A Hybrid Requirement Elicitation Technique for Android Applications

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Annex A

THESIS ACCEPTANCE CERTIFICATE

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A thesis submitted to National University of Sciences and Technology, Islamabad
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Devoted to my dad and mom,
whose extraordinary continuous
help and limitless prayers led me
to this accomplishment.

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Abstract

The challenges of requirement elicitation in Android application development within Pakistani software houses, as identified in our prior study, highlighted the necessity for a more structured approach. This case study proposes a hybrid requirement elicitation technique that combines interviews and prototyping to enhance requirement gathering processes. The proposed method addresses issues such as informal requirement gathering, lack of structured documentation, overburdened developers, and ambiguous requirements, which previously led to increased project costs and extended timelines.

By conducting detailed interviews with key stakeholders and developing low-fidelity prototypes, the hybrid technique facilitates clearer communication and more accurate requirements documentation. Iterative prototype reviews allow for continuous refinement based on stakeholder feedback, significantly improving project outcomes. Data collected through surveys from developers, project managers, and clients were examined through the use of regression analysis, chi-square testing, and descriptive statistics. The findings indicate a high level of satisfaction with the hybrid technique, demonstrating its effectiveness in reducing development time and costs while enhancing project quality.

The results show that this hybrid approach not only aligns better with stakeholder expectations but also fosters a more positive work environment for developers. Our collaboration with a mid-sized software house in Lahore provided empirical evidence supporting the hybrid technique's advantages in real-world applications. This study suggests that adopting such a structured and iterative requirement elicitation method can lead to substantial improvements in Android application development practices in Pakistani software houses.

Keywords

Requirement elicitation, hybrid technique, interviews, prototyping, Software Development Life Cycle (SDLC), Android development, project management, software quality, stakeholder engagement, Pakistani software houses, descriptive statistics, chi-square test, regression analysis.

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Chapter 1

Introduction

Acquiring accurate and thorough requirements is essential for project success in the quickly changing field of Android development. Precise requirement elicitation guarantees that the application developed satisfies stakeholder expectations and user needs minimizing the need for project revisions cutting expenses and raising overall quality. Even though they can be somewhat successful traditional methods of requirement elicitation frequently fail to meet the complex and dynamic nature of software projects. This thesis enhances requirement gathering for Android development projects by proposing a hybrid requirement elicitation technique that combines the benefits of prototyping and interviews. By addressing common problems like poor requirement documentation developer overload and project ambiguity this strategy seeks to promote a development process that is both more productive and successful.

1.1 Background and Motivation

Understanding and recording the needs and expectations of stakeholders lays the groundwork for a successful project during the crucial requirement elicitation phase of the Software Development Life Cycle (SDLC) as show in figure 1.1.

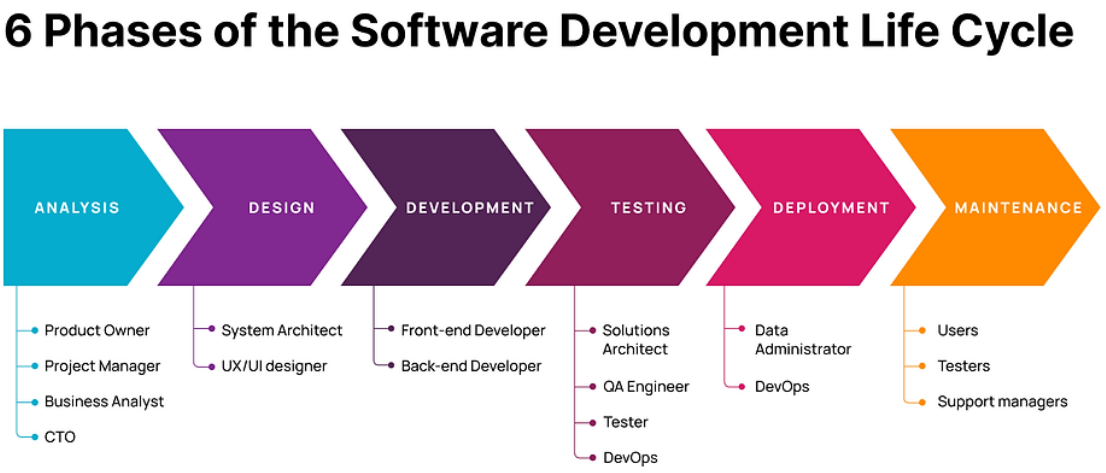

Figure 1.1.1 Phases of Software Development Life Cycle

Conventional techniques such as questionnaires interviews and document analysis are frequently employed however when these techniques are used in isolation, they may result in requirements that are unclear or insufficient particularly in complicated projects [1]. An approach to requirement elicitation that is more robust and adaptive is necessary in Android development due to the ever-changing expectations of users and the speed at which technology is developing [2]. Numerous issues with the requirement elicitation procedures used by Pakistani software companies have been brought to light by earlier research. These difficulties include unstructured documentation procedures irregular and informal methods of obtaining requirements and overworked developers who frequently have to complete requirement gathering tasks on top of their main development duties [3]. The quality of the finished product is eventually impacted by such practices which also result in higher project costs longer project timelines and a toxic work environment for developers [4]. The goal of this thesis is to present a hybrid requirement elicitation method that combines prototyping and interviews driven by these difficulties. This hybrid approach is justified by the desire to combine the best features of both approaches: direct

stakeholder interaction during interviews yields specific and detailed requirements while early user feedback and validation are facilitated by the visual and interactive representation of these requirements provided by prototyping [5]. The aim of the hybrid approach is to enhance stakeholder engagement throughout the development process decrease misunderstandings and increase the clarity and accuracy of requirements by combining these techniques. Furthermore, by applying the suggested hybrid technique in a practical context this study aims to empirically validate its efficacy. For one of their Android development projects a mid-sized Lahore software company decided to use the hybrid technique. Survey data that is gathered and statistically examined will shed light on how the hybrid technique affects project quality cost and development time. The ultimate goal is to show that Android application development procedures in Pakistani software companies can be significantly enhanced by implementing an organized and iterative requirement elicitation approach.

