Scrum Team Competence Based on Knowledge, Skills, Attitude in Global Software Development

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Abstract

Global Software Development (GSD) and Scrum are two pivotal tools in software engineering, which meet the needs of global economics in dealing with various disruptions, such as physical distancing due to the COVID-19 pandemic. This research focuses on Scrum with its three roles: Product Owner, Scrum Master and Development Team. They require a distinct set of competencies, including Knowledge, Skills, and Attitude (KSA). Therefore, this study aims to develop a list of Scrum team competence based on KSA in GSD. The authors conducted a comprehensive literature review to create the list. Then, it was followed by in-depth interviews with nine experts involving practitioners and academics having experience in Scrum, GSD, and educational psychology for validation. This study proposes a compilation of KSA-based competencies for all roles of the Scrum team. Each competency has been grouped and given a level based on Bloom's taxonomy. The research findings can be the basis for successful competency development for the Scrum team.

Keywords: global software development; Scrum Team; competence; knowledge; skill; attitude, bloom taxonomy.

1. Introduction

Global Software Development (GSD) is in great demand by IT companies in developing their software. Some reasons for implementing GSD are cost savings, ease of getting a skilled workforce, increased system development time, flexibility, and closeness to the local market (Ebert et al., 2016). The biggest reason is cost savings, especially the salaries of software engineers (Sievi-korte et al., 2018). Moreover, implementing GSD can also improve the quality of the system development time. Various time zones in the software engineers' residence allow system development to execute 24 hours (Kroll et al., 2018). Besides, GSD has provided software development continuity solutions as the COVID-19 pandemic necessitates governments to enforce physical distancing (Garro-Abarca et al., 2021).

GSD has three distances from offering many benefits: Temporal, Geographical, Socio-cultural (Casado-Lumbreras et al., 2014) that affect three challenges: Coordination, Control, Communication (Vallon et al., 2018). This study focused on Scrum as a prospective and popular methodology to harness the advantages of GSD (Vallon et al., 2018). It took particular competencies from the Scrum team in the GSD environment, as the human factor is at the core of Scrum methodology (Ibrahim et al., 2016). A Scrum team that has good competence will be successful in working on GSD projects. This study aims to develop a list of Scrum team competence based on KSA in GSD. The authors conducted a comprehensive literature review to

create the list.

2. Previous Works

The 14th Annual State of Agile Report in 2020 mentions that Scrum is the most widely applied methodology. There is increasing interest in using Scrum practices in GSD projects originating from intra-organizational and multi-national companies (Vallon et al., 2018). Scrum requires some adjustments to answer the challenges (Paasivaara et al., 2009).

Mapping was conducted and is presented in Table 1 to explore threats and opportunities in implementing Scrum GSD. The snowball method was used to gather papers that discussed the application of Scrum in GSD and discover thirteen articles with a period of 2009–2020. Over the last five years, some documents were still referred to because they made significant contributions and came from trusted journals and conferences.

Table 1 is a correlation matrix between three distances and three challenges, a development from previous research (Mistrić et al., 2014). Each comparison can have a different number of opportunities (+), challenges (-), and competencies (*). For example, the relationship between communication with temporal and socio-cultural distance produces one challenge and one chance. Meanwhile, when connected with Geographical Distance, it creates one challenge and two opportunities. Table 1 shows that a Scrum team with its competencies can overcome the challenges and opportunities of Scrum practices in the GSD environment (Motawi et al., 2018).

