International Journal on Advanced Science Engineering Information Technology

Vol.10 (2020) No. 2
ISSN: 2088-5334

An Improved Software Project Monitoring Task Model of Agile Kanban Method: A Practitioners' Perspective

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***Abstract*— Monitoring software project development is essential to ensure that the project progress is according to budget, schedule, and quality expectations. Currently, Agile Methods (AMs) have received wide recognition within the software engineering (SE) field due to their flexibility and effectiveness. One of the AMs methods used in managing software project development is Kanban method. This method is gaining attention due to its ability to enhance understanding, visibility, and controlling the project workflow. Thus, this paper aims to discuss the initial result of the proposed model for improving the software project monitoring task of the Agile Kanban method (i-KAM). To achieve this aim, the expert review method was used to ensure that suitable components and associated criteria have been included in i-KAM. In this study, six domain experts, which are software practitioners, have been identified based on predefined characteristics. The proposed model was verified based on five dimensions, which are understandability, relevance, feasibility, organization, and comprehensiveness. The experts' opinions and comments were obtained and subsequently quantified by using descriptive analysis. Findings revealed that this study has fulfilled its objective and has acquired constructive suggestions from the practitioners' perspective. Future work will continue to enhance i-KAM according to the recommendations and remarks from the experts. A focus group and case study methods could be conducted in order to validate the revised i-KAM. Besides, a prototype will be developed and then implemented within a real software development setting.**

***Keywords*—Agile; kanban method; progress monitoring task; expert review; practitioners' perspective.**

I. INTRODUCTION

Currently, the Agile Kanban method has been well received and used for developing software projects among software development organizations (SDOs) [1]. This is because this method has greater consistency in managing software engineering (SE) projects [2]. The annual 'State of Agile' report shows that the adoption of the Agile Kanban method in SDOs has increased sharply from 39% to 65% in recent years [3], [4].

Progress monitoring is an essential task during any project execution, whereby it ensures that a project plan is progressed according to budget, schedule, and quality expectations. Thus, successful implementation of software projects depends entirely on successful monitoring mechanisms, while the lack of monitoring the development process leads to the failure of such projects [5], [6]. However, the progress monitoring task of the Agile Kanban method has significant lacks in terms of tracking, controlling, and visualizing the workflows' progress. This problem has negative impacts on software projects' success because the delays in project scheduling lead to late delivery [7], [8].

Agile Kanban method needs to be improved through three components that play crucial roles and impact the current issues of progress monitoring tasks [2]. The first component is to integrate Kanban method with earned value analysis (EVA) method to have an adequate technique for effective progress tracking. This is because Kanban method needs to be integrated with a complementary method to keep the project schedule progresses as it is planned [5], [7]. The second component is to generate the optimum work-in-progress (WIP) limits for each stage in Kanban board. Yet, determining WIP limits is proved as a major challenge faces by software practitioners [8], [9]. The optimum number of WIP limits refers to suitable numbers for each stage that can monitor and control the team members with their tasks and ensure that project progress as it is planned. The third component is to visualize useful insights for the workflow to help project managers make meaningful decisions regarding the projects' progress. Nevertheless, Kanban board neither reports how much of work is left nor provides some indications of where the project ought to be [7], [10]. Consequently, an initial model for improving software project monitoring task of Agile Kanban method (i-KAM) was developed [2] and it is shown in Fig. 1.