1.2 Research Problem and Objectives

Research Problem

The primary challenge this study seeks to address is the insufficiency of traditional requirement elicitation methods are for managing the intricacies and dynamics of Android development projects. Informal and uneven methods of gathering requirements an absence of formal documentation procedures and overworked developers who are required to gather requirements on top of their development duties are common problems in Pakistani software houses [1]. Many times, these issues result in longer project durations higher project costs and lower final product quality [2]. Moreover, a more flexible and reliable approach to requirement elicitation is needed due to the fast-changing landscape of Android technology and user expectations. Even though they are helpful traditional methods like interviews can produce unclear or insufficient

requirements. Likewise, it's possible that certain details or stakeholder expectations are missed during prototyping. To increase the precision and thoroughness of requirements a hybrid approach that incorporates the advantages of several approaches is therefore necessary [3].

Objectives

The objectives of this research are twofold:

1. **Propose a Hybrid Requirement Elicitation Technique**:
    - Develop a hybrid technique that integrates interviews and prototyping to address the shortcomings of traditional requirement elicitation methods.
    - Ensure that this technique provides a more comprehensive and accurate requirement gathering process, reducing ambiguities and misunderstandings.
    - Enhance stakeholder engagement and satisfaction by incorporating iterative feedback mechanisms [4].
2. **Empirical Validation**:
    - Implement the proposed hybrid requirement elicitation technique in a real-world setting within a mid-sized software house in Lahore.
    - Collect and analyze data to assess the impact of the hybrid technique on development time, project cost, and overall project quality.
    - Employ statistical techniques such as descriptive statistics, Regression analysis and chi-square testing are used to evaluate and validate the suggested method's efficacy [5].

By achieving these goals, the study seeks to demonstrate that the proposed hybrid requirement elicitation technique can significantly improve the requirement gathering process for Android development projects in Pakistani software houses. The ultimate goal

is to foster a more efficient and effective development process, leading to higher quality products, reduced costs, and enhanced developer satisfaction.

1.3 Scope and Structure

Scope

This research focuses on the development and empirical validation of a hybrid requirement elicitation technique specifically designed for Android development projects in Pakistani software houses. The hybrid technique integrates interviews and prototyping to address the prevalent issues of inadequate requirement gathering, developer overburden, and project ambiguity. The scope of the study includes:

1. **Hybrid Technique Development**:
    - Design a detailed framework combining interviews and prototyping to form a comprehensive requirement elicitation method.
    - Ensure the technique is adaptable to the specific needs and challenges faced by software houses in Pakistan.
2. **Implementation**:
    - Collaborate with a mid-sized software house in Lahore to implement the hybrid technique on an actual Android development project.
    - Collect qualitative and quantitative data from the project stakeholders, including developers, project managers, and clients.
3. **Data Analysis and Validation**:
    - Apply statistical techniques to analyze the gathered data, focusing on the effectiveness of the hybrid technique in improving requirement accuracy, reducing project costs, and enhancing overall project quality.

- Utilize descriptive statistics, chi-square tests, and regression analysis to validate the results.

4. **Generalization of Findings**:
    - Evaluate the relevance and applicability of the proposed technique to other software houses and development contexts, considering the unique challenges of Android projects.

By limiting the study to Android development projects within Pakistani software houses, the research aims to provide targeted insights and practical solutions that can be readily implemented in the local software industry.

Structure

The thesis is organized into multiple chapters, each focusing on different facets of the research problem, methodology, and results. The structure is outlined as follows:

Chapter 1: Introduction

- Provides a summary of the research issue, including the history and motivation, the problem and goals of the study, the scope and structure of the thesis, and more.

Chapter 2: Literature Review

- Reviews existing literature on requirement elicitation techniques, their challenges, and their applications in software development. It highlights the gaps in current practices and the need for a hybrid approach.

Chapter 3: Research Methodology

- Explains the methodology, which includes how the hybrid requirement elicitation process was developed., data collection methods, and analytical procedures. It outlines the implementation process in the selected software house.

Chapter 4: Case Studies

- Outlines the conclusions drawn from the information gathered when the hybrid technique was put into practice. To verify the efficacy of the suggested approach, it comprises regression analysis, chi-square test findings, and descriptive statistics..

Chapter 5: Discussion

- Discusses the results in detail, comparing them with existing literature and theoretical expectations. It examines the impact of the hybrid technique on project outcomes, stakeholder satisfaction, and requirement accuracy.

Chapter 6: Conclusion

- Summarizes the key findings, discusses their implications for practice, and provides recommendations for software houses looking to adopt the hybrid requirement elicitation technique. It also outlines potential areas for future research.

Chapter 2

Literature Review

Requirement elicitation is a crucial stage in the software development lifecycle (SDLC), laying the groundwork for successful project results. Efficient requirement elicitation helps ensure that the software meets user needs and stakeholder expectations, minimizing the risk of expensive revisions and project delays. Various techniques have been employed in requirement elicitation, including interviews, surveys, document analysis, observation, and prototyping, each offering unique benefits and challenges. Interviews, for instance, provide detailed insights through direct stakeholder engagement, while prototyping allows for visualizing and refining requirements early in the development process. Despite the availability of these techniques, many software projects, particularly in the context of Pakistani software houses, struggle with issues such as incomplete requirement gathering, overburdened developers, and ambiguous documentation. These challenges often result in increased project costs, extended timelines, and compromised software quality. This literature review explores the existing requirement elicitation techniques, their applications, and the need for a hybrid approach that can address the limitations of traditional methods and improve the efficacy of the requirement gathering process in Android development projects.

