

## Team Formation for Agile Software Development: A Review

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**Abstract**— Rapid and unpredictable technology advancements cause a rise in demand for software products that can be delivered faster, adapt to volatile changes and save cost. Over the years, Agile Software Development (ASD) becomes more suitable as the software process that can cater to those demands while still maintaining the quality desired. With this Agile nature, it is apparent that the team that develops the software product need to have unique features as well. The team should also be formed correctly to gain effectiveness, strong performance and ultimately project success. Ineffective teams can be caused by, among others, conflict, inadequate skillset, unbalanced role assignment, lack of teamwork and non-competent team members. However, by far, the characteristics that need to be considered in forming effective teams are yet to be formalized. Thus, this study aims to identify the necessary characteristics in composing a competent team that is well balanced and can create coherent teamwork. The study involves a qualitative literature review which includes past studies about team formation specifically in the software development domain. The data were collected from online journal databases and analyzed using content analysis. From the analysis, six characteristics together with their attributes were identified as vital in team formation. Another two characteristics were also identified as influencing the six-team formation characteristics. These findings will need further empirical rigor before they can become a complete Agile Software Development team composition model. This model is believed to assist Agile practitioners in forming effective teams for their development projects.

**Keywords**— Agile software development; model; team formation; team composition.

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### I. INTRODUCTION

Software development is a crucial process in producing successful software products to meet demand from the rapid and unpredictable technology advancements. Development teams need to produce quality software that markets faster, has lower development cost and are quickly adapting to changes [1]. Agile Software Development (ASD) is seen to meet the criteria. On top of that, its development process is done iteratively in shorter phases as well as having secure communication between developers and customers, which apparently are among the factors for successful ASD [2].

Despite the glory of ASD, survey results have shown that Agile projects do face problems. The International Standish Group Chaos Report 2018 has stated that 58% of the Agile projects have failed or faced challenges. The “challenges” refers to projects that were either delivered late, experienced budget overrun, or have developed products with fewer functionalities than what was initially planned. On the other hand, ‘Fail’ means the projects were halted or never ever used at all after completion [3]. The causes of these failures can be traced back to the human aspects. Amongst the human aspects is about teams that function ineffectively [1]. Problems such as team members not complementing each

other, non-competent team members [4], conflicts due to incompatible personalities [5], insufficient skill-sets in a team and an imbalance of roles in a team can cause teams to be ineffective. Seemingly, these problems lead to the notion of inappropriate team formation (or team composition). Weak team composition can result in low performance and eventually can cause project failure [6].

A team is formed or composed by combining several individuals who are interacting with one and another in order to achieve common objectives. It should be formed correctly, with the right members doing the right tasks. This is done by getting the right combinations of team members’ characteristics with the appropriate roles they hold in a team [7]. Projects need effective development teams in order to achieve development success [8]. However, not much considerations were done on how the teams were formed and effective or ideal Agile team formations are yet to be discovered concretely. 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 motivation for this study.

To build a team formation model, it is essential to know what combinations of team roles’ characteristics that make

up the effective teams. Beforehand, the characteristics that should be taken into consideration must first be identified. To elucidate the concept of characteristics of roles in an Agile team, an analogy to a netball game can be used. The positions in the netball game can be likened to roles in an Agile team. Each position in the netball team requires certain characteristics for the position to be effective in a team. For example, the Wing Attack (WA) position requires a player who runs the fastest on-court, although she may not be the tallest. WA also needs someone with ball-handling and passing skills. Therefore, it is crucial to identify which player is suitable for which position in the netball team. Like the Agile team, each role requires specific characteristics that suit its purpose or responsibility in the team. Thus, the main aim of this study is to identify the necessary characteristics and their attributes to be considered in Agile software development team formation by reviewing past studies including existing models that are related to software development team formation. The characteristics identified are then consolidated into a conceptual model, containing characteristics needed to form a capable ASD team. The conceptual model will then be validated and refined in further empirical studies.

This paper has four sections. Section II is the material and methods which include related definitions and concepts which are a basis for our future discussions. Also included here is a brief explanation of the research methodology used in this study. Section III contains the results and discussions and finally, Section IV concludes the discussion together with future work.