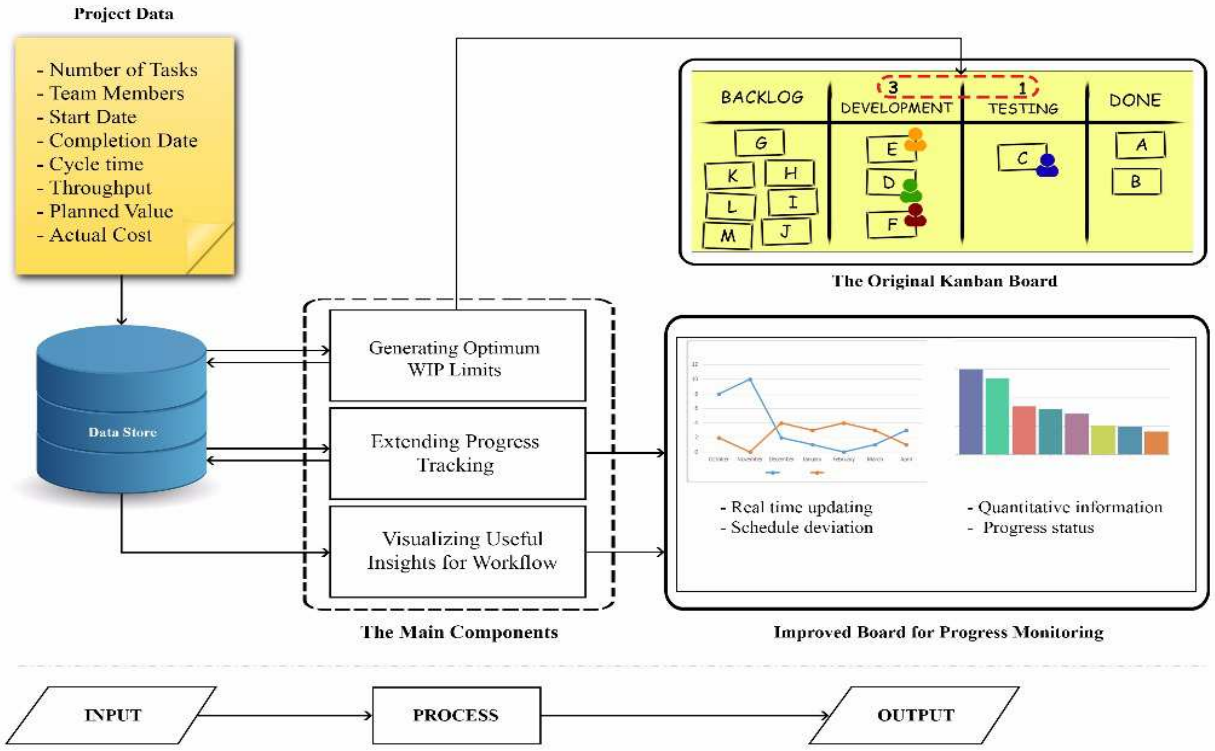

Fig. 1 The initial i-KAM

The proposed model consists of three main components, which are (1) extending progress tracking, (2) generating optimum WIP limits, and (3) visualizing useful insights for workflow. However, this model is still in initial phases and needs to be verified. Therefore, this paper aims to verify i-KAM through the expert review method in order to ensure that the proposed components and associated criteria have been appropriately constructed. The expert review method was selected because it is beneficial to yield experts' opinions about the proposed model. In addition, it is a popular method used for gathering qualitative data about a topic specified by the researcher [11]. As i-KAM is intended to be used by the software practitioners, therefore this study focuses on inspecting and exploring practitioners' perspectives. Besides that, practitioners can provide their insights from the real-life environment point of view.

The rest of the paper is organized as follows. Section II describes the materials and methods used to achieve the objective of this study. Next, the results of the verification process of i-KAM are presented and discussed in section III. Section IV concludes and summarizes the findings, and then outlines suggestions for the future works.

II. Material and Method

The expert review method is adopted to achieve the objective of this study. Typically, this method is used to verify the approach design in terms of justifying its potential for developing practical solutions, such as models, methods or tools for developing software projects [11]. In this study, the research method consists of four phases: (1) expert's identification, (2) verification dimensions, (3) instrument design, and (4) data collection and analysis. The explanation for each phase is provided in the following subsections.

