REQUIREMENTS CHANGE MANAGEMENT (RCM) TOOL FOR PAKISTAN SOFTWARE INDUSTRY

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ABSTRACT- The requirement engineering process is the initial and critical phase of the software development life cycle. Project success heavily depends on requirements elicitation and their management. Requirement change management is a vital aspect of requirement engineering. Incomplete understanding among stakeholders, technological shifts, functional improvements, and evolving business landscapes often trigger requirements changes. Continuous changes demand meticulous tracking and effective management to prevent project failure. Implementing a formalized approach to requirements change management is essential for controlling the impact of changing system requirements. Through surveys, interviews, and literature review, it becomes evident that within Pakistan software industry, numerous barriers hinder software engineers from effectively managing and addressing end-user change requests. Our solution addresses the challenges of requirement changes, emphasizing cost and time estimates. We recommend the RCM tool, which is user-friendly, free, and centralizes requirements. Access controls restrict project details to relevant team members, while versioning and notifications keep stakeholders informed. Organizing changes by SDLC phases aids analysis and learning. Overall, our solution promotes efficient, transparent requirement management within the SDLC framework and increases the success rate by managing change requests effectively.

INTRODUCTION

Requirement Engineering (RE) is the first and the most important step of the software development life cycle. Project failure and success depend upon this critical phase of requirement gathering and management [1]. Nowadays, software complexity increases, and the requirements change occurs frequently. This becomes the major hindrance to the success of a project. There are many reasons behind the requirements change i.e., change in technology, functional improvement, change in the business environment. Moreover, stakeholders do not completely understand the problem, or the problem cannot be fully defined by the stakeholders.

In Pakistan, it is observed that most organizations do not have any traceability policy, and for this purpose, a document or verbal communication is used [2]. There is no central database used to manage requirements change management process. All the requirements are merged mostly in the text document after collecting the requirements from all stakeholders. Requirements are not recorded for reuse in future similar projects. It is noted that the lack of communication with stakeholders directly affects the requirement engineering process and especially requirement change management activities in software development [2][3]. In the Pakistan software industry, most organizations are small consisting of fewer than 20 persons. Research shows that some organizations have a dedicated team of requirements engineers and most organizations do not have any dedicated team for this important phase. There is no systematic way to manage change in requirements. Only a few organizations use any tool for this critical process because there were some barriers to adopting a requirement change management process tool. Many tools were available for different phases of the requirements engineering. Research shows that Pakistan software houses do not use tools for this requirement engineering phase. There were different tools available that were time-consuming, costly, difficult to use, and needed training. If requirement management training is provided to the employees, then this situation becomes better, but the main hurdle is related to companies' financial issues [2].

Previous literature has barriers due to which the requirements and their changes were not properly managed systematically. As a result, the change requests were not handled properly, the budget increases, and therefore, rework increases [4]. If rework increases, then the project schedules get disturbed which eventually leads a project to failure. Researchers here identified the problems, but there is a need to come up with a solution

to overcome those barriers in the context of the Pakistan software industry.

In this research, we evaluated two projects: one managed with our Requirements Change Management (RCM) Tool and the other using traditional methods. The project managed with the RCM Tool demonstrated meticulous documentation of requirements and change requests, streamlined communication, and timely decision-making. In contrast, the project employing traditional methods faced challenges such as mismanagement and missed deadlines. A feedback survey among project team members validated the effectiveness of our solution, with users expressing satisfaction and preference for the RCM Tool. Overall, our study highlights the tangible benefits of our proposed solution in improving requirement change management processes and enhancing project success rates.

This paper explores the barriers to requirements change management in the context of the Pakistan software industry, investigates how these barriers influence the requirements change management process, and proposes a solution to overcome those barriers. The rest of the paper is organized as follows. Section 2 discusses the literature review whereas section 3 highlights the identified barriers of the change management process. The comparison of existing tools is briefly explained in section 4 and the traditional methods used for the change management process in Pakistan are introduced in section 5. The results of the survey and findings are mentioned in sections 6 and 7 respectively. Our proposed framework for the change management process is described in Section 8 whereas the tool validation process and feedback are presented in Section 9. Finally, section 10 concludes the research.

RELATED WORK

The requirement management phase is concerned with change management activities, and analysis of change impact on project time, schedules, and project budget. In its primary context, Sommerville [4] defines requirements change management (RCM) as a process of "managing changing requirements during the requirements engineering process and system development." Therefore, when managing change, the business and IT counterparts of an organization must work cohesively. Ambiguity in communication during the change management process leads to failure to produce the required output. Literature reveals that there are many frameworks proposed to overcome requirement change management problems.

