FACTORS INFLUENCING THE ADOPTION OF ELECTRONIC ROADMAPPING

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ABSTRACT

The objective of this study is to examine factors influencing the adoption of electronic (e)-Roadmapping in organization. This study employs expert checks and Analytic Hierarchy Process (AHP) methodology. The expert checks method is employed to identify appropriate factors. AHP method, then, is engaged to measure the influencing weight of factors and sub-factors. The AHP experts are from areas of academic, management executive, and roadmapping practitioner. The results obtained from this investigation can assist the organizational roadmap owner or facilitator to conduct and improve their roadmapping process. Furthermore, an example of how expert checks-AHP methodology can be used as a decision-making process tools in strategic management.

Keywords: Analytic Hierarchy Process (AHP), Electronic Roadmapping, Expert Checks-AHP Methodology, Factors Influencing, Adoption of Roadmapping.

INTRODUCTION

Roadmapping is one of strategic technology management toolkits which play an important role in supporting a wide range of technology management decisions and processes. It is a strategic planning tool in industry and government which is widely recognized and acknowledged (Phaal et al., 2016; Vatananan and Gerdsri, 2012; Cho et al., 2016). The key factors, leading to a successful Roadmapping, are the right process, data and people (Vatananan and Gerdsri, 2012). Phaal et al. (2001) describes the factors that contribute to successful Roadmapping including clear business need, desire to develop effective business processes, company culture, politics supported participation, the right people involved, commitment from top management, effective tools/techniques/methods, effective facilitation training, and effective process.

The Roadmapping process runs as workshop-based whereby the key stakeholders and domain experts are brought together to capture, share, and structure the knowledge (Kerr et al., 2013; Kerr et al., 2012; Toro-Jarrin et al., 2016; Yasunaga et al., 2009; Cho et al., 2016). It also promotes team interaction and participation by improving communication, engagement, and ownership within the process. However, in terms of the applicable scope of the workshop-based approach, the default situation is a physical or face-to-face (F2F) meeting. There are space and time limitations that decrease the degree of participation in the Roadmapping process. The real-time online tools or electronic approach can support the process as mechanisms which allow participation from individuals who are unable to attend the meeting and need a chance to give their inputs and get involved in the Roadmapping process (Kerr et al., 2013).

There are research opportunities mentioned on Roadmapping with Information and Communication Technology (ICT) supported, e.g. social networking and web-based form of

collaboration (Lee et al., 2012), ICT-based tools for development of foresight (Keller and Von der Gracht, 2014), ICT-supported Roadmapping for collaboration strategic planning (Rohrbeck et al., 2015), blended workshops or online engagement (Raford, 2015), and the blend of human and digital works. Therefore, there are potentials to incorporate electronic work with human into Roadmapping approach.

Regarding to factors influencing the adoption of Roadmapping in electronic approach, it is still an area of under-explored topic. Thus, this study intends to pinpoint and prioritize the significant factors influencing the adoption of electronic Roadmapping in organization. Appropriate decision-making procedures and evaluation criteria are essential, and quantitative tools should be integrated prior to the selection process (Tang et al., 2014). Expert checks (Wendelken et al., 2014) and the Analytical Hierarchy Process: AHP (Ishizaka and Labib, 2011; Russo and Camanho, 2015; Saaty, 2008) are used to analyse factor weights and prioritize the selected factors. In this study, an expert checks-AHP methodology is employed to establish a measurement system when selecting and prioritizing key factors. The following section discusses relevant literatures. The methodology, results, and discussions are, then, presented. They bring the major findings, conclusions and recommendation for future research of this study.

LITERATURE REVIEW

This chapter provides background information to this study. It provides descriptions, characteristics, and the current state of Roadmapping, as well as an overview of related previous studies to support this study.

Roadmapping

Roadmapping is a human-centric strategic management technique that provides the opportunity to participate with another person or group aimed towards co-created strategic planning solutions (Kerr et al., 2013). It is also a collaborative approach to introduce organizational change (Linnenluecke et al., 2017) and manage the Research and Development (R&D) planning, as well as to identify the future of technological progress at organizations (Cho et al., 2016). Roadmapping enables different stakeholder groups to reach a consensus on how to appropriately move a creative idea and vision forward (Kerr et al., 2017). The Roadmapping process focuses on the sharing of perspectives among participants which leads to an improved communication, new insights, creativity, learning, knowledge, and innovation (Yoon et al., 2017).