A. Experts Identification

The pool of experts was identified based on the chosen individuals having either an advanced degree in computer science (CS), software engineering (SE), information technology (IT), or a related field and at least 3−5 years of working experience in practicing software development using Agile methods. As a result of this selection process, six practitioners from the SE domain have participated in verifying i-KAM, which is an appropriate number, given that five experts from a related field should suffice [12]. Moreover, six experts is an acceptable number to obtain reliable and objective results in a verification process [13]. The demographic data of the study participants are presented in Table I.

TABLE I
Font Sizes for Papers Demographic Data of Experts

Expert (E)	Expertise	Current Position	Years
E1	Software Engineering	Developer / Lecturer	22
E2	Agile and Web development	Software Developer	10
E3	Agile Software Development	Software Developer	10
E4	Agile and Web development	Data Scientist	14
E5	Software / Web Development	IT Manager	13
E6	Software Process Improvement	IT Consultant	6

As noted above, all six participants possess expertise in the SE domain, especially in software process improvement

and software development using Agile methods. Moreover, all experts hold respected positions in software companies, and one has also been working as a senior lecturer for the last three years. Four experts have 10 to 14 years of experience, while the remaining two have 22 and 6 years of working experience in the related field, respectively.

B. Verification Dimensions

In this study, the i-KAM verification process was performed according to five dimensions, namely understandability, relevance, feasibility, organization, and comprehensiveness. The description of all five dimensions used to verify i-KAM is given in Table II.

TABLE II
DESCRIPTION OF THE VERIFICATION DIMENSIONS FOR I-KAM

Dimension	Description
Understandability	Describes the clarity in recognizing the used terminologies in the proposed model
Relevance	Examines the consistency between the components and study objective, and how the components and criteria are related to each other within the proposed model
Feasibility	Measures the suitability of using criteria in the proposed model
Organization	Denotes that the elements of the proposed model are well organized
Comprehensiveness	Shows that all required components and criteria are involved in the proposed model

The dimensions above have been chosen because they have received full acceptance among SE experts and researchers, and are increasingly being adopted in related studies, such as [14], [15], and [16], where the researchers employed this approach to verify their proposed model, method, and framework, respectively.

C. Instrument Design

The instrument for the expert review was developed by incorporating pertinent theoretical findings and by adapting several existing instruments that have been previously employed in measuring different dimensions of i-KAM. Care was also taken to ensure that the instrument layout is friendly, with clear instructions presented in understandable language. Therefore, the instrument went through several rounds of reviews and revisions to ensure that the content is comprehensive and appropriate. Additionally, a brief description of i-KAM and operational definitions were given before presenting the questionnaire, comprising of five sections about the dimensions, along with a section about demographic data and the proposed model. A detailed description of the questionnaire sections is given below.

Section 1 was intended to determine the degree of understandability of the terminology used in i-KAM. When responding to the questions in this section, experts were asked to state whether the listed terminologies are easy to understand, need some explanation, or need a very detailed explanation.

Section 2 was intended to identify the degree of relevance of the proposed components. The experts thus needed to state whether the listed components are relevant, may not be relevant, or are irrelevant. The aim of section 3 was to obtain experts' assessment of the feasibility of using all criteria associated with the proposed i-KAM components. In this section, the experts were required to state their opinion by rating their response on a four-point Likert scale, anchored at 1 = "strongly disagree" (SD), and 4 = "strongly agree" (SA). The neutral response available in a typical five-point Likert scale was omitted, as it did not reflect expert opinion [17].

Section 4 was intended to measure whether connections and flows between the components are well organized, whereas items comprising section 5 aimed to gauge experts' opinion on the comprehensiveness of i-KAM. In both sections, experts were instructed to respond to the questions by selecting either "Yes" or "No." Besides, an appropriate space was given within each section for experts' comments on the elements of the proposed model. Furthermore, experts could offer additional suggestions and other recommendations at the end of the questionnaire.