## II. MATERIALS AND METHOD

This section discusses the background information on Agile software development (ASD), ASD team and team formation, including the existing team formation models for software development. The final part of this section briefly explains the research methodology.

### A. Agile Software Development

ASD method has emerged to overcome the shortfall of traditional methods. It provides a more lightweight framework to help development teams to respond faster and iteratively deliver software in increments [9]. It is much more flexible, and productive as well as are more able to satisfy the stakeholders' needs.

As with other software processes, Agile methods also need to follow some guidelines. Four key values closely guide it along with twelve supporting principles, as outlined in the Agile Manifesto. The key values promote individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation and respond to change over following a plan [10].

There are various Agile frameworks in practice, namely Scrum, Extreme Programming (XP), Lean, Kanban, Feature Driven Development (FDD) and Dynamic Systems Development Methodology (DSDM) [10]. Each of the frameworks has its way of implementation but still adheres to the values and principles outlined in the Agile Manifesto.

Due to the unpredictable and volatile nature of ASD, an Agile team would likely need to have different

characteristics from that of the traditional teams. The next section briefly discusses the ASD teams.

### B. Agile Software Development Team

Agile development is a team-oriented development that relies more on individuals and interactions rather than predefined processes [10]. An ASD team is a small group of people that have complementary skills, brought together (collocated), committed to achieve a common goal, interact in frequent face-to-face interactions, self-organized as well as they are mutually interdependent [11].

In a generic Agile development project team, the members' roles comprise the Agile Manager, Product Owner (PO) and the Developers [12]. The developers can consist of analysts, programmers, testers and the database manager. Each Agile method has their own different roles but in general, the three roles are the most basic ones.

As mentioned before, the nature of ASD is different from the traditional methods such that it is more suitable for fast development as a result of rapid business changes. Due to this nature, it is quite practical that the team for ASD needs to respond to those rapid changes and act accordingly promptly. Therefore, the ASD team must-have features that can adapt to the Agile nature in order to gain success.

Besides, apart from the team, ASD also emphasizes teamwork. The team members need to work together coherently as a unit in completing project tasks and not work in a silo. Well coherent teamwork will ultimately become effective teams [1] and able to achieve project success. The following section will discuss team members' characteristics that can form effective teams.

### C. Team Formation/Composition

Team formation or team composition has long been studied in the social science domain such as in human resource management (HRM), sociology and psychology. The importance of forming working teams are such as to increase productivity, innovation and gain team member satisfaction. However, the problem in forming a capable team always exists in work organizations including education, sports and businesses [13]. Besides, in software engineering, the research on human aspects such as team formation, are still much limited as compared to studies in technology and process [14].

Team formation is done at the project initiation of the ASD lifecycle phase, apart from the requirements and resource planning activities [15]. It is a process that starts by identifying and selecting the individuals with a certain set of required characteristics and then bring them together to form a synergized team with an appropriate composition according to its context of use [16]. In this study, the context of use is ASD. The characteristics of everyone do not have to be perfect but the critical significance is about the composition of their characteristics and behaviors in achieving successful Agile development i.e. on time delivery, being cost-effective as well as satisfies the stakeholders' needs.

There are two approaches in team formation namely bottom-up or top-down. Top-down formation is the conventional way of team formation whereby the team members are selected, formed and controlled by the upper

management. On the other hand, the bottom-up approach is done amongst team members themselves but still preserving context needs such as knowledge, skills and abilities which are required by each different development project. There are two variations of a bottom-up approach that is self-organized and self-governance. The self-organized composition resembles ASD such that it is stated in one of the Agile Manifesto Principles “The best architectures, requirements and designs emerge from self-organizing teams.” This means, even though the teams are self-organizing themselves, there is still an external entity that overlooks the project progress including the product delivery as well as the end products [17].

Generally, team composition can be either homogeneous or heterogeneous. Homogeneous means that the team members have the same characteristics whilst various means that there is a significant difference in characteristics between the team members. Since the Agile Manifesto states that an Agile team should be cross-functional (a mix of skills in one team), then team composition for an Agile team should be heterogeneous. Moreover, some degree of heterogeneity can ensure team performance and keep the team synergized. In a heterogeneous composition, the team members have different backgrounds but they need to be balanced in terms of experiences, technical skills, domain knowledge, team size, diversity (gender, race, culture, ways of thinking and how they solve problems and make decisions) [18].

