Reliability Assessment Metrics: Requirement Defect Identification and Mitigation Perspective

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ABSTRACT
To deliver reliable and quality software product, the finally implementing software should have as few defects as possible. The motive of reliability management in a software product is to plan early stage defect identification and their proper solution for assessing early stage reliability and to give suggestive strategy for controlling and preventing the defect before the software is delivered. In this paper a set of requirements under requirement specification are taken for detecting the requirement defects through inspection technique, assigning severity and priority to these defects and best tried to mitigate these defects according to their priority through mitigation variables [1]. To achieve this goal there is a need of: (1) easy depiction of requirement information for defect detection (2) a proper classification of requirement defects (3) suitable mitigation variables for defect mitigation. Here, the requirement document of Result Information System from a premium University is taken for successfully implementation of Reliable Requirement specification (RRS) Framework [2]. This study is not only adhering to detect potential requirement defect and providing mitigation variables for defect removal but also assessing their degree of reliability through evaluating number of identified defects and their respective number of mitigation.

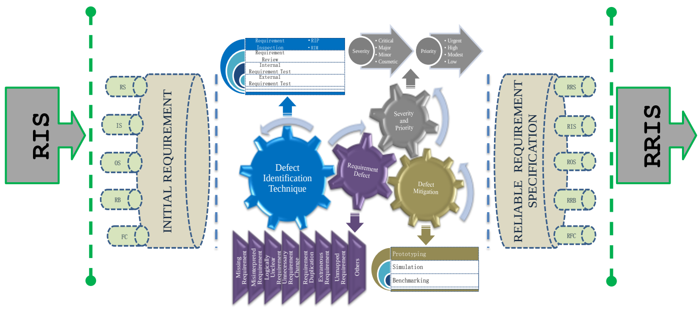
Keywords
Reliable Requirement Specification, Inspection Technique, Requirement Defect, Severity and Priority, Defect Mitigation.

1. INTRODUCTION
Among the costing, scheduling and *reliability* etc the reliability is one of the most important factor determining the accomplishment of a software product. Software reliability narrates the defect free operation under some specific conditions and environment within the given time for execution.

Requirement defect identification at early stage of requirement elaboration highly contributes to software development cost, quality and reliability. Defect detection may be treated as vital progress in the software development; detection may use better notations or alerts to narrate defects [3] or some of the supporting tool [4] or some limited approaches to detect the early phase defects, their mitigation and reliability assessment of the initial requirement [5].

In this study, inspection technique [6] is used for requirement defect identification, in which different participants and their respective process are used. Here, a requirement document for Result Information System (RIS) is presented and address the processing for defect detection as early as possible. The initial representation of requirement document for RIS is textual and may differ in structure and content from an operational concept.

2. IMPLEMENTATION OF PROPOSED FRAMEWORK
This study tries to implement the earliest established framework for RRS (Figure 1) [2] through the initial requirement for RIS of a premium University. In which initial requirement will enter from one end as Input in the Free Wheel Processing Assembly for rigorous treatment as: 1) propagation of requirement into small operational category named Initial Requirement 2) implementation of inspection technique for defect detection and store in Requirement Defect database 3) assignment of defect Severity and its Priority 4) implementation of mitigation variables for Defect Mitigation; then after deliver a reliable requirement specification at the outer end [2].



A Proposed framework for Reliable Requirement Specification (RRS)

Figure 1

A. *Defect Identification*
After processing the initially collected RIS requirement it will entertain by Inspection Method for defect identification. Here, few of the specific requirement defect type (Table 3) are taken for discussion, which will be handled by the Inspection Method [6] participants (Table 2) and their processes such as: 1) *Plan Development* where the RIS document selects for orientation process, in which it selects the Inspector and assigns the document inspection task. 2) *Outline Design* interacts with Author for registering the defects and Reader for interpreting requirement document. 3) *Preparation*, the Inspector frames the questions individually for each inspecting requirement statement where rework may also be occurring. 4) Finally, *Reporting* will provide overall requirement defects. Author and Moderator takes joint

decision for re-inspection if there is any need of it, else the status of requirement statement is closed.

TABLE 2: INSPECTION PARTICIPANTS AND THEIR ROLES & RESPONSIBILITIES [2]

Participants	Role Played in RIS Inspection
Moderator	• Moderator manages overall inspection tasks. • Moderator makes plan for Requirement Classification & inspection process schedule through collection of RIS data. • Moderator issues the requirement inspection report.
Author	• Author generates requirement inspection criteria based on severity. • Author described overall RIS requirement. • Author assigns the participants role for as per the inspection criteria.
Reader	• Reader reads the whole RIS for different object R1 to R5 revision. • Reader collects all interpreted sections of the objects for inspector. • Reader emphasizes each vital fact for defect identification.
Inspector	• Inspector will frame question for inspection. • Inspector inspects all requirement objects and different types of defects.
Recorder	• Recorder collects all type of Requirement Defects. • Recorder delivers the details of modified Requirement Document. • Recorder provides proper decision support for identified defects and recommendations. • Recorder collects all inspected defect and requirement residue.