2.1 Requirement elicitation techniques

Requirement elicitation is a crucial phase in the software development lifecycle (SDLC), focusing on gathering the necessary requirements from stakeholders to ensure the final product meets their needs. Various techniques have been developed and utilized to facilitate this process, each with its strengths and weaknesses.

Interviews

Interviews are a popular technique for gathering requirements because they allow the interviewer and stakeholders to interact directly and gain a thorough grasp of the needs and expectations of the user. Depending on the level of detail required and the nature of the project, these interviews might be conducted in an unstructured, semi-structured, or structured manner [5]. Unstructured interviews are more conversational and fluid, allowing for the discovery of latent requirements, while structured interviews follow a predetermined list of questions to ensure consistency.

Surveys and Questionnaires

Surveys and questionnaires are valuable tools for gathering data from a broad range of stakeholders, especially when requirements need to be collected from a widely distributed user base. They can include both open-ended and closed-ended questions to capture qualitative and quantitative information. However, the effectiveness of these tools relies significantly on the quality of the questions and the respondents' willingness to offer accurate and honest feedback[1].

Document Analysis

Document analysis involves examining existing documents, such as business plans, process manuals, and system specifications, to gather requirements. This approach is useful for gaining insight into the current system and pinpointing gaps that need to be

addressed in the new system. It is particularly useful in projects where stakeholders are not readily available for interviews or surveys [1].

Observation

Through observation, one can learn how users interact with the current system and determine their needs by looking at them in their natural setting. This method can reveal needs that stakeholders might not express in surveys or interviews and offers direct insights into user behavior. But observation can take a lot of time and isn't always possible, particularly in large or dispersed teams [4].

Workshops

Workshops bring together a variety of stakeholders to debate and develop requirements together. By promoting conversation and brainstorming, these meetings aid in reaching an understanding of the project's specifications. Workshops are especially useful for complicated tasks where integrating several points of view is necessary. Additionally, they help stakeholders feel more invested in the project, which can strengthen their commitment [3].

Prototyping

In order to visualize the requirements and get input from stakeholders, a preliminary version of the system, such to the one in figure 2.1, is created during the prototyping process. This method aids in the early detection of problems in the development process and the clarification of requirements. Prototyping may help guarantee that the

requirements are clear and drastically decrease ambiguity by enabling stakeholders to engage with a physical model of the system [6].

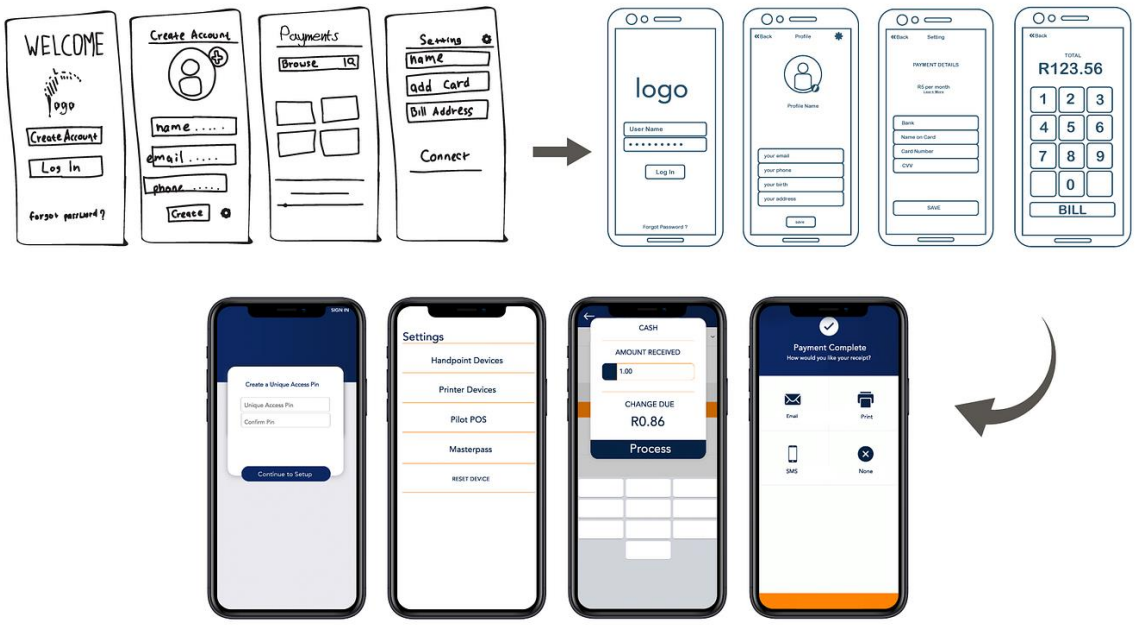

Figure 2.1.1 App Prototype

Use Cases and Scenarios

Utilization scenarios and use cases outline the practical applications of the system. They offer a story of the user-system interactions, which aids in defining the functional specifications and user expectations.This technique is particularly useful for capturing detailed requirements in a user-centric manner [7].

Focus Groups

Focus groups involve discussions with a selected group of stakeholders to gather their views and expectations. This technique can generate a wide range of ideas and insights, especially when stakeholders have diverse perspectives. Focus groups are effective for exploring new concepts and validating assumptions, but they require skilled facilitation to ensure productive discussions [8].

Brainstorming

Creative idea development and unstructured thinking are fostered by brainstorming sessions. Early in a project, this method might be helpful in determining requirements and possible solutions. To improve and validate the ideas acquired, more formal procedures must be employed afterward [9].