One of the early steps in team formation is the selection of team members having suitable characteristics needed in a precise composition. In HRM for a specific project, there are several selection criteria when forming a project team. As stated in the Project Management Book of Knowledge (PMBOK) guidebook, the criteria taken into consideration when selecting project team members are much similar to the composition characteristics mentioned before such as knowledge, experience, ability, skill, attitude, availability, cost and international factors [19]. Availability refers to the ability of a team member to commit to the project team until it ends. The cost criteria, on the other hand, are to verify whether the cost to acquire the team member is still within the allocated budget. International factors are referring to the member’s location, time zone and communication capabilities.

The majority of the past studies on team composition for software developers were focused on personality characteristics [6]. Personality signifies ways of thinking, feeling and behaving. Personality traits are different from one individual to another. In the same vein, a specific personality trait fits a specific role. By identifying a suitable personality for a specific role, a balanced combination of roles can then be determined for a team [8]. For example, a Scrum team comprises Scrum Master (SM), Product Owner (PO) and Development Team (DT) roles. So, a suitable personality should be identified for each of the roles. For example, for a SM, the person needs to have patience and both PO and SM should be an organized person. These personality traits can be assessed using established assessment tools that are available in the market. Amongst the famous ones in computing and psychology domains are as Myer-Briggs Type Indicator (MBTI), Keirsey

Temperament Sorter (KTS), Five-Factor Model (FFM) or famously known as The Big Five [20]) and HEXACO [21]. For this study, the personality attributes were extracted from HEXACO personality inventory items which comprise six traits namely Honesty-Humility, Emotionality, Extraversion, Agreeableness, Conscientiousness and Openness to Experience. The HEXACO was selected over FFM due to the Honesty-Humility trait which is vital in an Agile software development team [22] but was not included in FFM. Each of the facets can be further described by narrow traits as stated in Table I.

TABLE I  
HEXACO PERSONALITY INVENTORY

No	Personality Traits	Narrow Traits
1	Honesty-Humility	<ul style="list-style-type: none"> <li>• Sincerity</li> <li>• Fairness</li> <li>• Greed Avoidance</li> <li>• Modesty</li> </ul>
2	Emotionality	<ul style="list-style-type: none"> <li>• Fearfulness</li> <li>• Anxiety</li> <li>• Dependence</li> <li>• Sentimentality</li> </ul>
3	Extraversion	<ul style="list-style-type: none"> <li>• Social Self-esteem</li> <li>• Social Boldness</li> <li>• Sociability</li> <li>• Liveliness</li> </ul>
4	Agreeableness	<ul style="list-style-type: none"> <li>• Forgiveness</li> <li>• Gentleness</li> <li>• Flexibility</li> <li>• Patience</li> </ul>
5	Conscientiousness	<ul style="list-style-type: none"> <li>• Organization</li> <li>• Diligence</li> <li>• Perfectionism</li> <li>• Prudence</li> </ul>
6	Openness to Experience	<ul style="list-style-type: none"> <li>• Aesthetic appreciation</li> <li>• Inquisitiveness</li> <li>• Creativity</li> <li>• Unconventionality</li> </ul>
7	Interstitial Scale	<ul style="list-style-type: none"> <li>• Altruism</li> </ul>

Each value of the personality traits is then determined by assessing each of its narrow traits. An example of how HEXACO is used can be attained in [21]. However, just combining team members’ personalities is still not enough to form an ideal team such that it concerns only the “soft” skills portion. The good combination should also include “hard” skills [20]. Hard skills refer to technical skill and soft skills refer to non-technical such as personalities, interpersonal and intrapersonal skills. Isolating these two kinds of skills can detriment project success [23]. Skills belong to another composition characteristic that is called competency [24].

Competency is about the ability of someone to do a task correctly. In the management domain, it is considered as the combination of knowledge, skill, ability and attitude [25]. Therefore, these characteristics need to be considered in the formation model as they indicate how team members deliver their job. The differences of knowledge, skill and ability are as in Table II [26].

