

Fuzzy Delphi Method for Evaluating HyTEE Model (Hybrid Software Change Management Tool with Test Effort Estimation)

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Abstract—When changes are made to a software system during development and maintenance, they need to be tested again i.e. regression test to ensure that changes behave as intended and have not impacted the software quality. This research will produce an automated tool that can help the software manager or a maintainer to search for the coverage artifact before and after a change request. Software quality engineer can determine the test coverage from new changes which can support cost estimation, effort, and schedule estimation. Therefore, this study is intended to look at the views and consensus of the experts on the elements in the proposed model by benefitting the Fuzzy Delphi Method. Through purposive sampling, a total of 12 experts from academic and industrial have participated in the verification of items through 5-point linguistic scales of the questionnaire instrument. Outcome studies show 90% of elements in the proposed model consists of change management, traceability support, test effort estimation support, regression testing support, report and GUI meet, the value threshold (d construct) is less than 0.2 and the percentage of the expert group is above 75%. It is shown that elements of all the items contained in the venue are needed in the HyTEE Model (Hybrid Software Change Management Tool with Test Effort Estimation) based on the consensus of experts.

Keywords—Fuzzy Delphi Method; software traceability; test effort estimation; regression testing; software changes

I. INTRODUCTION

The software application is present in every area of our life. The small and large system is developed using the software. Change is a part of everyday life. Software changes after some time. In today's competitive atmosphere, brand new needs are arising, and existing needs are altering swiftly. Changes are accomplished for various reasons, for example, to include new elements, to amend a few errors or to improve the product.

According to Vasa [1], "Software evolution or changes are direct consequences and reflections of ongoing changes in a dynamic real world". These changes are occurring very fast because of the competitive market. Enhancing software is a common necessity in business today as they encounter lots of need changes, prolonging software features and function, and including brand new modules. We cannot ignore the critically of software changes because real software system changes and becomes more complex over time [1]. A current report distributed by the Standish Group International [2] which involved 13522 software projects, Fig. 1 showed that out of the

reviewed projects just 29 percent were effective, 18 percent is considered as "failed" and 53 percent are viewed as "suspected" and the fundamental driver of the failed project is the prerequisite change. Lam [3] propose that changing necessity are the main issues of the re-building and maintenance activities. The majority of the previous study demonstrates that software maintenance activities are concerning adaptive and completeness maintenance close to 80%. For this aim, the company must get the opportunity to manage requirement adaptation as part of the border software evolution approach. One estimate expresses that 40% of the necessity requirement during software development [4].

Estimation is limited as the shrewd conviction of the quantum or field that should be performed and the essential material (in particular, HR, money related assets, material assets, and time assets) required playing out the work at a future date in a characterized domain for determined strategies. Test Effort Estimation that estimate of the testing length, exertion, cost and timetable for a specific programming test project in an individual domain for particular strategies, tool and methods [6]. The test effort is the foundation of the effort spent on test action and the effort spent on debug action [7].

Research objective for this study is:

- 1) To develop a software traceability model to reduce operational cost during regression testing using the Fuzzy Delphi Method.

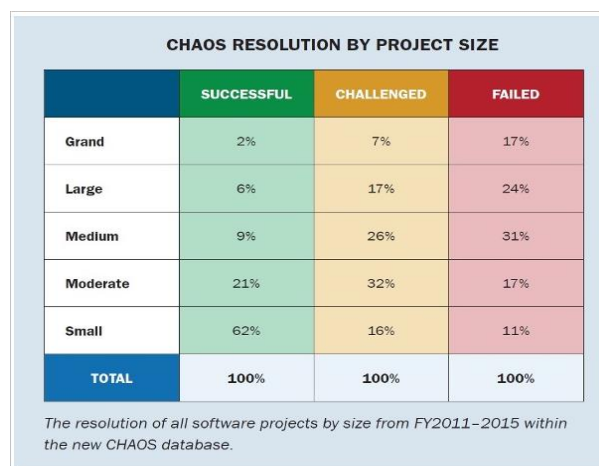


Fig. 1. CHAOS Resolution by Project Size 2011-2015 [5].

