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Team Formation for Agile Software Development - Crowdsourcing-based Empirical Study

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ABSTRACT

Agile Software Development (ASD) is gradually substituting the plan-driven Waterfall development process. The nature of ASD requires that Agile development teams be more effective than any other development team in that Agile development is incremental, rapid, and responds well to changes. Therefore, team formation should be done properly in order for effective teamwork which leads to great performance and project success. To date, there is limited guidance, model, or frameworks that can assist in achieving optimum team formation. Currently, team formation is done based on heuristics and instincts which seemingly results in bias and incorrectness. This study aims to validate the Agile team formation conceptual model. This paper reports the initial empirical study that was done using a crowdsourcing-based method due to pandemic restrictions on close contact. The study was done in an Agile professional network group platform on the internet. The data collected is then analysed using contents analysis. The respondents validated that the team formation characteristics in the conceptual model were applicable with an emphasis on continuous learning and having a growth mindset. Future plan would be to determine the optimized team formation by using elements of Artificial Intelligence algorithms such as Genetic Algorithm.

1. Introduction

Agile Software Development (ASD) has become the emerging software development process, as an alternative to the more traditional plan-driven software processes such as the Waterfall model. ASD deems to be able to keep up with the rapid and unpredictable technology advancements. It produces software that markets faster, has lower development cost, are quickly adapting to changes and provides good communication between customers and developers [1-3]. However, ASD do not guarantee Agile projects' success as reported by the 2020 Standish Group Chaos Study that stated 11% of the Agile projects have failed or 47% have faced challenges [4]. The causes of these failures can be traced back to the human aspects. Past research has stated that human capitals do play an important role in the success of any software projects [5]. Software projects are indeed best carried

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out in a team especially for ASD [6]. Team formation is a crucial project activity, but yet quite a challenge as it is a complex process [7]. Under the human factors problem, it was mentioned that ineffective functioning teams can cause project failure [8]. “Ineffective teams” can be reflected as incompetent members [9,10] and insufficient skill-sets [11] in a team, conflicts that occur due to mismatched members’ personalities [12], members not complementing each other [13] and team-roles imbalance [14]. Apparently, these team composition problems arise when team formation is done incorrectly. Incorrect team composition can cause low team performance and eventually can cause project failures [11].

Hence, a team should be formed correctly, with the right members doing the right tasks. A correct combination of team (the team composition) should have a well-balanced of team members’ characteristics with the appropriate roles they hold in a team [14]. Current practice of allocating team members to suitable roles in a team make use of heuristics, subjective perceptions and human instincts [7,15] which can result in bias decision making due to wrong human judgement [7]. Therefore, a structured or formalized method of Agile team formation is needed to overcome such problem. Furthermore, an analysis of previous studies shows that there seems to be a lack in comprehensive ASD team formation models that can guide practitioners to form effective teams, which became the overall motivation for this study.

The theoretical part of this research was done by reviewing past studies on team formation, especially for software development. Data collected in that study was analysed using contents analysis method and a conceptual model has been developed and reported Zainal *et al.*, [16]. The empirical phase of the research should have been conducted afterwards but due to the pandemic, the research progress has been delayed. It was not advisable to have face to face interviews, focus groups or on-site observations during the pandemic [17]. However, apart from having online interviews and focus groups, there is another approach that can be conducted that is the crowdsourcing-based method [18] to start off with the empirical phase. The data was collected from social media groups such as LinkedIn and Telegram applications that specializes in ASD. For this crowdsourcing-based method, the objective was to validate the theoretical findings as well as to find more characteristics of the Agile team composition. The following section will further discuss the method.

This following sub-section summarizes the background of the whole research which started with the theoretical phase [16].

1.1 Agile Software Development

ASD has become the new emerging software development method replacing the traditional plan-driven method. It is more flexible and responsive to changes. ASD iteratively delivers software in increments [19,20] and seems to be more likely to satisfy the stakeholders’ requirements.