The researchers from the Pakistan software industry have highlighted many issues in requirements engineering but none of them highlights the requirement change management issues separately for the Pakistan industry.

A. **Challenges in Pakistan's Software Industry:** Moazzama *et al.* [5] discuss barriers in the requirement elicitation process, stressing the importance of overcoming cultural, contextual, and stakeholder perspective differences. Proposals for tools to gather and manage requirements efficiently underscore the need for practical solutions tailored to the Pakistan industry's unique challenges. The proposed framework overcomes the barriers but still, there is a need to overcome the requirements change management barriers [5].

Zafar *et al.* [6] carried out detailed research to find out the reasons why the software industry does not adopt the best practices of requirements engineering to improve their process quality. In Pakistan, requirement engineering problems are faced due to organizational issues rather than technical. The author claims that in developing countries like Pakistan, Requirements Engineering processes and practices are not properly followed. The researcher recommends a tool for gathering requirements from clients and helping to manage them efficiently for future consultation in case of similar projects [6].

Saleem *et al.* [7] explore the procedures of requirements engineering activities and how the practices were implemented in the Pakistan software industry. In developing countries like Pakistan, requirements engineering best practices were not followed in the industry due to some major reasons like financial issues, tight time schedules, lack of dedicated team, and communication difficulties. It is noted that risk management and requirements inspections were ignored in small and medium organizations. It is really difficult to track the requirements if any change or conflict occurs. This research only focuses on identifying the issues in the Requirement engineering process but does not propose any solution on how to manage the changes in the future due to negligence in the requirement engineering process.

There are many challenges in the requirements change management process, like incomplete requirements is one of the apparent problems in describing and identifying requirements change. It was noted that time and cost are critical problems in requirements change management. Most of the time, tool support is not used for this critical process, so managing change control with a tool or agent-based automation is one of the most successful processes for handling these situations.

Riaz *et al.* [8] carried out detailed research that focuses on the customization of requirement engineering practices in different organizations in Pakistan. Their research focuses on the customization of requirement engineering practices in different organizations in Pakistan. The author tried to study local and offshore projects. Few undiscovered requirements cause a huge

cost for correction in future stages of the project. In Pakistan, 70% of all the start-ups' belong to the IT industry and usually get projects from freelancing platforms at a low cost as compared to other developed countries. Most of the software houses do not have any dedicated requirement engineers. In the project life cycle, only a few companies spend more than 20% of their time on the requirement engineering process, whereas other companies spend less than 10% time on the process [8].

E. W. Ali *et al*. [9] observed that a large proportion of the barriers in software development were related to requirements engineering. In Pakistan, small organizations do not follow the quality standards in this process, so they are unable to attract national and international customers. In this research, the questionnaire is used to target different small and medium organizations. The result shows that most organizations do not use tools for critical requirement engineering processes like change management. Small organizations ignore the importance of the training process whereas only a few organizations train their employees to use different tools for different processes. The other factors highlighted in this research that affect the requirement engineering process were several employees, employees dedicated to requirement engineering activities, and use of use case. The objective of the above research is to show how much requirement engineering principles were being followed in the software industry of Pakistan.

B. **Challenges in the Global Software Industry:**
Zainol at el. [10] observed the requirements management practices of CMM level 2 organizations in the Malaysian industry. In the Malaysian software industry, it is noted that the requirement management activities are less than 40% which means that the companies do not seriously implement the requirements management activities. However, still, their familiarity with the CMMI model is high.

Tong Li et. al. [11] surveyed to evaluate the requirement engineering practices in the Chinese software industry. It is noted that the most practiced requirement engineering techniques in the Chinese software industry are requirement specification, requirement description, and analysis and the less focused activities are requirement validation and change management. Only 40% of respondents use the tool for requirement engineering activities whereas 60% do not use any requirement engineering tools. Most of the respondents say that change in requirements is normal and negotiable with the customer to manage the change according to their impact on the project. This research only highlights the requirement for engineering practices situation in the industry to help improve the lack of these activities. [10].

Kurniawan at el. [12] aimed to survey to check the requirements for engineering practices followed in the Indonesian industry. The survey includes open-ended and close-ended questions to analyze the current situation in the industry. The survey highlights difficulties that mostly occur due to tight schedules, lack of analyst skills, and deficient tools used for managing requirements activities. The majority of the respondents understand the importance of the SRS document. Respondents who were already using the tool for requirement engineering activities did not face such a problem in using any tools. It is noted that respondents find it difficult to track the requirements of clients. It is noted that almost 45% of respondents found requirement changes due to unclear requirements, poorly written requirements, and weak documentation. The situation improves with the contribution of all the team members in requirements engineering activities. Respondents were familiar with RE practices but lacked the requirements of traceability, user involvement, unclear requirements, and tool support. This research only focuses on the problems faced by the respondents in the RE practices but have not, not proposed any framework to improve the situation.