This study utilizes the FDM as an evaluation to evaluate the proposed model. This paper is organized as follows. Section I is an Introduction to the background of the problem, Section II introduces the process of the FDM to assess the expert consensus and lists the alternative options in the order of preference. Section III shows results and finding of an element in Hytee model. The conclusion of the research findings and future work of this research is presented in Section IV. The results are expected to provide an element to support in design and development of Hytee Model.

II. FUZZY DELPHI METHOD

A. Introduction

This research study is about implementing the Fuzzy Delphi Method in designing and developing a software traceability model with the test effort estimation during regression testing in software changes. The Delphi Method is an approach that has been used and widely accepted to collect data for a study based on the validation expert in the research study of Hsu [8]. The strength of this method has also produced a diversity technique in obtaining empirical data like the Fuzzy Delphi Method (FDM). Talking about FDM, it is a method of measurement based on the modification on the Delphi Method.

This method has been presented by Kaufman and Gupta in 1988 [9]. The Fuzzy Delphi Method (FDM) is a combination of the numbering of the fuzzy set method and Delphi itself [10]. This brings the meaning that this is not a new approach based on a classical Delphi method where the respondents involved must be from within the circle of experts who have experience in the context of the study. This improvement indirectly strives to make FDM as a measurement approach that is more effective, whereby FDM is able to resolve the issue of who has uncertainty for some issues of the research.

The review of previous literature shows that FDM is a combination of the traditional method of Delphi (Classic) and fuzzy set theory (Fuzzy). The fuzzy set theory was introduced by an expert in the field of mathematics in 1965 which Zadeh [11] worked, and it works as an extension of a classical set theory where each element in a set is assessed based on the set of binaries (Yes or No). Fuzzy set theory assessment also allows a gradual review of each element. Ragin [12] states that the value of numbering fuzzy consists of 0 to 1 or in the unit interval (0,1).

There are two mains in FDM which is Triangular Fuzzy Number and Defuzzification Process. Triangular Fuzzy Number is m is made up of the value of the m_1 , m_2 , and m_3 where m_1 represents the value of the minimum (smallest value), representing the most reasonable value m_2 (most plausible value) and m_3 is referring to the maximum value (but there is value). All three values in the Triangular Fuzzy Number this can be seen through Fig. 2 shows the graph that triangles mean against the value of triangular shows that all three of these values is also in the range of 0 to 1 and it coincided with fuzzy numbers [12].

B. Procedure in FDM

For further details on the findings using the Fuzzy Delphi approach method (FDM), there are procedures that must be compiled. Table I show about the procedures in FDM cover for seven steps.

C. The Number of Expert in FDM

The selection of the number of experts for the Fuzzy Delphi Method (FDM) is a total of 12 people. This is based on the view of Adler and Ziglio [13], who pointed out that the number of experts for the Delphi technique was as many as 10 to 15 people if the experts can get an agreement with each other. However, there is also an opinion stating that the minimum number of experts for the Delphi technique is five experts [14]. This matches the argument from Rowe and Wright [15] that the number of experts can start from 5 to 20 people based on their areas of expertise. On the other hand, Jones and Twiss [16] suggested the number of experts involved in the Delphi method approach is 10 to 50 experts.

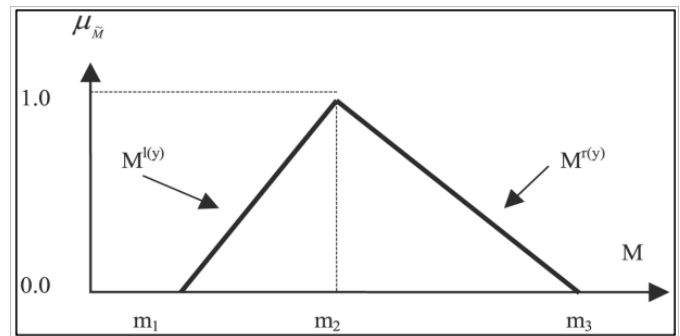


Fig. 2. Graph Triangle Min against the Value of Triangular.