Agile methods are guided by four main values and twelve principles as outlined in Agile Manifesto. One of the values stated that ASD promotes individuals and interactions more than processes and tools [21] which implies that people factor is important in ASD. Furthermore, it is a team-oriented development method. An ASD team comprise of a small group of people which have a mixed of various skills, mutually interdependent and committed to reach a certain common goal. They are usually collocated so that it is easier to interact face-to-face. ASD team is also self-organized and self-managed [2].

Due to rapid business and technology changes, ASD is destined to be more suitable for current software developments. Therefore, the ASD team is different from the normal software development

team in that they too need to respond accordingly to the rapid changes. Thus, the ASD team need to have special features that suits the Agile nature in order to achieve success.

As ASD emphasizes on teamwork whereby team members should work coherently together as one, not in silo to ensure successful project completion. Effective teams are said to be able to achieve project success [22]. So, it is vital to form that effective team which comes to the next sub-section that covers the team members' characteristics of forming effective teams.

1.2 ASD Team Formation Conceptual Model

The notion of team formation has been discussed in numerous social science domains such as human resource management, psychology and sociology. Team formation is done during project initiation together with other resources planning [23]. Team formation process is quite complex but it is important in order to increase innovation, productivity and gain satisfaction. However, to date, the software engineering (SE) researches on human aspects matter such as team formation is still limited as compared to research on technology and process in SE [24].

To build a team formation model for an ASD team, it is essential to know what combinations of team roles' characteristics that make up the effective teams (team composition). Team composition refers to the characteristics of the team members which must first be identified beforehand. Therefore, the overall study aims to answer three research questions (RQ):

- RQ1: What characteristics and attributes should be considered when forming an effective ASD team composition?
- RQ2: What dimensions to measure for each of these characteristics' attributes?
- RQ3: How does the composition of each of these characteristics and attributes be incorporated into an effective ASD team formation model?

RQ1 was catered by the theoretical phase of this study that have reviewed past studies including existing models that are related to software development team formation. The characteristics that were identified were consolidated into a conceptual model, containing characteristics needed to form an effective ASD team (refer Table 1).

The conceptual model for ASD team composition consists of two main characteristics that is Project Characteristics and Agile Team Composition Characteristics. Project Characteristics comprise of project size and project criticality. Agile Team Composition Characteristics comprise of six main characteristics namely knowledge, skill, ability, experience, personality traits and commitment. Each characteristic comprises of several attributes. The Knowledge and Skill characteristic have very similar attributes in that both of them includes the technical, domain/business and project management knowledge/skill. The unique attribute for Knowledge is education background whilst for Skill is interpersonal skill. The Ability characteristic includes learnability and adaptability. Experience includes quantity of similar past projects. This means, the more similar projects an individual have, the better. Commitment includes level of commitment. An individual who stays longer in a team infers high commitment. Finally, the Personality Traits, which includes the HEXACO attributes, measures the six dimensions of personality [25].

The initial empirical phase aims to validate the conceptual model and also to identify more characteristics (and attributes) of Agile team composition. Further empirical study should then determine the composition of the characteristics with reference to project characteristics. The idea behind this work is that, different project characteristics will result in different combinations of team members' characteristics. It is hoped that this empirical study will cater for this quest.

Table 1
 Agile team composition characteristics

Characteristic	Attribute
Knowledge	<ul style="list-style-type: none"> • Education background • Technical • Domain/Business • Project Management
Skill	<ul style="list-style-type: none"> • Interpersonal • Technical • Domain/Business • Project Management
Ability	<ul style="list-style-type: none"> • Learnability • Adaptability
Experience	<ul style="list-style-type: none"> • Quantity of similar projects
Personality traits (HEXACO)	<ul style="list-style-type: none"> • Honesty-humility • Emotionality • Extraversion • Agreeableness • Conscientiousness • Openness to experience
Commitment	<ul style="list-style-type: none"> • Level of commitment

