An EVTX model based approach for requirement prioritization

1Muhammad Tahir (MS130400020)

Department of Computer Science,

Virtual University of Pakistan,

Raiwind Road, Lahore, Pakistan

E-mail: 1[ms130400020@vu.edu.pk](mailto:ms130400020@vu.edu.pk)

***Abstract***— **In software development process it could be difficult to implement all requirements at once. Hence requirements are usually prioritized to get maximum project goals in minimum time. Set of prioritized requirements helps us to decide which requirement should implement first. On organization level there may have different criterions for requirement prioritization. Mostly these criterions covers organizational point of view only. Here a systematic approach is proposed for requirement prioritization. Core idea of this approach is to prioritize requirement by stakeholder’s point of view. Requirements are prioritize by involvement of different stakeholders as a result high user satisfaction level achieved. This technique provides a base step for software development and covers many aspects of requirements management.**

***Key words—Requirements, Prioritization, EVTX model***

# Introduction

Requirement engineering is basic step for all traditional or modern software development methodologies. In software development process all steps are based on fact “what to be made?” this leads to “Requirements Analysis and negotiation” phase of RE process. Due to criticality of this phase, a lot of research work is going on to handle this phase in systematic way. Requirement prioritization is one of the stages of requirements analysis and negotiation phase. Practically it is very difficult to implement all requirements at once. Hence requirements are prioritize to find out critical requirements for our decision making process. Researchers have concluded that requirements prioritization has following objectives.

1. To achieves most of the customer’s satisfaction level.
2. To perform cost value analysis of project.
3. To balance time and resources of project to achieve maximum goals.
4. To achieve maximum quality at final phase of project

Many tools and techniques are founded for this purpose. All techniques have different ideas for requirements prioritization.

In this paper a systematic approach is proposed for requirement prioritization. The main core idea behind this approach is to prioritize requirements by stakeholder’s point of view. Complete process is based on EVTX model which is developed by IBM. This model has for main stages for requirements prioritization. Entry criteria verify the conditions to enter in the process. Here two main processes will perform, first requirements will gather, refine and group into different module, and secondly different group of stakeholder will be indentified. In second stage stakeholders will assign different priority level to each requirement that further place into its priority level category. In third stage verification and validation of all actions will be checked. In last stage exist criteria will be define to terminate the process. Proposed technique is very simple and effective. Requirements are prioritize stakeholders groups as a result maximum user satisfaction level could be achieve. Secondly it is very helpful in requirement management. Ambiguity of requirements will be removing and requirement will be grouped according to different system modules. Requirement will be prioritize in each module. Hence this process will cover each corner of our system to be built.

# Related work

Requirements prioritization is not a simple process. Hence there is a no single technique for this process. A lot of research work has been done with many systems.

Satisfy-ability Modulo Theory (SMT) was used by Palma, Susi and Tonella et al. [13]. They perform pair wise comparison for requirements prioritization. The main goal to use SMT is to get more accurate result with minimum effort. At the input of process set of requirements is defined with each requirement priority and independency.

A simulation based technique was proposed by Port and Olkov et al [2] for requirement prioritization. Authors provide a detail description about simulator implementation, parameters adjustment and assumptions in strategy. This strategy can work in both Agile and plan development environment. This strategy prioritize requirements in following ways

In Agile environment requirements are prioritize at starting of each iteration, on “highest value first” base.

In plan environment requirements are prioritize at starting of project development only, on “highest cost benefit first” base.

Shao has proposed ranking based algorithm called a “sample selection method” [3]. Developer presents a set of requirements to their clients who prioritize them according to their requirement. These set of requirements are pass through an algorithm to find correct order for each item of set.

Kukreja and Boehm et al. have said that requirements will be re-prioritize after coming of each new request and after every change request.[4] Their method is not practically easy as seen; because a medium level project contains a set of 300 to 500 numbers of requirements. Hence there re-prioritization is a much complicated task. Authors have proposed a recursive approach to solve this issue.