In recent years, global software development has changed how software engineering works. It has made Requirement Change Management (RCM) more complicated. RCM helps projects adapt to new needs, but in global software development, it faces challenges. These include problems with distance, coordinating and talking with team members, limited budgets, absence of standard RCM Tools, and improper RCM practices and standards. Also, there are issues with how RCM is done and no standard tools for it. Despite knowing these problems, research hasn't suggested good ways to fix them globally. This paper discusses the challenges in RCM during global software development. But it shows that there's still a need for more research to find practical solutions for these challenges in this type of work [13].

Neha et. al. [14] have proposed the ARCM-GSD model, which enhances how we manage changes in requirements by adding new steps like tracing, sorting, deciding what's most important, and estimating how much work is needed. It combines fast and flexible ways of working with the process of managing requirement changes. Experts checked the ARCM-GSD model to see if it's easy to understand and use if it fits with the fast and flexible ways of working, and if it covers all the important things for managing requirement changes. They found that the model is easy to understand and use, fits well with fast and flexible ways of working, and covers all the important things for managing requirement changes. For people working on projects, the ARCM-GSD model offers a clear way to handle requirement changes, which could help make products better, save money, and make customers happier by focusing on talking with the people interested in the project, keeping track of progress, deciding what's most important, and estimating how much work is needed. However, it's important to test the model in real projects to see how

well it works and if it's easy to use. Adding tools that can automatically keep track of progress, sort out what's most important, and estimate how much work is needed could make the model even better.

C. **Comparative Analyses and Observations:** Most of the time change management difficulties occur due to tight schedules, lack of experience, and deficient tools used for managing requirements activities. Indonesian respondents who are already using the tool for requirement engineering activities do not face such problems in using any tools for the change management process [13].

Shafi et. al. [15] observed that the requirement engineering practices in the Pakistan software industry are not fully practiced in projects. The author explains the major aspects related to the requirement engineering process. This research results show that people from the software industry ignore the importance of tools for this process due to financial issues, time issues, and lack of training which makes it difficult to adopt the tool. Most organizations do not use tools for critical requirements engineering processes like change management. The other factors highlighted in this research that affect the change management process, are the number of employees, employees dedicated to requirements engineering activities, etc.

Jayatilleke *et al.* [16] highlighted the strengths and weaknesses of previous requirement change management techniques. It was noted that as the complexity of software increases day by day, the previous techniques of requirement change management were struggling to fulfill many gaps, but still, lacked in the change identification at different phases like communication difficulties, change validation, and cost estimation.

If the industry review of Pakistan is compared with Malaysia, Indonesia, and Chinese industries, then it is observed that Pakistan's software industry even lags in the basic requirements of engineering practices. In light of the above literature review, it is concluded that there were many barriers in the requirements change management process in our industry due to which eventually if the software industry fails to manage the change at the end it causes project failure. The main issues identified from the literature and semi-structured interviews are that there is no proper channel for the change request approval process, communication issues with stakeholders, time and cost estimation, usability issues, training issues, central repository, visual aid representation, change request report, etc.

To improve the requirement, and change management process in Pakistan, software developers need to introduce a framework that can give valuable solutions to Pakistan's software industry problems. The existing tool is not suitable for the Pakistan software industry as it mostly consists of start-ups that mainly focus on surviving in the market rather than improving the quality. It is, however, essential to develop a tool that encourages the industry to manage change and try to cater to these changes that keep their clients happy.

Identification of RCM barriers in the Pakistan software industry: In this section, the challenges faced by the Pakistan software industry in the requirement change management process are highlighted with the help of a survey from the industry. Also gone through the literature review to highlight the issues.

a. **Tight Time Schedules:** When the requirements are defined without checking its feasibility then tight time schedules are the reason for not following the RCM process. When any kind of change request comes from the end-user the proper feasibility report of the change request is not maintained. After that when someone is trying to implement the change later on, the time constraints do not allow them to cater to the change request systematically.

b. **No Use of Tool / Manual RCM Process:** Mostly Pakistan software industry doesn't follow the requirements change management process systematically. Most of the organizations do not adopt the tool for this process but go for the manual process. Most organizations have a lot of reasons behind not using the tool for this process like complexity, time & financial constraints.

