

REQUIREMENTS TRIAGE- CHALLENGES AND SOLUTIONS

SAIRAM VAKKALANKA¹ AND RANJITH ENGU²

¹Department of Software Engineering, Blekinge Tekniska Högskola (Blekinge Institute of Technology), Karlskrona, Sweden

savall@student.bth.se

²Department of Software Engineering, Blekinge Tekniska Högskola (Blekinge Institute of Technology), Karlskrona, Sweden

ranjithengu@lycos.com

ABSTRACT

This paper presents a discussion on the process of requirements triage in market driven requirements engineering and also reports the challenges, consequences, solutions and the experiences with the proposed solutions. Analyses of the observed results are also presented by the authors before conclusion.

KEYWORDS

Large scale requirements engineering, Market driven requirements engineering, MDRE, Requirements Triage, Requirements, Challenges, Solutions, problems.

1. INTRODUCTION

The extent to which a software system fulfills the purpose which it is intended for, determines its success [1]. This paves the way for requirements engineering as it provides what the systems needs to possess, produce, provide or accomplish in order to fulfill the needs of its customers [2]. Requirements engineering can be divided into two main approaches [3], one which is customer centric or customer specific, better known as the traditional way of requirements, which is the bespoke requirements engineering. The other is a market based approach which is known as the market driven requirements engineering.

The main motto of bespoke requirements engineering is to fulfill the requirements specified by the customer. This situation changes when it comes to Market Driven requirements engineering as there are number of customers involved and thousands of requirements need to be handled which pour from different sectors of the market.

Requirements in this approach do not come only from the insiders such as the sales persons, developers, market analysts [4] etc but might also be generated through competitors, customers, Inventors, end users etc. This leads to a situation where there is a continuous inflow on requirements to be handled by the organization [5]. Also with the increase in the business for the off the shelf software[6], market driven requirements engineering approach has acquired

popularity and rise in interest to opt this approach has grown by large when compared with the traditional requirements engineering[7].

When we make a comparison between the traditional and market driven approach, the RE activities are not constrained to development but are a part and parcel of the product management [8]. Requirements engineering in market driven requirements engineering starts with the elicitation of requirements which include requirements triage, requirements estimation, requirements prioritization and requirements selection. It is very important in MDRE from the perspective of management, to select those requirements which align with the goals fixed by the organization and managements, and possibly discard the other requirements which do not align, at an early step. This forms the path for requirement triage, which in brief is a step by step process of estimating, prioritizing and selecting the requirements based on the given criteria such as the available resources and limited time.

Requirements triage always results in providing a focus on the organizations aimed objectives and goals along with balancing the selection of requirements with respect to the time available and existing resources. The process of triage and requirements selection should always align with the business goals of the organization else might present a situation where, important business requirements might be less weighed when compared to unimportant ones, this scenario might leave the organization to face with an horrendous situation. The art of requirements triage is a tough task [9] which has different challenges to face with; these challenges are presented in the following sections.

1.1 Related work:

Requirements engineering being a widely researched area, many researchers have contributed in letting the world know the importance of requirements triage and understanding the process of triage.

Simmons [9] identified an area similar to requirements triage in medical profession where people suffer from the shortage of time and resources to do the required and have developed methodologies and techniques to deal with the shortage. He through his article suggests ways to adapt these techniques where adopted by professionals in medicine, which could identify and solve risks related to the requirements prioritization and selection.

A.M Davis [11] who is a prominent researcher in this area has suggested recommendations on conducting the process of requirements triage. He has identified certain guidelines which need to be followed while performing triage. He has devised these guidelines from observations made through several product development case studies at different organizations.

These two researchers have contributed to basic knowledge as to know what requirements triage is and how to conduct it successfully.

2. Requirements Triage

Triage is an important technique used in medical field to prioritize and select the treatment needed for patients in a war field, based on the severity of medication required [9]. This was first introduced by Dominique and Larrey who worked as surgeons in napoleon's army, this method was employed by them in the medical field for those soldiers who required immediate medical attention, depending on the type of the wound but not on the basis of rank of the soldiers [9]. This method of triage from medicine is applied to requirements engineering in market driven

requirements engineering. Requirements triage is an important technique and a very crucial step in requirements engineering in Market driven requirements engineering. This is used in picking requirements from a plethora of requirements persisting to the development of a product depending on the weight and priority of the requirements with respect to the product. The word triage has originated from a French verb "trier" which means to sort [9]. Triage according to different authors is presented below:

- Requirements triage is the art of making a decision, as to which features are needed to be included in the product [10].
- Requirements triage is the process of knowing which requirements are to be satisfied by a product when there are limited number of resources and time [11].
- Requirements triage can be considered as the art of balancing requirements between financial constraints and resources [12].
- Requirements triage is a set of activities which hold good for the analysis phase [34].
- Requirements triage is a well defined collection of practices deciding which requirements are the apt requirements [12].

2.1 Role of triage:

Triage of requirements is vital as many requirements pour in from different sources making an overload of the requirements, making it an overhead task. Triage is considered as the one of the most complex tasks, here the number of requirements to be handled is considered as the definition for complexity [13].