Huang and Denne et al. have proposed a requirement prioritization strategy based on value creating potential. [5] In this strategy financial detail of each requirement is given. Requirements are grouped according to revenue generating function called “chunks”. The aim of this process is to make a sequence of these “chunks” to maximize market value of project. Same as Kukreja tried to handle this problem by financial point of view. [6] He defined criteria that most valuable requirements are selected first. This strategy is complex when multiple stakeholders are involved with large number of requirements.

Racheva, Daneva and Herrmann handle this issue according to change in requirements. [7] Their aim is to accommodate changing in requirements from client side. They analyze the case study and forward their suggestions to handle the issue in batter way. This strategy is most commonly used in Agile Based Software Development Environment

# Importance of Requirements prioritization

After requirements elicitation process it is necessary to prioritize software requirements to reduce the extra rework in later development steps. Also time and money are always limited in software project so it is difficult to implement all elicited requirements. Hence we prioritize the requirement. Requirements prioritization is very complex decision. Initially it was done by client, how a requirement is valuable to him. Developer evaluates requirements for prioritization with the collaboration of client. The requirements prioritization is important because [1],

1. Client can set core components of system by requirements prioritization.
2. It reduces the confliction between requirements. It provides the technical information to customer.
3. Requirements prioritization provides driving force of each requirement for further developments steps.
4. developer can perform cost and benefit analysis of project
5. It calculates relative importance of requirements.
6. it helps the requirement team to work on optimally reduced requirements
7. development team can judge customer satisfaction level for each requirement
8. We can make marketing strategy by requirements prioritization.
9. Management can set their project scope with respect to time, resources and quality constraints.
10. Requirements prioritization with collaboration of client leads to more client/user satisfaction level.

# Techniques for Requirements Prioritization

Requirements prioritization is a complex process. A lot of research work has been done to resolve this issue. Many researchers proposed different techniques for requirements prioritization. The focus of these techniques is to achieve much customer satisfaction level at minimum cost. Now we shortly discuss major techniques for requirements prioritization.

## AGORA

Goal oriented requirements analysis (AGORA) is proposed by Kiyal. [8] It is goal base technique. Major step of this technique are to consider, detect and resolve all the issues on goals. In this technique contribution values of attributes with their matrices are present in goal graph. Second phase perform analysis and decompose goals. In this step preference values are present on graph nodes and contribution values are present on edges of graph. The contribution values tell the contribution of sub goals to achieve parent goal. At the end resultant graph provides complete quality detail of resultant document. Main feature of this technique is that requirements are not discuss with stakeholders. Requirements prioritization through AGORA is high level scientific process; hence skilled persons are required for requirements prioritization process.

## AHP

A structured technique AHP (analytical hierarchy process) is defined by Thomas L. Saaty [9]. It is very useful in analyzing the complex decisions. It does not provide a perfect decision but it helps us to choose best suitable decision. In this technique we break down main problem into sub problems. As a result hierarchy from main problem to sub problems occurs. These sub problems help us to solve the main problem. Decision makers evaluate each sub problem with numerical values. Then comparison between sub problems is preformed based on assigned weight of each sub problem. AHP process produces amazing results for requirements prioritization. Main feature of this technique is we can perform dimensional analysis. Because sub problems are evaluate at atomic level. Decision maker can make comparison from different point of view.

## Cost-Value approach

Cost value approach was proposed by Karlsson [10]. This technique is same as AHP with relative cost of each requirement. This technique has following steps for requirements prioritization,

1. Find a set of requirements where prioritization is required.
2. Apply AHP process and find relative value of each requirement.
3. Assess relative cost value of each requirement.
4. A cost value graph is plotted for requirements analyzing and prioritization.