Typically, the development of roadmaps is iterative process and workshop-based involving periodic review and improvement based on human interaction through meetings and workshops. Contributions from individuals and teams are necessary to ensure the successful implementation of a project or process in an organization. Key stakeholders involved in Roadmapping implementation come from different levels in their organization, have different areas of expertise, and come from both inside and outside of the organization. In summary, the Roadmapping process can be customized to suit the particular application in terms of both architecture and process (Phaal et al., 2003).

Information and Communication Technology (ICT)-Supported Roadmapping

ICT has a critical role in supporting organizations to achieve their goals. It allows a large group of users with rich content and functionalities (Rohrbeck et al., 2015). A people-technology hybrid approach can act as a key source for promoting organizational innovation and creativity by supporting of ICT, social media and people (Kandampully et al., 2016) on collaborative platform which can be either a face-to-face (F2F) or electronic platform (Mačiulienė and Skaržauskienė, 2016; Romero and Molina, 2011). Lee et al. (2012) suggested that the use of social networking and web-based forms of collaboration would enhance roadmap credibility. ICT-based tools will be the driving forces in the future development of foresight support systems (Keller and Von der Gracht, 2014), and ICT-based Roadmapping will enhance coordination and productivity of planning activities (Rohrbeck et al., 2015). Raford (2015) suggested that the study of encouraging interactive socialization in F2F, online settings in the form of blended workshops or online engagement should be conducted. Additionally, Phaal (2018) suggested that R&D on application software and digital technologies should continue, which would support Roadmapping and help balancing the blend of human and digital work. Wahl and Kitchel (2016) described the internet-based collaboration tools organized by asynchronous use (e.g. email and discussion boards), synchronous use (e.g. voice over internet protocol, web conferencing, and real-time collaboration), and hybrid use (e.g. text messaging and instant messages). In this respect, it is proven that ICT can connect people across space and time in one common environment (González-Rojas et al., 2016) which is ubiquitous and accessible for anyone from any place at any time by any device.

As shown in the previous studies mentioned above, the ICT-supported Roadmapping can be implemented using a collaboration platform, e.g. online communities and social networks. Electronic (e)-Collaboration with ICT-enabled can promote innovative co-creation by using collaboration and communication through online tools, mobile applications, and devices (Boling et al., 2014; Wong et al., 2016).

E-Collaboration

According to Kock et al. (2001), e-Collaboration is considered as collaboration among individuals engaged in a common task using technologies, not only limited to Computer-Mediated Communication (CMC) or Computer Supported Cooperative Work (CSCW) but also online collaboration (Kock and Nosek, 2005). E-Collaboration is about information sharing among individuals and organizations for the purposes of planning and coordinating.

The factors influencing the adoption of e-Collaboration consist of eight factors, which are: 1) accessibility (Keller and Von der Gracht, 2014; Rohrbeck et al., 2015); 2) documents and files sharing (Gerdsri et al., 2010; Vatananan & Gerdsri, 2012); 3) software for development, dissemination and upkeep of roadmap (Lee et al., 2011; Phaal et al., 2001); 4) centralization (Faber, 2014; Gerdsri et al., 2010; Soto-Acosta et al., 2014; Vatananan and Gerdsri, 2012); 5) usability (Graves and Doucet, 2016; Ostrand et al., 2016; Rohrbeck et al., 2015); 6) mobile accessibility (Ostrand et al., 2016); 7) training (Godin et al., 2017; Graves & Doucet, 2016) and 8) cost efficiency (Keller and Von der Gracht, 2014; Ostrand et al., 2016). The evolving area of e-Collaboration represents an enormous potential for organization of all activities.

Electronic (E)-Roadmapping

According to the information of Roadmapping mentioned above, the ICT, internet, social media, and software can be alternative supported tools to enable Roadmapping with electronic approach in the organization which also need to be integrated with human aspects of Roadmapping. The electronic approach with ICT and e-Collaboration technology-supported Roadmapping not only overcome the limitations of space and time but also increases the degree of communication.

