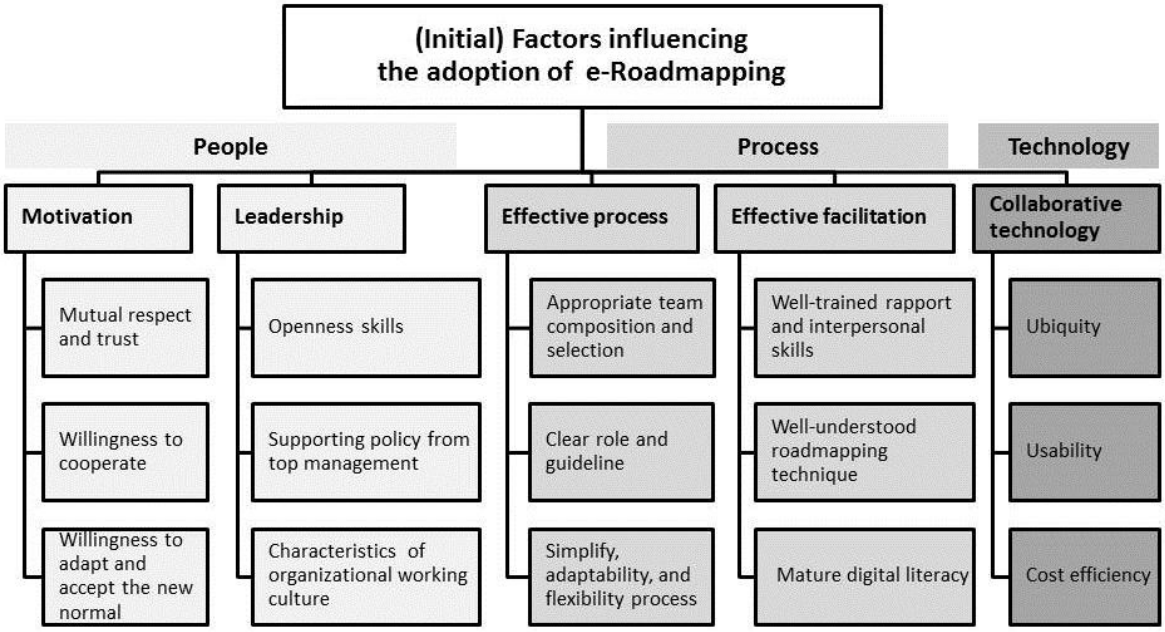

Figure 2 the initial factors influencing the adoption of e-Roadmapping in organization

Table 1 the definition of each factor

Factors/Sub-factors	Definition
People	
1. Motivation	
1.1 Mutual respect and trust	The respect and trust among roadmapping team.
1.2 Willingness to cooperate	A roadmapping team's willingness to cooperate with stakeholders.
1.3 Willingness to adapt and accept the new normal	A roadmapping team's willingness to adapt and accept the new tools.
2. Leadership	
2.1 Openness	The openness spirit of senior management.
2.2 Supporting policy from top management	The strong support from senior management and organizational policy support.
2.3 Characteristics of organizational working culture	Organizations working culture represents a positive working environment.
Process	
3. Effective process	
3.1 Appropriate team composition and selection	The appropriate of roadmapping team members from several sectors and expertise.
3.2 Clear role, responsibility and guideline	The roadmapping process is clear. Guideline is prepared for each member's role.
3.3 Simplify, adaptability, and flexibility process	The roadmapping process is easy and flexible to run.
4. Effective facilitation	
4.1 Well-trained rapport and interpersonal skills	Roadmapping facilitator needs strong interpersonal skill.
4.2 Well-understood roadmapping technique	Roadmapping facilitator needs in-depth roadmapping technique.
4.3 Mature digital literacy	Roadmapping facilitator needs digital literacy expertise.
Technology	
5. Collaborative technology	
5.1 Ubiquity	Support work from any device, any place, anytime, and any platform.
5.2 Usability	Easy to understand interface, easy to use.
5.3 Cost efficiency	Price is reasonable or would be open source software.

Expert's information

Name: ……

Country of residence: …….