## WIN-WIN Approach

This method was described by P. Gruenbacher. [11] it a very simple and general approach where stakeholders sit together to resolve the issue. In this process a meeting between stake holder groups is arranged. In stakeholder meeting a win win setuation is created to find a priortize group of requirements. If win win setuation is not achieved then issues are recoreded. Meeting is re arrange when issues are resolved. In this process resultant requirement is not optimal. It is just mutually agreed set by all stakeholders. This approach leads to achive more use statisfiction level product.

## 100 Dollar Test

It is most naïve and simplest technique. Especially it was designed to deal with non technical stakeholders and to evaluate requirements in terms of money. In this approach we give set of requirements and a hundred dollars to stakeholders. Then we ask to distribute these dollars between requirements. Stake holders are also informed to distribute dollar according to their priority. Hence the requirement that get more dollars having a high priority. This technique does not rank requirements efficiently also it ignores many important factors.

## Multi Criteria Performance Analysis

In this technique requirement analysis is performed with multi criteria [12]. During requirements analysis stakeholders are involved in each step. They evaluate requirements for each given criteria. It is very systematic and multi dimension approach where each stake holder is free to use different set of tools. In this technique finding prioritized requirements set is relatively tough task. But result is near to optimal solution.

1. ETVX Model for Requirement’s Prioritization

Here a requirements prioritization technique is proposed based on ETVX model. This model was defined by IBM in 1980. This process encounters the many problems that will need to encounter during development process. We will see that ETVX provide a systematic process where final output is a set of prioritize requirements. In ETVX model tasks are explicitly defined. Here input of ETVX model is a set of requirements and task will to find a set of “Prioritize Requirements”. The core idea for requirement prioritization is likely to “win win approach”. But here priority level assign to each requirement by its relative stakeholder. Mover over this core idea is covered by ETVX model to get more precise and refined result. For this purpose we include five types of stakeholders groups. These stakeholder groups will cover all aspects of requirements. This mechanism covers all corners of the system requirement will first separated in different system modules and then prioritized.

1. Entry Criteria:

It is initial step of our technique. It satisfies the criteria for process initiation. Also it enlist the items that are required as input for process. Entry criteria basically define policy, procedure and resources. Some basic needs for requirement prioritization will also define in this step

1. Our goals according to requirement prioritization will be define.
2. Responsibilities for requirements gathering, requirement refinement, requirement classification, and prioritization etc will be assigned.
3. Procedures for our process will develop.
4. Cost, budget, schedule will be planned.
5. Documentation for our process will be prepared.

In our technique this is a longest step. Initially we have a set of requirements that are required to be prioritized. Then requirements are further refined to get a valid set of prioritize requirements. Then following steps will be perform to refine input set of requirements.

1. *Requirement gathering*

In this step we collect all system requirements that are gathered from various resources. Requirements elicitation team is responsible for this process. RE team gather all type of requirements like stake holders, legislative, domain and inverse. In requirement gathering process, essential detail of each requirement will also be mention with it.

1. *Requirement Identification*

In requirement gathering there is chance that many un-required requirements may be injected in requirement set. Hence collected requirements further pass through a process called “Requirements identification process”. Requirement experts analyze each requirement and find that “given requirement is belong to our system or not”. Secondly they ensure that “is given requirement, actually a requirement?” Requirements identification is based on detail provided with each requirement by requirement gathering team.

1. *Requirement refinement*

In this step requirements are further refine. This step is performed by highly expert team each requirement is deeply refined. There are four main goal of this step.

1. To kill unclear, ambiguous and unrelated requirements.
2. To indentify and remove Non requirements, because some sentences look like a requirements but actually not a requirement.
3. Non function requirements play as umbrella requirement. In final product they are must be satisfied. These are related to all modules of the system. Here we encounter non functional requirements.
4. Composite requirement are divided into single atomic level requirement.

This is very sensitive step. Highly experienced team will be required to separate requirements. At the end of this step each requirement is purely single clear and Atomic level function requirement.