TABLE 3: REQUIREMENT DEFECT TYPE

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Requirement Scope (RS)	Input Section (IS)	Output Section (OS)	Requirement Boundaries(RB)	Functional Component (FC)

B. Requirement Defect and Mitigation Variables

In the above Inspection Method for defect identification some of the potential requirement defects have been identified under each specific type of requirement as stated in Table 3. As listed below the expected defects under specific requirement type we conclude that identified requirement defect, their severity & priority level [6] and mitigation variables in general may be defined as (Table 4):-

Table 4: Requirement Defects, Severity & Priority and Mitigation Variables [6]

Requirement Defect Type	Requirement Defects	Severity & Priority		Mitigation Variables
Requirement Scope (RS)	• Way to marks assignment for operational concept not defined • Cross functional Interface Description missing	Critical (S1) Major (S2)	Urgent (P1) High (P2)	• Redefinition of Product details • Correction in definition of product behavior, mission, business cases • Provide required Operational activity & Cross functional interfaces
Input Section (IS)	• Input marks repository missing • Data naming not defined • Precondition detail for extracting marks not defined	Major (S2) Minor (S3) Critical (S1)	High (P2) Modest (P3) Urgent (P1)	• Creation of input data repository • Inject agreeable & compatible naming for input data • Provide prerequisite dependent input requirement

Output Section (OS)	• Sessional marks data sink missing	Major (S2)	High (P2)	• Give details of output data storage place
	• Precondition detail for output missing	Critical (S1)	Urgent (P1)	• Provide Precondition detail output requirement • Provide expected outcome of the project
Requirement Boundaries (RB)	• Condition and environment detail missing	Minor (S3)	Modest (P3)	• Provide specific environment & conditional requirement limitation
	• Cross functional data boundary not defined	Critical (S1)	Urgent (P1)	
	• Unclear Resource allocation	Major (S2)	High (P2)	• Specifies requirement limitations for cross functional activity • Clear allocation or reallocations of Resources
Functional Component (FC)	• Functional actor as marks generator & its role missing	Critical (S1)	Urgent (P1)	• Name of operational actor, its roles & responsibilities must deliver
	• Sessional component name & state missing	Major (S2)	High (P2)	• Provide all functional components detail
	• Grace Mark condition not defined	Minor (S3)	Modest (P3)	• Specify the names & stages of functional component
	• Division & Distinction details not defined	Minor (S3)	Modest (P3)	• Clear declaration of cross dependent operations

3. RELIABILITY ASSESSMENT

Software reliability models [8, 9] or the concept of defect removal efficiency [8] can be used for quantitative management of quality, though these measures have some limitations for quality software product [7].

In this paper a sample requirement of result information system is taken for assessing the reliability of requirement prior deliver to design phase through defects identification mitigation. The specimen of identified defects and their respective mitigation variables (Table 4) for proper omission of requirement defect. Initially through the RIS review it has been observed that there are some fractions of requirement object under each specific head of requirement type. In this study the assessment of reliability for requirement is major research component for delivering the reliable requirement specification. For this purpose, along with RRS framework some metrics have been generated to show quantitative attributes of requirement document such as:-

Below mentioned reliability assessment metrics abbreviation and their respective notations recite the facts & figures which are being used for evaluating the corresponding reliability.

- Initial Requirement (InReq) document will be assessed through summation of all gathered requirement.

$$InReq = \sum_{i=1}^{m} N_i$$

- Requirement Defect (RD) will be identify through Inspection Technique (InspTech) analysis on Initial Requirement (InReq).