Combining these methods will enable a more thorough and precise set of needs to be elicited, resulting in a higher caliber output. Every technique has a context and an appropriate use for it; therefore, the selection of techniques should be based on the particular requirements of the project and the stakeholders.

2.2 Hybrid Approaches: Interviews and Prototyping

To address the limitations of traditional requirement elicitation techniques, hybrid approaches have gained traction in software engineering. Combining multiple methods can leverage the strengths of each technique, resulting in a more comprehensive and effective requirement gathering process. One such promising hybrid approach integrates interviews with prototyping.

Interviews

One of the most important methods for eliciting requirements is the interview, which involves speaking with stakeholders directly to learn about their requirements, preferences, and expectations. This method facilitates a deep understanding of the project's goals and user requirements, allowing the interviewer to ask follow-up questions and clarify ambiguities [10]. Structured interviews, with predefined questions, ensure consistency across multiple stakeholders, while unstructured interviews provide flexibility, enabling the discovery of unforeseen requirements [11]. However, interviews

alone may not fully capture the complexities of user interactions with the system, leading to incomplete or misunderstood requirements.

Prototyping

In order to visualize and evaluate requirements, prototyping entails building an early, reduced version of the software application. By using this method, stakeholders can engage with a physical model of the system and give quick feedback on its usability, design, and functionality [12]. By identifying unclear or missing requirements, prototyping helps make sure that the demands of stakeholders are precisely identified and understood. Low-fidelity prototypes, like sketches or wireframes, are easier to make and alter than high-fidelity prototypes, which are more like the finished product [13]. Prototyping has its benefits, but it may miss important details like as stakeholder interactions and functional requirements that are best recorded through direct communication.

Combining Interviews and Prototyping

A hybrid approach that combines interviews and prototyping can address the limitations of using each technique in isolation. This integration leverages the detailed, qualitative insights gained from interviews and the interactive, visual feedback provided by prototyping [14]. The process typically involves several steps:

1. **Initial Interviews**: Conduct detailed interviews with key stakeholders to gather initial requirements and understand the project's objectives and user needs. This step ensures a comprehensive understanding of the requirements from the outset [15].

2. **Create Initial Prototype**: Develop a low-fidelity prototype based on the information gathered during the interviews. This prototype serves as a preliminary visual representation of the system, capturing the core functionalities and design elements [16].
3. **Prototype Review and Feedback**: Present the prototype to stakeholders and conduct follow-up interviews to gather their feedback. Encourage stakeholders to interact with the prototype to identify any missing or unclear requirements. Document this feedback to refine the prototype accordingly [17].
4. **Refine Requirements and Prototype**: Update the prototype based on stakeholder feedback and refine the requirements. This iterative cycle of review and refinement ensures that all requirements are clear, validated, and aligned with stakeholder expectations [18].
5. **Finalize Requirements**: Once the prototype is finalized and validated, document the final requirements in a comprehensive Software Requirements Specification (SRS) document. Ensure that all stakeholders review and approve the final requirements to avoid future misunderstandings [19].

   Iterative improvement and ongoing stakeholder interaction are encouraged by this hybrid method, which produces more precise and comprehensive requirement documentation. Improved communication between developers and stakeholders, fewer misunderstandings, and close alignment of the finished product with user needs and expectations are the benefits of this approach. The efficiency and efficacy of the requirement elicitation process can be greatly increased by putting this strategy into practice in Android development projects.

2.3 Context of Android Development

The Android operating system, developed by Google, has become one of the most widely used platforms for mobile application development. Its open-source nature and extensive developer support have made it the preferred choice for a vast array of applications, ranging from simple utilities to complex enterprise solutions. Understanding the context of Android development is crucial for effective requirement elicitation, as it encompasses various unique challenges and opportunities.

Market Dynamics

The Android ecosystem is characterized by rapid technological advancements and a highly competitive market. Developers must frequently update their applications to support new Android versions, devices, and user expectations [20]. The fragmented nature of the Android market, with numerous devices from different manufacturers, adds to the complexity of development. This diversity necessitates thorough requirement elicitation to ensure compatibility and optimal performance across various devices [21].

User Expectations

Android users have high expectations regarding application performance, usability, and aesthetics. They demand seamless, intuitive, and visually appealing experiences. It takes a deep comprehension of user behavior, preferences, and pain spots to meet these expectations. To gather these ideas and turn them into workable needs, effective requirement elicitation methods like usability testing and user interviews are crucial [23].

Development Tools and Frameworks

A wide range of frameworks and tools are available to help Android development, such as Android Studio, Kotlin, and various libraries for UI/UX design, networking, and data storage. These tools streamline the development process but also introduce specific constraints and requirements. For instance, developers need to ensure that their applications adhere to Android's design guidelines and leverage the latest APIs and features. Prototyping and iterative development techniques can help in aligning the project requirements with these technical considerations [24].

Figure 2.3.1 Android App Development Tools

Agile Methodologies

Many Android development projects adopt agile methodologies to cope with the fast-paced and dynamic nature of the mobile app market. Agile practices, such as continuous integration, iterative development, and frequent stakeholder feedback as shown in figure 2.3, align well with the hybrid requirement elicitation approach of combining interviews and prototyping. This synergy enables the continuous refinement of requirements and ensures that the development process remains flexible and responsive to changing needs [25].