1.3 The Pandemic and Slight Change of Research Method

Starting late 2019, the world has experienced a Covid-19 pandemic that has never been experienced before [26,27]. Many sectors have been affected such as government and private sectors, economic and industries sector, including the education sector which also involves research activities [17]. Amongst the standard operating procedures that have been outlined during the pandemic include social distancing which means no group meetings in closed places. Physical interactions are prohibited in order to prevent from the widespread of coronavirus disease caused by SARS-CoV-2. Due to this, empirical study such as physical interviews, focus groups and site observations are strictly banned. With that hindering the empirical activities, a different approach has been chosen which is crowdsourcing-based data collection [18]. The objective of the crowdsourcing-based data collection is to confirm the elements in the conceptual model as well as to get more composition characteristics. The research method section will elaborate on this crowdsourcing-based method that was implemented in this study.

This paper has four sections. The following section is the research methodology. Section 3 comprises of the results and discussions and finally Section 4 concludes the paper and proposes future directions.

2. Methodology

This section describes the crowdsourcing-based empirical study that has been used in this research. This method is actually adapted from the private sector’s commercial marketing and has gained its usage in supporting the research process. It is actually not a new approach of data collection. Research firms such as Nielsen collects data via crowdsourcing, navigation service companies such as Waze uses this method to collect traffic data. Crowdsourcing method involves online voluntary participation from a large crowd of people. Meaning, the crowd can be as large as across the globe. There are four distinctive features of Crowdsourcing namely motivated crowd, far-

reaching, suitable participants to complete the task and adequate infrastructure to do the task. This method is said to be an option of inexpensive and fast for recruiting participants [28].

Crowdsourcing is now being employed in the academic research whereby data collection has been reported to be successful with encouraging results when used in various phases in the research lifecycle. This method can act as an alternative to the cognitive interviewing methods. This research has adapted the crowdsourcing-based research framework from a past research by Keating [18] which will be summarized here.

Before engaging in crowdsourcing activities, the researchers should consider the components of the crowdsourcing method in research to ensure the success of the approach. The components comprise of (in order of sequence):

- i. Establishing research goal
- ii. Determine target audience (“the crowd”)
- iii. Define engagement mechanisms
- iv. Determine the platform
- v. “Clean” the data

The following sub-sections lays out what have been done in this study for each component.

2.1 Establishing Research Goal

The research goal should be concrete, specific and measurable. The goal for this research is to validate the model for Agile team composition [16] as well as to discover more characteristics and attributes if any.

2.2 Determine the Target Audience (“The Crowd”)

The crowd that was chosen is from a LinkedIn group that engages in Agile and Lean software development discussions. Initially, several groups were selected but only one group that was actively involved in giving feedbacks. Thus, the following queries were asked in the selected group. The group is quite large with 185K members of Agile and Lean practitioners from all over the world. Members of the groups which consist of various levels of Agile practitioners (or Agilists), Agile coaches and Agile Project Managers, connect and exchange ideas on various topics among others such as Agile, Lean, eXtreme Programming and Scrum. The crowd was selected because of their background experiences in Agile practices as stated in their individual profiles.

2.3 Define Engagement Mechanisms

The initial purpose of this component is to encourage participation from the crowd. Ideally, participation is solicited by offering incentives such as monetary compensation or recognition by others. Motivations for participation can be direct compensation or social motives [18]. Direct compensation includes receiving monetary awards whilst social motives refer to the likely reactions of individuals whose views are valued by participants. For this research, the voluntary participation from the group members engaging in the discussions were very promising thus no monetary incentives were involved.

2.4 Determine the Platform

The platform for the crowdsourcing-based data collection was implemented in the LinkedIn discussion group. The platform supports postings and feedbacks from all registered members in the group. The group is administered by some members who are Agile professionals such as Agile coaches, Agile Project Managers and Agilists.

Before being able to post questions or comments to the group, an individual has to request to join the group from the group administrators. When approved, it means the person can now start to post questions or comments that are related to the Agile development. Questions posted by members are always filtered by administrators in order to hinder any malicious posts. Only approved postings appear in the group. Afterwards, members of the group can give feedbacks accordingly. The feedbacks from other members are monitored and filtered as well by the group administrators.

