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REQUIREMENTS ENGINEERING PROCESSES, TOOLS/TECHNOLOGIES, & METHODOLOGIES

MR. SHAMS-UL-ARIF, MR. QADEEM KHAN, S. A. K. GAHYYUR

Department of Computer Science

Faculty of Basic & Applied Sciences

International Islamic University Islamabad

Email: sunarif2002@gmail.com , qadeem_kustcs@yahoo.com , shahbaz.ahmed @iiu.edu.pk

ABSTRACT

This paper discusses software requirements engineering in deep with the help of the standard technologies, processes and methodologies. Requirements engineering is the initial step of software development activity in which the requirements from the customer are elicited and documented. This activity is very much vital for the success of the project because all of the rest of activities depends upon requirements engineering such as designing, implementation, testing, operation and maintenance. Requirements engineering is an iterative process which continues iteratively until the project is complete. The requirements engineering process models are the set of activities used to define the life cycle model for requirements engineering. There are many requirements engineering process models such as linear sequential model, linear iterative processes model, iterative process model and spiral model. These models have certain advantages and disadvantages hence there is no ideal requirements engineering process model but the problems with requirements engineering process models can be minimized by making the active involvement of the stakeholders whose concerns need to be addressed. The other main element in requirements engineering is the utilization of tools for requirements elicitation. The variety of tools exists such as interview, survey, questionnaires, task analysis, group-work, card sorting, CRC cards, observations, prototyping, repository grids etc. These tools are usually used in the conjunction so that complete requirements are elicited. The requirements engineering process can be automate by utilizing modern technology such as Neural Impulse Actuator (NIA) and web-based mobile technology. These technologies make advancement in the requirements engineering tools by automating them. For example NIA reads the human mind and we-based mobile technology provides the internet facility for stakeholder communication and also provides the dynamic plotting and arrangement of CRC cards, group tasks, charts, bars etc. The whole study has been grouped into requirements engineering processes, tools, technologies and methodologies along with their negative and positive aspects and also our suggested approaches. We also suggested the use of new technologies to automate the requirements engineering process.

KEY WORDS: *Requirements Engineering, Stakeholders, Requirements Engineering Processes Models, Tools & Technologies, Methodologies*

1. INTRODUCTION

Requirements engineering [1,38]is the most important activity in software project development as the other phases in the life cycle of software development depends on this important activity. As the name implies requirements engineering is a dig field responsible to cover all the activities involved in discovering, documenting, and maintaining a set of requirements for a computer based systems. A numbers of consequences may arise due to wrong requirements such as the system may be delivered late, more costly than the original estimation, customer and end-user will not be satisfied, the system may be unreliable and there may be regular system defects. According to the survey conducted by ESPI in 1995 that about 40-60% of all defects found in a software project can be traced back to errors made during the requirements stage. According to another survey conducted by Standish Group Study, 1994 that 13.1% projects fail due to the incomplete

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requirements and 8.8% projects fail due to the rapidly changing in the requirements. In our view the only way to kill these problems are to follow the best practices [2], processes, tools, technologies and methodologies for requirements engineering. In this paper we present these concepts in the light of the guidelines required to improve the requirements engineering phase.

2. REQUIREMENTS ENGINEERING

Software requirements engineering [35] is a process of discovering that purpose by identifying stakeholders, and their needs, and documenting these in a form that is amenable to analysis, communication and subsequent implementation. The more clear definition was defined by Zave[36]:

"Requirements engineering is the branch of software engineering concerned with the real world goals for functions of and constrains on the software systems. It is also concerned with the relationship of these factors to precise specifications of software behavior and their evolution overtime and across software families."

The typical definition of engineering refers to the creation of cost effective solution to practical problems by applying scientific knowledge [37]. A process involved in developing the system requirements are called requirements engineering.

3. REQUIREMENTS ENGINEERING PROCESSES

Like a life cycle development process there are some limited numbers of requirements engineering processes available. These are the set of activities involved in development of requirements. Although there is no ideal requirements engineering process but still it is possible to define a good requirements engineering process model.

3.1 Input/output of Requirements Engineering Process

This methodology is presented by Kotonia and Sommervile in 1998 in their work which describes five inputs to the process and three outputs of the process. The inputs are: existing system information, stakeholder needs, organizational standards, regulations and domain information. A detailed process is applied on these inputs and the agreed requirements, system specification and systems models are achieved as outputs. These inputs and outputs are similar for all organization [3] in the most of the cases but only the requirements vary. This is a general sort of requirement engineering process and is flexible to be adopted by any organization for any project through defining organizational applied standards and regulations. The system models which are one of the outputs of this process are the data flow, OO process models useful in designing the software system.

