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Priority based Agile Estimation for Size and Time (PAEST)

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Abstract: *Agile estimation process is an emerging research area because of agile practice of accepting requirements at any stage. Some agile practitioners are using agile estimation of size and time based on expert opinion and planning poker game. These methods are non-algorithmic method whereas algorithmic method of estimation always useful for novice estimator as it is based on empirical study. In this paper, we have proposed algorithmic method, Priority based Agile Estimation for Size and Time (PAEST) for projects using agile practices. PAEST incorporates the identification of factors estimating size of projects based on its priority and impact on the project. Size and Time estimation are computed as function of priority factor of project attributes and uncertainty in requirements of the projects. Paper also elaborates the case studies of various domain of software projects along with priority and intensity level of factors affecting the project estimation. We have incorporated three domains: web application, MIS project and critical software and seven project attributes out of 21 attributes used by generalized estimation method in our case studies. Number of project attributes can be scalable to any number depending on project domain. Algorithm prioritizes the project attributes and generates the estimates of the project more realistic. Introduction of prioritization helps novice to get estimates more precise. In our study we observed that uncertainty in project have more impact than project attributes.*

Index Term: *Agile Estimation, CAEA, GEM, Software Estimation.*

I. INTRODUCTION

Agile Methodology (AM) has generated the new era of software development by introducing concept of working software, daily meeting, continuous customer involvement etc. Agile estimation process is an emerging research area because of agile manifestoes and practices [5]. Some agile practitioners preferred that agile estimation is just fragile and wastage of time and opponents disagreed and found lack of estimation methods that eliminate the need of experts and historical data [2]. Increasing popularity of agile methods in volatile requirements has been generated the need of algorithmic estimation methods. Constructive Agile Estimation Algorithm (CAEA) has proven to be useful for agile estimation in case of unavailability of historical data and experts [3].

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CAEA incorporated vital factors for estimation namely; performance, complex processing, configuration, operation ease, data transfer, multiple sites and security [3].

It has been observed that CAEA has been beneficial for average project manager to estimate precisely but vital factors depends on only project under consideration. However, size and time estimation of project also depend on ergonomic environment of organization and team attributes A new Generalized Estimation Method(GEM) also introduced that incorporates around twenty one vital factors categorized in various classes [4]. We have analysed many projects of various domains and noticed that all aforesaid vital factors are important in estimation process but type of vital factors also plays an important role in estimation process. However, it has been observed that there are two limitations of the CAEA; firstly, it mainly concentrated on number of vital factors having high intensity levels instead of type of vital factors and lastly, algorithm generates the same results for two projects with all vital factors having same intensity values but having different uncertainty levels of requirements, technology and team. Later algorithm, GEM works on intensity level of vital factor but does not prioritize in view of customer. Although, GEM is useful for novice in agile estimation but there is need to develop algorithm for estimation that addresses the agile practices along with the simple method of computations.

In this paper, we proposed Priority based Agile Estimation of Size and Time (PAEST) for agile project estimation that computes the time and size of project estimates on the basis of priority of project attributes and level of uncertainty level in project requirements. Usefulness of PAEST is evaluated by estimating various projects of different application domains based upon various categories. These categories are classified on the basis of number of attributes to be considered with intensity along with prioritization. Also, impact of uncertainty of project has been studied in each category to establish the fact that uncertainty of requirements highly affects the project estimation.

II. REVIEW

Agile software development prefers customer satisfaction over contract negotiations [1, 2]. Agile practices such as continuous feedback for improving quality of software, customer involvement and acceptance of last minute changes result in higher adoption rates in industry [3].

Estimation of any project is always matter of chaos among the customers and project managers [4]. Agile projects deals with volatile requirements thereby making agile estimation cumbersome [5]. Realistic estimates are always a step towards building trust and faith among the customers as well as generate a satisfaction and confidence among the team by delivering the product on time and in budget [6]. Estimation of agile projects is always an emerging issue due

to lack of algorithmic estimation methods. Agile estimation has been performed using planning poker, disaggregation etc. as popular methods [7, 8, 9]. All these methods require expert and historical data to estimate the cost, size and duration of the project. Although, these methods estimated many project successfully [9]. However, there are chances to generate different estimates for same project depending on intuition of estimator thereby affecting planning process of projects [10]. Introduction of algorithmic method in agile project eliminates the availability of historical data and expert estimators [10]. Constructive Agile Estimation Method (CAEA) has incorporated vital factors for project estimation. These factors are namely; performance, configuration, complex processing, data transfer, operation ease, security and project domain [11]. It has been observed from literature that algorithmic method generates more realistic results used by many project managers [2, 5, 11]. However, it considers all the vital factors at same level and computes the same estimates for projects with different uncertainty levels. Generalized Estimation Method (GEM) is another algorithmic method that incorporates twenty one factors of estimation [12]. GEM has categorized estimation Thus, there is a strong need of algorithmic methods that quantify the effect of project attributes (vital factors in CAEA and GEM) as well as computes the estimates depending on the uncertainty level of requirements yet the process is simple as per manifesto of agile.