TABLE II  
HEXACO PERSONALITY INVENTORY

Aspects	Knowledge	Skill	Ability
Definition	Theoretical and practical understanding towards a certain subject.	The efficiency gained thru practice and experience.	The quality of being able to do something.
Acquired thru	Gained thru learning or experience.	Gained thru practice or learned behavior.	Naturally.
Development	Knowledge increases thru experience.	Skills can be developed thru practice.	Ability can be improved to a certain level.
Example	Know how to bake a cake (theory).	Have skills and practice in baking a cake.	Having a natural ability like attention to details.

Basically, knowledge covers education background such as professional certification [27], domain or business knowledge [10], technical knowledge [28] and project management [29]. Skill characteristic comprises of technical skill [30], domain skill [31] as well as interpersonal skill [10]. Interpersonal skill is actually a group of many other skills such as negotiation [9], [32], coaching and facilitating [28], [30], communication skill [24], decision making, conflict management and leadership skill [32]. In addition to that, the following skills are also related to interpersonal skill: team members should be responsive, able to share experiences [28], adaptive to changes as well as be protective of his or her teammate [22]. Each of the interpersonal skill elements found in literature regarding team composition that matches the definition of interpersonal skills are grouped together. For example, for the role of Scrum Master (SM), one of his/her job is to protect the team from forceful product owners. SM is also responsible to protect the team from being complacent or being too satisfied with their work that they would not push themselves in search of work improvements. Being protective is one of the values of leaders and thus it is grouped under “leadership”.

The third competency element that should be taken into consideration is the abilities of the team. Team members should have the ability to learn new knowledge [33]. As time progresses, technology advancements are inevitable. This would affect current knowledge that relates to the technology. Therefore, team members should be able to cope with any new knowledges that are needed to complete their tasks in development projects.

The attitude should also be considered because it determines whether a team member is able to work with others as a cohesive team [19]. It can also indicate if the team member is committed [9], that is being available during a project duration [34]. Also, attitude characteristic involves whether the team member implements good Agile practices in a development project [28], [32].

Experience is also beneficial to be considered when composing a team [5]. Experience represents any knowledge or skill acquired during the profession of a team member. The experience are such as experience of any similar

projects in the past [10], and experiences in managing projects are quite advantageous [31] to a project. The team member can learn from his or her past experiences and implement it in the current project.

This study also looks at existing software development team formation models. However, there were only a few models that were found in previous studies. The team formation models that were identified include team composition, team selection and team allocation models. Five examples of the models are a rule-based model [35], an enterprise social network [24], a guideline of agile team selection [36], team mental model [17] and capability-oriented software process model [37]. The characteristics taken into consideration in these models seem to be relevant to this study. From the analysis of the models, the characteristics that were identified are summarized as follows: gender, personality, experience, skills, knowledge, abilities, competence, roles, availability, team size. Team composition also depends on project complexity [38], project size and project criticality [10].

Past studies have also investigated the composition of the team according to members’ roles. As mentioned before, the roles are different across Agile methods. Thus, for each Agile method, there are specific responsibilities and tasks for different roles. For example, the SM role for Scrum Agile method. An SM is responsible for managing the Scrum processes, coaches and acts as a facilitator to the team, protects the team, improves team efficiency and also implements all Scrum practices [27]. So, in order to deliver the responsibilities, the SM need to have certain characteristics. For example, the interpersonal skill needed for a SM is coaching and facilitating skill. A SM also need to be good in communication skill in order to converse with the product owner and the team. SM also needs to be a good leader, which is also under the interpersonal skill category.

Project complexity, size and criticality can be grouped into Project Characteristics. Project characteristics affects the strategy in implementing Agile and each organization should set the ideal team for certain situation [38]. Agile team formation depends on project characteristics because different projects requires different team composition. Past studies also suggests that there should be some diversity in terms of the gender, age, race, ethnicity and culture [25] of team members. Team size also plays a part in the effectiveness of a team. Agile teams is said to be more effective in small sizes [15]. Therefore, the scope of this study will concentrate on small teams and thus the attribute is not included in the model.

#### D. Agile Software Development

In general, this study aims to answer the following research question (RQ): What are the necessary characteristics and their attributes taken into consideration when forming Agile software development teams?