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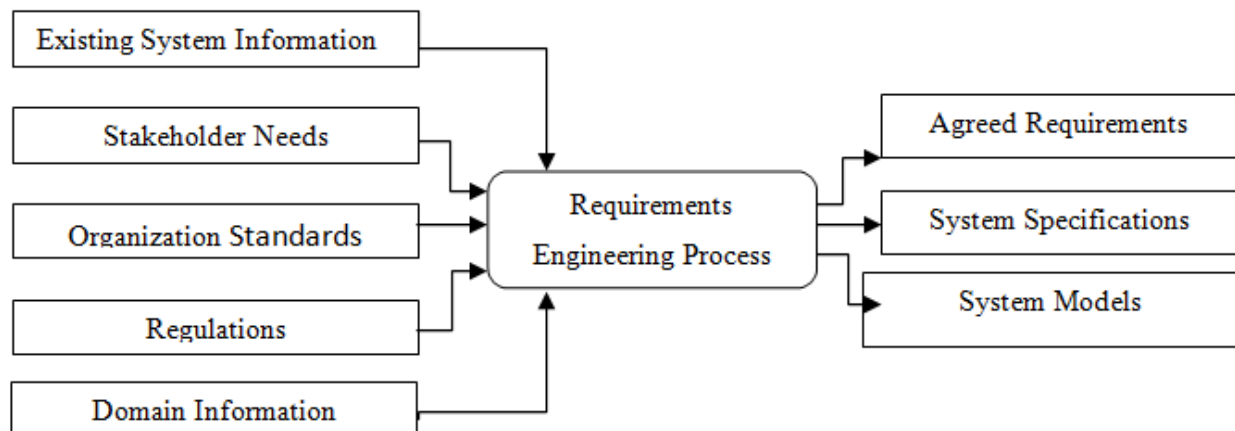

Figure 3.1 Input/output of Requirements Engineering Process[45]

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3.2 Linear Requirements Engineering Process Model

The linear requirements engineering process model was proposed by Linda Macaulay in 1996. There are five activities arranged sequentially in this model namely concept, problem analysis, feasibility and choice of options, analysis and modeling and requirement documentation. This is a simple model and mostly used for small projects with some less amount of complexity but this model is not good for some large and huge projects to get their requirements.

Fig 3.2 Linear Requirements Engineering Model[45]

3.3 Linear Iterative Requirements Engineering Process Model

The linear iterative requirement requirements engineering process model was proposed Kotonya and Sommervile in 1998 with some of the iterations used for validation the requirements engineering again and again. This iteration continues until the stakeholders are agreed and the final system specification is achieved. This model is useful for the system where the specifications should be pink point accurate and should be validated multiple numbers of times through the potential stakeholders.
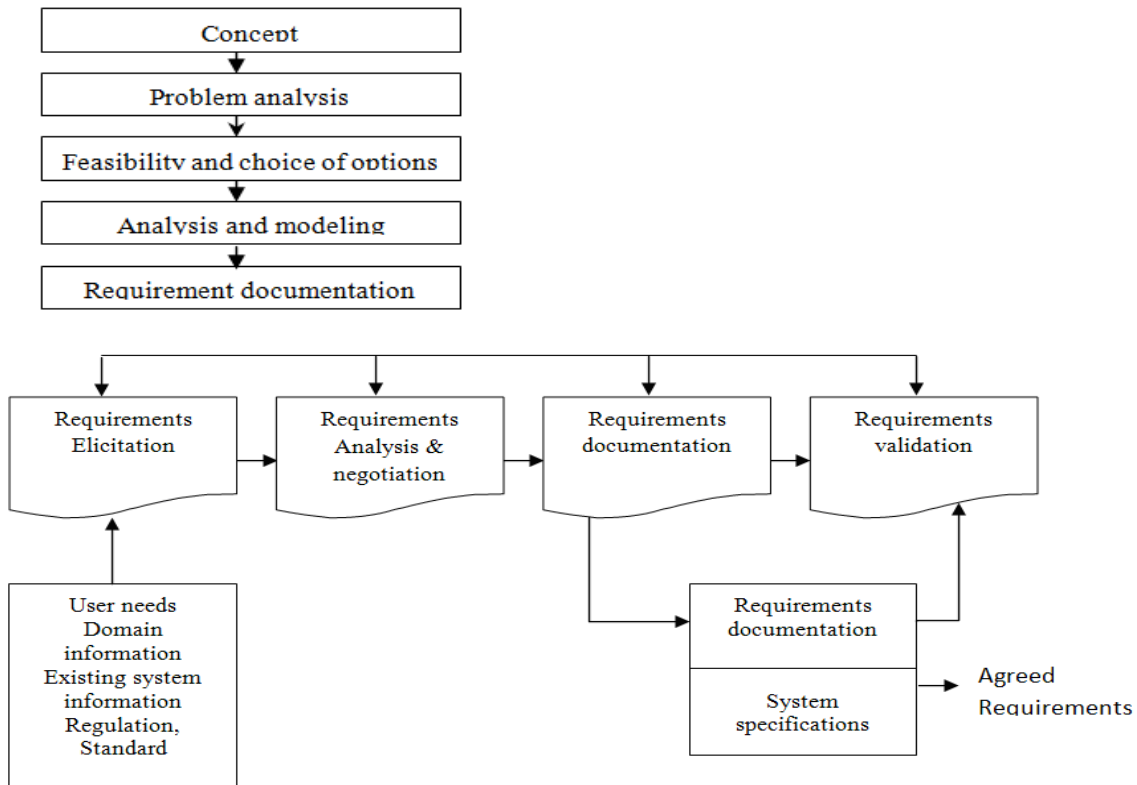

Fig 3.3 Linear Requirements Engineering Model [45]