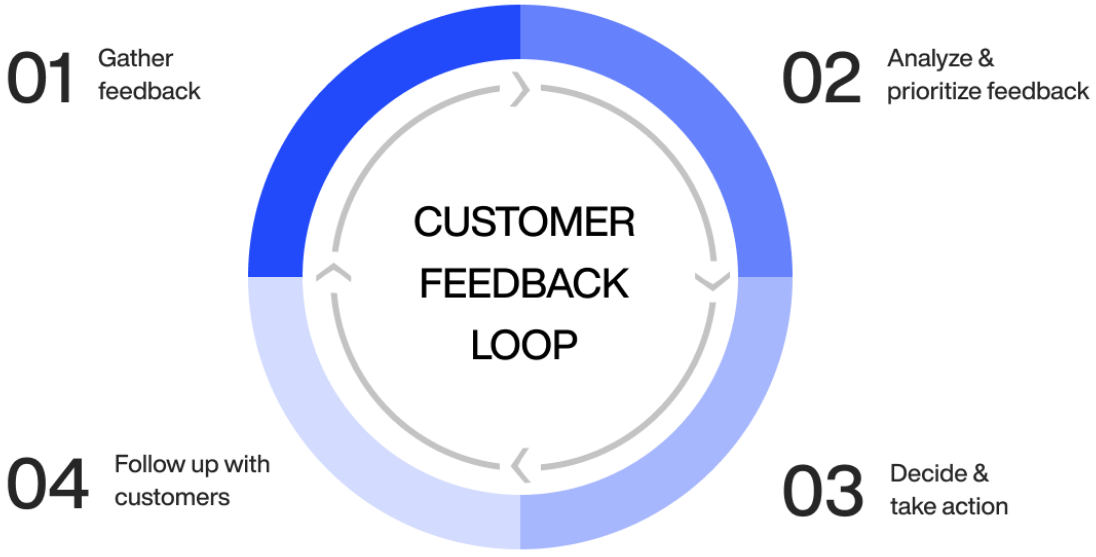

Figure 2.3.2 Feedback loop based on customers

Security and Privacy Concerns

With the increasing prevalence of mobile applications handling sensitive user data, security and privacy have become paramount concerns in Android development.

Requirement elicitation must encompass these aspects to ensure that applications comply with regulatory standards and protect user information. Techniques such as threat modeling and security-focused interviews with stakeholders can help identify potential vulnerabilities and define robust security requirements [26].

Local Context of Pakistani Software Houses

With reference to Pakistani software companies, several unique challenges and opportunities influence Android development projects. Limited resources, high client expectations, and a competitive market environment often pressure developers to deliver quickly, sometimes at the expense of thorough requirement elicitation. However, the growing demand for high-quality mobile applications also presents opportunities for adopting more structured and effective requirement gathering techniques [27].

Pakistani software houses often work with both local and international clients, requiring a nuanced understanding of diverse user needs and market conditions. The proposed hybrid requirement elicitation technique, integrating interviews and prototyping, can help these software houses better manage their projects by ensuring comprehensive and accurate requirement documentation, thus improving project outcomes and client satisfaction [28].

By understanding the specific context of Android development, including market dynamics, user expectations, development tools, agile methodologies, security concerns, and local industry conditions, this research aims to propose a requirement elicitation technique that addresses these multifaceted challenges effectively.

Chapter 3

Research Methodology

The research approach that was utilized to create, put into practice, and evaluate the hybrid requirement elicitation method—which combines interviews and prototyping—is covered in this chapter. It discusses the hybrid approach's architecture, the case study methodology used to put it into practice, and the methods used for data collecting and analysis to confirm the strategy's efficacy.

3.1 Overview of Hybrid Technique

In this research, a hybrid requirement elicitation technique combining interviews and prototyping is proposed to address the limitations of traditional requirement gathering methods. This hybrid approach leverages the strengths of both techniques to create a comprehensive and effective requirement elicitation process tailored for Android development projects.

Rationale for the Hybrid Technique

The rationale behind combining interviews and prototyping stems from the need to enhance the accuracy and completeness of the requirements gathered, while also improving stakeholder engagement and satisfaction. Interviews provide a direct line of communication with stakeholders, allowing for the collection of detailed and specific requirements through open-ended questions and discussions. This method helps uncover hidden requirements and clarifies stakeholders' needs and expectations [10].

Prototyping, on the other hand, involves creating an early, simplified version of the software application to visualize and validate requirements. This technique enables stakeholders to engage with a tangible model of the system, offering immediate feedback on its functionality, design, and usability. Prototyping helps identify missing or ambiguous requirements and ensures that stakeholders' needs are accurately captured and understood [11].

By integrating these two techniques, the hybrid approach aims to:

- **Enhance Requirement Accuracy**: Detailed interviews provide comprehensive insights into stakeholder needs, while prototyping validates and refines these requirements through iterative feedback.
- **Improve Stakeholder Engagement**: Regular interactions through interviews and prototype reviews foster better communication and collaboration between developers and stakeholders.
- **Reduce Ambiguities**: Prototyping offers a visual depiction of the system, reducing misunderstandings and ambiguities in the requirements.

- **Facilitate Iterative Refinement**: The hybrid approach supports continuous refinement of requirements, ensuring alignment with stakeholder expectations and project goals [17].

Steps of the Hybrid Technique

The proposed hybrid requirement elicitation technique consists of the following steps:

1. **Initial Interviews**:
    - Conduct detailed interviews with key stakeholders to gather initial requirements.
    - Focus on understanding the project's goals, user needs, and specific functional requirements.
    - Document the gathered information in a structured format (e.g., Software Requirements Specification, SRS document).
2. **Create Initial Prototype**:
    - Develop a low-fidelity prototype based on the initial requirements gathered during interviews.
    - Use simple tools like wireframes or mockups to create a visual representation of the application.
3. **Prototype Review and Feedback**:
    - Present the prototype to stakeholders and conduct follow-up interviews to gather feedback.
    - Encourage stakeholders to interact with the prototype and identify any missing or unclear requirements.
    - Document feedback and update the prototype accordingly.
4. **Refine Requirements and Prototype**:

- Based on stakeholder feedback, refine the requirements and update the prototype.
- Conduct iterative cycles of prototype review and refinement until all requirements are clear and validated.