- Requirement Defect (RD) will be assess through the difference of total number of requirement gathered (N) for each type of requirement and Defect Free Requirement (DFR).

$$RD = \sum_{i=1}^{m} (N_i - DFR_i)$$

- Weight (W) of Requirement Defect (RD) will assess on the basis of requirement Severity (S).

$$W_{max} = \sum_{j=1}^{m} RD_i \cdot (\prod_{i=1}^{n} S_i)$$

$$RD = (InspTech).(InReq)$$

- Requirement Defect will mitigate on the basis of their Priority (P) and Weight (W)

$$DMP = W_{max} \cdot (\prod_{i=1}^{n} P_i)$$

- Defect Mitigation Failure (DMF) may assess through the difference of total Requirement Defect (RD) and Defect Mitigated (DM).

$$DMF = \sum_{i=1}^{m} (RD_i – DM_i)$$

- This metric will assess the Reliability to Requirement through Defect Mitigation Failure (DMF) for each of the requirement type.

$$RReq = 1 - \{\sum_{i=1}^{m} DMF_i /m\}$$

- Defect density is the ratio of the number of defects found to the total volume of requirement artifact where volume can be the total number of modules or total number of requirements etc according to the suitability of software development process.

$$\text{Defect Density} = D / R * 100$$
$$\text{Defect Mitigation Density} = D` / D * 100$$

R: Total No. of Requirement
D: Total No. of Defect Identified
D`: Total No. of Mitigated Defect

These metrics are very much helpful in assessing the each major factor related to quantification of reliability for requirement. Here the reliability of RIS having 65 requirements is being assessed for reliable requirement delivery to fulfill the objective of RRS framework (Table 5).

TABLE 5:
RELIABILITY ASSESSMENT BEFORE AND AFTER DEFECT MITIGATION

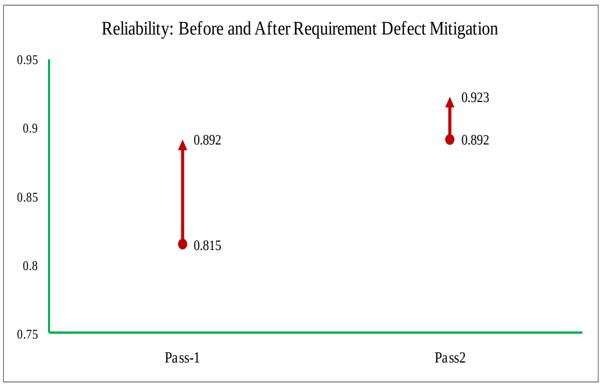
No. of Requirement	Passes (P)	Identified Defect	Reliability before defect Mitigation	No. of Mitigated Defect	Reliability after defect Mitigation	No. of Non-Mitigated Defect
65	P-1	12	0.815 (r)	05	*0.892*	07
	P-2	07	0.892	02	0.923(R)	05

4. RELIABILE REQUIREMENT SPECIFICATION

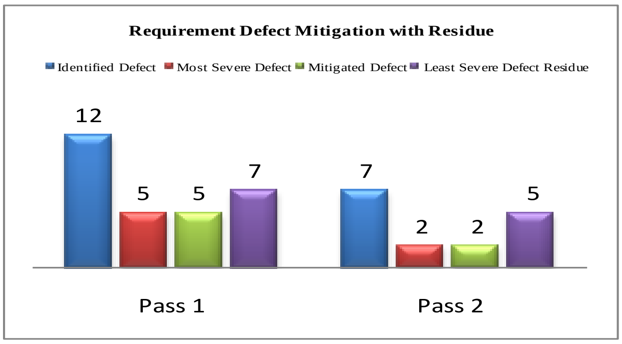
Through assessing the reliability of sample requirement data into two passes the framework makes itself capable to increase reliability of requirement. Here, the no. of sample requirement is 65 and whenever it enters into the RRS framework it takes two cycles (passes) to reach maximum possible reliability level through defect identification and its mitigation (Table 5). There is a noticeable difference between two reliabilities (R ~ r = 0.108 or 10.8%) which shows the overall degree of reliability for a sample requirement (Graph 1). Requirement defect density and defect mitigation density (Table 6) may also be justified that there is a defect density reduction which also shows the RRS capability. Therefore it may say that if we move for subsequent possible (two or three) passes (Graph 2)then degree of reliability increases so forth the Reliable Requirement Specification be achieved within the given time of span in requirement analysis.

TABLE 6:
RELATIVE DENSITY ASSESSMENT OF REQUIREMENT

Assessment	Project Requirement Perspective	
Defect Density	Before Defect Mitigation (%)	Before Defect Mitigation (%)
	18.46	07.69
Defect Mitigation Density	58.33%	



Graph 1



Graph 2

5. CONCLUSION

The mentioned illustration under this study shows considerable assurance for defect detection and mitigation as per their severity and priority. Through this assessment analysis it may say that defect identification technique and their mitigation process of this RRS framework is capable to deliver reliable requirement specification to achieve its objective. The differences between two successive reliability degrees before and after requirement defect mitigation are thoroughly perceptible. Requirement defect may be minimized through proper & concrete introduction of mitigation variables and their implementation. In some cases it may be needed to introduce some additional defect classification, augment our inspection processes or sometimes even recommend supplementary mitigation variables to mitigate the defect.

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