3.4 Iterative RE Process Model

The linear iterative requirement requirements are proposed by Loucopoulos and Karakostas. This model is used to perform the requirements engineering in multiple iterations and hence is better for those software development which are launched versions by versions in the market. There are three simple phases of this model called elicitation, specification and validations. The requirements are obtained from the user and problem domain of the software systems to be developed.
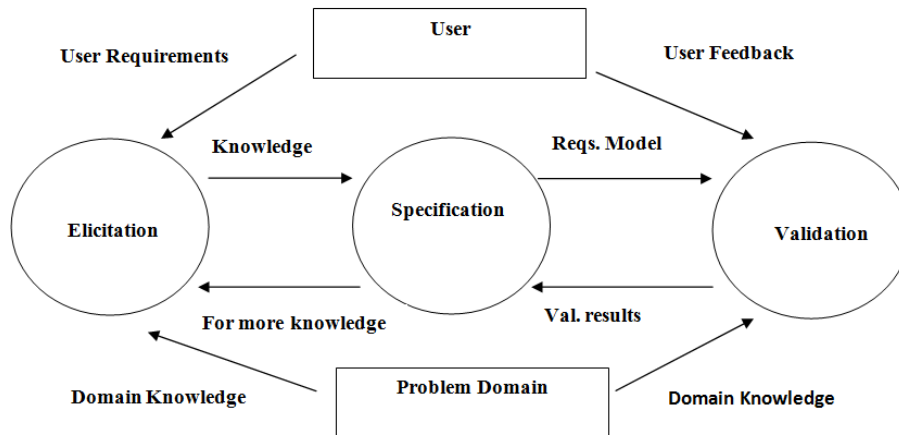
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Fig 3.4 linear Iterative Requirements Engineering Model [45]

3.5 Spiral Model of RE Process

The spiral model is suggested by Kotonya and Sommerville in 1998. This model is performed in spirals. One spiral represents the complete version of the requirements on the bases of which the system has to be developed. Each spiral is divided into four quadrants called specification elicitation, requirements analysis and negotiation, requirements documentations and requirements validations. The main characteristic of this model is to handle the unwanted consequences called risks [4] such as speciation delay, requirements change [5], low ROI etc which can badly affect the cost schedule and quality of the project.
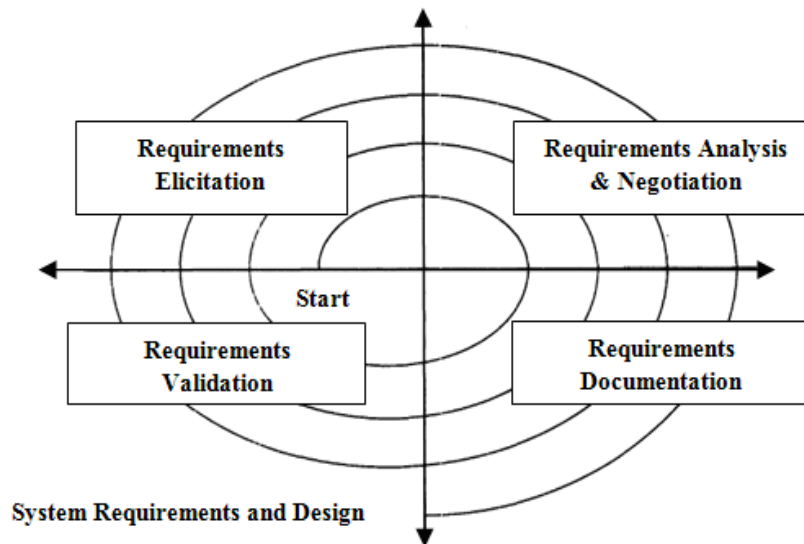

Fig 3.5 Spiral Requirements Engineering Model [45]

The new concept in this model is that the system design is also created on the bases of requirements. The design represents the structure of the requirements specification that is near to the implementation.

3.6 Critical Analysis of RE Process Models

The flowing section provides the critical analysis of all these models.

3.6.1 The linear RE process model is a basic model can be used for simple and small projects

only. This model provides a foundation for other models. But there are many problems associated with this model such as freezing of requirements ,no user feedback, no validation of requirements, no iterations of RE, and the most important that there is no strategy defined for risk management.

3.6.2 The Linear Iterative RE model solves some of the problems of linear RE process model such as freezing of requirements and requirements invalidation. There are also some problems associated with linear iterative RE process model such as no reverse engineering is possible and no risk management [4] is suggested by this model.

 3.6.3 The Iterative RE model suggests the user and domain information feedback [6] in case of new iteration in the product. The new iteration is called a version but still there is no methodology set to manage the risks in the project.

3.7 Our Suggested RE Process Model
As every model has some pros and cons so we suggested a combined approach for RE process model known as Tools Cost and Benefit Analysis (TCBA) RE model. In this model we introduced the selection of tools and technologies Appropriate for a particular project. If the users are spread over the whole globe then survey is the best choice and if the users are limited to a particular department or office then the interview [7] is the best option. Like spiral model; our model also focuses on the risk management. There is an important tasks such as resources and budget required to develop the project. In other words it's the computation of ROI right before in the start of the project. There are two types of cost: primary and secondary costs. The primary costs and some huge costs like staff payments, hardware/software and their maintenance cost. The secondary costs are some small costs such as recreational, library, networking, employee pensions and health facility costs. The primary costs are important and cannot be neglected for the prediction of overall budgets. These costs are helpful in calculating ROI for a project. Finally the user feedback is achieved by a detail discussion. If the user is agreed then all requirements are converted into a formal document known as Software Requirements Specification (SRS) document otherwise the whole or some of the later activities are re-performed.
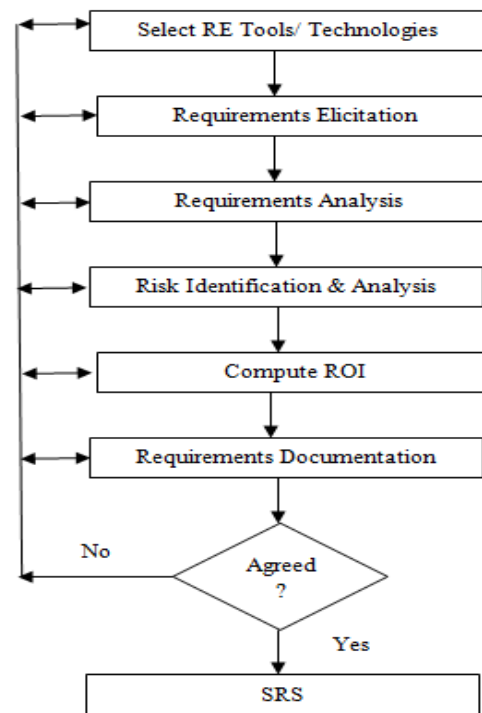