According to Davis [11], requirements triage is a difficult art which flirts with dangers both politically and financially, It may incur huge loss of revenue if prime requirements are discarded, also teams from marketing and technical departments consider triages as their own responsibility, making it susceptible to worries, politically.

Triage when not conducted in the starting stages, the sorting and management of the requirements turns too difficult to handle at a later step in the requirements engineering and shows its effect on the product development activity. After an initial selection and sorting of the requirements, estimates from costs and priorities are taken into consideration to analyzing the requirements which is known as release planning [14]. Always release planning plays a major role in effecting the success of the product. When planning a release for the product, priority of requirements against time and resources plays a major part. It becomes important not only to maintain a balance between the available resources and time but also make and alignment of requirements with the goals set by the organization and management. It is all about getting the right set of requirements are a right point of time (release) with an appropriate product. Hence triage plays a pivotal role in the requirements engineering in market driven requirements engineering approach.

2.2 Goal and Activities of Triage:

The goal of requirements triage is to provide a collection of features which can be implemented with the available resources and time to develop a product which could incur profit and success. There are three main activities of requirements triage; they are as follows [11]:

2.2.1 Prioritize the requirements:

This is the first step which establishes the priority of requirements, evaluating the priority of requirements also involves establishing the interdependencies of requirements also [11].

2.2.2 Estimate the requirements:

A calculation of the resources required and the time needed in order to work on the requirements is estimated [11].

2.2.3 Select the requirements:

A selection of those requirements is done which can bring profit and success when the given product is marketed [11].

2.3 Factors which influence Requirements Triage:

To conduct the activity requirements triage there are some factors which influence it, also known as criteria for requirement triage to be implemented, organizations should define these criteria to start with the process of triage and selection of the requirements.

2.3.1 System requirements

When choosing between requirements it is necessary to evaluate the effect of requirements on a system, as system requirements show their effect on the architecture and quality of a system [13].

2.3.2 Costs

The cost of implementing requirements plays its part in selecting requirements, calculation of implementation is necessary while choosing between requirements as profits are generated only when right requirements are chosen within the available budgets [15].

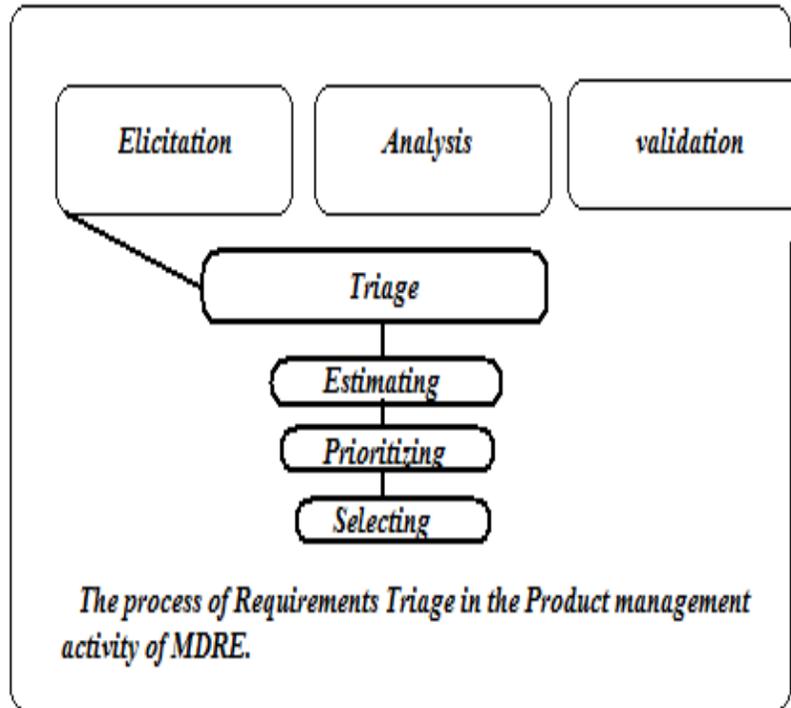


Figure 1: The Process of Requirements Triage in the product management activity of MDRE

2.3.3 Innovated requirements

At times requirements are not developed based on a customer, market or an organization, they are invented. The research and development wing in the organization predicts the need of the feature to be invented. These innovated requirements are dependent at times on the acceptance of the markets to this innovation, acceptance of the customer to this innovation etc [16].

2.3.4 Product expertise

During the requirements triage, the handling of requirements such as the choosing and discarding of requirements must be done by the experts with respect to the nature or domain of the product [14].

2.3.5 Interdependencies

The value of one requirement might depend on the other, if a requirement which is dependent on a higher priority requirement is discarded, it might result in losing the highly prioritized requirements which might affect the success of the product [17]. Requirements interdependencies are to be taken care while discarding and choosing requirements [18].

2.3.6 Release plans

To have a proper release plan, one needs to have accurate estimates which are related to choosing proper prioritized requirements, time to market which is dependent on the organization and market, plays an important role in selecting the requirements [19] [20].