D. Data Collection and Analysis

The instrument, along with i-KAM, was sent via email to the participating experts. Data collection took around five weeks due to the experts' busy schedules. Data and feedback were analyzed using descriptive and content analysis, the aim of which was not to explain or show any significant relationships between variables. Instead, the goal was to obtain the experts' opinions and establish the frequency of certain measures using frequency and cross-tabulation in order to enhance i-KAM. The results of this study are presented and discussed in the next section.

III. RESULTS AND DISCUSSION

This section presents and discusses the data that were gathered from the six domain experts. The collected data are thus tabulated as well as depicted in clustered charts. This is done to provide a clear and straightforward illustration of response frequencies obtained in individual questionnaire sections.

A. Understandability of Terminology used in i-KAM

Table III provides the results related to the understandability dimension and the degrees of all terminologies used in i-KAM.

TABLE III
UNDERSTANDABILITY OF TERMINOLOGY

Terminology	Frequency (n=6)		
	Easy to understand	Needs some explanation	Needs detailed explanation
Project Data	3	2	1
Data Store	3	2	1
Generating Optimum WIP Limits	5	0	1
Extending Progress Tracking	4	1	1
Visualizing Useful Insights for Workflow	4	0	2
The Original Kanban Board	5	1	0
Improved Board for Progress Monitoring	4	0	2

From Table III, it can be seen that most of the terminology used in i-KAM is easy to understand (67%), while about a third of experts indicated that some terms and definitions required further explanation (14%) or would benefit from a very detailed explanation (19%), as depicted in Fig. 2.

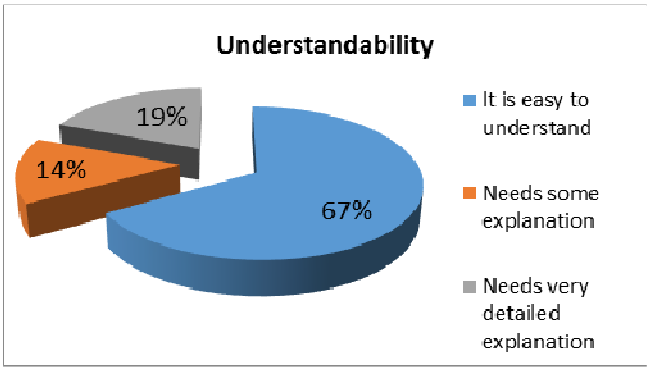

Fig. 2 Understandability

B. Relevancy of the Proposed Components in i-KAM

Table IV presents the results of the relevance dimension for each component proposed in i-KAM.

TABLE IV
RELEVANCE OF COMPONENTS

Component	Frequency (n=6)		
	Is relevant	May not be relevant	Is definitely not relevant
Progress Tracking	5	1	0
Optimum WIP Limits	5	1	0
Useful Insights for Workflow	4	2	0

Table IV shows that the majority of the experts (78%) were agreed that the proposed components are relevant, while the rest of them (22%) were indicated that components may not be relevant to i-KAM. However, none of the experts stated that the proposed component is definitely not relevant. Fig. 3 presents the result of the relevance dimension.

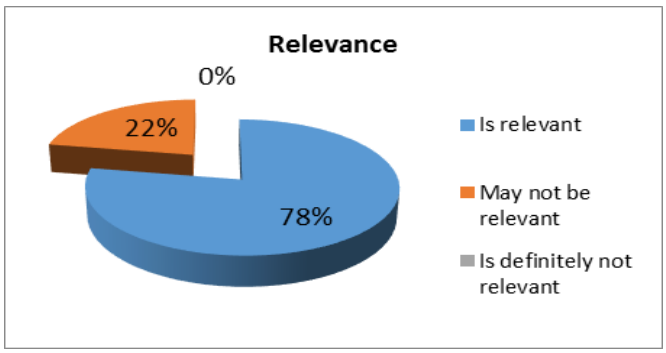

Fig. 3 Relevance

C. Feasibility of using Criteria in i-KAM

Table V presents the results of feasibility dimension and the degree of each criterion associated with the proposed components in i-KAM.