Fig 3.6.4 The Tools Cost Benefit Analysis (TCBA) RE Process Model

4. REQUIREMNTS ENGINEERING TOOLS

There is a wide variety of requirements engineering tools used for elicitation purpose. For the requirements elicitation, the tools selection is important task which should be carried out according to the type and complexity of the project. In this section we are explaining how to select the particular tool and also we provide different types of tools and also we provide the pros and cons and also the comparative approach of these tools.

4.1 Interviews

Interviews [7] are an old type of requirements engineering method in which the requirements are elicited through face-to-face conversion with the customer.
Interview is "A verbal exchange of information between two or more people for the principle purpose of one gathering information from the other/s" (Pole and Lampard 2002).

Types of interviews [39]
Different authors will 'categories' interviews in different ways. Generally however, interviews are often categorized in relation to their structure;

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- structured
- semi-structured and
- Unstructured (or in-depth).

Structured interviews

All the questions are closed ended and the respondent is not allowed to speak beyond the context and scope f the project. The responses are predefined here. This type of interview is preferred for the collection of quantitative data. In brief:

- The Structured interviews allows for interview with multiple interviewees.
- The data collected is more closed to the population –oriented and is easier to analyze.
- The interviewer has more control over interview by asking the questions in a specific order

Semi-structured interviews

In a semi-structured interview, the interviewer usually asks some predefined questions and also other spontaneous questions to find out the interests of the respondent.

- The pre-set questions set guidelines for an interview.
- Quantitative data can still be collected using pre-set questions.
- A great care has to be taken that where the spontaneous question should be asked.

Unstructured interviews

Unstructured interviews are informal and with no restriction about the scope and context of the topics called. There are no predefined questions prior to interview.
In brief:

- Unstructured interviews make the interview more conversational in style.
- Limited control over the interview.
- The data collected is totally qualitative and is difficult to replicate.
- Unstructured interviewing can be a time consuming way to generate data.
- There is greater potential for interviewer bias using this type of interview.

Advantages of Interviews …
- Collecting the rich and detailed data
- Collecting information to design a survey or other usability activity
- Getting a holistic view of the whole system

Disadvantages of Interviews …
- Collecting data from large samples or people
- When it need to collect the data very rapidly

4.2 Surveys

The surveys [8] are used to conduct the RE over a large population of interest. This technique covers the whole geographical region to get the large set of requirements. Mostly appropriate for general purpose software development. The response rates can vary from 1% (charity surveys) to 95% (census surveys) [9].

Advantages of using survey…
- Collect information from a large number of users simultaneously.
- If designed correctly, it can be quick & easy to analyze the data.
- Relatively cheap.

Disadvantages of using survey…
- Rich data collection is not possible
- Does not provide the holistic view of a system

4.3 Questionnaires

Questionnaires [7] are used as a simple tool which may consist of open and/or closed questions. The get right results and response, the questionnaires must be clear, defined and concise with respect to the domain of the system to be developed. Questions must focus on the problem. The redundancy in the questions much be avoided.

Advantages of Questionnaires…
- Questionnaires provide an efficient way to collect information from multiple stakeholders quickly.
- Generally questionnaires are considered more useful as informal checklists to ensure fundamental elements are addressed early on, and to establish the foundation for subsequent elicitation activities

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Disadvantages of Questionnaires…

- Questionnaires lack the opportunity to investigate further on a topic, or expand on new ideas.
- In the same way questionnaires provide no mechanism for the participants to request clarification or correct misunderstandings.

4.4 Task Analysis

Task analysis [10] provides the tasks in a hierarchical fashion with a top-down manner. This approach is main task and the sub-tasks are described by different levels in the tree format and hence this detail continues until the root tasks are encountered. The primary objectives of this technique is to construct a hierarchy of the tasks performed by the users and the system, and determine the knowledge used or required to carry them out. The task analysis is also useful for representing design analysis, integration with business models and model of requirements change. This representation is provided by the article on task analysis [10] and dynamic environment. The model of requirement change is shown by the following diagram in the context of task analysis hierarchy.

Advantages of Task Analysis…

- Task analysis provides the interaction of both user and the system with respect to some task that takes place.
- Task analysis is used by the project manager to manage the user and system tasks.