The RQ was answered qualitatively by using literature review method. This review involved data that was collected from online published journal databases namely IEEE, Scopus, Springer Link, Science Direct, Emerald and Google Scholar. The basic search keywords were Agile AND (team OR group) AND (“team formation” OR “team composition” OR “team allocation” OR “team selection” OR “team

building” OR “team creation” OR “team configuration” OR “team setup”). This basic search query was then fine-tuned to match the formats of each online journal databases accordingly.

The selected articles were published from 2007 to 2019 although some earlier articles were also retrieved through snowballing technique. The search scope was refined to include only for collocated teams thus, excluding the globally distributed teams or virtual teams. Also included are studies whose participants involved university students enrolled in computing courses such as Software Engineering or Information Technology. The students were also involved in a software development project thus are appropriate and aligned with this study. In addition, the Agile methods were not restricted to certain types such as Scrum or XP, therefore all Agile methods were included. Another point to note is that, the literature uses terms such as team formation and team composition very regularly to hold the same meaning. However, when “team composition” term is used, normally the objective of the article is focused on the team composition characteristics and not about team formation in general.

The selected journal articles were then analyzed using Contents Analysis [39], which is a qualitative analysis technique. This research technique is used to simplify the contents of text materials such as speech text, written text and interviews into a more understandable format [40]. The technique includes making conclusions from the text material whereby text contents are organized and classified into more logical categories. In this study, this was done inductively and deductively, repeatedly throughout the study until no new characteristics or attributes were found from the collected data. The result is a conceptual model of ASD team formation that is discussed in the following section.

### III. RESULTS AND DISCUSSION

From past studies and current team formation models for software development domain, the characteristics that have been identified are as shown in a conceptual model in Fig. 1.

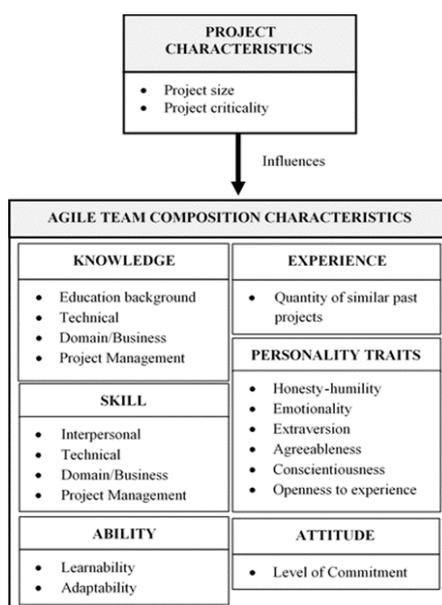


Fig. 1 Conceptual model for ASD team formation

The figure contains two main components namely project characteristics and Agile team composition characteristics. As depicted in the figure, the Project Characteristics can influence the Agile Team Composition Characteristics.

Project characteristics comprise of attributes such as project size and project criticality. The project complexity was omitted because it relates to project size such that the bigger the size, the more complex it gets. The project characteristics’ attributes influence the team composition in that different values will result in different composition. For example, a high project criticality may need more expertise on a certain area in the team and so forth. Personnel diversity takes into consideration the diversity of team members in terms of age, gender, race, ethnicity and culture. The more diverse the team members are, the higher the diversity value is.

The team member roles depend on which Agile methods that are being implemented. For example, in Scrum, there are three main roles namely Scrum Master, Product Owner and Developers. Each of these roles will have different composition characteristics. For example, the interpersonal skill that is important for a Scrum Master are such as negotiation skill, coaching/facilitation skill and motivation skill. However, the development team need not have facilitation skill but importantly needs to have presentation skill.

Five main Agile team composition characteristics are taken into consideration namely knowledge, skill, ability, experience, personality and attitude. To form an effective team, these team composition characteristics should achieve the right combination of all the characteristics and their attributes for each role.

Competency is also known as knowledge (K), skill (S) and ability (A). The three KSA characteristics are closely related and their differences are very subtle. Knowledge is the theoretical part of a subject and the skill is the proficiency that one has developed over the years in applying the knowledge. Ability in the other hand, refers to the qualities of being able to apply knowledge and skill in doing something.