For this data collection, each characteristic was asked in a post, one at a time with a few weeks gap in between each characteristic. A sample question post would be like so: "Does knowledge (perhaps education level, technical knowledge, domain knowledge or any knowledge which matters), are important when forming and Agile development team?"

2.5 "Clean" The Data

The initial question postings and all feedbacks are then copied and pasted into the MS Word file and then analysed using Contents Analysis outlined by Krippendorff [29]. Speech, written and interview texts are simplified using this research technique [30]. The results of the analysis are presented in the following section.

3. Results

3.1 Knowledge

Most feedbacks agreed that knowledge is indeed important in forming a team. Team members need to have sufficient knowledge to start on the team. Knowledge is important to minimize mistakes in development. Developers tend to make mistakes if they lack in knowledge. One respondent stated that having knowledge is important but not the complete knowledge because that is not achievable. Lack of knowledge can also slowdown the team which can create bottlenecks and dependencies, also limits the ability for the team to innovate, deliver new ideas which in turn impacts the business. Knowledge also works well with the growth mindset and the practical application. Knowledge is gained by discovering the unknown. From practical, knowledge is accumulated. Apart from knowledge, the way to use the knowledge to deliver tasks is equally important. Key areas of knowledge can be: Business domain, technology platforms usage, programming languages, Agile/lean software development, practices and principles, product lifecycle, and must also know how to be a collaborative team and work with customers. Several times, respondents mentioned the importance of the ability to learn, lifelong learning and continuous learning. Some excerpts from the respondents' feedbacks are such as:

"An agile development team has knowledge workers as members. They need to have sufficient knowledge to start on the team and they must have the skills to discover and learn what they do not know yet."

“When we lack knowledge, we tend to make mistakes – that is our planned approach does not produce a favourable outcome...”

3.2 Skill

In the responses for the Knowledge characteristic, several respondents have also mentioned about the importance of having skills as well. Skill is the ability to apply the knowledge in a focused way to deliver a task. Developers must have the skills to discover and learn what are unknown to them. One respondent gave an example which states that a scrum team must collectively possess all the skills and expertise to the task as well as share or acquire such skills as needed. Skills such as skills to explore, design, build, test and deploy (development skills) are very significant. It is also recommended to have heterogenous team with different and complementary skills and characters.

As commented by the respondent, these are critical success factors for creating a high-performance team. It is also important to look at what mastery level of the skills the team members have. As much as it is important to consider the current needed skills for a team, it is more important to constantly enhance the skill of existing teams and its members because a team should actually be long lasting (stable) and infrequently recreated. Social skills were also mentioned by one of the respondents. Some excerpts from the respondents' feedbacks are such as:

“Yes. Skills still matter. Maybe broader than in times past, but put 4 Cobol guys on an API initiative and hope they learn fast...”

“Yes! But I'd divide skills up into a) method, b) mindset + character. It's eminent important to have a heterogenous team with different, complement skills + character. These are critical success factors without which no high-performance team can emerge.”

3.3 Ability

The ability to learn and the ability to learn effectively is the most mentioned by the respondents. The ability to perform a specific role because of the skills and knowledge that has been achieved thru education and experience. Some excerpts from the respondents' feedbacks are such as:

“... the ability to apply knowledge in a focused way – is also important...”

“Skill in what? The only skill that matters is the ability to learn, and yes, that's important.”

“The only skill that matters when forming a team is the ability to learn. What really matters is social skills. Knowledge can be acquired. Same for ability. A good team provides a place to grow and learn. Current ability is not particularly important.”

“When setting up a team, which is something we wouldn't often do but every team starts at some point, we want to ensure the team either has all the ability it needs to do the work, or can pick up the abilities in a timely manner. This implies that we need to consider the individual abilities so that the total across the team members is adequate.”