III. PRIORITY BASED AGILE ESTIMATION OF SIZE AND TIME (PAEST)

We proposed Priority based Agile Estimation of Size and Time (PAEST) that incorporates various attributes of project along with uncertainty level in project requirements. PAEST is extension of GEM. It follows project domain classification as per GEM method as shown in Table 1. Project attributes are classified in four categories mainly: project, sociological, technological and ergonomic as shown in Table 2 as cheat sheet to identify the presence of the particular attributes in project. Terminology used in estimation process is shown in Table 3. Intensity and prioritization of project attributes are different as prioritization deals efforts required at various phases of software development cycle whereas intensity of project attribute defines impact of attributes working software. For example, CRM project attribute operation ease has higher intensity level and highest priority for development is high volume data transfer. In this section, we introduce PAEST in detail.

A. Estimation Process

Estimation process is iterative and incremental method in agile as it follows the practice of last minute changes. Initially, uncertainty level in project is high. Estimation is done in two phases: early estimation and iterative-incremental estimation. Early estimation is the estimation based upon initial understanding and requirements of the project. But it also identifies the intensity of project attributes affecting the project and prioritization of project attributes. On other hand, iterative estimation is starting activity of each iteration and based upon feedback of previous iteration. Iterative estimation process alsoincorporates attributes in estimation to reduce the uncertainty in duration and size of working software. Estimation process is presented in Fig. 1. Early Estimation process involves project team members seat together in board room and identify the attributes affecting the project with intensity levels. Identification of attribute is based on planning poker method. We have used ranking method for prioritization of identified attributes. After ranking of attributes, all attributes are classified in three levels; low moderate and high.

All project attributes identified by GEM methods can be considered but PAEST proposed to prepare the cheat sheet of intensity level and prioritization of attributes and those having negligible impact on cost may be discarded. Impact of attributes on project is identified by ranking method. There may be number of factors that affect the estimation of project but we have concentrated on seven attributes mainly; configuration, complex processing, performance, data transfer, operation ease, security, and multiple sites for our case studies and derived the estimation based upon their priority. Depending on basis of ranking given by the team members, PAEST proposed to compute priority factor (PF). We have considered thirty one case studies in university environment for estimation. We prioritized the aforesaid attributes in three levels to assign the priorities to them. Level I possesses the attributes at highest priority such as performance, configuration and complexity. Level II includes attributes mainly; data transfer and security whereas level III consists of attributes viz. operation ease and multiple sites and are at lowest priority. Although, developers may have overlapping of attributes or different attributes in these level. It has been noticed that any level I attributes requires maximum efforts to develop the project. On contrary, least priority have been assigned to level III attributes as these are the need of today's mobile and internet application and design and development of project is done taking in account of these aforesaid factors.

Prioritization has been realized in estimation of agile projects by assigning weights to the level known as priority factors. These weights have been computed by using probability theory and Bayes theorem. We have used square series for quantification of intensity levels of vitals factors as preferred *CAEA* algorithm. Priority factor allotted to the level I, level II and level III are 4/7, 2/7 and 1/7 respectively as shown in Table 1. *PAEST* used same square series i.e. 1, 4, 9 for low,

medium and high intensity value of aforesaid attributes.
Although, estimator is free for assigning the values as per his/her ease.

PAEST also introduces the uncertainty factor *CF* that deals with level of uncertainty in project and possesses value between 0 and 1. For example, uncertainty factor value near to 0 depicts that, uncertainty level of project is low. Any project with low uncertainty level indicates that most of the requirements of project have been well understood thereby reducing the risk of the project. As the value of CF tends towards the one, uncertainty of the project has been increased thereby risk of the project has been increased.