2.3.7 Requirement value

The value of requirements can be assessed by taking into consideration the business value of the product, which depends on the sales of the product, ability to market the product or the market scope for the product and customer's acceptance or the willingness towards the product [13] [21].

2.3.8 Continuous change in requirements

As new requirements keep flowing, these might have a slightly higher priority than those which already exist. These changing requirements should be handled using change management process [14] [22].

2.3.9 Prioritization based on competitor

At times, the prioritization of requirements depends on the competitors in the market; these competitors indirectly determine which features are to be introduced in the product which in turn determines the priority of requirements which are to be included [23].

These are some of the factors which influence the process of requirements triage.

2.4 Benefits of Requirements Triage:

There are a number of organizational and business benefits when the activity of requirements triage is handled well. These benefits reflect in the products success only when the triage is properly done, else would turn as challenges or threats to the organization or the management.

2.4.1 Handles continuous inflow of requirements:

In traditional way of requirements engineering, the flow of requirements can be seen only from a customer or a development team. This differs in market driven requirements engineering as requirements pour in from different sources such as the market, developers, surveys, inventions, customers etc. there are huge number of requirements to handle often resulting in requirements overload. This is handled well by conducting a proper requirements triage which selects and organizes the requirements which are best suit for the product [24] [25].

2.4.2 Helps in a better release plan:

Evaluation and estimation of value of the requirements when done at an early stage in requirements triage [26] [27], helps in providing a proper and better release plan. Release planning in most cases is done based on improper estimations like the evaluated value of requirement in the development of the product. If the evaluation of requirements value is done earlier in the requirements triage, it saves a lot time and resources used.

2.4.3 Reduces the communication gap:

A requirement might have a higher priority in the perspective of technical employees, a lower priority in the perspective of management employees or vice-versa. This reflects that there is a difference in the opinion as to discard a requirement or not, due to difference in perspectives between the two groups. This leads to a communication gap often leading to rift between the two groups. A proper criterion in requirements triages solves these issues by maintaining a balance between the perspectives of the two groups [28] [24].

Also, there are many other benefits such as the proper prioritizing, evaluating and selection of requirements.

3. Challenges

Being a difficult task to handle, while conducting requirements triage, one has to deal with number of challenges.

3.1 Between technology push and market pull (Alignment to business goals):

3.1.1 Problem Definition:

It become always very difficult to balance between technology push, which is and market pull, which are the requirements such as the needs, demands, innovations competitiveness etc from the markets and the technology pull, which are requirements originating from the developer such as innovating new features. These can also be considered as the short-term versus the long term business goals. Alignment of requirements to these business goals is a tough task [17].

3.1.2 Context:

Consider, a situation where there is a situation to choose from two types of which are of equal priority, one type originates from the long-term goals and the other comes from the short-term goals. If we now have to choose one requirement it becomes a difficult task, as choosing one requirement and discarding the other might result in and imbalance in the system or may show effect on the success of the product when marketed [37].

3.1.3 Consequences and Implications:

The consequence of this problem, if the requirements from the short term business goals are discarded might result in an end product where which doesn't have the required features demanded by the market or customers, which makes it not acceptable and may indeed result in the failure of the product. If the requirements originating from the long term goals are discarded might result in the late delivery of the product, missing the deadlines for delivery making it to lose the competitive edge over its competitors, which might indeed result in incurring huge loss to the organization. Proper balance between these business goals will help in achieving a successful product, satisfaction of the customer and will incur profits [37].

Example: Long term goals for mobile company might be release date of a particular series of mobiles, short term goal might be the introduction of a new feature, and features in the mobile can be discarded or added depending on the customer satisfaction, but the release dates for the series of mobiles on platform is long term plan. So balance between these must be handled well.

3.2 Improper knowledge

3.2.1 Problem Definition:

In requirements triage, there is no provision for storing the decisions related to the selection process, which makes it difficult to revisit the choices and learn through the success and failures of those. This results in a problem of lesser domain knowledge in this context. People performing will not be in a position to gain the knowledge on how to correct their exiting process or how to make necessary improvements so as to make more profits and success in the markets [29].

3.2.2 Context:

Consider, a situation where there is a need to train the personnel in the organization about the process of requirements triage and selection, it becomes really difficult to train the staff as there is no scope for recording the process of requirements triage. This presents a situation where the analysis of based on the decision and outcomes cannot be made resulting in a poor knowledge base of the personnel handling the process of requirements triage [37].

3.2.3 Consequences and Implications:

Stored decisions in the process of requirements triage might help in making an examination and review of the decisions taken during the process of selecting requirements. But, the lack of knowledge base doesn't even provide the people involved with handling the requirements to have a retrospect on the process, which in turn doesn't provide knowledge on improving the requirements triage process with respect to improving the chance of success of the product in the markets. This annexes the chances of learning through the decisions made from the process of triage. When this is handled well, it results in an improved business of the product, helps in providing proper knowledge to the people involved in these activities of requirements triage [37].

Example: Consider a situation where a mobile company develops wants to develop second version software for its release, and the first version has not received much success in the markets. Hence there is a need for the post mortem on the requirement decisions. But due to the lack of storage mechanism for the decision attributes, triage in this case becomes a tough process.

