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A Selection of Affected Parameters of AGILE Methodology using Analytical Hierarchical Process

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Abstract :

Requirements engineering (RE) is considerably different in agile development than in more traditional development processes. Agile software development has large success rate due to its benefits and promising nature but natively where the size of the project is small. Effective Agile adoption increase overall productivity and quality of software but the complexity of software projects and multidisciplinary nature of requirements engineering (RE) makes the agile implementation a cumbersome process. Though agile provides values to customer's business needs, changing requirement, and interaction, also we have to face impediments in agile, many of which are related to requirement challenges.This article aims to find out the characteristics being faced during requirement engineering of agile projects. We conduct a quantification of AHP based priotrization of agile characteristicswith specific value of the included studies.

Keywords: Requirements Engineering, AHP, Agile software development

I Introduction :

Over the years, most of the software development methods have been made immaculate and then referred to as traditional methods. One of the oldest of these traditional methods is waterfall which was firstly explained by Winston Royce in 1970. It is still very much in vogue widely practiced both in large and small projects. The Waterfall model is a sequential design process which is used in software development processes where progress palpably is flowing downwards like a Waterfall through the phases of requirement gathering and analysis, design, coding, testing and maintenance. Every stage is to be treated separately at an opportune moment so you cannot jump stages. Documentation is done at every stage of a Waterfall model, providing an opportunity to the people to decipher as what has been done. Similarly testing is carried at every stage. Waterfall method is understood for its concrete and complete requirements and these features make this approach more viable and stable. It is often said about this method that spending more time early in the cycle can pave way to greater success at later stages.The Agile development method came to limelight as the result of gathering of seventeen representatives from the software development industry in snowbird, Utah in 2001. Their intention was to develop innovative approaches to software development that would make organization react rapidly and adapt to volatile requirements and technologies.**S. Nerur et al. (2005)** conducted a systematic literature review on the topic of the integration of agile methods and user centered design approaches. The review focused on usability issues in agile methods with respect to design. The findings show that usability issues in agile methods can be addressed by incorporating a user centered design specialist role in agile teams. P. Rola **et al. (2016),** examined the effect of the usage of agile development practices in large organizations. Software Requirements describe features and functionalities of the target system it also tells the expectations of the users from the software product. The requirements can be obvious or occult, either it is known or not known, expected or unexpected from client's point of view. The formidable single part of making a software system is deciding clearly as what to build. No other part of the conceptual work is as formidable as making the detailed technical requirements. The process to glean the software requirements from client, analyze and document them is named requirement engineering.

II Suggested Integration of activities into Agile Methodologies :

A Scrum is merely an agile, lightweight method for managing and controlling software and product development in fast-changing settings in terms of agile project leadership. Agile is Scrum is a prevalent misconception, and while Scrum is indeed agile, it is not the only technique employed for implementing agile principles. Scrum is just one of many agile product development methods.Scrum therefore, is simply an agile technique of delivering iterative and incremental products using frequent feedback and collaborative decision-making.**Agile-Scrum** is an iterative development process becoming very popular in industry. However, as in all Agile methodologies, there is a resistance to the development of traditional documents. Instead of a requirements specification. In the Agile-Scrum methodology, changing the product backlog is a normal part of the development process **(**J. Lopez-Martinez**, 2016).** This notion conflicts with much of the current literature on requirements engineering and management. Even in traditional development processes, requirements frequently change; but there is usually a decrease in quality and an increase in cost that is associated with the level of changes. Based on Agile methodology, growing popularity and positive reviews by developers and users, there must be some aspect of Agile-Scrum that mitigates the traditional problems associated with high levels of requirements changes. Agile-Scrum is an iterative framework for managing complex work, such as new product development commonly used with agile software methodologies. Change is an inherent part of Agile-Scrum. One of the most important aspects of Agile methodology is that change is a built-in aspect of the process. However, Agile-Scrum sees change in requirements as a positive aspect to the success of the software project and quality of the software product. Changes to requirements are inevitable in the software development process. There is need to manage these frequent changes so the quality of the product can be measured or to ascertain that the prioritized requirements have been implemented and traced to the source. Requirements management and Agile developments are current areas of study. Agile is release-oriented and intended for conditions where value is required fast, frequent, and without fail**(P. Sincharoenpanich, 2013).** The advantages of the Agile approach for patching are:

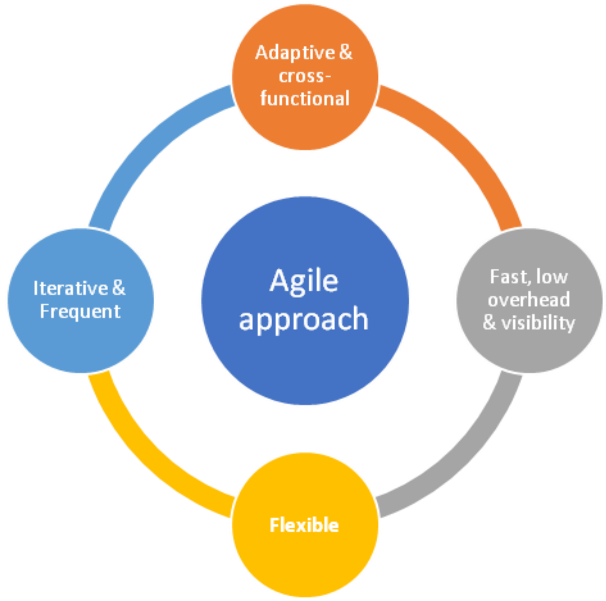

Fig 1: Supports parameters for agile approach

III Fishbone Model :

In this observation, we have developed to fishbone model for identifying and grouping the causes which generate a quality problem.The method has been used also to group in categories the causes of agile methodology improvements problems which atarget confronts with. This made Fishbone diagram become a very useful instrument in **(C1:Iterative & Frequent, C2: Fast, low overhead & visibility, C3:Adaptive & cross-functional, C4:Adaptive & cross-functional)**identification stage. This paper proposes to extend the applicability of the method by including in the analysis the probabilities and the impact which allow determining the characteristics for each category of Agile methodology. The Fishbone diagram is an analysis tool that provides a systematic way of looking at effects of agile criteria and the causes that create or contribute to those effects on Scrum based observation. Because of the function of the diagram,it may be referred to as a cause-and-effect diagram. The design of the diagram looks much like the skeleton of anagile issues.Some of the benefits of constructing a fishbone diagram(belowfigure) are that it helps determine the rootcauses ofa problem or qualitycharacteristic usinga structured approach.