TABLE I. PROCEDURES IN FDM

Step	Detail
1	Criteria to determine the experts involved in the study. <ul style="list-style-type: none"> ❖ Expert in FDM ➤ 10-15 expert (Adler & Ziglo, 1996) ➤ 10-50 expert (Jones & Twiss, 1978)
2	Convert all linguistic variables into a triangular fuzzy number
3	All data is scheduled to obtain the average value (m_1 , m_2 , m_3)
4	Determine the distance between the 2 numbers fuzzy to determine the value of the threshold, d $d \leq 0.2$, meaning that all the experts reach consensus.
5	Determine the consensus of the Group <ul style="list-style-type: none"> ❖ Value of the percent agreement of experts that must be equal to or more than 75.0%
6	Define Aggregate Fuzzy Evaluation by adding all fuzzy numbers
7	Data analysis using the average of fuzzy numbers or average response (Defuzzification Process)

The criteria and characteristics of this study involved software engineering specialists in software testing from the academic and industrial sector. Selection is also based on Berliner [17],[18] who argues that the expert is competent if they participated in a particular field consistently exceeding a period of 5 years. Nonetheless, there are other scholars pointing out that experts are highly skilled and experienced in the areas studied [19][20].

Based on Table II, the discussion for selection of the respondents for the design and development phase, the researcher lists down the criteria for selecting the experts, as below:

D. Questionnaire

This research uses the questionnaire as an instrument to get quantitative data for element requirements of Hytee Model. The questionnaire is aimed at in order to meet the criteria and conditions of the using the technique of fuzzy Delphi Method where this technique involves the use of a mathematical formula in order to obtain the consensus of experts. Instruments used by researchers is the instrument that has been modified based on the needs of the study researchers. The original of this questionnaire was adapted from the study of Ibrahim (2006) [21]. Table III shows the element in the questionnaire.

The process of data collection in the study is carried out using the Fuzzy Delphi approach between the processes involved in an interview for the Delphi technique while the questionnaire is analyzed with techniques of a fuzzy number. 5-point scale used Rahman, M. N. A. (2013) [23] to determine the expected kinds of video games against aspects of basic skills in the Malay language for foreign students to obtain consent or consensus of a group of expert. To facilitate experts, answer questionnaires, researchers have put the value of the scale of 1 to 5 to replace the Fuzzy value as shown in Table IV for linguistic scale 5 points follows;

TABLE II. CLASSIFICATION OF HETEROGENEOUS EXPERTS

Expert	Background	Number of Participants
Industry	Public Bank (System Analyst)	1
	Iris Berhad (It support)	2
	Mimos Berhad (Software Tester)	2
	Mesiniaga (It Engineer)	2
Government	It Officer (KPKT)	1
	It Officer (LGM)	1
	It Officer (MBPP)	1
Academicians	Lecture It (Polytechnic Penang)	2
Total		12

TABLE III. QUESTIONNAIRE IN FDM

Section	Element	Questionnaire
B	Change Management	B1: Do you agree that Hytee model support change management of software artifact? B2: Do you agree that change management support will help to save time? B3: Do you agree that Hytee model can help the current practice in after getting PCR B4: Do you agree that Hytee model provide appropriates content B5: Do you agree that Hytee model that the system and process developed to achieve the change are transparent
C	Traceability Support	C1: Do you agree that Hytee model provide traceability for requirement, test cases, and code C2: Do you agree that Hytee model it is easy to create traceability link between artifact C3: Do you agree that Hytee model it easy to locate test cases to the requirement or vice versa C4: Do you agree that developers get a benefit from requirements traceability when evolving and maintaining a software system? C5: Do you agree that Hytee model using top – bottom and bottom to up will help to find the bug?
D	Regression Testing Support	D1: Do you agree that Hytee model in regression testing provide the helpful function D2: Do you agree that Hytee model of RT function will help the user to save a time D3: Do you agree that Hytee model can help the current practice during RT D4: Do you agree that Hytee model provide appropriates content
E	Test Effort Estimation Support	E1: Do you agree that Hytee model provides a basis to cost estimation and plan schedules E2: Do you agree that Hytee model in test effort estimation support will help the user to estimate the cost after changes. E3: Do you agree that Hytee model in test effort estimation support provide appropriates content E4: Do you agree that Hytee model in test effort estimation support help the user save time /cost/skill E5: Do you agree that Hytee model in test effort estimation support will reduce <i>situational and human biases</i>
F	Report	F1: Do you agree that Hytee model produced the report is helpful F2: Do you agree that Hytee model provide the reports be invoked which identify the fields which have been modified F3: Do you agree that Hytee model these reports provide a complete record of all such changes
G	GUI	G1: Do you agree that Hytee model is user-friendly G2: Do you agree that Hytee model which the term in the prototype understandable G3: It helps me be more effective G4: Do you agree that Hytee model organization of information very clear