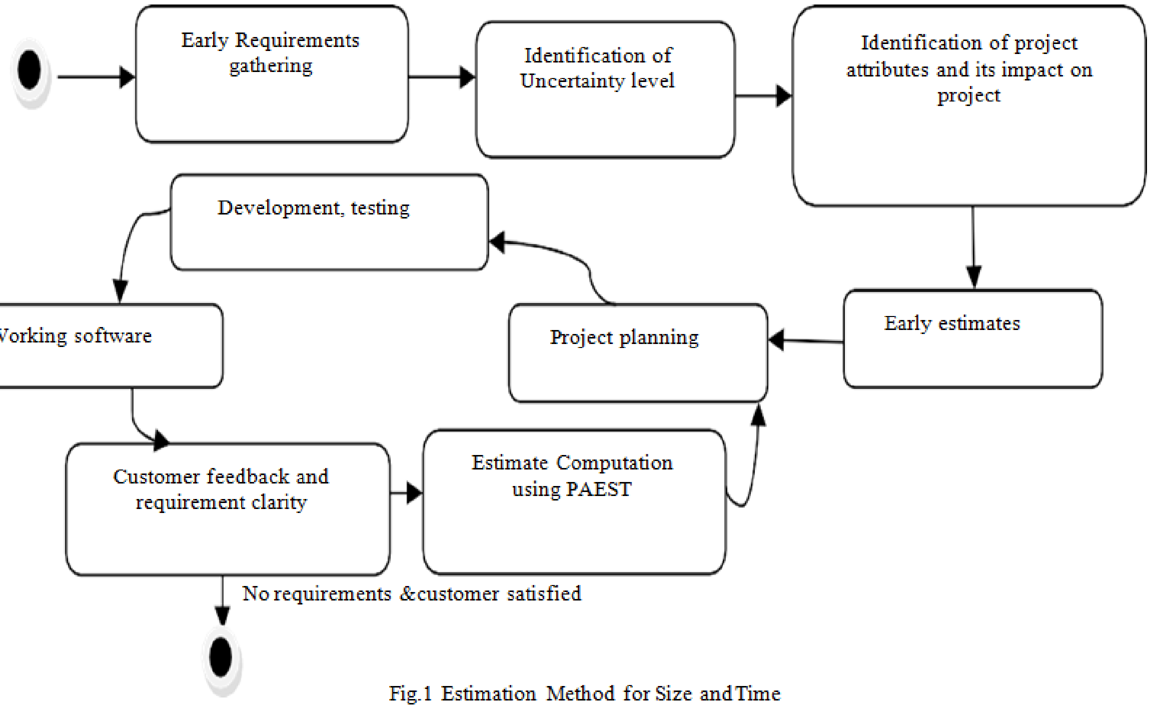

Fig.1 Estimation Method for Size and Time

Table 1 Project Domain Classification as per GEM used in PAEST

Sr. no.	Domain	Sub-domain	Description
1	Critical software	System Software	Software that are used to control the devices such as telephone system, computer fall under this category. Operating System, compilers, tools are considered in this category.
		Military Software	Software developed for military organization
		Lifesaving software	Medical or scientific software that require higher accuracy such as PAEST shuttle software, medical software
		Financial Application	High security and large volume of data required to access therefore integrity and consistency of software must be maintained. High efforts are required
2	Application Software	Commercial Software	Software that are leased or marketed to client such as spread sheets, word processor etc.
		Information System	MIS systems that are produced in-house support such as payroll, attendance
		Out Sourced Software	A software that built under the contract to client organization
		Web application	Software that use client server technology
		End user application	Software for personal use
		Mobile Application	Simple mobile application

Table 2 Cheat Sheet for identification of Project attributes in Project Estimation

Sr. no	Classificatio n	Vital Factors	Description	Impact on project			
				N C	L	M	H
1	Project Specific	Configuration	Requirement of special hardware or software				
		Complex processing	Special Scientific calculations				
		Performance	characterized as execution time, designing and coding standards, accuracy in outcome etc. as per customer requirements				
		Data Transfer	Volume and frequency of data transfer from peripherals/ machine to remote machine/ peripheral.				
		Security	Data security, authentications				
		Operational ease	Facilities provided to user more than must have feature				
		Multiple Sites	Software run on multiple sites				
		Constraints	Special constraint required by user such as higher reliability , time constraint etc.				
2	Sociological	Team Size	Number of professional working on team (full time)				
		Team Experience	Experience person ratio in team				
		Communication	Mode of communication in team				
		Domain expertise	Experience in project domain				
		Language expertise	Team command on language				
3	Technologica l	Language	Procedural or object oriented				
		Methodology	Particular agile method or hybrid practices				
		Project management Techniques	Project tracking and monitoring				
		Reusable material	Reusability components				
		Automated tools	Use of automated tools				
4	Ergonomic	Physical layouts	Open space or cubical				
		Customer involvement	Full time customer, proxy customer				
		Level of distraction in office	Frequency of distraction during the work				