The definition of Electronic (e)-Roadmapping can be described as the fusion between a typical face-to-face and online approach which achieves features through an alignment with ICT and e-Collaboration tools to serve the shift the Roadmapping process from face-to-face (F2F) to Electronic (E) (Ateetanan, 2018).

RESEARCH METHOD

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 1.

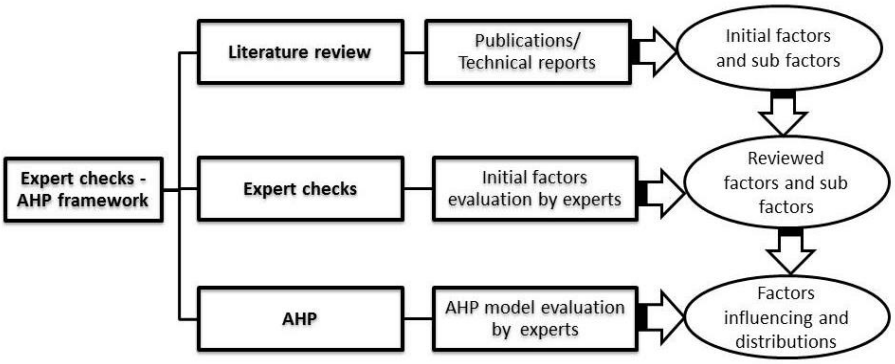

FIGURE 1
EXPERT CHECKS-AHP METHODOLOGY

Expert Checks

The knowledge and experience of Roadmapping expert is essential for making scientific decisions (Tang et al., 2014; Wendelken et al., 2014). For this check, six 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 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 2. The experts, then, were asked to review, comment and return feedback, based on their experiences. Afterwards, the expert checks were conducted.

Table 1
EXPERTS DEMOGRAPHIC PROFILE

Expert	Expertise	Experience	Position/Organization	Expert Checks	AHP
Academic: A					
A1	Technology management and strategic roadmapping.	10 yrs in advanced science and technology university.	Japanese university professor.	☑	-
A2	Service science, business innovation and roadmapping.	22 yrs in R&D of Japanese ICT Corporate and 12 years in advanced science and technology university.	Japanese university professor.	-	☑
A3	Business, technology and strategic management.	25 yrs in business, technology and strategic management.	Korean university professor.	-	☑
A4	Knowledge/innovation management and strategic Roadmapping.	15 yrs in research, consulting, training on Roadmapping.	Thai university professor.	☑	☑
A5	Strategic Roadmapping and strategic technology management.	21 yrs in strategic Roadmapping.	UK university principal research associate.	-	☑
A6	Technology and engineering management.	20 yrs in technology and engineering management.	USA university professor.	-	☑
Management: M					
M1	Information system development and Roadmapping.	12 yrs in information system development.	Japanese technical director of IT Services company.	-	☑
M2	ICT management.	12 yrs of information system and ICT strategy development.	Thai director of ICT strategy and policy bureau of independent agency.	☑	-
M3	Policy research and development.	15 yrs in Science (S), Technology (T), and Innovation (I) policy development	Thai senior policy research and team leader in national science, technology, innovation policy.	☑	☑
M4	ICT, knowledge and innovation management.	15 yrs in ICT, knowledge and innovation management.	Thai university Chief Information Officer.	-	☑
Roadmapping practitioner: R					
R1	Strategic technology planning.	10 yrs of strategic technology development	Japanese LCD monitor company.	-	☑
R2	STI master plan formulation.	17 yrs in ICT and STI master plan formulation.	Thai policy researcher and director of platform technology management division of national R&D center for electronics and computer technology.	☑	☑
R3	S&T policy research.	12 yrs of S&T policy development.	Thai director of policy research division in national R&D center on S&T	☑	☑
R4	Innovation management.	15 yrs in management consultancy services.	UK managing director of management consulting firm.	-	☑

Table 2
THE INITIAL FACTOR INFLUENCING THE ADOPTION OF E-ROADMAPPING-EXPERT CHECKS ROUND

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.

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 et al., 2008; Tansakul et al., 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 1 presents the demographic profile of all experts.