3.4 Commitment

Regarding commitment, respondents have mentioned that team members should be “permanent” or “stable”, meaning that, they are in a team for a long time, for as long as even five years. Being stable and permanent in a team implies commitment. Some excerpts from the respondents’ feedbacks are such as:

“I favour keeping team membership stable; don’t change membership when not necessary...”

“...When building a team, we should expect the team to be “permanent”; we aren’t thinking just about the next 6 months to a year, but thinking that this individual will be a team member for 5 years or more...”

3.5 Experience

Respondents was not asked directly about experience because when they answered on Knowledge and Skills, some have mentioned the importance of experience as well. Some excerpts from the respondents’ feedbacks are such as:

“Someone old (experienced pro), someone new (a bright charger with development skills) ...”

“You need sufficient knowledge, experience and understanding on the team that they can do, or can learn in a timely manner to do, all that they would need to do.”

“In setting up any development team I would want to see some breadth of experience and some range in the depth of experience – but – for an agile team (as others here have said) the more important thing is the ability and willingness to challenge your own assumptions and to feedback from the real experience of current practice – that is, to learn”

3.6 Personality

Personality characteristic of team member should also be considered up to a certain degree which may vary across organizations and countries. However, it does seem right to have only ideal personality traits but also, we do need to give some “empathy” to allow a person to change for the better. One response also mentioned that they can become more holistic by having a diverse group of thinking with different personality traits. From his experience, he was wrong to think that having the same mentality speeds up performance. Another response said that it is not a “need” but it is good to have covered enough diversities of opinions across the team members. Some excerpts from the respondents’ feedbacks are such as:

“For each possible personality trait there might typically be a range from “Ideal” to “Harmful”. It makes sense to avoid people whose traits are in the “harmful” part of the range, though 1) few are in the harmful range and 2) people change...”

“What I have learned over the course of years was that I thought that I wanted to have developers speed the same mentality, I was wrong. Having a diverse group of thinking team members with different personality traits is absolutely key to becoming holistic.”

The composition characteristics and the validations from respondents are summarized as in Table 2.

Table 2
 Validated agile team composition characteristics

Characteristic	Attribute	(✓/×)	Note
Knowledge	Education background	✓	“Education” was mentioned generally
	Technical	✓	ASD/lean, technology platforms, programming languages
	Domain/ Business	✓	Including regulations and constraints
Skill	Project Management	×	None of the respondents mentioned this
	Interpersonal	✓	
	Technical	✓	Look at levels of skills: <ul style="list-style-type: none"> • Having all skills • Acquire skills if do not have it • Look at individual skills
Ability	Domain/ Business	✓	
	Project Management	×	None of the respondents mentioned this
	Learnability	✓	This was emphasized many times.
	Adaptability	✓	Growth mindset can be aligned with this characteristic
Experience	Quantity of similar projects	✓	Depth of experience and a range of that depth
Personality Traits (HEXACO)	• Honesty-humility	✓	
	• Emotionality	✓	
	• Extraversion		
	• Agreeableness		
	• Conscientiousness		
Commitment	• Openness to experience		
	Level of commitment	✓	A team membership should be as long as possible for the team to be effective and optimized

4. Conclusion

In conclusion, the respondents agree to all the characteristics for Agile team composition except for Project Management attribute of the Knowledge and Skill characteristics. Repeatedly, the ability to learn was mentioned many times in the responses. Respondents have also mentioned about the team members who should have a growth mindset, meaning that team members are open to new knowledge and grow by going through the developmental experiences. Next empirical phase is to measure the degree of each characteristic (the dimensions such as Low, Medium or High). This would be done through face-to-face interviews and focus groups.

Future work involves that the consolidated data would then be used in optimizing the team formation. Team formation is quite complex and hard to reach optimization without the use of Artificial Intelligence (AI) element. From past research, optimization proses uses AI such as Fuzzy Logic [31] and Genetic Algorithm [32,33]. Thus, this research will move towards utilising such AI elements to obtain the optimized team formation which combines the characteristics obtained from the theoretical and empirical studies.

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