TABLE IV. LINGUISTIC VARIABLES FOR 5 POINT SCALE

Linguistic Variables	Likert Scale	Fuzzy Scale
Strongly agree	5	(0.9,1.0,1.0)
Agree	4	(0.5,0.7,0.9)
Neither agree	3	(0.3,0.5,0.7)
Disagree	2	(0.1,0.3,0.5)
Strongly disagree	1	(0.0,0.0,0.1)

III. RESULT AND FINDING

Data analysis is to follow the approach of Fuzzy\ Delphi through step 3 to 7 will answer questions the study disclosed. For viewing the degree of agreement among experts, the findings for each of the items were analyzed by a Threshold value (d) for two fuzzy numbers $m = (m_1, m_2, m_3)$ and $n = (n_1, n_2, n_3)$ are calculated using the formula:

$$d = \tilde{m}, \tilde{n} \sqrt{\frac{1}{3} [(m_1 - n_1)^2 + (m_2 - n_2)^2 + (m_3 - n_3)^2]}$$

It is supported by the Rahman, 2013 [22] and Jamil, 2013 [23] which States that in order to analyze the data, the distance between two Fuzzy number is calculated by measuring the average value of the deviation between the experts. Whereas the criteria used to assess the expert group consensus is based on the degree of agreement in excess of 75%.

In this study, one (1) is complied with because the value threshold for most of the subitem is ≤ 0.2 , but only at part subitem only. However, the second condition (2) has also been observed because the expert group consensus is above 75%. Result value threshold ≤ 0.2 , indicating that this study gets the value of the threshold exceeds 75% 77.8% by registering for a theme that includes a total of 5 subitems. This shows the degree of agreement among the experts has reached a consensus that good. Therefore, the second round for fuzzy Delphi is not needed because of data acquisition complies with both conditions.

Below show the findings for elements of Hytee model based on the consensus of experts. This data consists of the value of the threshold each element (d item), the value threshold constructs (d)

A. Change Management

Table V display findings for Change Management components for Hytee proposed model on the consensus of experts using the Fuzzy Delphi Method (FDM). The findings of this study show the value threshold (d) and the percentage of the expert group.

B. Traceability Support

Table VI display findings for Traceability Support components for Hytee proposed model on the consensus of experts using the Fuzzy Delphi Method (FDM). The findings of this study show the value threshold (d) and the percentage of the expert group.

TABLE V. CHANGE MANAGEMENT COMPONENTS

EXPERT		Change Management				
		B1	B2	B3	B4	B5
1	Expert 1	0.131	0.239	0.120	0.370	0.098
2	Expert 2	0.261	0.154	0.275	0.076	0.098
3	Expert 3	0.261	0.154	0.275	0.317	0.294
4	Expert 4	0.131	0.154	0.275	0.076	0.098
5	Expert 5	0.131	0.526	0.709	0.076	0.098
6	Expert 6	0.261	0.154	0.275	0.317	0.294
7	Expert 7	0.131	0.239	0.120	0.076	0.098
8	Expert 8	0.131	0.154	0.120	0.076	0.098
9	Expert 9	0.131	0.154	0.120	0.076	0.098
10	Expert 10	0.261	0.154	0.275	0.317	0.294
11	Expert 11	0.131	0.239	0.120	0.076	0.098
12	Expert 12	0.131	0.154	0.120	0.076	0.098
Threshold Value (d) of each item		0.174	0.206	0.234	0.161	0.147
The percentage of each item $d \leq 0.2$		100.0	91.7	91.7	66.7	100.0
Average of fuzzy number (score fuzzy)		0.789	0.861	0.778	0.750	0.767