TABLE V
FEASIBILITY OF USING CRITERIA IN I-KAM

Component	Items	Frequency (n=6)			
		SD	D	A	SA
Progress Tracking	Using EVA method	0	0	6	0
	Data collection	0	0	2	4
	Cost and schedule controlling	1	0	2	3
	Maintaining the current status	1	0	4	1
	Planning and forecasting	0	0	4	2
	Schedule deviation	0	0	3	3
Optimum WIP Limits	The number of team members	0	0	2	4
	The maximum tasks per member	0	0	2	4
	Cycle time	0	2	2	2
	Throughput	0	1	1	4
	Starting date	1	0	1	4
	Completion date	1	0	1	4
Useful Insights for Workflow	Data collection	0	0	2	4
	Data presentation	0	1	1	4
	Real time updating	0	0	3	3
	Quantitative information displaying	0	0	4	2
	Schedule deviation	0	0	2	4
	Progress status reporting	0	0	4	2

Table V also reveals that all experts agreed to integrate EVA method with the Agile Kanban method because this integration can extend the progress tracking mechanism. Besides, the results confirmed that criteria associated with the proposed components are practically feasible. Significantly, half of the criteria (50%) included in the questionnaire were given a score of 4 (SA), with 42% scoring 3 (A), and the remaining 8% being rated at 2 (D) or 1 (SD). Fig. 4 depicts the results related to the feasibility dimension.

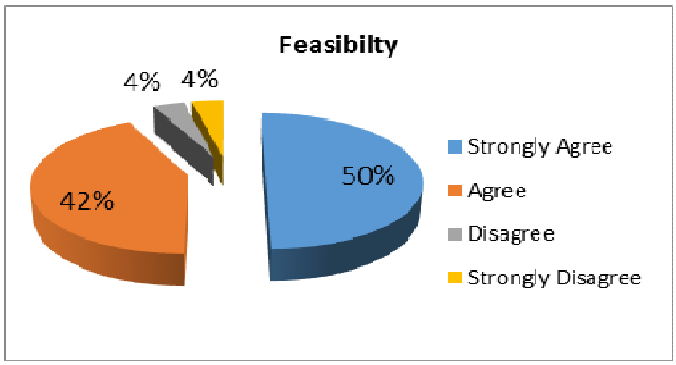

Fig. 4 Feasibility

As shown above, experts provided positive perspectives on the criteria associated with each component. More clarification, agreement responses (agree and strongly agree) as well as disagreement responses (disagree and strongly disagree) are combined in order to ease data analysis. Specifically, 94% of experts have agreed to use criteria associated with extending the progress tracking component, while only 6% disagreed. Moreover, 86% of experts have agreed to use criteria associated with generating optimum WIP limits component, while the remaining 14% disagreed.

Besides, 97% of experts have agreed to use criteria associated with visualizing useful insights for workflow, while only 3% disagreed. Based on the combined responses, Fig. 5 presents the results of the feasibility of using criteria for each i-KAM component separately.

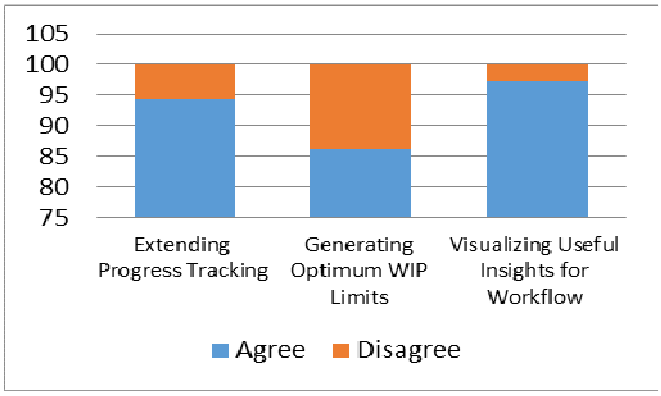

Fig. 5 Feasibility of criteria for each component

D. Organization of Connections and Flows in i-KAM

Fig. 6 depicts the results about the organization dimension, whereby many experts (83%) emphasized that the connections and flows between the i-KAM components are logical and well organized.