c. **Expensive Tool:** In Pakistan, the software industry is developing so it is difficult for small and medium organizations to use tool support due to financial issues. Organizations go for manual documentation instead of using any tool for maintaining and tracking the requirements change management.

d. **Tool Complexity:** In Pakistan, small and medium-size organizations do not want to adopt any tools and one of the reasons is that the tools are complex to use. Tools used globally for the RCM process are complex to use or users need proper training for this purpose. Organizations in Pakistan do not focus on training employees to use this kind of tool. Tool usability and simplicity matter a lot to encourage the user.

e. **Central Database:** Nowadays manual paper, emails, and personal notes are used to manage change requests. Need to manage the change requests in a way that all the changes are kept in a central database to avoid any kind of missing or tempering to any of the change requests. The central database helps us to manage the change request of the project which is also used as a lesson learned for future decision-making processes for similar change requests.

f. **Time and Cost Constraints:** When any change request comes, the acceptance of change depends upon the change request feasibility of available resources, time, and cost limit. When time and cost are not properly estimated then overdue costs and out of the scheduled delivery can eventually fail the project.

g. **Requirement Identification and Prioritization:** In the software industry, the manual way is used to handle change requests. If a change request is not properly managed, it causes many problems. If a change request is not uniquely identified, then change management becomes difficult. There is also a need to give proper prioritization to the requirements and their change requests by the users [17].

h. **User Defined group for Communication:** Lack of effective communication is one of the important factors in the failure of a project. Effective communication helps us to manage and decide on accepting and rejecting the request. After accepting the changes, the developer and other related users must be timely informed about the changes otherwise miscommunication causes a loss [18].

i. **Change Request Versioning:** In the Pakistan software industry when any record changes there is no proper track of the change maintained. If the change tracking is not properly followed, then there is a possibility that any team member may miss some change requests and work on the old version.

j. **No Proper Access Authorization:** In a software house, there is no systematic way to handle the requirements change request. When everyone has access to accept and reject the request then a lot of issues occur. Not everyone has a right to accept or reject the change request only high authority decides what to accept or reject after risk assessment in changing requirements [18]. These issues can only be handled by the proper access authorization of the high authority. Peers should be updated about the accepted and rejected change requests.

k. **Lack of Visual Aids:** People focus more on the graphical user interface rather than the descriptive details of any system. The self-explanatory visual aid helps the stakeholders and developers to understand the requirements and change requests in the requirements.

l. **No Track of Change Request according to the SDLC Model:** There is a need to track and identify the SDLC phases in which most change requests come from the clients. There is a need to track the change request according to the phases that help us to manage and track the phase of SDLC in which most of the requirements come from the clients.

m. **Change Requests Report:** After tracking the change request requirements in different phases of the SDLC there is a need to properly show the change request in the tree-hierarchical form of a report. This research helps us to maintain the record manually plus in the tool database. Currently, using a manual way to keep and manage the change requests in projects helps us to slowly shift to the tool system.

n. **Record Rejected Requirements:** In the requirements engineering process, many requirements and their change request are accepted as functional or non-functional requirements, but requirements are rejected too by mutual consent of stakeholders due to project deadlines, budget, and any other technical constraints. In our industry, there is no record maintained for rejected requirements.

Comparison of existing tools: There are tools used worldwide to manage the requirements and manage the requirement changes. In an industry like Pakistan, the requirement management and change requests are manually handled by email or on the freelancing platform because most small start-ups or organizations are based on freelancing and local projects. Given below are some of the tools being used worldwide.

a. **ReqSuit [17]:** It is a paid tool that charges per month or user. In this tool, users can manage the requirements according to the SDLC phases. No cost and time estimates were done on the change request. Any change in requirements can be identified by comparing the changes in both versions. There is no proper way to manage the change request and change approval of new feature requirements in the project.

b. **Modern Requirements [18]:** It is a paid tool that supports requirement management. It is a web-based application that helps to manage the requirements but not according to the SDLC life phases and it's also specific to the agile development model. This tool is developed to integrate with DevOps and the team foundation server (TFS) tool that manages the overall project. There is no estimation of cost and time to analyze the change request impact if accepted. There is no change approval process, but the user can change the requirement.

c. **Open-Source Requirements Management (OSRMT) [19]:** It is an open-source tool for requirements management and somehow tracks the requirements but cannot manage the change request or track the changes in the requirement. It is a single-user desktop-based application used separately by one user at a time. OSRMT's latest release was updated almost two years ago and then there is no such user guide for users. Nowadays, users focus on GUI to increase usability. This tool solves financial issues, and then usability issues occur due to old technology. Pakistan's industry needs a collaborative tool that informs others about the change requests, change approval process, and the latest version

of requirements [20]. Table I shows how the existing licensed and open-source tools are not able to fill the gaps in the Pakistan software industry.