Table 3 Terminology Used in PAEST

Sr. no	Terminology	Description	Value
1	Project Domain (PD)	Project under size estimation belongs to which project domain.	High for critical software and low for Application software
2	Project Attributes(PA)	Project Attributes classified as per Table 2	Table 2 is used as cheat sheet to identify the project attributes affecting the project
3	Prioritization Factor(PF)	Prioritization of PF based on Project requirements for the current release	Prioritization weights are assigned based Ranking method /square method

4	Intensity of PF	Intensity level refers to influence/ impact of a particular vital factor in a project.	low (L), medium (M) and high (H) intensity levels of a vital factor
5	Unadjusted Values(UV)	It is sum of product of prioritization and intensity of PA	Float number
6	Uncertainty Factor(UF)	Level of uncertainty in project requirements	If project domain and requirement are well understood by team then value of UF is Low(L) otherwise it varies from Medium(M) to High(H)
7	Story Point	Same as in Agile Points assigned based on efforts required to develop the story	Number

PAEST Estimation Process

Step 1: Identify the attributes affecting project estimation using planning poker method (PA).

Step 2: Individual team member rank the attributes on scale 1 to n, where n is number of attributes.

Step 3: Team discussion to get a common opinion on assigning the rank to attributes considered (Planning Poker method to assign the rank).

Step 4: Attributes are classified in three levels based on their impact on project.

Step 5: Priority P_i is assigned to each attributes depending on the priority level as shown in Table 1

Step 6: Use rank method for intensity of each attribute and denote it as I.

Step 7: Compute Unadjusted Value (UV) using equation 1.

Step 8: Identify uncertainty Factor (CF) on the basis of requirements at beginning of project (or at the beginning of each iteration).

Step 9: Break the identified requirements in small stories and assign story points to each story as per Agile method(S_i).

Step 10: Summation of all S_i is total story point (SP) of the project using equation II.

Step 11: Compute Adjusted Story Points (ASP) values on the basis of equation III.

Step 11: Compute size of project and duration using equation IV, V respectively.

The Computation of *ASP* values is performed using following equations:

$$UV = \sum_{i=1}^{n} P_i * I_i \text{------} (I)$$

$$SP = \sum_{i=1}^{m} S_i \text{------} (II)$$

$$ASP = SP + CF * UV \quad 0<CF<1 \text{------} (III)$$

$$\text{Size of Project (SOP)} = \sum_{i=1}^{m} ASP_i \text{------} (IV)$$

$$\text{Duration of project (DOP)} = SOP / velocity \text{ --(V)}$$

where UV is unadjusted value,

I_i is intensity value of i^{th} vital factor

P_i is prioritization weight of particular category,

CF is uncertainty factor having values between 0 to1,

SP is story point based on the size. m is total number of story

ASP is adjusted story point SOP is size of project

DOP is duration of project

IV. CASE STUDIES WITH RESULT

We have considered various cases to study the usefulness of proposed algorithm on the basis of prioritization of project attributes and uncertainty of the projects from web application, MIS and critical or military project domain. We have used square series for quantifying the efforts required for the project, for example web application 1, MIS as 4 and Military project as 9. Assuming standard story point 25 for a project, new story point will be 26, 29 and 34 respectively for web application, MIS and Military projects. Further, these projects are divided in eight categories such as category I includes the projects with all vital factor low, category II includes project with any one vital factor at high intensity values etc. In our study, we fixed the number of vital factors at high intensity with varying prioritization levels. A project with high performance, high configuration, high data transfer, high complexity and low security, low complexity with all other remaining factors at medium intensity is the candidate project of category V that represents any project with any four vital factors at high intensity levels. The impact of prioritization of project attributes on estimation also has been studied through *ASP* computation using *PAEST* algorithm. Study incorporated various uncertainty levels of projects so that impact of uncertainty has been also taken in account for evaluating usefulness of *PAEST*. For maintaining the simplicity, encoded form of the projects has been used on the basis of the intensity of vital factors.