Disadvantages of Task Analysis…

- The task analysis requires a lot of effort as compared to interview.
- The detail of level is mandatory in task analysis and hence it needs a lot of detail for the low level tasks.
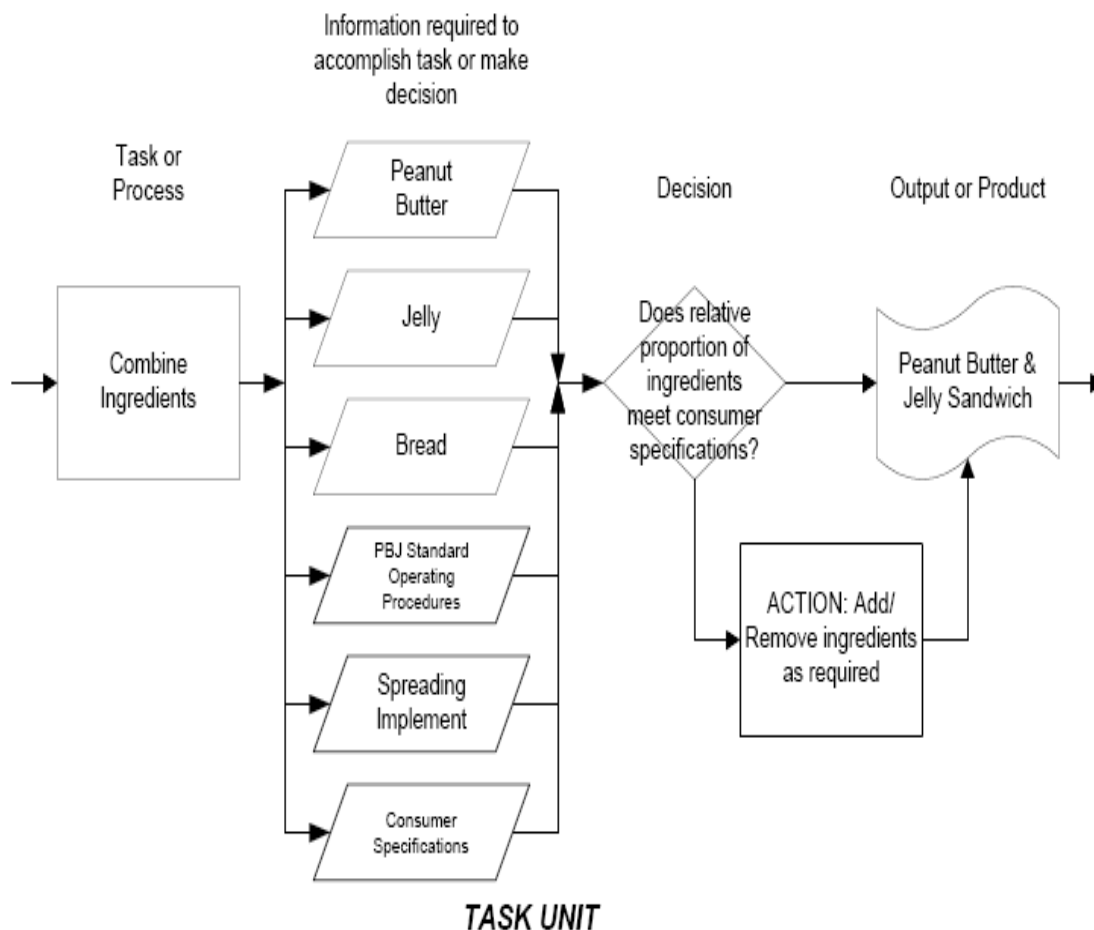

Fig 3.1.4 The Tools Cost Benefit Analysis (TCBA) RE Process Model[40]

4.5 Domain Analysis

Domain analysis [11] provides domain knowledge, and identification of reusable concepts and components. The term was coined in the early 1980s by James Neighbors [41][42]. It is an earlier eliciting technique which investigates the thorough domain area by the domain expert. These types of investigations are particularly important when the project involves the replacement or enhancement of an existing legacy system. The domain analysis id so much important and it is found inside in the requirement analysis. The following diagram is the SDET context view of domain analysis. Arango and Prieto-Diaz [1] present a model of domain analysis summarized in the following SADT diagram:
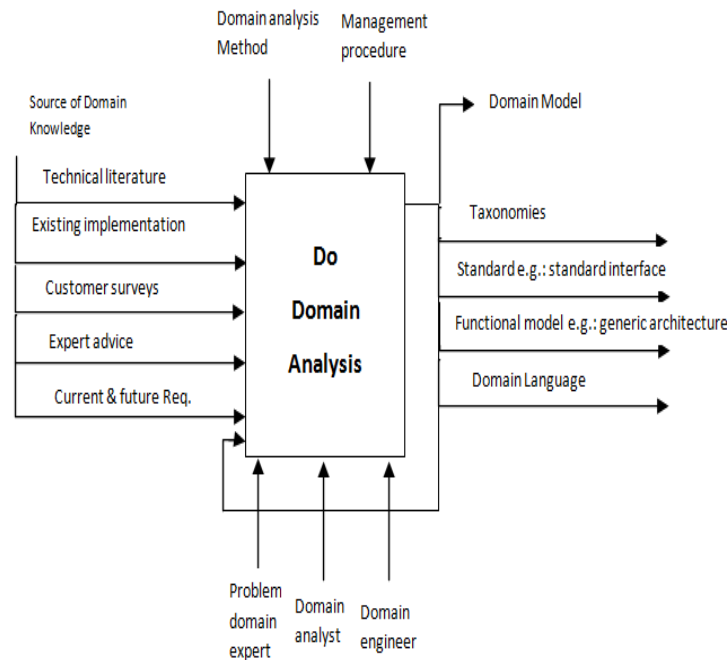

Fig 3.154 The Domain Analysis of SADT diagram *[43]*

Advantages of Domain Analysis…

- Domain analysis is useful for eliciting requirements include design documents, instruction manuals for existing systems and other files and forms used in the current business process.
- This technique is used in the conjunction of other elicitation techniques as an input. For example, analysts use previous experience in similar domains as a discussion pattern for helping group work and conducting interviews.
- Domain Analysis provides the opportunity to reuse specifications and validate new requirements against other domain instances [11].
- Problem Frames [13] in particular provide a method for detailed problems examination in order to identify patterns that could provide links to potential solutions.