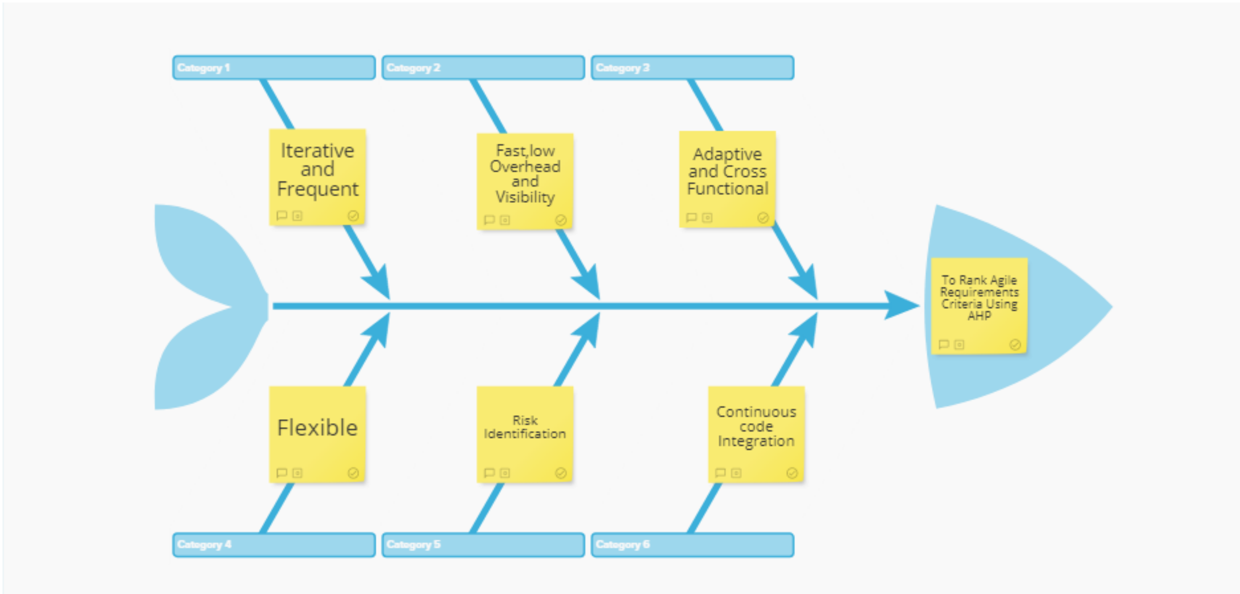

Fig 2: A fishbone model for agile methodology improvement

IV Model Development :

To address agile criteria selection problem, a study using Analytic Hierarchy Process (AHP) is conducted. The Analytic Hierarchy Process (AHP) is a method for organizing and analyzing complex decisions, using math and psychology. It was developed by Thomas L. Saaty in the 1990s and has been refined since then. It contains three parts: the ultimate goal or problem you're trying to solve, all of the possible solutions, called alternatives, and the criteria you will judge the alternatives on. AHP provides a rational framework for a needed decision by quantifying its criteria and alternative options, and for relating those elements to the overall goal.

The model as shown in Figure 3 can be divided into four parts, the first part on the top that describes the factor variables in proposed model , that are iterative and frequent, fast, low overhead and visibility, adaptive and cross functional and flexible. The criteria are selected from the literature review as they are the most important factors that most of the authors are focusing.

The second part on the left that describes the general steps of AHP i.e.

1. Problem Structuring :

   i) Define the decision problem and goal

   ii) Identify and structure decision criteria and alternatives

2. Evaluation :

   iii) Judge the relative value of the alternatives on each decision criteria

   iv) Judge the relative importance of the decision criteria

   v) Group aggregation of judgments

   vi) Inconsistency Analysis of judgments

3. Choice :

vii) Calculation of weights of the criteria and priorities of the alternatives

viii) Conducting sensitivity analysis

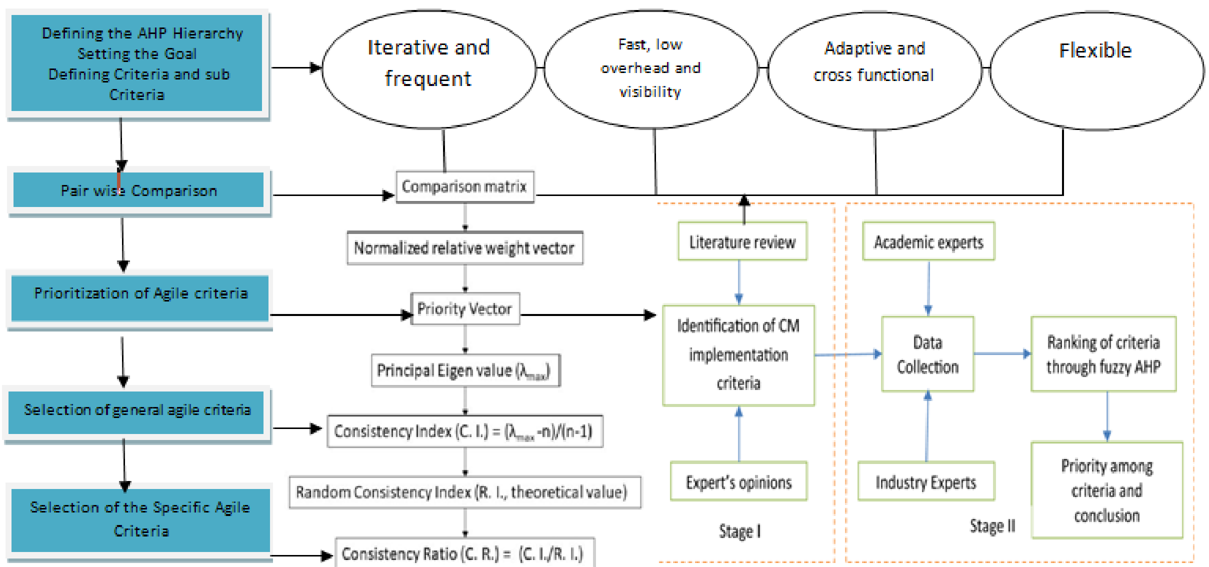

Fig 3: AnAgile Criteria Selection Model for Agile Methodology Improvement using AHP