Fig. 6 Organization

E. Comprehensiveness of i-KAM

Fig. 7 presents the results of the comprehensiveness dimension analyses, indicating that all experts (100%) concurred that the required components and criteria are involved in the proposed model.

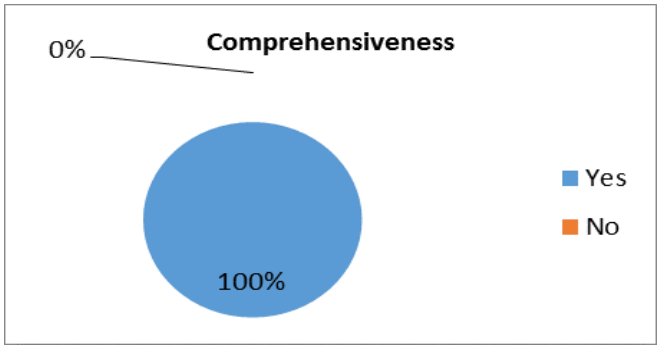

Fig. 7 Comprehensiveness

F. Comments of Experts on i-KAM Elements

As a part of the verification process, experts have provided their feedback on elements of the proposed model. Table VI summarizes the significant comments given by the six experts on i-KAM.

TABLE VI
A SUMMARY OF EXPERTS' COMMENTS ON I-KAM ELEMENTS

i-KAM Element	Expert (E)	Comments
Terminologies	E2	Rephrase some of the used terminologies, in which the current one sounds are more as processes than components. For instance, using the terminology (progress tracking extension or extended progress tracking) instead of extending progress tracking. Another example is to use the terminology (optimum WIP limits generation or generate optimum WIP limits) instead of generating optimum WIP limits
Project Data	E6	Add another criterion to the project data which is referred as "Total Value" or "Maximum Value," whereby this criterion is crucial of any project
Generating Optimum WIP Limits	E1 and E3	Clarify how the optimum WIP limits will be generated
	E4	Use the number of member's absence, the number of blockers expected, and the number of ad-hoc tasks to generate the optimum WIP limits Avoid the use of several team members and the maximum tasks per member, whereby these criteria are determined completion date, not the other way around
	E1 and E5	Add the "Priority of Task" criterion to be used in generating the optimum WIP limits
Visualizing Useful Insights for Workflow	E1	The proposed visualization should be better than the existing process; therefore, comparing the proposed design of monitoring metrics with original Kanban board is required
	E3	Visualize EVA values and results of its calculations
	E3 and E4	Visualize extra criteria, such as bottlenecks, possible points of improvements, and the potential impacts if improvements are made
	E6	For effective visualization, use synoptic analysis, which is kind of data science-based analytics

Furthermore, the experts were asked to suggest other components that could improve the progress monitoring of the Agile Kanban method. However, most experts emphasized the relevancy of the three components that are already incorporated into i-KAM. For example, E1 stated, "I believe these three are the core components, thus better to focus on," whilst E5 objected to the inclusion of cost management criterion in extending the progress tracking component. Only E6 proposed adding an extra component to i-KAM, whereby the suggested component might be focused on user feedback or stakeholder involvement aspect as well.

G. General Suggestions and Recommendations

At the end of the instrument, the experts were asked to provide additional suggestions or other recommendations for enhancing i-KAM. E2 suggested removing the original Kanban board from i-KAM because it is unrelated to study contribution. E5 stated that the model should show the distinguishing features that are not in the original one. He added, "i-KAM needs to show how development monitoring would be improved." Likewise, E2 and E4 recommended highlighting how i-KAM is different from other existing models since several tools are performing similar functions.