1. *Requirement separation*

Requirements further classified and categories to differentiate them into system modules. Each system module is found out in terms of requirements. Limitations and boundaries of each module are defined. Hence sub set of requirements occurs according to each module. Some composite module will further divided into sub modules. Limitation and boundaries of each module are defined. Requirements in each system module further refine according to un-related requirement. Requirement engineer confirm that each requirement should be an atomic level requirement. Ambiguity of requirements will be clear and un-related requirements will be remove.

1. *Stakeholder identification*

In our model requirements prioritize by different group of stakeholders. Here we indentify different group of stakeholders. Each group has its own ability and knowledge about system to be built. We concern with five types of stakeholders for this purpose.

***System Developers****:* System developers actually implement the requirements in system. They just pickup a software requirement and make its physical look. They mainly concern with system design and implementation details and assign priority according to system development.

***Management:*** management is final authority that manages all process of our system development. All members in management team are highly technical and experienced. They clear about system to be built and what are the ultimate goals. Management covers all aspects of development process.

***Marketing group*:** marketing group guides us about marketing demand and new trends. They assign priority level to requirements according to marketing competition and our product demand in market. Inversely this group will responsible to get maximum earnings from our software product.

***Client:*** mostly these are final product users. All development process will perform for them. They have a lot of experience of our product using. There may be difficult to get information from end users. User feedback system, Surveys and interviews will be done for this purpose. Requirement prioritization from end user is very effective because product has longest relation with end user.

***Share holders and financers:*** these are indirect stakeholder of our product. They have mostly concern with reliability of product.

1. Task

It is core part of our technique. Here requirements are actually prioritized. Requirement engineering team performs this process with the help of different stakeholder groups. First different priority level categories are defined. Set of requirements is given to stakeholders and ask them to prioritize it. After it requirements are put into different categories according to their priority. This stage has three main parts.

1. *Requirement Categorization*

This part is like entry criteria of “Task”. In this part each module further refine into different categories. Each category shows a requirement a priority level and entry criterion for each category is defined. After defining requirement priority each requirement will put into its relative category. In other words this part provides us structures to place prioritize requirements. Priority of each requirement will be clear in each module. Requirements that have no clear priority are put in separated set of requirements.

1. *Requirement prioritization*

This is core part of our process. Set of requirements given to different stake holders. Each stakeholder will provide its level of interest and set priority level for given requirement. Requirement level of priority will usually enforce by user, domain or legislation. At this stage requirements are categories and prioritize relevance to their specific stakeholder groups. Categorization according to relevance stakeholder group is must core part of this model. For this purpose we will involve five types of stakeholders as mentioned above. There will be different techniques to set a priority level like numerical value, statistical analysis etc. Important point is that stakeholder must have clear understanding about system what to be built and what its goals are. So under this broader scope of information, they can prioritize the requirements in a better way. During requirements prioritization stakeholder works in iterative manner to get well understanding about system. In prioritization process requirement engineering team is present to assist them. Before starting this process, RE team will find stakeholder for each requirement. Each requirement will allot to its single group of stakeholder that will define its priority level.

Here there may be some contradictions,

1) A requirement may be related to multiple stakeholders.

2) Also different stakeholder of same group can assign different priority level to same requirement.

In this case requirements engineers will take maximum of all priority levels. Some time contradiction can exists between stakeholders for same requirement. In this case requirements engineering team set priority level factor for each stakeholder like system developers and end users have high priority than financers or marketing team. At the end of this stage all system modules have a priority level for each requirement.

1. *Requirement placement*

Here we will have requirements with defined priority level. Requirement engineering team checks that requirement prioritization is finalized and put it into its relative priority level category. High priority requirements put in top priority level category. Priority of each requirement is clear in module. Requirements that have no clear priority are put in separate set of requirements. These requirements again send to stakeholder groups to define clear priority. This process continues until priority of all requirements is defined.