5. **Finalize Requirements**:
    - Once the prototype is finalized and validated, document the final requirements in a comprehensive SRS document.
    - Ensure that all stakeholders review and approve the final requirements to avoid future misunderstandings.

Implementation Plan

The suggested hybrid technique will be put into practice in a real-world context at a mid-sized software company in Lahore to confirm its efficacy. The company will adopt the hybrid technique for one of their Android development projects, involving a utility application with complex functional requirements. The implementation will follow these steps:

1. **Training and Preparation**:
    - Train the project team on the hybrid requirement elicitation technique, including interview techniques and prototyping tools.
    - Prepare necessary resources and materials, such as interview guides and prototyping software.
2. **Conduct Initial Interviews**:
    - Schedule and conduct interviews with key stakeholders, including clients, project managers, and end-users.
    - Document the gathered requirements in an SRS document.

3. **Develop Initial Prototype**:
    - Create a low-fidelity prototype based on the documented requirements.
    - Use wireframing tools to develop a visual representation of the application.
4. **Iterative Review and Refinement**:
    - Present the prototype to stakeholders and gather feedback through follow-up interviews.
    - Refine the requirements and prototype based on the feedback.
    - Repeat the review and refinement cycles until the requirements are clear and validated.
5. **Finalize and Document Requirements**:
    - Finalize the prototype and document the validated requirements in an SRS document.
    - Obtain approval from all stakeholders to ensure alignment and agreement.

By following this structured approach, the hybrid technique aims to improve the requirement elicitation process for Android development projects, resulting in more accurate, complete, and validated requirements that align with stakeholder needs and project goals.

3.2 Case Study approach

Rationale for the Case Study Approach

For this research, the case study method was chosen because it works well for analyzing complicated phenomena in the context of real-world experiences. This approach enables a thorough grasp of the dynamics involved in the requirement elicitation process for

Android development projects by focusing on one or a small number of scenarios in depth. The case study approach is especially suitable for this research since it provides practical insights and empirical validation of the suggested hybrid requirement elicitation technique's efficacy in a real-world setting [20].

Selection of Case Study Site

The chosen case study location is a mid-sized Lahore software company, Pakistan. This company was chosen based on several criteria:

1. **Relevance**: The software house specializes in Android development projects, making it an ideal setting to test the proposed hybrid requirement elicitation technique.
2. **Willingness to Participate**: The company agreed to adopt the hybrid technique for one of their ongoing projects and collaborate throughout the research process.
3. **Complexity of Projects**: The software house undertakes complex projects with diverse stakeholder needs, providing a rich context for applying and evaluating the hybrid technique [27].

Case Study Design

The purpose of the case study is to capture comprehensive data on the requirement elicitation process using the hybrid technique. It involves the following phases:

1. **Preparation Phase**:
    - **Training and Orientation**: The project team is trained on the hybrid requirement elicitation technique, including conducting interviews and developing prototypes.
    - **Project Selection**: An ongoing Android development project is selected for implementing the hybrid technique. This project involves developing a utility application with complex functional requirements.
2. **Data Collection Phase**:

- **Initial Interviews**: Detailed interviews are conducted with key stakeholders, including clients, project managers, and end-users, to gather initial requirements. The interviews are recorded and transcribed for analysis.
- **Development of Initial Prototype**: Based on the preliminary needs that were obtained during the interviews, a low-fidelity prototype is produced.
- **Iterative Feedback and Refinement**: The prototype is presented to stakeholders, and their feedback is gathered through follow-up interviews. The prototype and requirements are iteratively refined based on the feedback.

3. **Validation Phase**:
    - **Finalization of Requirements**: After the prototype is validated, the final requirements are compiled into a detailed Software Requirements Specification (SRS) document. This SRS is then reviewed and approved by all stakeholders.
    - **Implementation and Observation**: The project is developed based on the finalized requirements. The researcher observes the development process to gather insights into the impact of the hybrid technique on project outcomes.
4. **Analysis Phase**:
    - **Descriptive Analysis**: The collected data, including interview transcripts, prototype iterations, and stakeholder feedback, are analyzed descriptively to identify patterns and themes.

- **Statistical Analysis**: Quantitative data, such as development time, project cost, and stakeholder satisfaction, are analyzed using statistical techniques such as regression analysis and chi-square testing to verify the efficacy of the hybrid approach [28].

Data Collection Methods

The case study uses a variety of data collection techniques to guarantee that the requirement elicitation process is fully understood:

1. **Interviews**: Both initial and follow-up interviews with stakeholders are conducted to gather detailed requirements and feedback. These interviews provide qualitative data on stakeholder needs, expectations, and perceptions of the hybrid technique.
2. **Prototyping**: The development and iterative refinement of prototypes provide visual and interactive representations of the requirements, facilitating stakeholder engagement and validation.
3. **Observations**: In order to determine how the hybrid approach affects project execution, including any difficulties and advantages the project team may encounter, the researcher keeps an eye on the development process.
4. **Surveys**: Surveys are distributed to stakeholders at various stages of the project to collect quantitative data on their satisfaction with the requirement elicitation process and the final product [29].

Ensuring Validity and Reliability

The following steps are taken to guarantee the authenticity and dependability of the case study findings:

1. **Triangulation**: Multiple data sources (interviews, observations, surveys) and data collection methods (qualitative and quantitative) are used to corroborate the findings.