Occupation: …….

Affiliation: ……..

Position: ……..

Contact information

E-mail: …….

Phone number: ……

Expert's comment

Please give suggestions for improving factors influencing the adoption of e-Roadmapping in organization. You can make comments on any issue you wish.

You may suggest inserting, updating, deleting or moving factor as you wish.

Review & Revise

Factors/Sub-factors	Your comment
1. Motivation	
1.1 Mutual respect and trust	
1.2 Willingness to cooperate	
1.3 Willingness to adapt and accept the new normal	
2. Leadership	
2.1 Openness	
2.2 Supporting policy from top management	
2.3 Characteristics of organizational working culture	
3. Effective process	
3.1 Appropriate team composition and selection	
3.2 Clear role, responsibility and guideline	
3.3 Simplify, adaptability, and flexibility process	
4. Effective facilitation	
4.1 Well-trained rapport and interpersonal skills	
4.2 Well-understood roadmapping technique	
4.3 Mature digital literacy	
5. Collaborative technology	
5.1 Ubiquity	
5.2 Usability	
5.3 Cost efficiency	

Other comments

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Thank you very much for completing this part of questionnaire

Please save the questionnaire and send it back by e-mail to Pornprom Ateetanan (pornprom@jaist.ac.jp)

Appendix E:

AHP Questionnaire survey

Factors influencing the adoption of e-Roadmapping in organization

Dear Participant

We are currently conducting a research project **'Factors influencing the adoption of Electronic (e)-Roadmapping in organizations'.** As part of this research, we are conducting a multi-criteria analysis in order to elicit stakeholders' opinions for evaluating factors to adaption of e-Roadmapping in organizations.

> Electronic (e)-Roadmapping or e-RM is the fusion between a typical face-to-face and online setting which achieves features through an alignment with computer-supported collaborative work (CSCW) and e-Collaboration tools to serve the shift of roadmapping from face-to-face to electronic.

Making decisions about the adoption of e-Roadmapping involved the readiness and application of people, organization, process, and technology aspect. The purpose of this study is to identify and evaluate factors which could promote the adoption of e-RM in organizations.

In the next pages we would like to obtain your opinion as expert/academician/executive through a survey questionnaire, in which you are requested to prioritize the factors influencing the adoption of e-RM by Analytic Hierarchy Process (AHP) method.

The information you provide will be of great value for this research, and accordingly, your participation is anticipated and very much appreciated.

We sincerely hope you can assist.

Pornprom ATEETANAN

Doctoral student
Shirahada lab, School of Knowledge Science
Japan Advanced Institute of Science and Technology (JAIST)
pornprom@jaist.ac.jp

Researcher: Pornprom ATEETANAN, Doctoral student
Supervisor: Assoc. Prof. Kunio SHIRAHADA, Ph.D.

INFORMED CONSENT FORM

Dear Participant,

You are being asked to participate in a research study regarding adoption of e-Roadmapping. Investigator Mr. Pornprom ATEETANAN is conducting this research under the supervision of Assoc. Prof. Kunio SHIRAHADA.

Please read the information provided in Sections A and B carefully. You can ask Mr. Pornprom to explain any sections that are unclear to you and to answer any questions that you may have. If, after deciding to participate in this study, you find you have more questions, you can contact the researcher at the given contact information at the end of this form.

If you decide to participate in this research, please complete the survey and return it directly to the researcher by email. By completing and returning the attached survey, you are consenting to participate in this research.

SECTION-A – INFORMATION FOR PARTICIPANTS

Participants: Roadmapping experts, academicians, executives, and roadmapping practitioners are identified as key participants of this study.

Time to complete survey: The survey will take approximately 20-30 minutes to complete.

Conducting survey:

1) The survey will be conducted by mailing questionnaires directly to participants by e-Mail and asking the respondent to mail the survey back when completed.
2) Please save the questionnaire and send it back by e-mail to Pornprom Ateetanan (pornprom@jaist.ac.jp) by Wednesday, June 27, 2018.