Disadvantages of Domain Analysis…

- Domain analysis is quite complex task because it needs to focus on different type of domains and hence is very much complex technique.
- There required a lot of expertise and skills from diverse fields of software engineering.

4.6 Introspection

The introspection [14] technique is the starting point for other requirement elicitation techniques. Introspection is the mental thoughts of the requirements engineering about the wants and needs of the stakeholders about the systems.

Advantages of Introspection…
- It helps the other elicitation techniques. So it is a good starting activity for requirement elicitation.
- There are almost no costs of this technique.

Disadvantages of Introspection…
- In case of using the introspection the analyst should not only be familiar with the domain and goals of the system, but also should be expert in the business processes of the users.
- In other words this technique requires a huge experience of the requirement analyst.

4.7 Repertory Grids

Repertory grids [15] develop a grid in the form of a matrix used to store the requirements involve asking stakeholders to develop attributes and assign values to a set of domain entities.

Advantages of Repertory Grids…
- It is a useful approach to identify the similarities and differences between different information domains.
- It represents a level of abstraction unfamiliar to most users.
- Traceability becomes easy in the repository grids.

Disadvantages of Repertory Grids …
- The repertory grids are somewhat limited in their ability to express specific characteristics of complex requirements.

4.8 Card Sorting

In card sorting [16] technique the customer is provides with a set of cards to sort it according to the names of domain entities. Also the costumer has to provide the criteria according to which the cards are sorted.

Advantages of Card Sorting…
- It provides the requirements prioritization [17] by sorting and placing the most

important requirements at the top of the cards.
- It provides how much the customer has the knowledge about the problem domain.

Disadvantages of Card Sorting…
- It requires deep knowledge about the domain and also all the entities should be included in the process otherwise this technique gives wrong results.
- The group work is much effective than card sorting as group work does not need so deep knowledge about the domain.
- Complex cards can confuse the novice stakeholder.

4.9 Class Responsibility Collaboration

They were proposed by Ward Cunningham and Kent Beck [1]. CRC [18] cards represent the software requirements in the form of cards whose shapes resemble as like classes. The responsibilities are assigned to each class that processes the user requirements.
The following is a simple structure of CRC card.

Class Name	
Description	
responsibility1	Collaborators:
responsibility2	Another Class

Fig 3.154 CRC Card Structure diagram*[44]*

Advantages of CRC…
- CRC provides the abstractions
- This technique shows the collaboration among the classes.
- This technique is helpful for UML designing

Disadvantages of CRC…
- CRC cards provide limited details about the software elicitation because of the high level abstraction.
- This card is much preferred to be used by the designer, not a software engineer.

4.10 Laddering

In laddering [19] technique, a series of simple questions are asked from the stakeholders which are answered in a clear way by the stakeholders. These questions are arranged into a hierarchical format which is useful to show the order of the

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questions that has been asked. The stakeholder domain information is vital for the success of this technique.

Advantages of Laddering…
- This technique provides the close contact with the stakeholders by asking them about their prioritized needs.
- This technique arranges the customer requirements in proper hierarchical format that is easy to be understood.

Disadvantages of Laddering…
- This technique becomes more complex for a large numbers of requirements and hence is not good than the repository grid.
- The maintenance of this technique becomes very hard when adding and deleting the requirements anywhere in the laddering.

4.11 Group Work

In the group work [20], different stakeholders are invited to conduct the group meeting in a collaboration to elicit the requirements of the system to be developed. This technique is mostly used technique but needs a lot of hard work to conduct.

Advantages of Group Work…
- This technique is very much effective to resolve the conflicts among customers in order to bring them at one table.
- Each and every aspect of requirements is discussed and proper suggestions are given using group work.
- The stakeholders provide the direct remarks about the software requirements.
- Stakeholders work in the cooperative environment.
- Group work Provides the remarkable

Disadvantages of Group Work…
- This technique needs a lot of effort as compared the other requirements engineering techniques.
- Sometimes all the stakeholders can join at the same time as it may be possible that they may be busy in other tasks.
- Group work is less effective in the highly political tense situation.

4.12 Brainstorming

Brainstorming [21] is a process where participants from different stakeholder groups engage in informal discussion to rapidly generate as many ideas as possible without focusing on any one in particular. So much severe criticism is not allowed in this type of technique because due to this the biasness can be generated. The ideas are freely explained and everyone has to interpret it in a very pleasant environment with some informal discussion.

Disadvantages of Group Work…
- Brainstorming are mostly used for the innovative sort of projects where each participant provides his or her own ideas after their personal research about the project to be started.
- This technique is often used make the key decisions about the requirements of the project.
- It promotes free thinking and expression of ideas.
- Brainstorming provides the innovative ideas about the project to be developed.

Disadvantages of Brainstorming…
- Brain storming is seriously affected by exploring the critique ideas.
- Brainstorming is not used to resolve the major issues.