2. **Member Checking**: Stakeholders are asked to review and confirm the accuracy of the collected data and the researcher's interpretations to ensure that the findings accurately reflect their perspectives.
3. **Documentation**: To facilitate study replication and offer a transparent audit trail, data collecting and analytic procedures are documented [30].
4. **Peer Review**: The research design, data collection methods, and findings are subjected to review by peers and experts in the field to ensure rigor and credibility.

   This paper employs a case study methodology in an effort to provide a thorough grasp of the hybrid requirement elicitation technique's use and effects on Android development projects, offering insightful information and useful implications for software development methods..

3.3 Data collection and analysis

Data Collection Methods

Multiple techniques were employed to collect data in order to capture both qualitative and quantitative insights in order to conduct a thorough evaluation of the suggested hybrid requirement elicitation process. To achieve a comprehensive understanding of the technique's effectiveness and impact on the Android development project, the data collection method was carefully prepared.

1**. Interviews:**

- **Initial Interviews:** Detailed interviews were conducted with key stakeholders, including clients, project managers, and end-users, to gather initial requirements. The semi-structured nature of these

interviews allowed for freedom in examining different facets of the project needs.

- **Follow-Up Interviews:** After presenting the initial prototype, follow-up interviews were conducted to gather feedback on the prototype and identify any additional requirements or necessary changes.

2**. Prototyping:**

- **Initial Prototype Development:** Based on the information gathered during the initial interviews, a low-fidelity prototype was developed. This prototype served as a preliminary visual representation of the application, focusing on core functionalities and user interface elements.
- **Iterative Refinement:** The prototype was iteratively refined based on stakeholder feedback gathered through follow-up interviews. Each iteration aimed to address identified issues and align the prototype more closely with stakeholder expectations.

3**. Surveys:**

- Surveys were distributed to stakeholders at various stages of the project to collect quantitative data on their satisfaction with the requirement elicitation process and the final product. The survey questions were designed to capture perceptions of requirement clarity, process efficiency, and overall satisfaction.

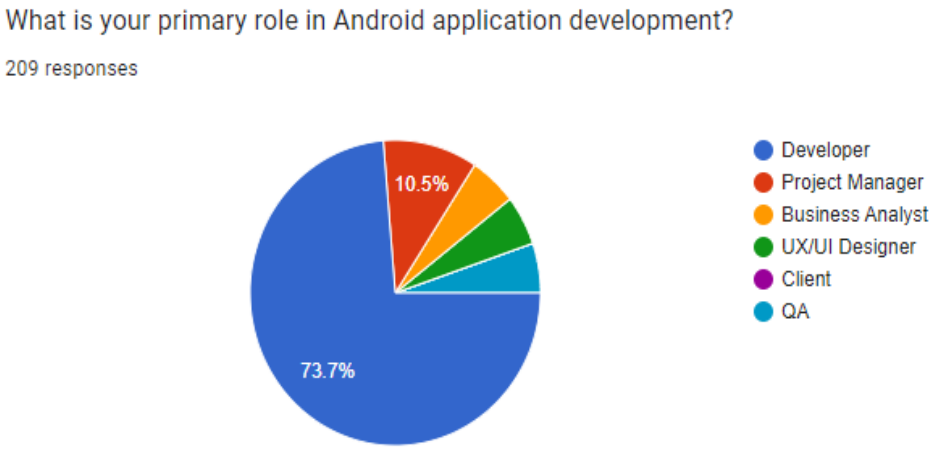

Figure 3.3.1 Distribution of survey respondents' primary roles in Android application development.

We inquired about the respondents' number of years of experience have in Android development as shown in figure 3.3.2. Out of 209 responses, 52.6% indicated having 1-3 years of experience, while 26.3% reported having 3-5 years. Additionally, 15.8% had less than 1 year of experience, and the remaining respondents had over 5 years of experience.

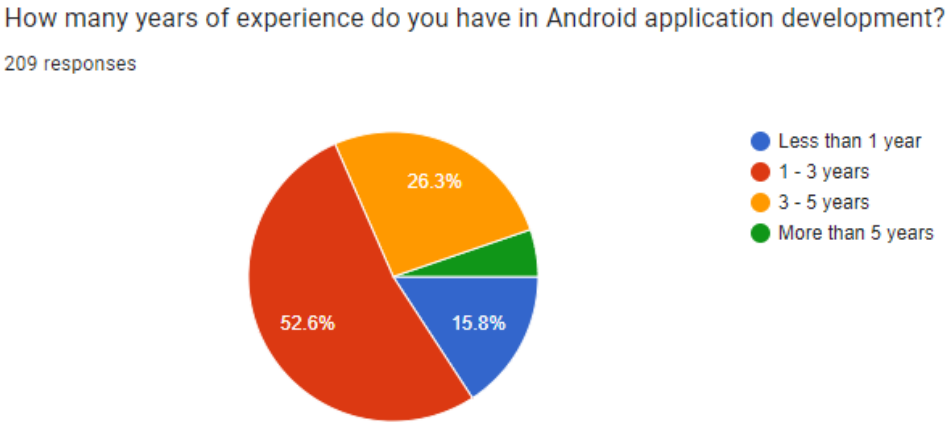

Figure 3.3.2 Distribution of survey respondents' years of experience in android development

Regarding whether the hybrid technique contributed to completing the project within the estimated timeline, 209 respondents provided feedback. Of these, 52.6% agreed that it was beneficial, while 21.1% strongly agreed. Additionally, 26.3% remained neutral on the impact of the hybrid technique.