3.3 Interdependencies

3.3.1 Problem Definition:

While choosing between requirements in requirements triage, one has to have an understanding of what dependencies exist between the requirements which are to be prioritized and to what extent one effect the other has to be levied [30]. But it becomes a difficult task to know the interdependencies and to properly discard the requirements without one showing effect on the other [31].

3.3.2 Context:

In the market driven requirements engineering, requirements have links and dependencies between one another. Consider a situation where there are two requirements, one which needs to be discarded, and the other which does not exist without the existence of the former requirement which needs to be discarded as it has a low priority. Now, it becomes trivial to choose whether to discard this requirement or to discard another requirement keeping the former one intact though it has no effect on the products success and is really costly to implement it [37].

3.3.3 Consequences and Implications :

The consequence of this challenge might result in showing an adverse effect on the success of the product, when the requirement that needs to be discarded has a dependency on other requirements which is really important in success of the product, but doesn't exist without the former one then it is really tough to discard the former requirements but without discarding it might leads to a situation where more budget is crossed, release date might be crossed etc, leading to a situation where it is really difficult to develop the product any further. When the requirement dependencies are managed well, it results in the success of the product, makes the process of requirements triage much easier and prioritization and selection of requirements turns into a smooth sail [37].

Example: There is mobile company which needs to provide changes for their next release, they are at the step of requirements triage. They are now left with two requirements one, improvement in talk time, this can only be done if a more powerful battery is provided in the mobile, but to provide a powerful battery exceeds the budget, scope of the market, and other criteria making it impossible to implement as it might adversely affect the success of a product. Hence it becomes trivial to judge between requirements, when there is a dependency between the requirements.

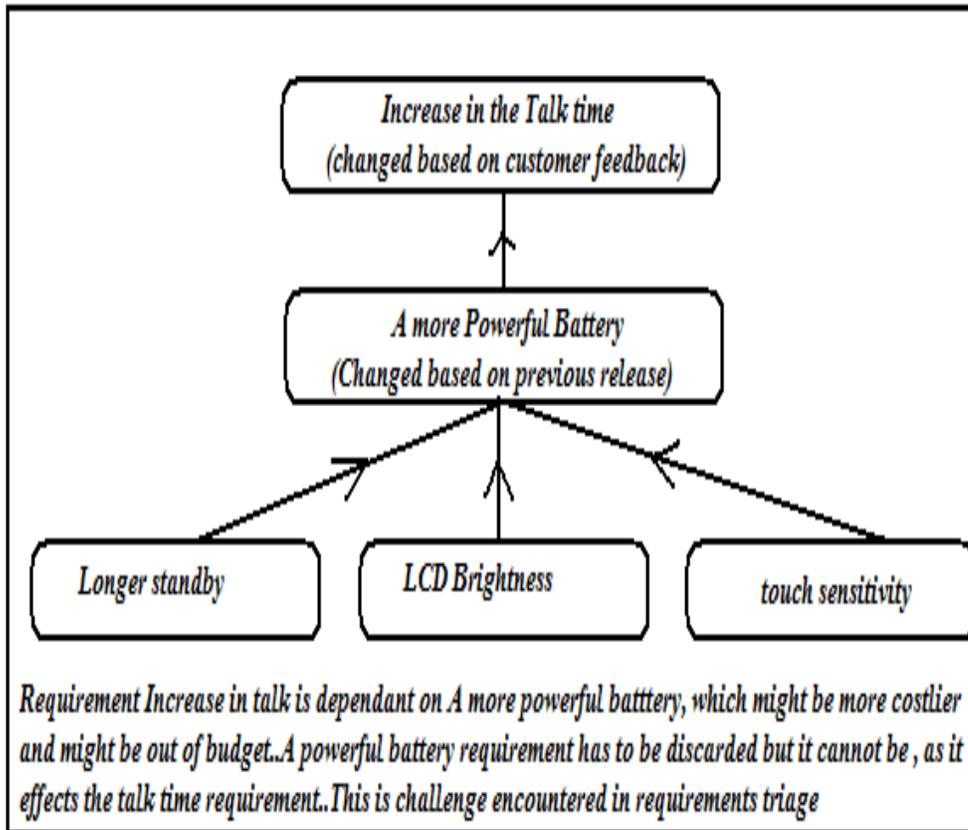


Figure 2: example of consequences and implications in dependencies between Functional and Non-Functional requirements

3.4 Between Functional and Non- Functional requirements

3.4.1 Problem Definition:

It becomes a difficult job to choose between the non-functional requirements and functional requirements such as to make a selection between the requirements which originate from the quality attributes and the requirements which originate from requirements such as testability, security, interoperability etc. It becomes a tough job to estimate the effect of non- functional requirements which act as constraints on the process [32] [33].

3.4.2 Context:

Consider a situation where one needs to choose between the quality of a product and the features of the product, neither of these requirements can be given less importance as both of these have equal priority and to choose between one of these requirements becomes tricky. We cannot compromise on the quality of a product nor can we compromise on the essential features of the product. Also, non-functional requirements such as, the quality attributes is hard to determine and estimate [37].