4.13 Joint Application Development (JAD)

Joint Application Development (JAD) [22] is a combined business analysis approach that solves a problem in which large numbers of stakeholders are interested. This approach is most used for Agile [20, a5] development in which the quick amounts of requirements are elicited. The discussion also provides the ways of solving the problems.

Advantages of JAD…
- JAD provides the rapid decision making about the problem and also the solution of the problem.
- JAD handles the rapid changeability in requirements.
- JAD provides the well formatted structured approach.
- JAD provides the direct communication between all stakeholders of the project.

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Disadvantages of JAD…
- As JAD should provide the rapid solution so hence sometime this technique is un-able to provide the exhaustive validation in so least amount of time.
- JAD team requires huge experience and expertise in the problem domain.

4.14 Requirements Workshops

Requirements workshop [23] is a collection of different types of meeting conducted by the stakeholder to elicit the requirements of the project to be developed.

Advantages of Requirements Workshop…
- This technique provides a complete set of requirements as compared to brainstorming and group meetings.

- Requirements are mostly unchanged whenever elicited with this type of method.

- This technique is feasible for the large and complex solution.

Disadvantages of Requirements Workshop…
- It's a very costly techniques I terms of time and money.
- Requirements workshop is unfeasible for small projects
- It provides slow requirements elicitation.

4.15 Ethnography

Ethnography [24] means how the people understand the problem. It is in-fact the way how people perceives the problems and also the solution of the problem in their mind. From the software requirements engineering context, the ethnography defines how people perceive their needs to be fulfilled by the software.

Advantages of Ethnography…
- Ethnography is useful to collects the quality attributes requirements such as usability and efficiency etc which are necessary for the success of the project.
- Ethnography much effective when to determine the social factors and patterns in the solution of the problem.

Disadvantages of Ethnography…
- Ethnography fails in many cases because there are so much diverse communities of people belonging to different social and ethical sects.
- It is difficult to analyze the social requirements of the people and hence the psychologists are required to provide their services.

4.16 Observation

It is one of the ethnographic techniques in which the requirements engineer visits and observes the environment of the customer where the software has to perform the services. This technique is often used with the conjunction of other requirements engineering techniques like interview and task analysis.

Advantages of Observations…
- Observations are highly authentic requirements engineering tool because the requirement engineer by himself goes there and observes the whole environment of the customer.
- Observations are mostly used in order to validate and verify the requirements.

Disadvantages of Observations…
- Observations are very much expensive to be performed because of the travelling costs.
- Mostly the results of observations are wrong as the customer problems cannot be understand as they are being watched during observations and adjust themselves.

4.17 Protocol Analysis

Protocol analysis [25] is a sort of meeting where participants discuss the requirements of the customer while talking loudly. Protocol Analysis [26] also provides the required actions to be taken for fulfilling the user requirements by using rationale [27].

Advantages of Protocol Analysis…
- This technique can provide the analyst with specific information on and rationale for the processes the target system must support.
- This technique enables all the stakeholders to provide active participation.

Disadvantages of Protocol Analysis…

- Sometime this technique does not provide the true picture of the requirements as talking through operations.
- Conflicts can occur among the participants while talking loudly.

4.18 Prototyping

Prototype is a version of a product launched into market to provide the so for services to the customers. Prototyping is used to provide a version of the software and which is not final so that the customer can gain the experience and also may be able to provide other requirements that need to be implemented in the next prototyping. The response of the user is in the form of a feedback [6] which is recorded as like requirements of the system.

Advantages of Protocol Analysis…

- Prototyping provides the detail information by investing each and every prototype by the customer.
- Prototypes are mostly used in conjunction with other elicitation techniques such as interviews and JAD.
- Prototypes useful when developing human-computer GUI interfaces.
- Prototypes provide a good chance to the stakeholders an effective rule and to be involved in the requirements engineering.
- The technique is extremely helpful developing new systems for entirely new applications.

Disadvantages of Prototyping…

- In many cases prototypes are expensive to produce in terms of time and cost.
- A great problem for prototyping is that the user often resists making changes if once they get experienced.

How to Selecting the Tools to Use

The tool selection depends upon the type and complexity of the project to be developed. If the project is general purpose market project then survey is the best option and if the project is specific for the particular organization then interview is the best option. Another tools can be selected according to their pros and cons applied on the project. Hickey and Davis [33, 34] have investigated the elicitation technique selection

and state that a particular elicitation technique may be selected for a variety of reasons.

- The technique selected is the only one the analyst knows,
- The technique selected is the analyst's favorite
- The selected technique is the one prescribed by a specific methodology that is being followed for the system development, and
- The choice of technique is governed solely by the intuition of the analyst to be effective in the current context.

Although there is no hard and fast role to select the tool but it depends on our past experience and skills about the particular tool to be selected.

5. REQUIREMNTS ENGINEERING TECHNOLOGIES

The modern technology has important role in every field of life and industry also it should be utilized in software industry especially in automating the requirements engineering. Here in this paper we discuss two important technologies that can automate the requirements engineering.

5.1 Neural Impulse Actuator (NIA)

NIA [29] is an AI device that has the capability to read minds by incorporating an electro-myogram, electro-encephalogram, and electro-oculogram into a small headband and a little black box with a USB connector. This is a control system that can translate eye movements, facial muscle movements, and brain waves into game input. As a result, the NIA is a strange contraption that requires some very unusual participation from the user.