It follows the sequence of vital factors i.e. highly prioritized vital factors, second level of prioritization and lowest prioritization of vital factors. For example, LLLLHLLL represents the project with highest prioritized vital factors (performance, configuration, complex processing) having low intensity values, data transfer is having high intensity value and security is at low intensity from level II, lastly, all vital factors from level III are having low intensity values. Various categories with uncertainty level of projects have been discussed in this Section.

A. Category I

Category I includes the projects with all project attributes of any prioritization level having low intensity and encoded as LLLLLLL. *ASP* values have been computed for three project domains namely; web application, MIS project and military project as *ASP1*, *ASP2* and *ASP3* respectively with *SP* value as 25. *UV* values and corresponding *ASP* computations with various level of uncertainty such as 0.2, 04, 0.6 and 0.8 are shown in Table 4. It has been evident that prioritization of vital factors has marginal impact on CSD estimation. However, impact of vital factors has been realized as uncertainty level of project increased.

B. Category II

This category deals with projects with at least any one vital factor of any priority level of the project as high intensity levels and other as lower intensity levels (i.e. L, M) for *ASP* computations. We have considered the projects with any one vital factor high from each priority level encoded as HLLLLLL, LLLHLLL and LLLLLLH respectively as shown in Table 6. Other projects that can be considered in this category are HMLLLLL, HMMLLLL, HMMMLLL, HMMMMLL, HMMMMMML, HMMMMMMM etc. We have observed that increasing one vital factor from low to high changed value of *ASP* values and more affect has been noticed in case of high priority level. It has been analysed that project with vital factor from level I priority having high intensity value possesses *UV* value almost twice than the project with vital factor from level III having high intensity value. This reveals that project with high intensity of level I vital factors require more efforts than the project with high security but low configuration.

C. Category III

Category III is set of projects having any two project attributes of any prioritization level at high intensity values. We have considered some of projects for study the usefulness of *PAEST* mainly; HHLLLLL, LLLHHLL and LLLLLHH as shown in Table 5. Although, category also includes projects such as HLLHLLL, HLLLLLH, LLLHLLH, HHMLLLL and HHMMLLL etc. It is interesting to note that projects with any two high prioritized level project attributes at high intensity and other project attributes are at medium intensity (i.e. may be HHMMMMM) has highest *UV* in this category whereas lowest *UV* value in this category is 4.87 of projects with all two project attributes from lowest priority and remaining project attributes of other prioritization level are at low intensity (i.e.LLLLLHH case). It has been evident from Table 7 that any two project attributes from highest priority having high intensity have higher impact on estimation. Further, this change is more evident in case of higher uncertainty level. It has been noticed that some values of *UV* and *NSP* values of category II are repeated in Category III. This repetition reveals that project with one project attribute high from highest priority level and a project withtwo attributes from middle level prioritization having high value have almost same estimation.

D. Category IV

Algorithm uses any three project attributes high from any prioritization levels with remaining vital factors at either low or medium intensity levels as input for this category. Some projects included in this category are HHHLLLL, LHHHLLL, LLHHHLL, LLLHHHL, LLLLHHHL, LLLLHHH, HLLLLHH, HHLLLHL, HLLHLHL, HHHMLLL, HMLHHLL etc. as shown in Table 8. It is interesting to study about variation in ASP values and UV values of the projects due to changes in the priority levels of project attributes. For example, the difference between UV value of HHHLLLL and LLLLHHH projects is almost double due to difference in prioritization levels of the project attributes at high intensity levels. Further, major differences are noticed in case of higher uncertainty levels. It has been observed that lowest ASP value is computed as 27.42. The military project having three project attributes at high intensity level of prioritization level I and remaining vital factors at low level with high level of uncertainty has highest ASP value as 47.02. It has been analyzed that PAEST has generated the estimates very higher side depending on uncertainty of requirements.

E. Category V

ASP1, ASP2 and ASP3 values are computed for projects with any four vital factors at high intensity levels and remaining vital factors with combination of either low or medium intensity levels for this category. We have included some of the important cases for our study as shown in Table 9. It has been analysed that higher uncertainty factor has more affect on project as compared to high intensity level of high prioritization. For example, a low uncertainty project with vital factors from high prioritization level having high intensity levels (i.e. HHHHLLL, UF= 0.2) has low ASP values as compared to the high uncertainty project with vital factor having high intensity from low prioritization level (LLLHHHH, CF=0.8). Thus, impact of uncertainty is more than the impact of prioritization of vital factors. It has been observed that high uncertainty and high intensity values of prioritization level add 14 more SP to compute ASP but additional 14 SP in each story CSD of projects in unrealistic estimation.