3.4.3 Consequences and Implications:

The consequences of this challenge might result in degrading the quality of the product, if the non-functional requirements are selected, it may in turn show its effect on the satisfaction levels of the customer. If the functional requirements are neglected then it may show its effect on the features present in product, making it vulnerable to loss of an edge over its competitors, also will shows its effect on the success of the product. If a proper balance is made between the functional and non-functional requirements, it might result in the success of the product, also satisfaction of the customer and an edge over its competitors [37].

Example: When a mobile company has to deliver a new release of its product, it has to judge between the huge set of requirements available, it has to judge between the quality of its product and costs which to maintain a trade-off between these becomes difficult.

These are some of the challenges identified; there are also some challenges of lesser importance such as prioritizing requirements [34] [31], which are mitigated by the solutions in the following sections

4. Solutions

There are many solutions present in the literature as an answer to the problems of requirements triage. Out those solutions we present here those which cover the above stated main challenges of requirements triage.

4.1 MERTS (Method for Early Requirements Triage and Selection utilizing product strategies)

MERTS is a step by step method which makes use of product strategies for early requirements triage [23]. This method was created based on the requirements of the organization and is validated in organization after the creation [23].

Yet this method alone doesn't go well, it should be used with methods such as RAM, which is a requirement abstraction method. Steps involved in MERTS are as follows:

4.1.1 Specify

This is the first step in MERTS which specifies which ways the product should move in order to stick to the organization's mission statement [23]. This step answers the questions such as in which direction should the product move? How to move and achieve its intended purpose? What needs to be done? [23].

4.1.2 Assign weights

Assign weights to the answers from the first step, each answer is given a weight of 100 weights from the three answers sum up to 300, and requirements are prioritized in such a way that the total value of the three answer sum up to a weight of 100 [23].

4.1.3 Compare requirements

A comparison of requirements is based on the given weight to each requirement out of 100 [23].

4.1.4 Specify product roadmap

Once if the requirements are prioritized, focus is shifted to how to implement the requirements and deliver the product [23]. A road- map provides the way for the product release with the involvement of technology [23].

4.1.5 Estimate resources

This forms the last step of MERTS where a feasibility study is made against the resources available and budget required [23].

4.2 PARSEQ

The PARSEQ method is devised to improve the way how the post- mortem is conducted in triage [35]. It also improves the state of release planning decisions which are being made [35]. This method is step by step approach to improve the process of decisions in triage. It is mainly categorized in four steps, which are again at a later step subdivided.

1. It starts with the sampling of requirements which act as a representative set to the whole lot of requirements [35].
2. The re- estimation of cost and value for this release are done based on the post release priority list of the previous release [35].
3. Then the root cause analysis is made as to know why the decisions regarding the planning decisions are made and on what basis [35].
4. Last step of this method is the elicitation in requirements which in turn results in process improvement proposals making the process of requirement decisions visible [35].

4.3 Automating requirements prioritization

As the existing models for requirements prioritization do not handle the automation of large projects, this method is created [36].

This method is a semi automated technique for obtaining a set of prioritized requirements which are taken from a huge set of requirements coming from different sources [36].

4.4 Triage from medical approach

In this method the author suggest ways, how to apply the art of triage from medical field to requirements engineering [9]. This method provides solution for the challenge of alignment of business goals. He compares the steps in the treatment triage to those in the requirements triage.

4.4.1 Physiology

These are concerned with the vital signs of the patient, these are applied to triage as the vital signs of efforts, requirements engineering might consist of such as the team size, volatility, budget size etc [9].

4.4.2 Injury anatomy

These are visible signs of the injury when applied, provide visible requirements effort, which include missing milestones, missing deadlines, missing specifications etc [9].

4.4.3 Injury Mechanisms

These are assessment of likelihood for a severe injury, such as the likelihood of market changes, inability to apply known methods etc [9].

4.4.4 Comorbid factors

These are not the cause of injuries but actually might produce in fatal injuries, these when applied in requirements engineering produce, inexperienced workers, and lack of domain knowledge etc [9].

5. Davis Recommendations

Davis [11] has conducted a study on the art of requirements triage. He has described how the process of triage is done and has presented us case studies which stand as an example to show how one can err in the process of conducting the requirements engineering. This also presents a brief discussion on the challenges encountered in requirements triage. He also presents recommendations to mitigate the challenges faced during the requirements triage. The essence of his recommendations is as follows [11]:

5.1.1 Document the list of requirements

Maintain a document specifying the number of requirements, requirements which are needed to be implemented etc [11].

5.1.2 Store the necessary dependencies

Make a list of which requirements are dependent on which other dependencies, which helps in determining the necessity of requirements which have interdependencies [11].

5.1.3 Prioritize the requirements by effort

Estimate how much effort is required to implement each requirement and prioritize accordingly [11].

5.1.4 Prioritize with respect to the importance

Requirements can be prioritized using methods such as the hundred dollar method and show of fingers method [11].