Designing AHP Questionnaire

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 2 and Table 3. Accordingly, the obtained data were used to develop AHP questionnaire to

evaluate seven factors by obtaining the opinions of twelve experts. The AHP questionnaire was comprised of the introduction of AHP method, the AHP comparison scale, example of AHP judgement, and factors and sub-factors judgements. The experts compare the relative importance of the decision alternatives of pair-wise with respect to factor and sub-factors as shown in Figure 2. Each expert is requested to enter his/her judgements and makes a distinct and identifiable contribution to the issue.

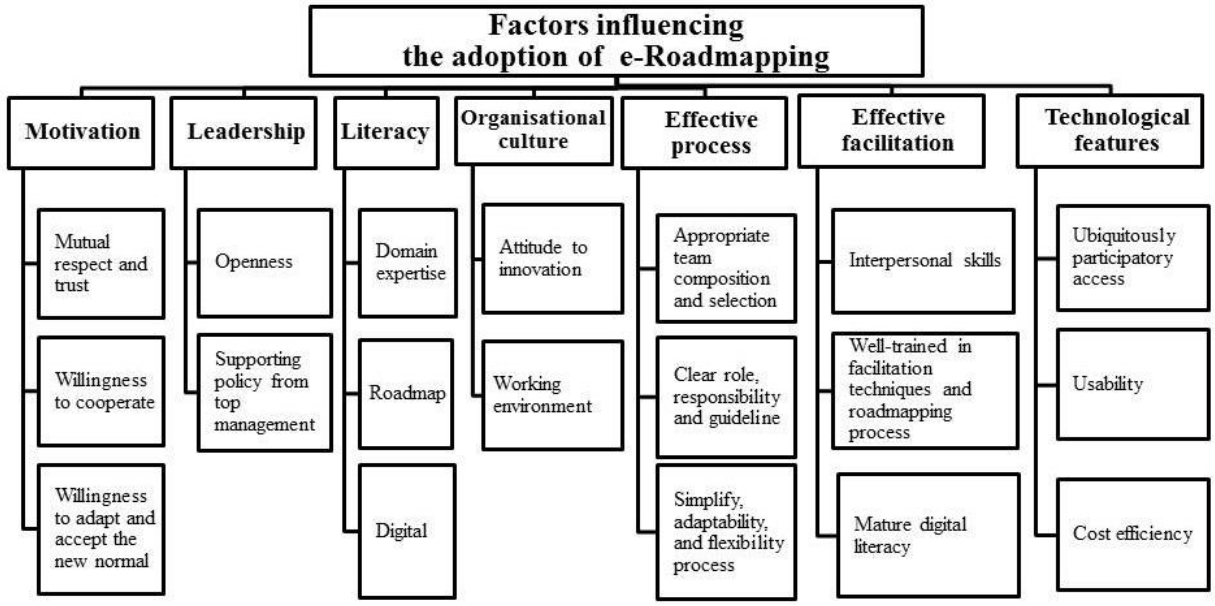

FIGURE 2
HIERARCHY STRUCTURE OF THE AHP MODEL

Applying AHP Software

The Super Decisions is decision making software based on the AHP. There is free license version by accessing at https://superdecisions.com/. In this study, the Super Decisions version 28 for windows was used for modelling, calculating and synthesizing the relative weight within the AHP model.

Implementing AHP Model by the Super Decisions

AHP model is simulated on the Super Decisions software as presented in Figure 3. The pair-wise comparisons judgements of factors and sub-factors are collected by questionnaire and analysed by The Super Decisions. Figure 4 presents a sample page from the AHP questionnaire.

Table 3
FACTOR INFLUENCING THE ADOPTION OF E-ROADMAPPING-AHP EXPERTS ROUND

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.

Table 3
FACTOR INFLUENCING THE ADOPTION OF E-ROADMAPPING-AHP EXPERTS ROUND

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.
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.
Technological Features	
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.