Table 4 Prioritization Weight of Project Attributes

	Level I			Category II		Level III	
	Performance	Complexity	Configuration	Data	Security	Multiple	Operation
Priority	4/7	4/7	4/7	2/7	2/7	1/7	1/7

Table 5 ASP Computations for Category I Projects

S. No.	CASE	Uncertainty Factor(UF)	UV	CF*UV	ASP 1	ASP 2	ASP3
1	LLLLLLLL	0.2	2.57	.514	26.51	29.51	34.51
		0.4		1.028	27.02	30.02	35.02
		0.6		1.5428	27.54	30.54	35.54
		0.8		2.057	28.05	31.05	36.05

Table 6 ASP Computations for Category II Projects

S. No	CASE	Uncertainty Factor (UF)	UV	CF*UV	AP1	ASP2	ASP3
1	HLLLLLL	0.2	7.1428	1.42	27.42	30.42	35.42
		0.4		2.85	28.85	31.85	36.85
		0.6		4.24	30.24	33.24	39.24
		0.8		5.71	31.71	34.71	40.71
2	LLLHLLL	0.2	4.857	.971	26.971	29.971	34.971
		0.4		1.94	27.94	30.94	35.94
		0.6		2.91	28.91	31.91	36.91
		0.8		3.88	29.88	32.88	37.88
3	LLLLLHL	0.2	3.71	.748	26.74	29.74	34.74
		0.4		1.48	27.48	30.48	35.48
		0.6		2.28	28.28	31.28	36.28
		0.8		2.97	28.97	31.97	36.97

Table 7 ASP Computations for Category III Projects

S. No	Case	Uncertainty Factor (UF)	UV	CF*UV	ASP1	ASP2	ASP3
1	HHLLLLL	0.2	11.714	2.34	28.34	31.34	36.34
		0.4		4.68	30.68	33.68	39.68
		0.6		7.02	33.02	36.02	41.02
		0.8		9.37	35.37	38.37	43.37
2	LLLHHLL	0.2	7.1428	1.42	27.42	30.42	35.42
		0.4		2.85	28.85	31.85	36.85
		0.6		4.24	30.85	33.85	39.85
		0.8		5.71	31.71	34.71	40.71
3	LLLLLHH	0.2	4.857	.971	26.971	29.971	34.971
		0.4		1.94	27.94	30.94	35.94
		0.6		2.91	28.91	31.91	36.91
		0.8		3.88	29.88	32.88	37.88

Table 8 ASP Computations for Category IV Projects

S. No	Case	Uncertainty Factor(UF)	UV	CF*UV	ASP 1	ASP2	ASP 3
1	HHHLLLL	0.2	16.28	3.25	29.25	32.25	37.25
		0.4		6.51	32.51	35.51	40.51
		0.6		9.77	35.77	38.77	43.77
		0.8		13.02	39.02	42.02	47.02
2	LLHHHLL	0.2	11.714	2.34	28.34	31.34	36.34
		0.4		4.68	30.68	33.68	39.68
		0.6		7.02	33.02	36.02	41.02
		0.8		9.37	35.37	38.37	43.37
3	LLLHHHL	0.2	8.28	1.65	27.65	30.65	35.65
		0.4		3.31	29.31	32.31	37.31
		0.6		4.96	30.96	33.96	38.96

		0.8		6.62	32.62	35.62	40.62
4	HLLLLHH	0.2	8.85	1.77	27.77	30.77	35.77
		0.4		3.54	29.54	32.54	37.54
		0.6		5.31	31.31	34.31	39.31
		0.8		7.08	33.08	36.08	41.08
5	LLLLHHH	0.2	7.14	1.42	27.42	30.42	35.42
		0.4		2.85	28.85	31.85	36.85
		0.6		4.24	30.24	33..2	39.24
		0.8		5.71	31.71	34.71	40.71
6	LHHHLLL	0.2	14	2.8	28.8	31.8	36.8
		0.4		5.6	31.6	34.6	39.6
		0.6		8.4	34.4	37.4	42.4
		0.8		11.2	37.2	40.2	45.2
7	HLLHLHL	0.2	9.14	1.82	27.82	30.82	35.82
		0.4		3.65	29.65	32.65	37.65
		0.6		5.48	31.48	34.48	39.48
		0.8		7.31	33.31	35.31	41.31