Table I: Barriers to adoption of existing tools for RCM.

s/n	Features	MR	ReqSuit	OSRMT
1	Requirement unique Identification	Yes	Yes	Yes
2	Hierarchical Change View	Yes	No	No
3	Early Time Estimation	No	No	No
4	Change Approval Process	Yes	No	No
5	Record rejected changes and reasons	No	No	No
6	Early Cost Estimation	No	No	No
7	Required Training	Yes	Yes	Yes
8	Central Repository	Yes	Yes	Yes
9	Change Requests Reports	No	No	No
10	Manage Change requests in SDLC's	No	No	No
11	Change Versioning	Yes	Yes	No
12	Defined Team Groups	Yes	Yes	No
13	Visual Aid	Yes	Yes	No
14	Role-based access	Yes	Yes	No
15	Communicate Change	Yes	No	No

V. techniques used for rcm in Pakistan: In the Pakistan software industry, most of the small and medium organizations usually get projects from freelancing platforms. In 2019 Pakistan was ranked in 4th position in the freelance market. Freelancing projects are low-cost and have tight schedules as compared to normal budget projects [21]. According to the survey conducted, most of the common techniques used for managing the change request are:

   i.   Manual Documents
  ii.   Meeting Notes
 iii.   Emails
 iv.   Personal Notes

Vi. Survey To Identify Rcm Barriers In Pakistan: This section analyzes the feasibility of research by surveying industry experts. The survey includes 17 questions, and the sample size of respondents is more than 130. The respondents belong to different organizations and designations that included requirement analysts, CTOs,

software engineers, software developers, project managers, software quality assurance, UI/UX designers, etc. Most of the respondents belong to different small and medium-sized organizations in Pakistan.

RESULTS AND FINDINGS

After getting the responses from the maximum number of respondents on the survey, a reliability test is applied to the survey responses to calculate the reliability (Cronbach's Alpha) of the data collection methods [1]. The statistic calculated from the survey is 0.73, which shows that our research instrument is optimal. The challenges faced by the Pakistan software industry in the requirement change management process are highlighted with the help of surveys and expert interviews from the industry. This section, proposed solutions for the major challenges faced by the Pakistan software industry as discussed in Table II.

Viii. Proposed Rcm Tool: We identified the challenges faced by following the requirement change management process in the Pakistan software industry. These challenges are then compared with other already developed tools and concluded that not a single tool could overcome all the challenges faced by the Pakistan software industry. Therefore, a framework is proposed, and the tool is developed to overcome the difficulties identified in small and medium organizations.

Moreover, a web application is developed that users can operate by signing up to the system. After that, users can log in with their respective account credentials. Administrator users manage access control of every user according to their role in the project. Every user has specific access according to their assigned role. The user can create a new project and define other important details like Project ID, Name, Project Type, Project Head, time schedules, and description, etc.

Due to space limitations, all the screenshots of the tool cannot be added. Figure. 1 shows the dashboard where all the current projects are displayed. Only authenticated and assigned users can add the requirements to the project. Requirements and their change requests can only be accepted by the head and team leads of the project. On rejecting any change request, the user needs to give the reason for rejecting the change requests. These rejected requirements are used as a lesson-learned register in future projects. Other users have received notifications of adding, accepting, and rejecting the change request. Whenever a change request is accepted, the users can add the sample picture and document given by the client side. Later, the cost and schedule of the change request are added to the project's total cost and time.

If any other user wants to track the change to perform development, design, and QA, they can view the changes in the requirement through the report that helps