# Verification/Validation

Validation/verification section defines steps for validating/verifying that the requirement prioritization process has been properly executed. It also verifies that the associated work has properly done. This process is done by quality assurance group of RE team. The verification/validation stage has an iterative relation with Task stage. If QA group found anything else in prioritize requirements. They report back to “Task” process until the problem is settled down. In our ETVX the validation/verification team has following goals.

1. Verification/validation entry criteria for each requirement to be prioritize.
2. Conformation of Task process and verifies for any possible inconsistency, un-completeness or any ambiguity.
3. It conforms that all standard procedures has followed for requirement prioritization.
4. All organizational standards will be confirmed.
5. Process documentation is continuing with process.
6. How much effort has used for requirement prioritization with including time and money.
7. All risks in given process are indentifies.
8. It confirms that all stakeholder groups are indentifies.
9. It verifies that process has completed in its given time schedule.

All stakeholders are satisfied on given priority level.

1. Exit Criteria

Exit criteria define criteria that must be fulfill to terminate from process. In our model exist criteria will be verified by our Quality teams. To verify exit criteria our team has following goals.

1. There is no pending work, all requirements have properly prioritized.
2. All process documentation is maintained and recorded for reference.
3. Process rework has performed.
4. Tolerance between expected work and actual work has been recorded.
5. Open issue about requirement prioritization has been recorded.
6. Process related issued that need to be review has been noted.

After verifying this criterion our process will ready to exit. As a result we will get set of prioritize requirements.

1. Conclusion

Requirement prioritization is one of the stages of requirements analysis and negotiation phase. Practically it is very difficult to implement all requirements at once. Given technique provide a systematic approach to prioritize software requirements. Main feature of this technique is it prioritizes software requirements with stakeholder point of view. Secondly system is devoid into different modules. So it covers each corner of project during development. Once this system is developed, it very easy to put a requirement on its place.

1. References

**[1]** Karlsson J, Ryan K, “Improved Practical Support for Large Scale Requireemnts Prioritizing”, 1997

**[2]**Dan Port, Alexy Olkov, and Tim Menzies, "Using Simulation to Investigate Requirements Prioritization Strategies," *IEEE*, pp. 268-277, 2008.

**[3]** Peng Shao, "Sample Selection: An Algorithm for Requirements Prioritization," ACM, pp. 525-526, 2008.

**[4]** Nupul Kukreja and Barry Boehm, "Integrating Collaborative Requirements Negotiation and Prioritization Processes: A Match Made in Heaven," ACM, pp. 141-145, 2013.

**[5]** Jane Cleland Huang and Mark Denne, "Financially Informed Requirements Prioritization," *ACM*, pp. 710-711, 2005.

**[6]**Nupul Kukreja, "Decision Theoretic Requirements Prioritization," *IEEE*, pp. 1465-1467, 2013.

**[7]** Zornitza Racheva, Maya Daneva, and Andrea Herrmann, "A Conceptual Model of Client-driven Agile Requirements Prioritization: Results of a Case Study," *ACM*, 2010.

**[8]**Haruhiko Kaiya, Hisayuki Horai, and Motoshi Saeki, "AGORA: Attributed Goal-Oriented Requirements Analysis Method," *IEEE*, 2002.

**[9]** Wikipedia. (2013) Analytical Hierarchy Process. [Online]. HYPERLINK <http://en.wikipedia.org/wiki/Analytic_hierarchy_process>

**[10]** Joachim Karlsson and Kevin Ryan, "A Cost-Value Approach for Prioritizing Requirements," pp. 67-74, 1997.

**[11]** P. Gruenbacher, "Collaborative Requirements Negotiation with EasyWinWin," *Second International Workshop for Requirements Engineering Process*, 2000.

**[12]** H. Olson and D. Rodgers, "A Requirements Negotiation Model Based on Multi-Criteria Analysis," *IEEE*, p. 312, 2001.

**[13]** Francis Palma, Angelo Susi, and Paola Tonella, "Using an SMT Solver for Interactive Requirements Prioritization," *ESEC/FSE*, pp. 48-57, 2011