Table 9 ASPs Computation for Category V Projects

S. No	CASE	Uncertainty Factor (UF)	UV	CF*UV	ASP 1	ASP 2	ASP3
1	HHHHLLL	0.2	18.57	3.71	29.71	32.71	37.71
		0.4		7.48	33.48	36.48	41.48
		0.6		11.42	37.42	40.42	45.42
		0.8		14.85	40.85	33.85	48.85
2	LHHHHLL	0.2	16.28	3.25	29.25	32.25	37.25
		0.4		6.51	32.51	35.51	40.51
		0.6		9.77	35.77	38.77	43.77
		0.8		13.02	39.02	42.02	47.02
3	LLHHHHL	0.2	12.85	2.57	28.57	31.57	35.83
		0.4		5.14	31.14	34.14	39.14
		0.6		7.71	33.71	36.71	41.71
		0.8		10.28	36.28	39.28	44.28
4	LLLHHHH	0.2	9.42	1.88	27.88	30.88	35.88
		0.4		3.77	29.77	32.77	37.77
		0.6		5.65	31.65	34.65	39.65
		0.8		7.54	33.54	36.54	41.54

Table 10 ASPs Computation for Category VI Projects

S. No	CASE	Uncertainty Factor	UV	CF*UV	ASP1	ASP 2	ASP 3
1	HHHHHLL	0.2	20.85	4.17	30.17	33.17	38.17
		0.4		8.34	34.34	37.34	42.34
		0.6		12.51	38.51	41.51	46.51
		0.8		16.68	40.68	45.68	50.68
2	LHHHHHL	0.2	17.42	3.48	29.48	32.48	37.48
		0.4		6.97	32.97	35.97	40.97
		0.6		10.45	36.45	39.45	44.45
		0.8		13.94	39.94	42.94	47.94
3	LLHHHHH	0.2	14	2.8	28.8	31.8	36.8
		0.4		5.6	31.6	34.6	39.6
		0.6		8.4	34.4	37.4	42.4
		0.8		11.2	37.2	40.2	45.2
4	HHHLLHH	0.2	18.57	3.71	29.71	32.71	37.71
		0.4		7.48	33.48	36.48	41.48
		0.6		11.42	37.42	40.42	35.42
		0.8		14.85	40.85	33.85	48.85

F. Category VI

Projects with five project attributes from any prioritization levels having high intensity values are included in this category. It includes HHHHHLL, HHHHHMM, LLHHHHH, MMHHHHH, HHHLLHH, HHHMMHH,
LHHHHHL, MHHHHHM etc. and some of the cases of this category are shown in Table 10. It is very interesting to notice that number of projects in particular category decreases, as number of attributes having high intensity values increases. It has been noticed that UV values of this category have been drastically increased thereby increasing ASP values at least by two SP. It has been observed that at

least one project attribute from higher prioritization level is high and increase the CSD of the project drastically.

G. Category VII

This category consists of projects with any six project attributes at high intensity values and others as either low or medium intensity levels. Some projects of this category are shown in Table 11 with corresponding ASP and UV computation. It is evident that any project with high performance, high configuration and complex processing require more efforts in case of higher uncertainty level. It has been noticed that projects encoded as LHHHHH and HHHLLHH (member of category V) have same UV values. This reveals that after the prioritization of project attributes in estimation of various categories are overlapping.

H. Category VIII

This Category includes projects with all attributes having high intensity level. UV value of these types of projects is
very high that increase at least 4 story points in each story. With higher uncertainty level ASP values are increased and generated higher estimates as compared to CAEA. Results of all high intensity level is shown in Table 12.

V. CONCLUSION

We have proposed the algorithmic method based on prioritization of project attributes affecting the CSD estimation and uncertainty level of agile project. Prioritization is realized by classifying priority in three levels and assigning weights to project attributes. We tried to estimate various agile projects of three domains mainly; web application, MIS project and military project. In this manner, we computed 26 UV values 312 *ASP* computations of agile projects of three aforesaid domains with different uncertainty levels.