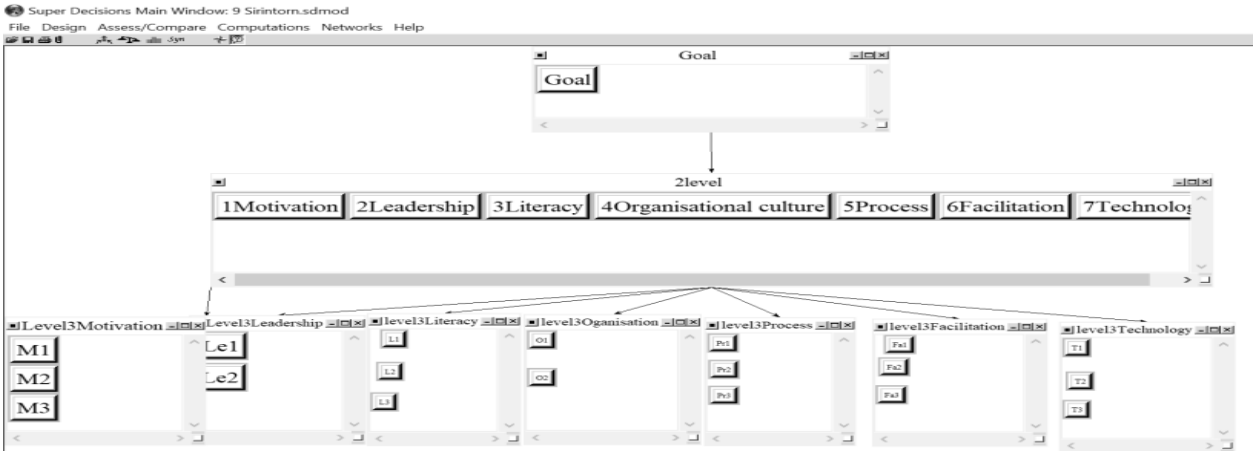

FIGURE 3
AHP MODEL SIMULATED WITH THE SUPER DECISIONS

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

FIGURE 4
SAMPLE PAGE OF AHP QUESTIONNAIRE

Judgement for Each Factor and Sub-Factor

The pair-wise comparison scale is used to express the importance of one element over another as depicted in Table 4 (Saaty, 1996) and sample of page of AHP judgement by the Super Decisions in Figure 5.

Table 4
COMPARISON TABLE

Explanation	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

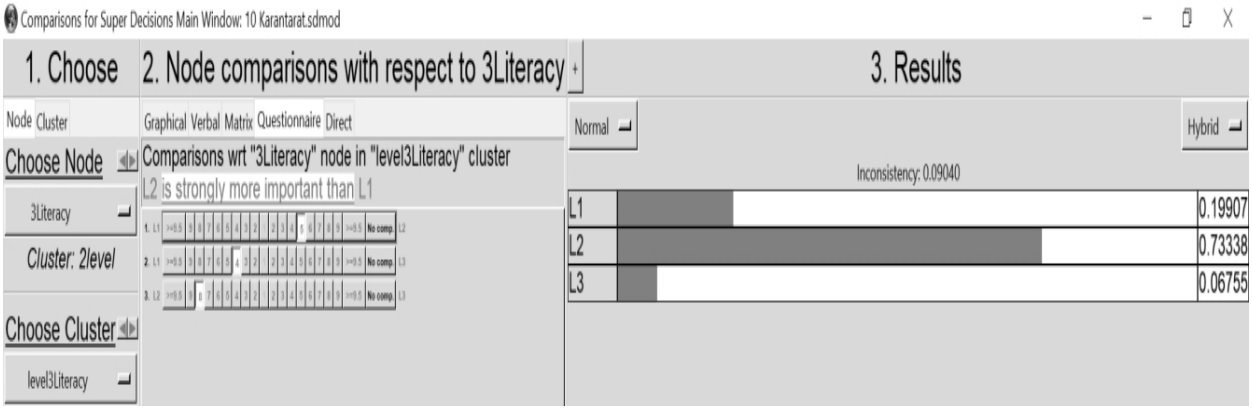

FIGURE 5
SAMPLE PAGE OF AHP ADJUSTMENT

Data Validation

The AHP allows the inconsistency of every expert's survey responses to be represented by the consistency ratio. 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.

RESULTS

Based on the input related to experts' judgement, Table 4 shows the weights computed by Super Decisions software for all factors and sub-factors. 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 processes'* and '*Motivation*' should be considered to fulfil 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.

Table 5
THE WEIGHTS OF ALL FACTORS AND SUBFACTORS IN THE HIERARCHY

Main factor			
Area	**Weight**	**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

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 (Table 5).

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'*.

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 approach.

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 centre 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.

CONCLUSIONS AND RECOMMENDATIONS

The objective of this study is to identify the factors influencing the adoption of electronic 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 electronic 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.

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