to understand the change request and their impact as shown in Fig. 2. By managing change requests, the early estimation of cost and time schedules enables the users to discuss the change impact with the client so that they increase the time and cost of the project with mutual agreement. Our proposed tool can manage the requirements and their change request according to SDLC phases throughout the project. It is claimed that our tool will help overcome all the challenges faced during the RCM process in the Pakistan software industry.
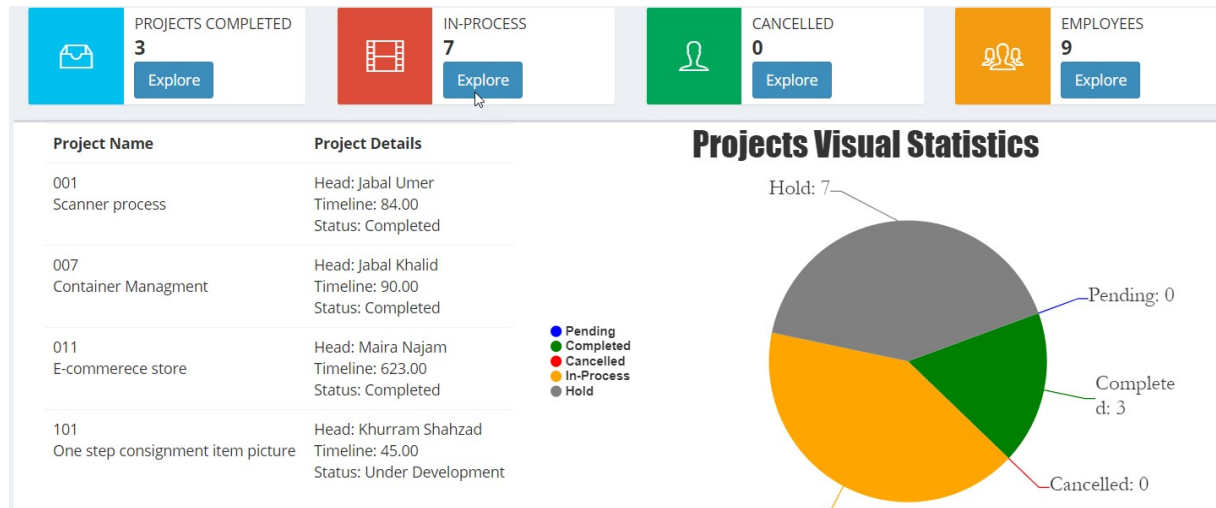
Figure 1. RCM Tool Dashboard

Table II: RCM process challenges and their proposed solutions

Issues	Challenges	Solutions
Time and Cost Constraints	If any unclear Requirement changes, then project time and cost also increase. Even a small change can increase project schedule times and costs.	Whenever any change request is received, there is a need to do an early rough estimation of cost and time to either accept or reject the request timely.
No Tool Usage	In our industry mostly emails from the client side are used as a change request tool or to create the text document [24].	There is a need to use worldwide tools to automate this process. We proposed the RCM tool as a better replacement for the manual process.
Expensive Tool	As Pakistan is a developing country, it is difficult for a small and medium-sized organization to afford a monthly license for a tool.	There is a need to develop tools that give the most important functionality to handle this change management process.
Tool Complexity	Companies in Pakistan do not spend time and cost on the training of their employees as the tools are complex to use.	Our Proposed RCM tool is very user-friendly as compared to other tools available in the market and it is free of cost.
No Central Database	In a traditional system, there is no concept to store requirements and change requests at a central place. There is no concept to save the requirements to reuse them in the future.	Our proposed tool helps to store the requirements in the central database to avoid any kind of loss and reuse the accepted and rejected requirements in the future.
No Requirement Identification	In the traditional method, no unique identification is assigned automatically to the requirements. By not assigning any unique identification it is difficult to manage and track the requirements if any change request occurs from the client side.	Our proposed framework helps to assign a unique ID to the requirement and a unique version according to it. This helps us to keep all the requirements and their changes safe.
No User-defined group	If requirements and their changes are not well managed within the defined team, then any unauthorized person may cause damage or perform any unwanted action.	Our proposed tool helps team owners to keep their details limited to the related person and not everyone can view or edit the details of the project. Therefore, any changes, costs, versions, and schedules are shared

|		
No Change Request Versioning	In traditional methods, there is no versioning assigned to the latest accepted change requests as a result sometimes teammates keep on working on previous versions which disturbs the whole project's schedules.	Our proposed tool helps to assign versions to accepted or rejected changes and also keeps everyone informed by sending a notification about any change added by the team head.
No Access Authorization	When any kind of change in requirement occurs, the change acceptance and rejection is done by any non-technical person. They bring a lot of problems for the developers.	Our proposed framework ensures that if any change occurs only authorized persons have access to accept or reject the change, but other stakeholders are well informed about the changes. All the requirement changes are accessible to the only related team member and only the team head is allowed to perform edit or decline any change.
No Visual Aid	Mostly clients share sample material to explain what kind of system they need to arrange the sample files and pictures with the requirement. If these samples are not properly saved and not shared with the stakeholders, then the designer and developer cannot understand them.	Our proposed framework helps to manage the change with the client-provided sample so that they can see it shared with other stakeholders for better understanding and also save these for the future if users are doing a similar project.
No Changes Report	The traditional methods of change management are handled by email or paper. These changes are difficult to track and evaluate their impact on a complete project [2].	Our tool helps to show the requirement change in the hierarchal form that helps us to see the change versioning in requirements according to the SDLC cycle and also its cost, time rough estimation impact on the project.