TABLE VI. TRACEABILITY SUPPORT COMPONENTS

EXPERT		Traceability Support				
		C1	C2	C3	C4	C5
1	Expert 1	0.186	0.261	0.196	0.261	0.163
2	Expert 2	0.186	0.131	0.196	0.131	0.228
3	Expert 3	0.186	0.131	0.196	0.261	0.163
4	Expert 4	0.186	0.131	0.196	0.131	0.228
5	Expert 5	0.495	0.261	0.196	0.131	0.163
6	Expert 6	0.206	0.131	0.196	0.131	0.163
7	Expert 7	0.206	0.261	0.196	0.261	0.163
8	Expert 8	0.186	0.131	0.196	0.131	0.228
9	Expert 9	0.186	0.131	0.196	0.131	0.228
10	Expert 10	0.206	0.131	0.196	0.131	0.163
11	Expert 11	0.206	0.261	0.196	0.261	0.163
12	Expert 12	0.186	0.131	0.196	0.131	0.228
Threshold Value (d) of each item		0.219	0.174	0.196	0.174	0.190
The percentage of each item $d \leq 0.2$		91.7%	100.0%	100.0%	100.0%	100.0%
Average of fuzzy number (score fuzzy)		0.839	0.878	0.833	0.878	0.811

C. Regression Testing Support

Table VII display findings for Regression Testing Support components for Hytee proposed model on the consensus of experts using the Fuzzy Delphi Method (FDM). The findings of this study show the value threshold (d) and the percentage of the expert group.

D. Test Effort Estimation Support

Table VIII display findings for Test Effort Estimation Support components for Hytee proposed model on the consensus of experts using the Fuzzy Delphi Method (FDM). The findings of this study show the value threshold (d) and the percentage of the expert group.

TABLE VII. REGRESSION TESTING SUPPORT COMPONENTS

EXPERT		Regression Testing Support			
		D1	D2	D3	D4
1	Expert 1	0.065	0.249	0.141	0.108
2	Expert 2	0.326	0.145	0.251	0.284
3	Expert 3	0.065	0.249	0.141	0.108
4	Expert 4	0.326	0.145	0.141	0.108
5	Expert 5	0.065	0.833	0.432	0.401
6	Expert 6	0.065	0.145	0.251	0.108
7	Expert 7	0.065	0.145	0.251	0.108
8	Expert 8	0.065	0.145	0.141	0.284
9	Expert 9	0.065	0.145	0.141	0.284
10	Expert 10	0.065	0.145	0.251	0.108
11	Expert 11	0.065	0.145	0.251	0.108
12	Expert 12	0.065	0.145	0.141	0.284
Threshold Value (d) of each item		0.109	0.220	0.211	0.191
The percentage of each item $d \leq 0.2$		83.3%	91.7%	91.7%	91.7%
Average of fuzzy number (score fuzzy)		0.744	0.867	0.794	0.772