5.1.5 Conduct the process of triage visibly

The input to triage is observed from three sects of stakeholders, such as the customers, developers and sales representatives [11]. Conduct triage in such way that business decisions are visible.

5.1.6 Decide on more ways than mechanisms

Never blame the mechanism when you opt for it in an organization, always try avoiding the use of mechanisms and techniques [11].

5.1.7 Establish a mode of teamwork

Many organizations waste their time in maintain relationships with the staff which at all time do not have a good result. Instead of wasting time on these, try to develop the habit of teamwork in the organizations [11].

5.1.8 Manage and negotiate

Manage and negotiate the requirements of the customer. There are several methods to negotiate the outcomes such as the cumulative probability graph [11].

5.1.9 Team needs to understand how to approach a problem

There are several approaches to encounter a problem such as the optimistic approach, pessimistic approach and the realistic approach, choose accordingly [11].

5.1.10 Plan for multiple releases

While conducting the requirements triage plan in such a way that triage is being conducted for more than one release [11].

5.1.11 Plan again before every release

With the changes in markets, things always changes with respect to an older release. So, plan before thinking about a new release [11].

5.1.12 Never be intimidated

Disaster strikes organizations which have a plan which represents a very less chance of success. Never be intimidated, think of new plans and innovative ideas [11].

5.1.13 Think of a solution early

Before the problem strikes you think of a solution which can avert the problem, never make decisions at very late step [11].

5.1.14 Perfection is impossible

Never waste resources on obtaining the perfect product as perfection in most of the cases are an impossible task [11].

5.2 Solutions as an answer to the problems

This section presents how the prescribed solutions answer these challenges. A table is shown below which provides a mapping.

MERTS, Automation and triage from medicine answer the challenge of balancing the technology push and the market pull, i.e aligning the requirements to business goals. PARSEQ is a method for solving the problem of visibility of the requirements triage decisions, and it provides a way for conducting post-mortem on the decisions takes during the process of requirements triage [29], it answers the problem of lack of knowledge base, by storing the requirement decisions. These can be used as a post mortem analysis on the next release of their future product. Davis recommendations provide solutions to Interdependencies, by proposing guidelines.

Solution	Problems answered
MERTS	Aligning requirements to business goals (market pull vs technology push)
PARSEQ	Improper knowledge (Post- mortem analysis on the business decisions)
Automation requirements	Aligning requirements to business goals (market pull vs technology push)
Triage from medicine	Aligning requirements to business goals (market pull vs technology push)
Davis recommendations	Interdependencies

Table1: Overview of Solutions and Problems Answered

5.3 Usability and Usefulness of the solutions

The usability and usefulness of MERTS depends highly on the alignment of a new requirement with the MERTS model [15]. The PARSEQ method is mainly useful and intended to the users in software organizations [38]. Triage from medical approach is useful to those who want to know how to apply the triage from medical approach to the field software engineering [9]. Davis recommendations are useful for those who are new and need to be trained on the process of requirements triage [11].

6. Issues identified with the proposed solutions

The proposed solutions have cons and issues related with them, they are as follows:

6.1 MERTS

6.1.1 Strengths/ solves:

1. It is most sought after mitigation technique [9][11].
2. MERTS can be used by both large scale and small scale organizations.

6.1.2 Weakness / does not solve

1. It is not useful to deal with the interdependencies, to make a balance between the functional and non-functional requirements and improper knowledge base [37].
2. It is based on a subjective evaluation, the results might vary [15].

6.2 PARSEQ

6.2.1 Strengths/ solves:

This stores the requirement decisions which are taken during the triage process, in a way helps during the post mortem analysis for the next release and triage process.

6.2.2 Weakness / does not solve

Not all decision attributes are stored by PARSEQ, only those which are taken as an improvement decision are stored in this method [37].

6.3 Automating requirements prioritization

6.3.1 Strengths/ solves:

The method for automating the requirements prioritizations does not hold good for those organizations which are small- scale, with lesser work potential, less budget, lesser market etc.

6.3.2 Weakness / does not solve

The method of automating requirements is only feasible for large scale organizations with huge work power, budgets, markets etc [9].

6.4 Triage from medical approach

6.4.1 Strengths/ solves:

1. It is a method which suggests how to apply the triage found in medicine to the field of software engineering.

6.4.2 Weakness / does not solve

1. It also does not provide solutions to others challenges such as handling interdependencies etc.
2. It doesn't provide any particular method or framework to solve problem of aligning with business goals, but just provides recommendations [37].

6.5 Davis Recommendations

6.5.1 Strengths/ solves:

1. It proposes recommendations, which are really helpful while conducting the process of requirements triage.

6.5.2 Weakness / does not solve

1. Though Davis's recommendations hold good for mitigating challenges such as alignment to business goals and handling the interdependencies, it doesn't provide recommendations to the other challenges.
2. Here also there is no specific method specified in order to attack the challenges, only recommendations are provided which could help in conducting a better process of requirements triage.