Confidentiality: The information provided by participants will not be disclosed. Participant's name, address and other personal data are not asked, however, if provided, they will be removed from the questionnaire and not known to others. The answers s/he gives will be only used for research purposes and for writing a report.

Use of Information: The information and findings obtained will be used for the degree of Ph.D. dissertation. In addition, they may be used in seminars, conference presentations, and research publications.

Risk: The identified potential risk to the participants could be losing their time for completing the questionnaire. The questionnaire is expected to take approximately 20-30 minutes to complete.

Contact information: for answers to questions about the research or to voice concern or complaint about the research, or to report a study-related problem:

Pornprom ATEETANAN
Doctoral student, Shirahada lab, School of Knowledge Science
e-Mail: pornprom@jaist.ac.jp
Skype ID: nong.ateetanan@outlook.com, Line ID: nong.pornprom

SECTION-B – MULTI-CRITERIA ANALYSIS FOR EVALUATING FACTORS

Introduction

Through a survey questionnaire, we intend to evaluate seven factors by obtaining the opinions of stakeholders. For a multi-criteria analysis, Analytic Hierarchy Process (AHP) is employed. The AHP is method designed to help in prioritizing very complex decision alternatives involving multiple stakeholders and multiple goals. Pair-wise comparisons are the fundamental buildings blocks of AHP.

By using the questionnaire, the participants compare the relative importance of the decision alternatives of pair-wise with respect to factor and sub-factors explained below (Figure 1). Each participant is requested to enter his/her judgements and makes a distinct, identifiable contribution to the issue.

As shown in Figure 1, the first level of hierarchy is the ultimate goal of the project; the second level represents the factor of the adoption of e-Roadmapping and the third level presents the sub-factors respectively.

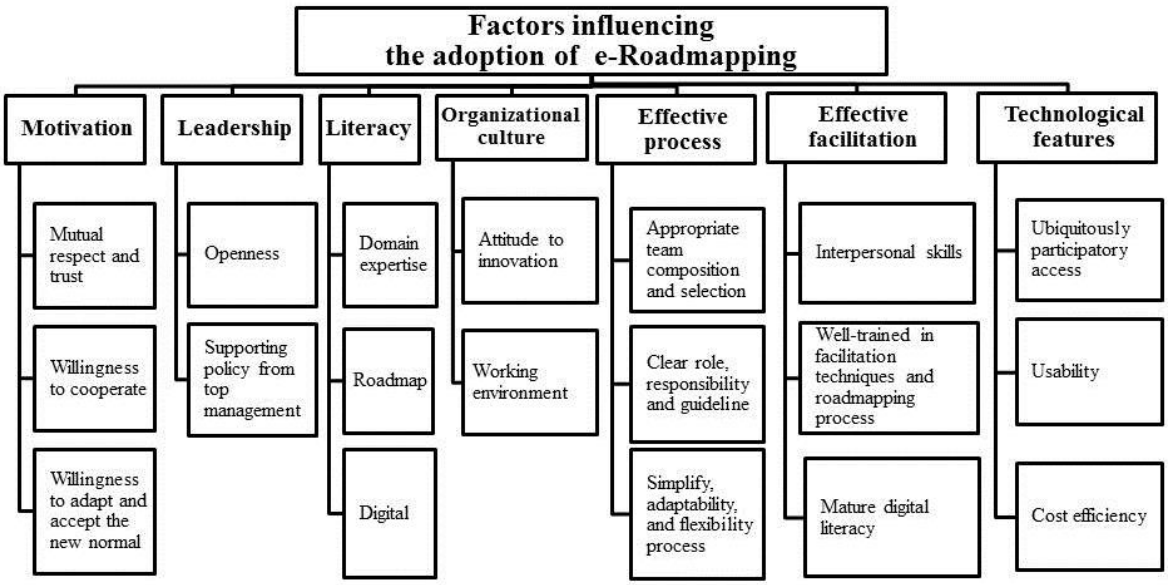

Figure 1 Analytic Hierarchy of the Decision

Goal: To identify factors influencing to the adoption of e-Roadmapping

Factor and sub-factors: Seven factors and respectively sub-factors are chosen in the AHP evaluation as shown in Table 1.