The third part in the middle that describes how to implement AHP using above agile requirement criteria.A **Pairwise Comparison Matrix** (PCM) is used to compute for relative priorities of criteria or alternatives and are integral components of widely applied decision making tools: the Analytic Hierarchy Process (AHP).Fundamental AHP judgment **scale** with integers 1 to 9 and their verbal equivalents (**Saaty**, 2008). Theoretically there is no reason to be restricted to these numbers and verbal gradation, and several other numerical **scales** have been proposed. They are summarized, based on Ishizaka & Labib (2011).The normalized principal **Eigen vector** is also called priority **vector**. Since it is normalized, the sum of all elements in priority **vector** is 1. Principal **Eigen** value is obtained from the summation of products between each element of **Eigen vector** and the sum of columns of the reciprocal matrix.The consistency of the AHP will be determined by the value of C.I. from the pairwise comparison table. If its value is for the case exceeding 0.1 (Saaty's criteria 1990) is not consistent, pairwise comparison has to perform again.A true **Consistency** Ratio is calculated by dividing the **Consistency** Index for the set of judgments by the Index for the corresponding random matrix.A CR of 0 means that the judgments are perfectly **consistent**.If the **value** of **Consistency Ratio** is smaller or equal to 10%, the **inconsistency** is **acceptable**. If the **Consistency Ratio** is greater than 10%, we need to revise the subjective judgment. And the last fourth part on the right side describes the general layout of all the three parts.

V Model Implementation using Analytical Hierarchical Process :

As per the table 1 we have selected four factors and will apply AHP method to determine its priority, it one of the finest and popular solution to determine the priority of different factors. Generally, there are six stages in the product development process [7]. One of them is conceptual design. It consists of three processes, namely concept generation, concept evaluation and concept development. Be this as it may, concept evaluation or selection is discussed in this paper. In order to choose the most suitable method for the preparation of nanoparticles, the following AHP steps:

Define the problem :

A case study for this research is about selecting the best method for the preparation of nanoparticles. After performing several steps of method selection, there are seven possible methods remain, as listed below. Thus, it is necessary to choose the most suitable of these methods by using AHP:

Criteria: C1, C2, C3, C4

C1 **Iterative & Frequent**,

C2 P **Fast, low overhead & visibility**,

C3 **Adaptive & cross-functional**,

C4 **Adaptive & cross-functional**,

Alternatives:A1 Low, A2 Moderate, and A3 High.

Table 1: Alternative and Criteria decision table

Column1	Iterative & Frequent	Fast, low overhead & visibility	Adaptive & cross-functional	Flexible
Low				
Moderate				
High				

Table 2: Pairwise comparison of criteria with respect to low Alternative

Low	Iterative & Frequent	Fast, low overhead & visibility	Adaptive & cross-functional	Flexible
Iterative & Frequent	1.00	4.00	5.00	6.00

Fast, low overhead & visibility	0.25	1.00	4.00	5.00
Adaptive & cross-functional	0.20	0.25	1.00	4.00
Flexible	0.17	0.20	0.25	1.00

In the table 2, we have also assigned the weight for the criteriawith respect to low Alternative. We have connected the results of the complete evaluation with the factor analysis and the results of the factor analysis have served as input in the multicriteria decision model (AHP) that we have developed in thistable. We have used factor analysis to validate the theoretical model **(Table 2),** to reduce a large number of variables to a smaller number of factors for modelling purposes **(AHP Modelling),** to specify the strength of the relationship between each criterion and each alternative and to determine which sets of items should be grouped together in the theoretical model [6]. For the next phase of the AHP model, paired comparisons were made between the sub-criteria on the same level [5]. In order to, Pair Judgment Scale was used for these comparisons and the preferences for each element were, therefore, determined. Having obtained these values, comparison matrixes were generated for the sub-criteria and generates the agile characteristics value, as shown in Tables 3, 4.