TABLE VIII. TEST EFFORT ESTIMATION SUPPORT COMPONENTS

EXPERT		Test Effort Estimation Support				
		E1	E2	E3	E4	E5
1	Expert 1	0.196	0.261	0.108	0.239	0.173
2	Expert 2	0.196	0.131	0.284	0.154	0.219
3	Expert 3	0.196	0.261	0.108	0.239	0.463
4	Expert 4	0.196	0.261	0.108	0.239	0.173
5	Expert 5	0.196	0.261	0.401	0.526	0.173
6	Expert 6	0.196	0.131	0.108	0.154	0.219
7	Expert 7	0.196	0.131	0.108	0.154	0.173
8	Expert 8	0.196	0.131	0.284	0.154	0.219
9	Expert 9	0.196	0.131	0.284	0.154	0.219
10	Expert 10	0.196	0.131	0.108	0.154	0.219
11	Expert 11	0.196	0.131	0.108	0.154	0.173
12	Expert 12	0.196	0.131	0.284	0.154	0.219
Threshold Value (d) of each item		0.196	0.174	0.191	0.206	0.220
The percentage of each item $d \leq 0.2$		100.0%	100.0%	91.67%	91.67%	91.67%
Average of fuzzy number (score fuzzy)		0.833	0.878	0.772	0.861	0.817

E. Report

Table IX display findings for Report components for Hytee proposed model on the consensus of experts using the Fuzzy Delphi Method (FDM). The findings of this study show the value threshold (d) and the percentage of the expert group.

F. Graphical user Interface

Table X display findings for Graphical User Interface components for Hytee proposed model on the consensus of experts using the Fuzzy Delphi Method (FDM). The findings of this study show the value threshold (d) and the percentage of the expert group.

TABLE IX. Report COMPONENTS

EXPERT		Report		
		F1	F2	F3
1	Expert 1	0.294	0.076	0.015
2	Expert 2	0.098	0.317	0.382
3	Expert 3	0.294	0.076	0.015
4	Expert 4	0.098	0.076	0.015
5	Expert 5	0.294	0.370	0.309
6	Expert 6	0.098	0.076	0.015
7	Expert 7	0.098	0.317	0.015
8	Expert 8	0.098	0.076	0.015
9	Expert 9	0.098	0.076	0.015
10	Expert 10	0.098	0.076	0.015
11	Expert 11	0.098	0.317	0.015
12	Expert 12	0.098	0.076	0.015
Threshold Value (d) of each item		0.147	0.161	0.070
The percentage of each item $d \leq 0.2$		100.0%	66.67%	83.33%
Average of fuzzy number (score fuzzy)		0.900	0.750	0.706

TABLE X. GRAPHICAL USER INTERFACE COMPONENTS

EXPERT		Graphical user Interface			
		G1	G2	G3	G4
1	Expert 1	0.141	0.261	0.239	0.108
2	Expert 2	0.251	0.131	0.154	0.284
3	Expert 3	0.251	0.131	0.154	0.284
4	Expert 4	0.141	0.131	0.154	0.108
5	Expert 5	0.432	0.261	0.526	0.401
6	Expert 6	0.141	0.131	0.154	0.108
7	Expert 7	0.141	0.261	0.239	0.284
8	Expert 8	0.251	0.131	0.154	0.108
9	Expert 9	0.251	0.131	0.154	0.108
10	Expert 10	0.141	0.131	0.154	0.108
11	Expert 11	0.141	0.261	0.239	0.284
12	Expert 12	0.251	0.131	0.154	0.108
Threshold Value (d) of each item		0.211	0.174	0.206	0.191
The percentage of each item $d \leq 0.2$		91.67%	100.0%	91.67%	91.67%
Average of fuzzy number (score fuzzy)		0.794	0.878	0.861	0.772

G. Result Consensus of the Expert

Requirement:

- 1) Triangular Fuzzy Numbers
 - a) Threshold value, $d < 0.2$
 - b) Percentage of Consensus Expert Group, $\% \geq 75.0 \%$
- 2) Defuzzification Process
 - a) Score Fuzzy (A) \geq Value $\alpha - \text{cut} = 0.5$

Refer to Table XI, the Fuzzy Delphi Analysis of the present study has shown a satisfactory and good overall outcome.

From the findings, all the item meets the expert consensus $\geq 75.0 \%$. The first two elements, in change management and the report, has an average value of “d” threshold of less than 0.2. Accordingly, both have reached the percentage of expert consensus of more than 75%, and the defuzzification scores greater than 0.5, making them acceptable as antecedents for the customer engagement concept studied. This study for evaluation Hytee Model 2 item needs to revise again and update in the Hytee System. That action was done to able the whole % item “d” ≤ 0.2 has achieved the agreement of 78%, making this construct successfully maintained.