Table 1 the definition of factors and sub-factors

Factors/Sub-factors	Definition
People	
Motivation	
Mutual respect and trust	The respect and trust among roadmapping team.
Willingness to cooperate	A roadmapping team's willingness to cooperate with stakeholders.
Willingness to adapt and accept the new normal	A roadmapping team's willingness to adapt and accept the new tools and processes for increasing benefit and decreasing cost.
Leadership	
Openness	The openness spirit of senior management.
Supporting policy from top management	The strong support from senior management and organizational policy support.
Literacy	
Domain expert	Literacy on a particular topic of multi-stakeholders
Roadmap	Literacy on roadmap and roadmapping
Digital	Literacy on digital and ICT
Organizational culture	
Attitude to innovation	Positive attitude in creativity and innovation process
Working environment	Flexible work either physical or virtual environment
Process	
Effective process	
Appropriate team composition and selection	The appropriate of roadmapping team members from several sectors and expertise.
Clear role, responsibility and guideline	The roadmapping process is clear. Guideline is prepared for each member's role.
Simplify, adaptability, and flexibility process	The roadmapping process is easy and flexible to run.
Effective facilitation	
Interpersonal skills	Roadmapping facilitator needs strong interpersonal skill.
Well trained in facilitation techniques and roadmapping process	Roadmapping facilitator needs in-depth roadmapping and facilitation skill and technique.
Mature digital literacy	Roadmapping facilitator needs digital literacy expertise.
Technology	
Collaborative technology	
Ubiquitously participatory access	Support participatory work from any device, any place, anytime, and any platform. Supports sharing documents, files, and centralization/integrated platform, promoted feedback and learning features are provided.
Usability	Easy to understand interface and easy to use.
Cost efficiency	Price is reasonable. Groupware would be open source software.

In the next sections, we would like to elicit your opinion in order to select amongst the alternatives. The pair wise comparison scale is used to express the importance of one element over another (Table 2).

Table 2 Saaty comparison scale

Explanation	Mark [X] ⇨	**Numeric values**
If Option A and Option B are equally important		1
If Option A is moderately more important than Option B		3
If Option A is strongly more important than Option B		5
If Option A is very strongly more important than Option B		7
If Option A is extremely more important than Option B		9
Use even numbers for intermediate judgements		2,4,6,8

Example:

Given Options A & B, you can judge their relative importance as shown below example:

If you think the option ‘Motivation’ in column **A** is strongly more important than the option ‘Leadership’ in column **B**, then you mark 5 with (X) on the left hand side.

If you think the option ‘Literacy' in column **B** is extremely more important than the option ‘Leadership’ in column **A**, then you mark 9 with (X) on the right hand side.

A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B Options**
Motivation	9	8	7	6	X	4	3	2	1	2	3	4	5	6	7	8	9	Leadership
Leadership	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	X	Literacy

PARTICIPANTS' TASKS

FACTORS AND SUB-FACTORS EVALUATIONS

FACTORS EVALUATION																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Motivation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Leadership
Motivation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Literacy
Motivation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Organizational culture
Motivation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness process
Motivation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness facilitation
Motivation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological features
Leadership	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Literacy
Leadership	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Organizational culture
Leadership	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness process
Leadership	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness facilitation
Leadership	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological features
Literacy	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Organizational culture
Literacy	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness process
Literacy	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness facilitation
Literacy	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological features
Organizational culture	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness process
Organizational culture	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness facilitation
Organizational culture	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological features
Effectiveness process	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effectiveness facilitation
Effectiveness process	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological features
Effectiveness facilitation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Technological features

SUB-FACTORS EVALUATION: 1. MOTIVATION																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Mutual respect and trust	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Willingness to cooperate
Mutual respect and trust	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Willingness to adapt and accept the new normal
Willingness to cooperate	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Willingness to adapt and accept the new normal

SUB-FACTORS EVALUATION: 2. LEADERSHIP																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Openness	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Supporting policy from top management

SUB-FACTORS EVALUATION: 3. LITERACY																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Domain expertise	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Roadmap
Domain expertise	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Digital
Roadmap	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Digital