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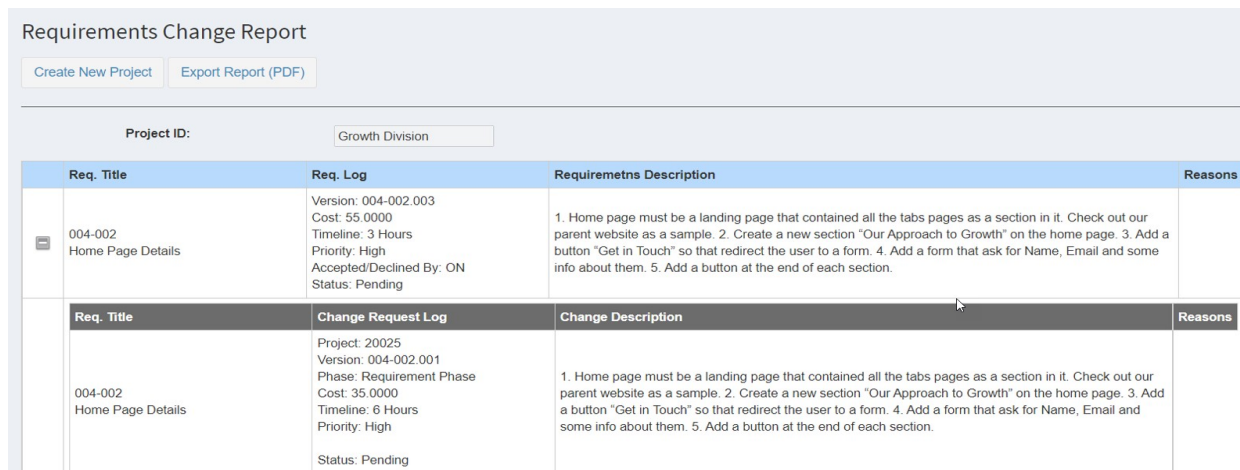
FIGURE 2. RCM Tool Change Request Report

**Table Iii. Comparison Between Change Requests Managed By The Rcm Tool And Traditional Methods**

Change Requests Managed by RCM Tool	Change Requests Managed by Traditional Methods
• Every change request is recorded in the RCM tool.	• Changes are made during the meeting.
• An auto-generated email informs everyone about the new change request.	• Conduct Meetings, inform and analyze the changes with stakeholders.
• Only allowed team members can accept/reject the changes.	• Senior resources accept/reject the changes in meetings.
• Formally inform the stakeholders about change request decisions during the development phase.	• Every stakeholder has his meeting notes for writing their changes.
• Share the actual requirements with their updated change requests report and impact on time cost with the client for final approval.	• The project manager discusses the changes with the client through Messenger.
	• Negotiate the change impact with the client and get

- Negotiate the change impact with the client and get an extension on the time and cost of the project.
- Formally inform the team members through email and assign tasks to them.
- Completing the promised change requests, no requirement was missed by any stakeholder because all requirements are located in the central repository shared with another member as per their role.
- The project became successful as the team did not make any unrealistic promises and formally controlled the change requests, by informing all the stakeholders and recording the rejected changes for future use.
- After all the changes the total budget increases but approximately remains the same and the project managed by the RCM tool takes a few days more than the other projects with the consent of the client.
- Successfully managed the requirements and their change requests after negotiation.
- Change requests report and their impact on cost and timeline shared with clients and team members helps us to negotiate the change impact so they timely decide about the approval or rejection of requests.
- Timely communication and a central repository keep the team on the same page after any new change request.

- an extension in the time and cost of the project.
- Every stakeholder has his meeting notes for writing their changes. And verbal assignment of the task to team members.
- Unfortunately, they didn't complete the promised change requests as they missed a few change requests due to mismanagement.
- A few team members were not aware of the latest requirement version.
- Change request Document not updated so they can't use this in future as a lesson learned register.
- After all the changes the total budget of the project is approximately the same.
- They fail to manage the change requests within the given deadline due to mismanagement, miscommunication, and an unclear understanding of requirements.
- Delay in communicating the change causes the team to work on the previous version of the requirement which results in a lot of reworks.

IX. Validation Of RCM Tool: Tool validation is performed after the deadline of both projects is completed. To validate the RCM Tool, two projects are involved, one being the controlled group using the RCM Tool and the other being the uncontrolled group using traditional methods. Both the projects were web-based. The team members were the same. Due to privacy concerns, the names of projects are not mentioned. The only difference was the usage of the RCM tool. It was noticed that the project where the RCM tool was used to manage all the change management activities was successful while the other project failed and could not deliver the project on time because they could not manage the requirements change request activities. Therefore, it is concluded that the RCM tool is a solution to overcome the change management barriers. The comparison between the traditional methods and RCM tool management is described in Table III.