Moreover, E5 recommended clarifying the methods that would be used in the visualization part, along with the features of improved board over the original Kanban board and how it can help. Similarly, E4 claimed that information on the improved board should be actionable by the members, instead of being just visible to certain roles in the software houses. Besides, E1, E4, and E5 asked some questions about project data and data storage, suggesting that some project data needs to be clarified, while also showing how data is stored and how responsibilities are allocated to team members. In the same vein, E6 preferred mentioning the type of data storage used in this model.

Regarding the organization dimension, E1 recommended aligning main components to the improved board for progress monitoring, so that it could depict a better picture. Further, E5 suggested moving the third main component. On the other hand, E4 argued that the proposed model does not represent the iterative concept belongs to the Agile Kanban method, whereby she noted that there are one-way directions in i-KAM.

Generally, E2 stated that i-KAM looks good in terms of giving the overall project status to the team and project manager, and delineating what can be done in case of project delays. E3 acknowledged that i-KAM is a reasonable, easy to understand the model. Moreover, it could contribute to the development of software projects in terms of improving the progress monitoring tasks of the Agile Kanban method. E5 summarized his perspective on i-KAM as follows: "Overall, I think the proposed approach is good and inspiring." Meanwhile, E6 expressed his opinion by saying: "Your research work on proposing this model is highly appreciated."

IV. Conclusion

This paper presents the verification process for the improved software project monitoring task model of Agile Kanban method (i-KAM) from the practitioners' perspective. Expert review method was adopted as practitioners' opinions and insights can help identify areas that need to be improved. In this study, only six practitioners participated in verifying i-KAM; however, they have ample experience in developing software projects using Agile methods, thus ensuring that their input is relevant and trustworthy. Therefore, the verification process using the expert review method was successful in enhancing the proposed model.

In general, findings revealed that i-KAM is a good, reasonable, and inspiring model. Furthermore, it can improve the progress monitoring task of the Agile Kanban method in terms of extending its tracking mechanism, controlling the WIP limits, and providing useful insights on the project status. Most of the terminology used in i-KAM was easy to understand, even though some terms and definitions need further clarification. Experts agreed that the proposed components and criteria within i-KAM are relevant and feasible. In addition, all experts have agreed to integrate the EVA method with the Agile Kanban method in order to extend its progress tracking mechanism. Moreover, majority of experts concurred that connections and flows between the components are logical and well organized, while emphasizing the comprehensiveness of i-KAM. However, the participating experts gave constructive suggestions and recommendations that need to be considered and incorporated into the revised version of i-KAM.

Overall, this study has fulfilled its objective, which was to obtain domain experts' feedback on i-KAM. Nevertheless, the perspective of (academic) knowledge experts is significant and can help in verifying any proposed models. An extended study may thus focus on verifying the proposed model and exploring opinions of academic experts. Therefore, i-KAM will be verified and improved based on the feedback provided by knowledge and domain experts.

In addition, future work will focus on evaluating the applicability of the proposed model, i.e., to determine whether it can be practically implemented in the real environment or not [18]. Therefore, a prototype tool will be developed as a proof of the concept, whereby prototyping is a suitable approach for assessing the success of implementing proposed models after verifying its elements. Subsequently, the developed prototype tool will be implemented and evaluated by software practitioners through conducting focus group session or/and case study. Focus group is cost-effective method which has recently gained popularity within the evaluation studies in the SE domain. Moreover, it is adopted to obtain feedback and gather qualitative insights on proposed approaches or designed prototypes [19]. However, case study is an empirical method used to implement and assess proposed frameworks, models, and methods in software development organizations [20].

Acknowledgment

The authors wish to thank the participants who shared their views, experiences, and valuable contributions to this study. The authors also wish to thank the Universiti Utara Malaysia for funding this study under University Research Grant Scheme, S/O project cod e: 13853.

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