Fig4.1 Neural Impulse Activator (NIA) device

Fig 5.1(a) Neural Impulse Activator (NIA) device[29]

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The NIA read the brain waves which indicate what the stakeholder is thinking about. On the user's PC, the NIA control software converts electrical potentials from the headband into usable input. This software separates the different frequencies in these potentials using proprietary algorithms not unlike fast Fourier transforms. Running these algorithms on a continuously streaming flow of data can apparently hog some "serious CPU cycles," although we didn't see the control application eat up much more than 10-15% of our test rig's Core 2 Duo E6400.
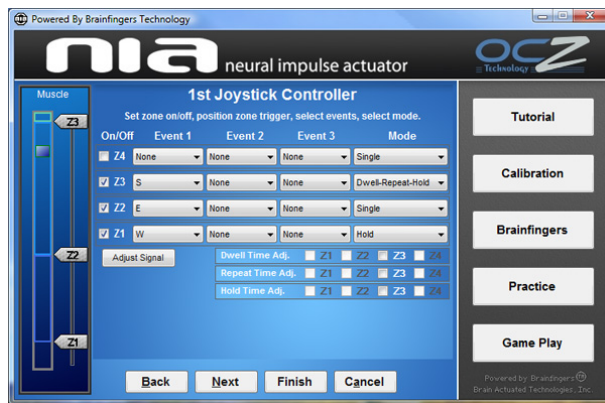

Fig5.1 (b) Neural Impulse Activator (NIA)

Interface [29]

5.1.1 How can NIA Automate RE Process?

NIA can be used in the conjunction with other requirements engineering tools such as interview, brainstorm and introspection in which the body gestures and mind reading is very much important to elicit the complete and accurate requirements. Also this technology is very much easy to make it available and also is cheap to buy.

5.2 Mobile Technology Devices

Mobile Technology devices [30] provides automation to requirements elicitation and is important for stakeholder communication regarding understanding and formulating the problem. The advance technology of mobile devices and mobile tools can significantly contribute to the automation of RE activities. Although other devices and tools used in different requirements gathering activities are mostly desktop computer or laptop base but because of their size and less mobility feature,

they are usually not brought to the workplace of the stakeholders. So we suggest automating the requirements elicitation activities by using mobile devices and designing and implementing a web-based [31] mobile RE tool.

5.2.1 How can Mobile Technology Devices Automate RE Process?

Mobile devices are affective in requirements engineering process by a numbers of its features such:

- The web–based communication enables all stakeholders to communicate with each other even they are physically distributed all over the world.
- Its GUI interface can provide dynamic and easy to use different requirements engineering tools such as plotting repository grids, hierarchical tasks analysis, card sorting, CRC cards etc.

6. METHODOLOGY of REQUIREMENTS ELICITATION

Requirements engineering utilizes different types of methodologies to represents the modular structure of the systems. For this purpose the Model Driven Approaches provide the analytical techniques to define the components and elements that cope with the requirements of the stakeholders. MDA is a good approach to follow because its structures the requirements in an easy format that becomes easy to be understood by the designer and developer as well. Also a stakeholder with some small knowledge about MDA approach can understand it very easily.

Goal, scenario, and agent based modeling techniques are also used for requirements elicitation which defines the run time process of the system to interact with the user.

6.1 Structured Analysis and Design (SAD)
SAD [45, 46] is used 1970s and is a functional oriented approach.

6.1.1 Data Flow Diagram (DFD)
DFD is an example of this approach which shows the flow of data among the proceeding elements. The raw data is taken from one side and the other side information is produced. The functional decomposition is achieved using this technique.

6.1.2 Entity Relationship Diagram (ERD)

ERD is another example of SAD which shows the complex information in the form of entities, attributes and their mutual relationships.

6.1.3 Unified Modeling Language (UML)

SAD also describes the UML which represents the user requirements by using several techniques such as Use Case diagrams [47], Activity diagram, deployment diagrams etc. All of these define the functional behavior of the system which defines the customer requirements.

Combining the Models

It is a best approach to combine use these models as this will becomes very easy to handle complex projects that need different models. But it can introduce the problems of complexity and will become headache for the next phases for software development. So we recommend that an immense care should be taken while combining the models.

7. CONCLUSION AND FUTURE WORK:

In this paper we have discussed all aspects of requirements engineering including requirements engineering processes, tools (approaches), technologies and methodologies. The requirements engineering processes model selection is very much important task and it must be related with the size, complexity, costs, budges of the project. In this paper we discussed pros and cons of each requirements engineering life cycle process and also we suggested The Tools Cost Benefit Analysis (TCBA) RE process model which focuses on the selection of appropriate requirements engineering tools, risks management and computing the ROI at the very start of the requirements engineering activity. RIO is important to compute because it provides the inside view for all stakeholder about the business feasibility of the project. We also disused different requirements engineering tools such as interviews , surveys, questionnaires, group works, tasks analysis, domain[32] analysis, ethnography, observations etc along with their advantages and disadvantages and also we compared them with each other.

Modern technology has a vital role in requirements engineering and of course there exists some modern AI tools that can easily reads the mind of the people. In this paper we have suggested an AI tools known as Neural Impulse

Actuator (NIA) that reads human mind accurately. NIA is a control system that can translate eye movements, facial muscle movements, and brain waves into game input. As a result, the NIA is a strange contraption that requires some very unusual participation from the user. This technology is very much feasible with respect to cost and availability in requirements engineering. NIA can automate the ethnography approach in requirements engineering process.

8. ACKNOWLEDGEMENT:

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