RCM Tool feedback survey was distributed among all the project team members involved in the project development. The survey sample consists of 8 questions that help in analyzing the results. Figure 3 shows that requirement change management barriers were successfully overcome by using our proposed framework. The project deadline was extended as they early discussed the change effects with the client and insisted on increasing the deadlines to cater to all the changes in requirements.
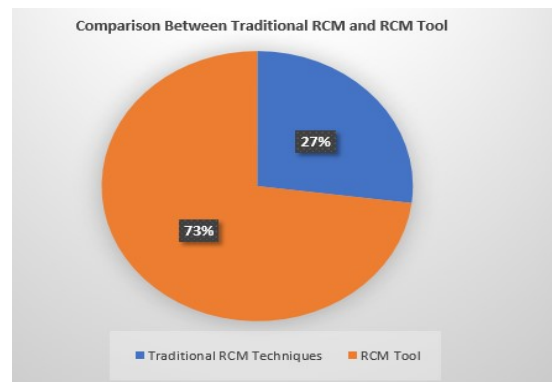
FIGURE 3. Comparison of RCM Tool with Conventional RCM Approaches

In the other project, the team failed to manage the change requests and did not spend time on early estimation and change management. Therefore, uncontrollable change requests for the project failed to deliver the project on time. Survey results show that our proposed framework is better than other traditional techniques used to handle the change requests in the project. Moreover, the users are very much satisfied with our RCM Tool and are likely to recommend other professionals to use this tool to improve the requirement change management process in the Pakistan software industry.

Table IV illustrates how our tool resolves the change request management process by addressing the barriers present in other tools available.

Table IV: Comparison between change requests managed by the RCM tool and other tools according to the barriers faced (mr= modern requirement tool).

Barriers	MR	ReqSuit	RCM Tool
Requirement unique Identification	Yes	Yes	Yes
Hierarchical Change View	Yes	No	Yes
Early Time Estimation	No	No	Yes
Change Approval Process	Yes	No	Yes
Record rejected changes and reasons	No	No	Yes
Early Cost Estimation	No	No	Yes
Required Training	Yes	Yes	Yes
Central Repository	Yes	Yes	Yes
Change Requests Reports	No	No	Yes
Manage Change requests in SDLC's	No	No	Yes
Change Versioning	Yes	Yes	Yes
Defined Team Groups	Yes	Yes	Yes
Visual Aid	Yes	Yes	Yes
Role-based access	Yes	Yes	Yes
Communicate Change	Yes	No	Yes

Conclusion: This research identified factors that affect the change management process in our industry by surveying the industry experts. The survey questions highlighted the barriers identified by the literature review and the industry experts. These responses include technical stakeholders i.e. project managers, software engineers, requirement analysts, CTO, CEOs, Project managers, software engineers, quality analysts, etc.

Our research has pinpointed several barriers hindering effective requirement change management in Pakistan's industry. These include ambiguous and undefined requirements, time and budget constraints, lack of tool utilization or access to costly and complex tools, absence of a centralized requirements database, inadequate requirement identification and user-defined groups, challenges in change request versioning, access authorization issues, and absence of visual aids, change reports, and change request tracking within the SDLC model. Addressing these barriers is crucial to facilitating the adoption of robust requirement change management practices among industry experts in Pakistan. The negative impact caused by these barriers has been mentioned in this research.

RCM tool is developed to overcome the identified requirement change management barriers in the Pakistan software industry. This tool enables the users to manage the requirements and their change requests from the end-user. When requirements and their change approval process are done systematically, project success chances increase. The RCM tool makes sure that all the changes were accepted keeping in view the budget and timeline of the project and their impact was discussed with the clients too. RCM tool is evaluated by taking two projects of content management system platform. One project's requirements and its change request impact were managed by traditional techniques and other project requirements and their change requests were managed by the RCM tool. It was noted that the project named "Growth Division" which used the RCM tool successfully got deployed by managing the change requests and their impact on the project while another project "Lost Solezz" was not deployed on time being unable to manage the changes and their impact on the project. The feedback given by the users showed that they were satisfied with the result and highly recommend others to use the RCM tool for their requirement change management.

In the future, we intend to give different solutions to manage change in requirements of other SDLC models like agile scrum and iterative model. These models were mostly followed in our industry for developing various projects. The agile model needs sprints for gathering requirements and their change requests and the iterative model intends to provide the iterative requirement change management process in different SDLC phases.

Conflicts Of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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