7. Analysis and discussion

We have presented the existing challenges in requirements triage and ways to mitigate these challenges. Out of all presented challenges, alignment with business goals can be considered as one challenge which is presented in different publications, also one of the important challenges that need to be treated. The best available method to treat this problem is MERTS which also handles maintain a balance between the functional and non-functional requirements. But MERTS can't be implemented all alone. It requires the help of a requirement abstraction method such as RAM [23]. There isn't a single solution which can provide mitigation strategies to all the challenges presented. Though there are several articles on triage, many of them mostly illustrate the art of requirement triage, just provide some suggestions or state guidelines for conducting triage, none of these articles present a method / model or a framework which act as a solution to the given problem. A better way to solve these problems is to work on building a framework to avert these challenges or to design a method or model such that incorporates mitigation strategies to all challenges encountered during the process of requirements triage. One such solution to the challenge of improper knowledge can be devised by storing the requirement decisions in a specific format which at a later stage can be used by those who are interested in conducting a post-mortem on the business decisions. Similarly, strategies to mitigate the challenges can also be devised.

8. Conclusion

We have made a discussion on the requirements triage and have presented an analysis based on the observations made from the process of triage, identified challenges and the solutions reported. We have tried to present those challenges which are of main concern to those who handle the process of requirements triage. Also, presented those solutions which attack the given problems and difficulties. The Issues identified by people who worked with these presented solutions are also reported in this document. Though we have made all attempts to find challenges and solutions to the given problem, there is always a scope for future work.

9. References

- [1] Bashar Nuseibeh Steve Easterbrook Requirements Engineering: A Roadmap <http://mcs.open.ac.uk/ban25/papers/sotar.re.pdf>
- [2] E. Kazmierczak, Requirements Engineering

<http://ww2.cs.mu.oz.au/~dmwilm/downloads/641.pdf>

- [3] Requirements Engineering Process Maturity Model UniREPM, Tony Gorschek, Blekinge Institute of Technology, Sweden 2011-01-15.
- [4] Potts C (1995) Invented Requirements and Imagined Customers: Requirements Engineering for Off-the-Shelf Software Proceedings of the Second IEEE International Symposium on Requirements Engineering (RE'95), PP 128-130
- [5] Gorschek T (2004) Requirements Engineering Supporting Technical Product Management. PhD Thesis No. 2006:01, ISBN 91-7295-081-1. Blekinge Institute of Technology, Ronneby.
- [6] Carmel E, Becker S (1995) A Process Model for Packaged Software Development. Engineering Management, IEEE Transactions. Volume 42, Issue 1, PP 50-61.
- [7] Karlsson L, Dahlstedt G, Natt J, Regnell B, Persson A (2002) Challenges in Market-Driven Requirements Engineering - an Industrial Interview Study. In Proceedings of Eighth International Workshop on Requirements Engineering: Foundation for Software Quality (REFSQ'02), Universitat Duisburg-Essen, Essen, Germany, PP 101-112.
- [8] M. Dixon-Woods, S. Agarwal, B. Young, D. Jones, and A. Sutton, "Integrative approaches to qualitative and quantitative evidence," London: Health Development Agency, vol. 181, 2004.
- [9] E. Simmons, "Requirements triage: what can we learn from a medical approach?," Software, IEEE, vol. 21, no. 4, pp. 86-88, 2004.
- [10] P. K. Suri, R. Soni, and A. Jolly, "Potential Effect of Creeping User Requirements on Project Management: A Simulation Approach," IJCSNS, vol. 9, no. 11, p. 256, 2009.
- [11] A. M. Davis, "The art of requirements triage," Computer, vol. 36, no. 3, pp. 42-49, Mar. 2003.
- [12] A. M. Davis, "Requirements Management," Encyclopedia of Software Engineering, 2002. [Online]. Available: <http://onlinelibrary.wiley.com.miman.bib.bth.se/doi/10.1002/0471028959.sof281/full>. [Accessed: 30-Apr-2011].
- [13] N. Dzamashvili-Fogelström, S. Barney, A. Aurum, and others, "When Product Managers Gamble with Requirements: Attitudes to Value and Risk," in 15th International Working Conference on Requirements Engineering: Foundation for Software Quality (RefsQ), 2009.
- [14] T. Gorschek and C. Wohlin, "Requirements abstraction model," Requirements Engineering, vol. 11, no. 1, pp. 79-101, 2006.
- [15] M. Khurum, T. Gorschek, L. Angelis, and R. Feldt, "A Controlled Experiment of a Method for Early Requirements Triage Utilizing Product Strategies," Requirements Engineering: Foundation for Software Quality, pp. 22-36, 2009.
- [16] N. D. Fogelstrom, M. Svahnberg, and T. Gorschek, "Investigating impact of business risk on requirements selection decisions," in Software Engineering and Advanced Applications, 2009. SEAA'09. 35th Euromicro Conference on, 2009, pp. 217-223.
- [17] L. Karlsson, A. Dahlstedt, J. Natt och Dag, B. Regnell, and A. Persson, "Challenges in market-driven requirements engineering-an industrial interview study," in Proceedings of the Eighth International Workshop on Requirements Engineering: Foundation for Software Quality (REFSQ'02), 2003, pp. 101-112.
- [18] R. Bertsson Svensson, T. Gorschek, and B. Regnell, "Quality requirements in practice: An interview study in requirements engineering for embedded systems," Requirements Engineering: Foundation for Software Quality, pp. 218-232, 2009.
- [19] M. Höst, B. Regnell, and others, "Exploring bottlenecks in market-driven requirements management processes with discrete event simulation," Journal of Systems and Software, vol. 59, no. 3, pp. 323-332, 2001.
- [20] B. Regnell and S. Brinkkemper, "Market-driven requirements engineering for software products," Engineering and managing software requirements, pp. 287-308, 2005.
- [21] J. Azar, R. K. Smith, and D. Cordes, "Value-Oriented Requirements Prioritization in a Small Development Organization," IEEE Software, vol. 24, no. 1, pp. 32-37, 2007.
- [22] U. Nikula, J. Sajaniemi, and H. Kälviäinen, A State-of-the-practice Survey on Requirements Engineering in Small-and Medium-sized Enterprises. Citeseer, 2000. 74.
- [23] M. Khurum, K. Aslam, and T. Gorschek, "A Method for Early Requirements Triage and Selection Utilizing Product Strategies," in Asia-Pacific Software Engineering Conference, Los Alamitos, CA, USA, 2007, vol. 0, pp. 97-104.
- [24] B. Regnell, M. Höst, J. Natt och Dag, P. Beremark, and T. Hjelm, "Visualization of agreement and satisfaction in distributed prioritization of market requirements," in Proceedings of 6th International Workshop on Requirements Engineering: Foundation for Software Quality, 2000.