	Temporal Distance	Geographical Distance	Socio-Cultural Distance
Communication	<ul style="list-style-type: none"> + Improved record of communication (Saldaña-ramos et al., 2014) - Reduced opportunities for synchronous communication (Zahedi et al., 2016) * Ability to manage global synchronous and asynchronous communication (Zahedi et al., 2016) * Ability to use information and communication technologies (Saldaña-ramos et al., 2014) 	<ul style="list-style-type: none"> + Closer proximity to the market (Peters et al., 2015) + Access to remote skilled workforces (Saldaña-ramos et al., 2014) - Face to face meetings are difficult (Holtkamp et al., 2015) * Ability to effectively communicate using common terminology and language (Peters et al., 2015) * Ability to identify competence and skill of teamwork (Saldaña-ramos et al., 2014) * Understanding of importance and limitations of various information sources (Holtkamp et al., 2015) 	<ul style="list-style-type: none"> + Innovation and sharing of best practices (Khan & Khan, 2017) - Cultural misunderstandings (Holtkamp et al., 2015) * Ability to share knowledge and information and have initiative (Khan & Khan, 2017) * Understanding of the influences and implications of culture and other personalities in work life, ability to communicate sensitively (Holtkamp et al., 2015)
Coordination	<ul style="list-style-type: none"> + Coordination needs can be minimalised (Saldaña-ramos et al., 2014) - Typically, increased coordination costs (Saldaña-ramos et al., 2014) * Ability to use advanced techniques for distributed communications (Saldaña-ramos et al., 2014) 	<ul style="list-style-type: none"> + More flexible coordination planning (Jim et al., 2014) - Reduced informal contact can lead to a lack of critical task awareness (Peters et al., 2015) * Ability to communicate with a distributed team (Jim et al., 2014) * Ability to communicate informally and improvisation skills (Peters et al., 2015) 	<ul style="list-style-type: none"> + Greater learning and richer skill set (Holtkamp et al., 2015) - Inconsistent work practices can impinge on effective coordination (Jim et al., 2014) - Reduced cooperation arising from a misunderstanding (Peters et al., 2015) * Ability to use other people's knowledge and expertise (Holtkamp et al., 2015) * Skills to gain the team's trust and confidence (Peters et al., 2015)
Control	<ul style="list-style-type: none"> + Time zone effectiveness can be utilized for gaining efficient 24x7 working (Tuffley, 2012) - Management of project artefact may be subject to delays (Monasor, Vizcaíno, & Piattini, 2010) * Leadership skills and time management skills (Tuffley, 2012) * Ability to use knowledge and document management and control version tools (Monasor, Vizcaíno, & Piattini, 2010) 	<ul style="list-style-type: none"> + Communication channels can leave an audit trail (Monasor, Vizcaíno, Piattini, et al., 2010) - Difficult to convey vision and strategy (Alsanad et al., 2019) - Perceived threat from low-cost training rivals (Beecham et al., 2014) * Knowledge of data, tools, methods, and processes in a distributed project (Monasor, Vizcaíno, Piattini, et al., 2010) * Ability to adapt and adjust plans, goals, and strategies (Holtkamp et al., 2015) * Ability to create and manage online training (Gheni et al., 2019) 	<ul style="list-style-type: none"> + Proactiveness inherent in certain cultures (Holtkamp et al., 2015) - Different perceptions of authority can undermine morale (Moe et al., 2010) - Managers must adapt to local regulations (Peters et al., 2015) * Ability to manage diversity within the team, allowing everyone to contribute and participate (Holtkamp et al., 2015) * Positive attitude and motivation capacity (Moe et al., 2010) * Managing ambiguity and uncertainty (Peters et al., 2015)

Table 1: Scrum GSD opportunities and challenges

Additional literature studies were conducted to enrich the references. This research used the snowball method and discovered a total of 18 references. The results of literature studies were used to develop the list of competencies in Table 1. Competencies were identified for each role in the Scrum team, namely Product Owner, Scrum Master, dan Development Team. In the next step, we used Bloom's Taxonomy as a reference to classify competencies into KSA and assess the acquired level. Activities in GSD indirectly link the development of KSA with the Scrum Team.

3. KSA Based Competency

Competence is a demonstrated ability to apply KSA to achieve observed results (European Committee for Standardization (CEN), 2014). Review capabilities from an

individual perspective can use KSA-based competencies (Holtkamp et al., 2015). Competence refers to the characteristics of an individual that makes up superior performance. Construct educational objectives focusing on curriculum development used Bloom's taxonomy (Ching & Da Silva, 2017).

Bloom's taxonomy is a hierarchical structure that identifies skills ranging from low to high levels. In order to reach a higher level, the lower level must be completed first. Within this conceptual framework, Bloom's Taxonomy refers to taxonomies for educational purposes and is categorized into three domains of intellectual behavior: cognitive (K), affective (A), and psychomotor (S). Table 2 shows Bloom's taxonomy of KSA and its level. The Preparation of KSA used these verbs and levels. The use of Bloom's taxonomy has so far focused on K rather than S or A (Adams, 2015). The contribution of this research is to discuss the components of KSA thoroughly.

Level	Knowledge	Skills	Attitude
1	Remember	Perception/awareness	Receiving
2	Understand	Set	Responding
3	Application	Guided response	Valuing
4	Analysis	Mechanism	Organisation
5	Evaluation	Complex overt response	Characterization
6	Creation	Adaptation	-
7	-	Origination	-

Table 2: Bloom's taxonomy

4. Validation

This research conducted in-depth interviews involving Scrum, GSD, and educational psychology experts to validate the compiled competencies. Their data are in Table 3. The two experts are currently domiciled in the Netherlands and worked for companies A and G, while others are from Indonesia.