Table 3: Pairwise comparison of criteria with respect to Moderate Alternative

Mod	Iterative & Frequent	Fast, low overhead & visibility	Adaptive & cross-functional	Flexible
Iterative & Frequent	1.00	2.00	3.00	4.00
Fast, low overhead & visibility	0.50	1.00	2.00	3.00
Adaptive & cross-functional	0.33	0.50	1.00	2.00
Flexible	0.25	0.33	0.50	1.00

Table 4: Pairwise comparison of criteria with respect to High Alternative

High	Iterative & Frequent	Fast, low overhead & visibility	Adaptive & cross-functional	Flexible
Iterative & Frequent	1.00	3.00	4.00	5.00
Fast, low overhead	0.33	1.00	3.00	4.00

& visibility				
Adaptive & cross-functional	**0.25**	**0.33**	1.00	2.00
Flexible	**0.20**	**0.25**	**0.50**	1.00

In this stage, once the comparison matrices **(table 5)** have been constructed, they are standardized. One of the most frequently used standardization procedures is to divide each number of a column in the paired comparison matrix by the total sum of the columns. Subsequently, the arithmetic mean is computed for each line (C1, C2, C3, and C4) of the standardized matrix and the relative priorities (auto-vectors) for each of the criteria are thus determined. Table 5 provides a matrix for the agile approach sub-criteria in:

Table 5: Pairwise comparison of criteria with respect to overall

	Iterative & Frequent	Fast, low overhead & visibility	Adaptive & cross-functional	Flexible
Iterative & Frequent	1.00	3.00	4.00	5.00
Fast, low overhead & visibility	**0.36**	1.00	3.00	4.00
Adaptive & cross-functional	**0.26**	**0.36**	1.00	2.67
Flexible	**0.21**	**0.26**	**0.42**	1.00

Calculation of criteria weight decision :

Based on linguistic variables the evaluation values of attribute weight for each decision maker can be obtained on average of individual assigned weight and the results are shown in Table 6.

Table 6: Individual Ratio of criteria

Criteria Weight	0.39473684	0.31578947	0.21052632	0.07894737			
	Iterative & Frequent	**Fast, low overhead &**	**Adaptive & cross-**	**Flexible**	**Weighted Sum**	**Criteria Weight**	**Ratio**

		visibility	functional		Value		
Iterative & Frequent	0.21596545	0.20495951	0.10005211	0.03116343	0.552141	0.39473684	1.398756
Fast, low overhead & visibility	0.07798752	0.06831984	0.07503908	0.02493075	0.246277	0.31578947	0.779878
Adaptive & cross-functional	0.05639098	0.02467105	0.02501303	0.0166205	0.122696	0.21052632	0.582804
Flexible	0.02428791	0.01157824	0.00495307	0.00246027	0.043279	0.07894737	0.548207

Synthesizing the pairwise comparison :

To calculate the vectors of priorities (table 6), the average of normalized column (ANC) method is used. In ANC the elements of each column are divided by the sum of the column and then the elements in each resulting row are added and this sum is divided by the number of elements in the row (n). This is a process of averaging over the normalized columns. The summary results for this calculation are shown in table 6. In mathematical form, the vector of priorities can be calculated as:

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_i^n a_{,ij}}, i, j = 1,2, \dots \dots n$$

Table 6: Consistency test for criteria

Criteria Weight	0.39473684	0.31578947	0.21052632	0.07894737
	Iterative & Frequent	**Fast, low overhead & visibility**	**Adaptive & cross-functional**	**Flexible**
Iterative & Frequent	0.21596545	0.20495951	0.10005211	0.03116343
Fast, low overhead & visibility	0.07798752	0.06831984	0.07503908	0.02493075
Adaptive & cross-functional	0.05639098	0.02467105	0.02501303	0.0166205
Flexible	0.02428791	0.01157824	0.00495307	0.00246027

Ratio determination of each criterion :

Weighted sum of individual criteria divided by individual criteria weight will result into the ratio of each criterion as shown in table 8.