- [25] D. Leffingwell and D. Widrig, *Managing software requirements: a unified approach*. Addison-Wesley Longman Publishing Co., Inc. Boston, MA, USA, 1999.
- [26] O. Saliu and G. Ruhe, "Supporting Software Release Planning Decisions for Evolving Systems," in *Software Engineering Workshop, Annual IEEE/NASA Goddard*, Los Alamitos, CA, USA, 2005, vol. 0, pp. 14-26. 72
- [27] B. Regnell, P. Beremark, and O. Eklundh, "A Market-driven Requirements Engineering Process", *Engineering*, London, vol. 19, p. 20, 1998.
- [28] C. Alves and A. Finkelstein, "Challenges in COTS decision-making: a goal-driven requirements engineering perspective," in *Proceedings of the 14th international conference on Software engineering and knowledge engineering*, 2002, pp. 789–794.
- [29] B. Regnell, L. Karlsson, and M. Host, "An analytical model for requirements selection quality evaluation in product software development," in *Requirements Engineering Conference*, 2003. *Proceedings. 11th IEEE International*, 2003, pp. 254–263.
- [30] P. Carlshamre, K. Sandahl, M. Lindvall, B. Regnell, and J. Natt och Dag, "An industrial survey of requirements interdependencies in software product release planning," in *Requirements Engineering*, 2001. *Proceedings. Fifth IEEE International Symposium on*, 2001, pp. 84–91.
- [31] T. Gorschek and A. M. Davis, "Requirements engineering: In search of the dependent variables," *Information and Software Technology*, vol. 50, no. 1-2, pp. 67–75, 2008.
- [32] K. Saleh and A. Al-Zarouni, "Capturing non-functional software requirements using the user requirements notation," in *The 2004 International Research Conference on Innovations in Information Technology*.
- [33] L. Chung and J. do Prado Leite, "On non-functional requirements in software engineering," *Conceptual Modeling: Foundations and Applications*, pp. 363–379, 2009.
- [34] L. O. Lobo, "Analysis and evaluation of methods for activities in the expanded requirements generation model (x-RGM)," *Virginia Polytechnic Institute and State University*, 2004.
- [35] A. S. Danesh and R. Ahmad, "Evaluation of release planning improvement activity in PARSEQ method," in *2010 2nd International Conference on Software Technology and Engineering (ICSTE)*, 2010, vol. 1, pp. V1-84-V1-87
- [36] P. Laurent, J. Cleland-Huang, and C. Duan, "Towards Automated Requirements Triage," in *Requirements Engineering, IEEE International Conference on*, Los Alamitos, CA, USA, 2007, vol. 0, pp. 131-140
- [37] Niroopa Uppalapati, Ramya Veeramachineni, *A Framework for Requirements Triage Process*, Master thesis, Blekinge tekniska hogskolan, Thesis no: MSE 2011:63, sept 2011
- [38] L. Karlison, B. Regnell, J. Karlsson, and S. Olsson, "Post-release analysis of requirements selection quality - An industrial case study," In *Proceeding of the 9th Int. Workshop on Requirements Engineering - Foundation for Software Quality (REFSQ'03)*, ppt. 47-56, 2003.

Authors

Sairam Vakkalanka is now pursuing masters in software Engineering at Blekinge Tekniska Högskola (Blekinge Institute of technology), Karlskrona, Sweden.



Ranjith Engu has completed Masters in Software Engineering at Blekinge Tekniska Högskola (Blekinge Institute of technology), Karlskrona, Sweden in December 2011.