Interviews were conducted online via a zoom meeting with 1–2 hours for each expert to sought input and suggestions from Scrum GSD experts regarding the suitability of compiled competencies with practice in the field. Several weeks earlier, the draft list of competencies was sent to them. When conducting the interview, the experts have understood the material and are ready with their thoughts.

Company	Business Type	Position	Expertise
A	e-commerce	Senior Software Engineer	Scrum, GSD
B	IT Services, software solution	Chief Executive Officer	Scrum, GSD
C	Online coding learning platform	Co-Founder	Scrum
D	Consulting, research & legal Services	Chief Executive Officer	Scrum, GSD
E	Digital commerce platform	Chief Executive Officer	Scrum
F	Transaction banking platform provider	Head of Quality Assurance-Product Development	Scrum, GSD
G	Software and technology services	Data Architect	Scrum, GSD
H	Vocational public university	Educational Psychology Lecturer	Competency
I	Public university	Educational Psychology Lecturer	Competency

Table 3: Expert's data

The in-depth interview consisted of two stages. The first stage involved seven Scrum and GSD experts. These interviews aimed to confirm the suitability of each competency with its application in industrial practices. In addition, there was also an examination of the appropriateness of competency groupings in the roles of Scrum Master, Product Owner, and Development Team. There were discussions for each competency in detail.

After making improvements according to the experts' input, the author tried to group the competencies into KSA and score the level. The second stage involves two educational psychology experts aiming to validate grouping and level from academic perspectives. The recording results were analyzed with content analysis using NVivo software tools to obtain input points for improving the KSA competency structure.

5. Findings

The compiled competency list has obtained a great deal of input from the first stage of in-depth interviews with Scrum and GSD experts. The experts considered that some competencies should be removed, and new competencies should be added to the list. Assessed from the grouping of competencies to a role of the Scrum team, several competencies do not fit into the three roles of the Scrum team. So, there are additions or deletions of competencies from these roles. Improvements were made based on these inputs.

6. Discussion

This study's findings reinforce previous studies' opinions that

many difficulties arise when the Scrum team works in a GSD environment (Noll et al., 2016). The Scrum teams must master more complex competencies to implement the modified Scrum practices successfully. The developed competencies greatly help them prepare to face the distances and challenges of modified Scrum practice in a GSD environment.

With the expert's input on the compiled competencies, there were some improvements on several aspects of competencies. The first improvement was the addition and deletion of competencies based on suggestions from the experts. The second was revisions of the discrepancies in the Scrum team's role of ownership of competency. It relates to a competency that should be included or removed from one of the Scrum team roles. In other words, several competencies were not in the right places; for example, the transfer of competency from Development Team to Product Owner, from Scrum Master to Development Team, from Scrum Master to Product Owner, and other transfers.

The third was on the sentence structure to suit the context of the intended competence. Attitude (A) was added to some competencies by providing words that explicitly show Attitude (A) in the sentence. Last, adjust the competency grouping, the verb, and leveling by refers to Bloom's taxonomy. Some competencies are not according to the level; for example, they should be at level 6 but given level 5. Also, some verbs are not according to their level, so they must be replaced. A small part of the composition of competence can be seen in Table 4—Column K for Knowledge, S for Skills, and A for Attitude. The detailed competence developed in this work is available at <http://rse.cs.ui.ac.id/?open=gsd/index>.