VI Discussion and Observation :

From table 8, we have moved to calculate consistency and induvial ranks of each criterion. Also, we apply to the comparisons are carried out through personal or subjective judgments, some degree of inconsistency may occur. To ensure the judgments are consistent, a final operation called consistency verification, which is regarded as one of the most advantageous features of the AHP, is incorporated in order to measure the degree of consistency among the pairwise comparisons by computing the consistency ratio. In order to, we have calculated to consistency ratio (CR), consistency ratio (CR), eigenvalue from following formula:

Calculate the consistency index (CI):

$$CI = (\lambda_m - n)/(n - 1)$$

Where n is the matrix size.

Finally calculate consistency ratio (CR). The CR can be calculated using the formula:

$$CR = CI/RI$$

Selecting the appropriate value of random index (RI), for the matrix size of five using established RI chart and then calculate the consistency ratio (CR), The summary results for this calculation are shown in Table 9. In table 9, we have to initiated the CR and CI value for complete observations respect to agile characteristics. The table 9 are shown that CR value < 0.05 =0.09 (true), so we have ensured that our observations for criteria priority is accurate.

Table 7:Summary and CR value

Eigen value	**1.398755946**	
CI=	**0.867081351**	
RI for n 4	**9.9**	
CR=	**0.09**	**TRUE**

It is quite clear that selection of agile characteristics factor involves a large number of considerations. The use of AHP method is observed to be quite capable and computationally easy to evaluate and select significant effect of criteria from figure 2. AHP method uses the measures of the considered criteria with their relative importance in order to rank the agile criteria with respective results in chart 1. Thus, this popular AHP Method can be successfully employed for solving agile criteria of decision-making having any number of criteria and alternatives in the agile scrum-based domain. In next we have moved to establish the correlation between agile scrum-based domain and security observations of agile methodology.

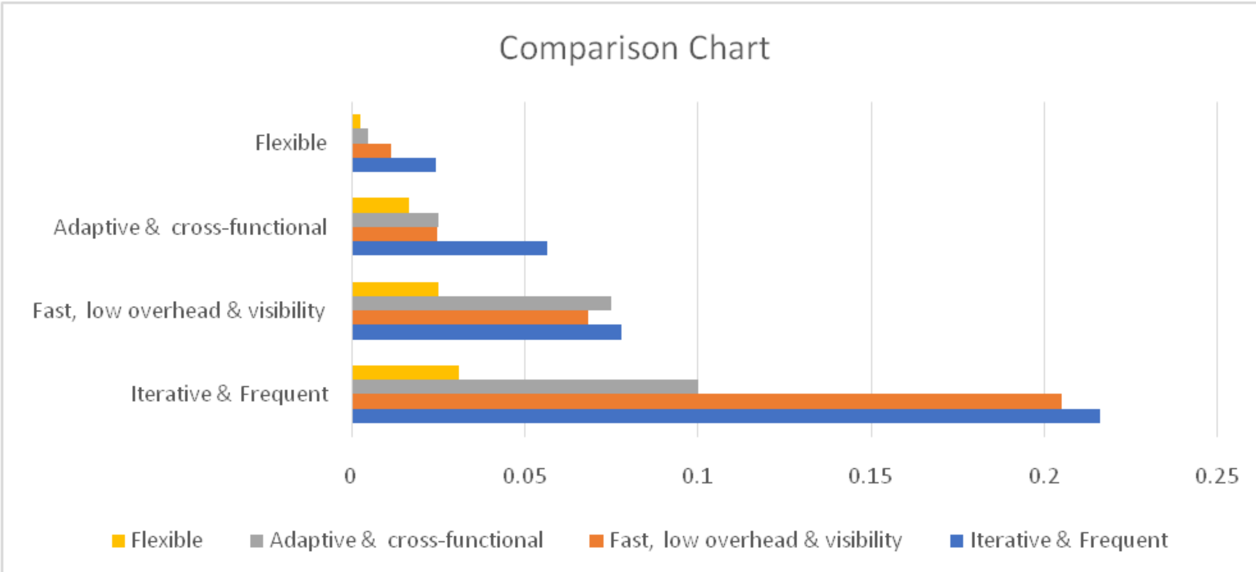

Fig:1 Comparison of criteria weights

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