TABLE XI. RESULT OF A CONSENSUS OF THE EXPECT

No. Item/ Element		Triangular Fuzzy Numbers		Defuzzification Process				The Consensus of Experts
		The threshold value, d	Percentage of Consensus Expert Group, %	m1	m2	m3	Score Fuzzy (A)	
1	B1	0.174	100.0%	0.633	0.800	0.933	0.789	ACCEPT
2	B2	0.206	91.7%	0.750	0.883	0.950	0.861	ACCEPT
3	B3	0.234	91.7%	0.633	0.792	0.908	0.778	ACCEPT
4	B4	0.161	66.67%	0.583	0.758	0.908	0.750	REJECT
5	B5	0.147	100.00%	0.600	0.775	0.925	0.767	ACCEPT
6	C1	0.219	91.67%	0.717	0.858	0.942	0.839	ACCEPT
7	C2	0.174	100.00%	0.767	0.900	0.967	0.878	ACCEPT
8	C3	0.196	100.00%	0.700	0.850	0.950	0.833	ACCEPT
9	C4	0.174	100.00%	0.767	0.900	0.967	0.878	ACCEPT
10	C5	0.190	100.00%	0.667	0.825	0.942	0.811	ACCEPT
11	D1	0.109	83.33%	0.567	0.750	0.917	0.744	ACCEPT
12	D2	0.220	91.67%	0.767	0.892	0.942	0.867	ACCEPT
13	D3	0.211	91.67%	0.650	0.808	0.925	0.794	ACCEPT
14	D4	0.191	91.67%	0.617	0.783	0.917	0.772	ACCEPT
15	E1	0.196	100.00%	0.700	0.850	0.950	0.833	ACCEPT
16	E2	0.174	100.00%	0.767	0.900	0.967	0.878	ACCEPT
17	E3	0.191	91.67%	0.617	0.783	0.917	0.772	ACCEPT
18	E4	0.206	91.67%	0.750	0.883	0.950	0.861	ACCEPT
19	E5	0.220	91.67%	0.683	0.833	0.933	0.817	ACCEPT
20	F1	0.147	100.00%	0.800	0.925	0.975	0.900	ACCEPT
21	F2	0.161	66.67%	0.583	0.758	0.908	0.750	REJECT
22	F3	0.070	83.33%	0.517	0.708	0.892	0.706	ACCEPT
23	G1	0.211	91.67%	0.650	0.808	0.925	0.794	ACCEPT
24	G2	0.174	100.00%	0.767	0.900	0.967	0.878	ACCEPT
25	G3	0.206	91.67%	0.750	0.883	0.950	0.861	ACCEPT
26	G4	0.191	91.67%	0.617	0.783	0.917	0.772	ACCEPT

IV. CONCLUSION AND FUTURE WORK

It has concluded that all the elements in Hytee Model (except 2 elements) are maintained and certified of Hytee model based on the consensus of an expert. Using Fuzzy Delphi Method analysis, this study has proven the importance of element in Hytee Model. The findings of the study are in line with its purpose to answer the questions pertaining to the agreement of experts on an element into work developing proposed Hytee Model. The defuzzification process is greatly used to filter the priority of element. In change management, the contribution of this result to ensure the user understands the environment of change management. For traceability support the contribution of this study to prove the flow of the system using the traceability model. For regression testing support refer to Table VII is to show the function of regression testing in Hytee Model. In test effort estimation refer to Table VI show the user the result after all the flow of change of the error. For report and GUI refer to the table, we can see that the expert agree with the GUI of Hytee Model.

As future work, in this stage, the researcher will design the model based on the data from the Fuzzy Delphi Method discussion within the expert review. From elements of change management, traceability support, regression testing support, test effort estimation support, report and GUI, the findings it to continue to upgrade the proposed model to the actual model for improvement.

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