In our study we found some interesting facts. These observations and facts are as follows:

- This algorithm computes different estimates for the projects with varying uncertainty levels. Hence, it mitigates the risk in project estimation.
- *PAEST* provides flexibility to project manager on number of project attributes. Although, we have taken the example for project specific attributes only.
- Algorithm prioritizes the project attributes and generates the estimates of the project more realistic. Introduction of prioritization helps novice to get estimates more precise.
- It is observed that uncertainty of project has more impact as compared to prioritization of the project attributes.
- Case studies reveals the overlapping of various categories of same prioritization level but different uncertainty levels. This results show that uncertainty in project have more impact than project attributes. For example the range of computation for category III for uncertainty value
0.4 is 1.94-4.68 whereas for category IV is 2.91-
7.02 (same uncertainty level 0.4). Table 13 depicts such overlapping.

Thus, proposed algorithm is good option for not only novice estimators but also generate the same estimates for different estimators.

Table 11 ASPs Computation for Category VII Projects

S. No.	CASE	Uncertainty Factor	UV	CF*UV	ASP 1	ASP2	ASP3
1	HHHHHH L	0.2	22	4.4	30.4	33.4	38.4
		0.4		8.8	34.8	37.8	42.8
		0.6		13.2	39.2	42.2	49.2
		0.8		17.6	43.6	46.6	51.6
2	LHHHHH H	0.2	18.57	3.71	29.71	32.71	37.71
		0.4		7.48	33.48	36.48	41.48
		0.6		11.42	37.42	40.42	45.42
		0.8		14.85	40.85	33.85	48.85
3	HHHLHH H	0.2	20.85	4.17	30.17	33.17	38.17
		0.4		8.34	34.34	37.34	42.34
		0.6		12.51	38.51	41.51	46.51
		0.8		16.68	40.68	45.68	50.68

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Table 12 ASPs Computation for Category VIII Projects

S. No.	CASE	Uncertainty Factor	UV	CF*UV	ASP 1	ASP 2	ASP 3
1	HHHHHHH	0.2	23.14	4.62	30.62	33.62	38.62
		0.4		9.25	35.25	38.25	43.25
		0.6		13.88	39.88	41.88	47.88
		0.8		18.51	44.51	47.51	52.51

Table 13 Comparison on the basis of projects

CF	Category	CF*UV	ASP Computations Range		
			ASP1	ASP2	ASP3
0.2	I	0.51	26.7	29.7	34.7
	II	3.71-7.14	27.5-29.3	30.5-32.3	35.5-37.3
	III	4.85-11.71	28.3- 29.8	31.3-32.8	36.3- 37.8
	IV	7.14-16.28	29.1-30.3	32.1-33.3	37.1-38.3
	V	1.88-3.71	29.9-30.8	32.9-33.8	37.9-38.8
	VI	2.8-4.17	30.7-31.2	33.7-34.2	38.7-39.2
	VII	3.7-4.4	31.5-31.8	34.5-34.8	39.5-39.8
	VIII	4.62	32.3	35.3	40.3
0.4	I	1.028	27.02	30.02	35.02
	II	1.48-2.85	27.48-28.85	30.48-	35.48-36.85
	III	1.94-4.68	27.94-30.68	30.94-	35.94-39.68
	IV	2.85-6.51	28.85-32.51	31.85-	36.85-40.51
	V	3.77-7.48	29.77-33.48	32.77-	37.77-41.48
	VI	5.6-8.34	31.6-34.34	34.637.34	39.6-42.34
	VII	7.48-8.8	33.48-34.8	36.48-37.8	41.48-42.8
	VIII	9.25	35.25	38.25	43.25
0.6	I	1.54	27.54	30.54	35.54
	II	2.28-4.24	28.28-30.24	31.28-	36.28-39.24
	III	2.91-7.02	28.91-33.02	31.91-	36.91-41.02
	IV	4.249.77	30.24-35.77	33.24-	39.24-43.77
	V	5.65-11.42	31.65-37.42	34.65-	39.65-45.42
	VI	8.4-12.51	34.4-38.51	37.4-41.51	42.4-46.51
	VII	11.42-13.2	37.42-39.2	40.42-42.2	45.42-49.2
	VIII	13.88	39.88	41.88	47.88
0.8	I	2.05	28.057	31.057	36.057
	II	2.97-5.71	28.97-31.71	31.97-	36.97-40..71
	III	3.88-9.37	29.88-35.37	32.88-	37.88-43.37
	IV	5.71-13.2	31.71-39.02	34.71-	40.71-47.02
	V	7.54-14.85	33.54-40.85	36.54-	41.54-48.85
	VI	11.2-16.68	37.2-40.68	40.2-45.68	45.2-50.68
	VII	14.85-17.6	40.85-43.6	33.85-46.6	48.85-51.6
	VIII	18.5	44.51	47.51	52.51

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