SUB-FACTORS EVALUATION: 4. ORANISATIONAL CULTURE																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Attitude to innovation	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Working environment

SUB-FACTORS EVALUATION: 5. EFFECTIVE PROCESS																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Appropriate team composition and selection	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Clear role, responsibility and guideline
Appropriate team composition and selection	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Simplify, adaptability, and flexibility process
Clear role, responsibility and guideline	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Simplify, adaptability, and flexibility process

SUB-FACTORS EVALUATION: 6. EFFECTIVE FACILITATION																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Interpersonal skills	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Well-trained in facilitation techniques and roadmapping process
Interpersonal skills	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mature digital literacy
Well-trained in facilitation techniques and roadmapping process	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Mature digital literacy

SUB-FACTORS EVALUATION: 7. TECHNOLOGICAL FEATURES																		
Using the scale from 1 to 9 (where 9 is extremely and 1 is equally important), Please indicate (X) the relative importance of options A (left column) to options B (right column).																		
A Options	Extremely		Very strongly		Strongly		Moderately		**Equally**		Moderately		Strongly		Very strongly		Extremely	**B options**
Ubiquitously participatory access	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Usability
Ubiquitously participatory access	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost efficiency
Usability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cost efficiency

Other comments

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Thank you very much for completing this part of questionnaire

Please save the questionnaire and send it back by e-mail to Pornprom ATEETANAN (pornprom@jaist.ac.jp) by Wednesday, June 27, 2018.

List of Contributions

International journals

Pornprom Ateetanan and Kunio Shirahada. “Factors influencing the adoption of electronic roadmapping”, Academy of Strategic Management Journal, Vol 17, Issue 4, 2018

Pornprom Ateetanan, Kunio Shirahada, Sasiporn Usanavasin, Thepchai Supnithi, Wantanee Phantachat. “Value co-creation roadmapping with stakeholders for creating innovative technology”, International Journal of Technology Management, Oct 18, 2017, Revising (Second round reviewing), 18 Pages

Pornprom Ateetanan, Sasiporn Usanavasin, Kunio Shirahada. “e-Roadmapping for organizational strategic planning”, International Journal of e-Collaboration, April 3, 2018, Reviewing, 24 Pages

International conference proceedings

Pornprom Ateetanan, Sasiporn Usanavasin, Kunio Shirahada, Thepchai Supnithi. “From service design to enterprise architecture: the alignment of service blueprint and business architecture with business process model and notation”, Lecture Notes in Computer Science: Serviceology for Services: Proceedings of the 5th International Conference on Serviceology for Services (ICServ 2017), July 12-14, 2017, Vienna, Austria, Vol. 10371, pp. 202-214, 2017.

Pornprom Ateetanan and Kunio Shirahada. “A seamless value co-creation service roadmap of assistive technologies for the elderly”, in Portland International Center for Management of Engineering and Technology: PICMET'16. 2016, September 4-8, 2016, Hawaii, USA., pp. 2751-2761, 2016

Pornprom Ateetanan, Kunio Shirahada, Sasiporn Usanavasin, Thepchai Supnithi, Wantanee Phantachat. “Conceptual framework for implementing virtual and value co-creation service roadmapping for Thailand R&D firm”, in International Research Symposium in Service Management: IRSSM7. 2016, August 2-6, 2016, Nakhonpathom, Thailand., pp. 215-226, 2016

Poster presentation

Pornprom Ateetanan, Kunio Shirahada, Sasiporn Usanavasin, Thepchai Supnithi, and Wantanee Phantachat. “Conceptualising a Value Co-creation Roadmapping with Stakeholders in Organizations”, JAIST World Conference (JWC2018), February 27-28, 2018, Ishikawa, Japan

Oral presentation

Pornprom Ateetanan, Sasiporn Usanavasin, Kunio Shirahada, Thepchai Supnithi. “Transformative roadmapping: From service research to strategic planning for well-being”, Smart Information/Smart Knowledge/Smart Material Workshop (SISKSM2017), September 26-27, 2017, Bangkok, Thailand