Competencies for Development Team, Scrum Master, Product Owner	K	S	A
Ability to discuss how to manage the technical risks be effective in the empirical process (Scrum.org, 2020)	2		2
Ability to use clear and fluent writing and conversation in a foreign language to communicate with teams with different cultures and personalities (Srivastava & Jain, 2017)	3	5	
Ability to describe the concept of GSD and the application of Scrum in GSD (Hossain & Babar, 2009)	2		
Competencies of Development Team and Scrum Master	K	S	A
Ability to associate Agile values and principles with practical Scrum in GSD context (Faniran et al., 2017)	2		
Competencies of Scrum Master and Product Owner	K	S	A
Ability to cope with conflicts with geographically dispersed stakeholders (Bass, 2013)(Noll & Butterfield, 2016)	6	7	
Ability to explore ways of implementing practices to make risks transparent (Arumugam & Kaliamourthy, 2017)	3		
Competencies of Development Team and Product Owner	K	S	A
Ability to facilitate re-platforming and security considerations with technology leadership (Noll & Butterfield, 2016)	6	5	
Ability to manage and approve release planning and schedule (Majeed, 2012)	6		4
Habitually practicing, which makes the work and collaboration more agile (Faniran et al., 2017)			5
Development Team Competencies	K	S	A
Ability to adapt working hours to get efficiency from the Follow the Sun concept (Bass, 2015)(Maria & Vilardell, 2016)(Hossain & Babar, 2009)	5	6	
Ability to assess Scrum practices and products from various cultural perspectives (Maria & Vilardell, 2016)	6		
Ability to make incremental products to produce value (Scrum.org, 2020)	6	7	5
Ability to adapt to different cultures and overcome interpersonal conflicts (Zahedi & Ali Babar, 2016)		6	4
Ability to form cooperation and coordination with Development Teams in other locations (Bass, 2013)(Majeed, 2012)	6		4
Scrum Master Competencies	K	S	A
Ability to support Development Team and Product Owner tailored to the distributed work allocation (Srivastava & Jain, 2017)	5		
Ability to make organizations understand and apply Agile principles in GSD (Beecham et al., 2014)	6	7	5
Ability to form cooperation and coordination with Scrum Masters in other locations (Bass, 2013)(Majeed, 2012)(Bass, 2015)(Maria & Vilardell, 2016)	6		4
Ability to facilitate the combination of distributed and centralized Scrum team (Bass, 2014)(Maria & Vilardell, 2016)	6	5	
Ability to direct, support, supervise, and maintain the development process by providing the information needed by distributed teams (Bass, 2014)(Hossain & Babar, 2009)		5	4
Product Owner Competencies	K	S	A
Ability to direct the conflict within a team so that each member feels challenged, encouraged, and motivated (Bass, 2015)(Noll & Butterfield, 2016)		5	4
Capability guarantees what many Scrum GSD teams need (Maria & Vilardell, 2016)	4		5
Ability to review collaboration strategies with other Product Owners (Maria & Vilardell, 2016)	4		
Ability to make stakeholders or customers involved and update at any time (Maria & Vilardell, 2016)	6	7	5
Ability to facilitate communication between customer and distributed Development Team (Srivastava & Jain, 2017)	6	5	

Table 4: Competence-based KSA for Scrum GSD team

The grouping was done because there are many slices of competence from the Scrum team's three roles. The first is the competence possessed by all roles. Next is the competence possessed by two roles: Development Team with Scrum Master, Scrum Master with Product Owner, and Development Team with Product Owner. The rest are competencies owned by each role.

Developing an educational process for increasing competence by compiling courses can use data from Table 4. The steps are designing instructional activities and assessment criteria for competencies as learning objectives. Planned activities can be in the form of discussion, oral presentation, case studies, simulation of actual situations with games, or group dynamics in developing software projects (Ching & Da Silva, 2017)(Mahnič, 2015). One example of implementing Scrum teaching with practical team-based project work is using Scrum protocols and artifacts in previous research (Poženel & Mahnič, 2016).

The common assessment method is in the form of questions. Examples of question models can refer to previous studies (Ching & Da Silva, 2017)(Kim et al., 2012). One example of a Scrum team competency assessment is the open assessment available at www.scrum.org. Some questions utilize multiple-choice models: choose one of two or many choices and choose two or more of the many options provided.

These competencies are beneficial for formal and informal

education. Higher education can incorporate them into teaching materials and curricula. For the training institutions, they could be references in preparing training programs and certification. The expected output is a Scrum team whose members are competent so they can work successfully in GSD.

7. Conclusions And Future Works

After a comprehensive literature review, in-depth interviews, and data processing using content analysis, the Authors compiled a KSA-based competency with its corresponding levels. Each Scrum team's roles, namely, Product Owner, Scrum Master, and Development Team, have their own KSA set. Not all competencies have a complete Knowledge (K), Skills (S), Attitude (A) component. Some competencies have one part, namely, K or A only. Others have two parts, namely, K with A, K with S, or S with A.

There are competencies that all Scrum team roles must have because they are the nature of Scrum and GSD. Several slices of competencies show the close collaboration of roles in the Scrum team, which is cross-functional (George et al., 2018). Particular competencies only have one role, which indicates the division of tasks in a self-managed Scrum team.

The research significantly contributes to forming the basis for

developing instructional activities and assessment criteria. This study provides an enriching reference for future studies that focus on GSD, competence, and KSA.

The authors will conduct validation involving stakeholders from the company and the GSD Scrum team, training institutions, professional associations, and government representatives for further research. The next project will develop a maturity model to enhance the competence of the Scrum team.

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