Knowledge of a team member that are to be considered is his background knowledge in Agile software development. For example, for a Scrum Master role, it would be advantageous to have a professional certificate for Scrum Master. In the other hand, technical knowledge or skills refer to the technology part of computer-related tasks. Examples for technical knowledge/skill are such as code programming, networking and system design. Also, this includes specific Agile practices such as pair programming and refactoring. Domain/business knowledge and skills refer to the knowledge/skill of the environment where the developed software operates. Examples are such as financial system, educational management system and weather monitoring system. The knowledge and skill also include for project management knowledge and skill respectively.

Interpersonal skill is regarding the skill of a person when interacting with others. It covers a wide range of skills such as negotiation, coaching, facilitation, communication, decision making, critical thinking, conflict management, creative thinking, game thinking, leadership, collaboration, teamwork, time management, planning, problem solving,

dealing with change, diplomacy, stress handling, presentation, active learning, relationship management, socialize, motivation and also respect. Each role in a team needs to have certain interpersonal skills, appropriate to the tasks that the role is responsible for. Therefore, when forming a team, it is also necessary to assess the team member's interpersonal skill in order to determine the suitability of the person to the role. As for the ability characteristic, its attribute is the ability to learn new knowledge when needed as well as adaptability to changes. Adaptability is an important attribute in Agile development as mentioned earlier in this paper.

Experience characteristic includes the quantity of similar past projects. The idea behind this is, the more a team member has experienced similar projects in the past, the better. This might not be applicable to all roles in a team but having such experiences can be beneficial to the team and ultimately to the whole project.

The attitude is also another important characteristic that need to be considered when forming a team. A team member needs to give full commitment to the team and be available throughout the project duration and not involving with other teams.

Finally, is the personality characteristic. Personality signifies a person's ways of thinking, feeling and behaving. It is the personality that differentiates a person to another. Past studies have been done to find compatible personality composition in a team. Personality can be measured by utilizing well established assessment tools from the psychology domain. Two widely used tools that are suitable to measure personalities of software developers are the MBTI and FFM. However, during the theoretical data analysis, there was one attribute identified in the literature but does not belong to any of the two tools which is the "honesty" trait. Nevertheless, there is another personality inventory tool called HEXACO that includes "honesty" and deems suitable to be the alternative personality assessment tool in this study.

HEXACO tool measures personality from six traits dimensions. The dimensions are i.e. Honesty-Humility, Emotionality, Openness to Experience, Agreeableness, Conscientiousness and Extraversion. Each personality dimension comprises of more narrow traits that is more precise in describing that trait. For example, for a positive Extraversion dimension, the facets are outgoing, lively, extraverted, sociable, talkative, cheerful and active. In the other hand, a negative value for Extraversion dimension includes facets such as shy, passive, withdrawn, introverted, quiet and reserved. In short, a certain personality type is suitable for a certain role. The suitability of which personality types to roles will be identified during empirical study. During team formation, to ensure that a person suits a role, his or her personality type need to be determined first by taking the test. The results of the test will then be mapped against the suggested personality type-role to determine which role is suitable for that person. However, it is important to take note that personality composition alone is still not adequate in forming effective teams and thus need to include other characteristics as mentioned in this section.

One possible use of the characteristics that have been identified in this study is a team composition matrix. The

composition matrix be an extension of the competency matrix. The matrix contains columns and rows that represents the roles in a team and the characteristics respectively. Each characteristic will be detailed by its corresponding attributes. The cross-section of the rows and columns may or may not contain values (e.g. high, low or medium). For each attribute, the composition is determined by the different values for each role. Different project characteristics will have different team compositions. The values for each attribute that corresponds to each role will be determined during empirical study. At the end of the day, the matrix can be a guide to practitioners when forming a team, according to the project characteristics.

#### IV. CONCLUSIONS

This paper has identified the vital team composition characteristics together with their attributes when forming an effective team. The elements were collected from various past studies regarding team formation for software development teams, including any related models. Using contents analysis, the study has identified six composition characteristics namely knowledge, skill, ability, attitude, experience and personality. Another characteristic that was found to be influencing the composition characteristics, which is the project characteristic. The findings are collected solely from literature and thus future work involves more rigorous empirical work before a comprehensive model can be developed and validated. This model is expected to assist the Agile practitioners in forming effective teams. It is hoped that by having effective teams, projects will have less impediments in achieving success.

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