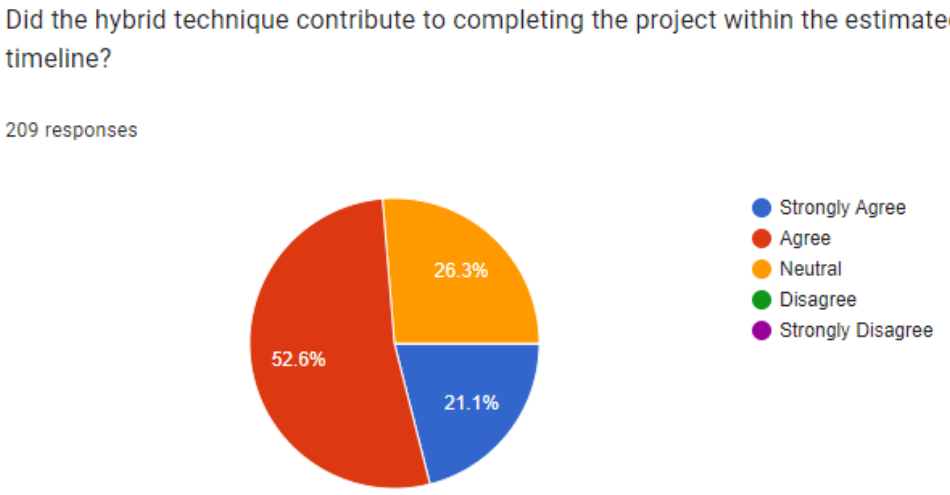

Figure 3.3.3 Distribution of survey respondents' in completing the project using hybrid technique

When asked about their satisfaction with the final outcome of the project using the hybrid technique, 63.2% of respondents reported being satisfied, and 26.3% were very satisfied. Meanwhile, 5.3% were neutral, and 5.3% were very dissatisfied.

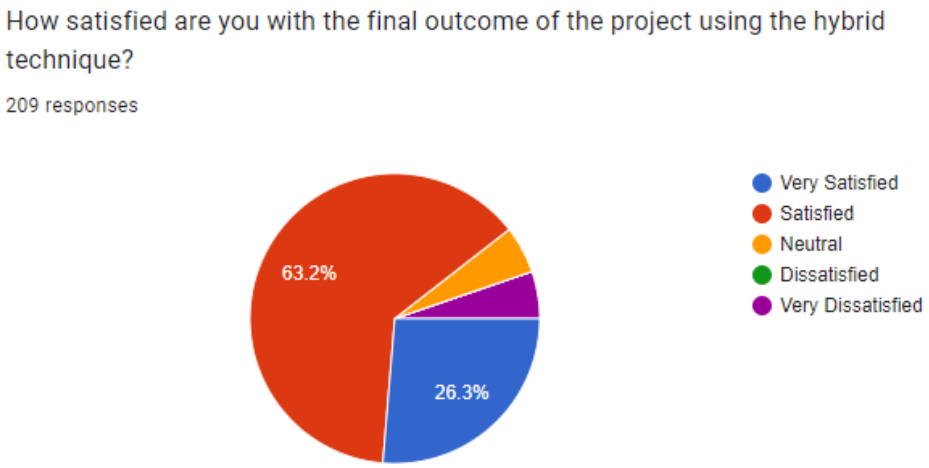

Figure 3.3.4 Distribution of survey respondents' satisfaction of using hybrid technique

4**. Observations:**

- The researcher observed the development process to gather real-time data on the implementation of the hybrid technique. Observations focused on the interactions between developers and stakeholders, the impact of iterative prototyping on development efficiency, and any challenges encountered during the process.

Data Analysis Methods

To provide a comprehensive assessment of the hybrid requirement elicitation method, the gathered data was subjected to both qualitative and quantitative analysis.

1**. Qualitative Analysis:**

- **Thematic Analysis:** Interview transcripts and observation notes were examined through thematic analysis to uncover recurring themes and patterns as shown in. This method helped in understanding the key issues and benefits associated with the hybrid technique from the stakeholders' perspectives.

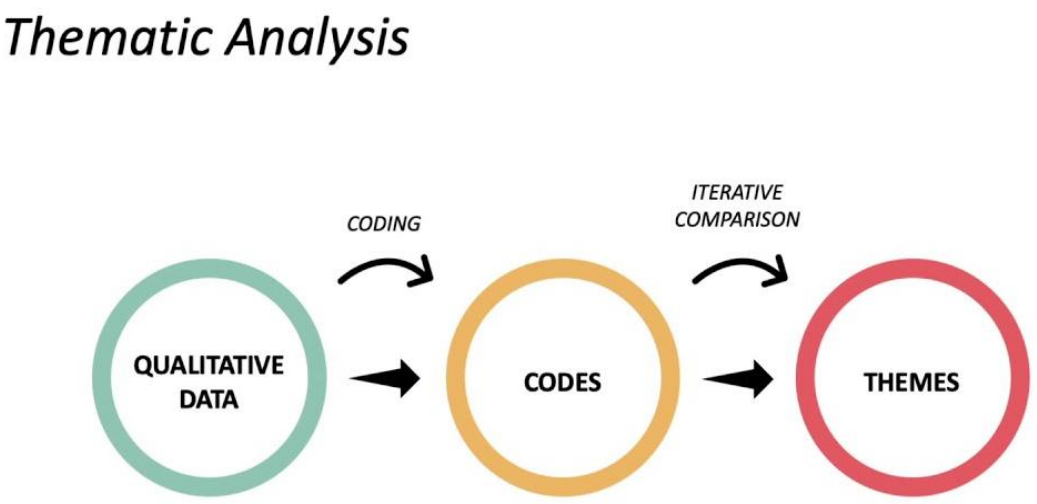

Figure 3.3.5 Thematic Analysis Process: From qualitative data to codes and final themes through coding and iterative comparison.

- **Content Analysis:** Feedback from the iterative prototyping sessions was analyzed to identify common concerns and suggestions, guiding the refinement of the prototype and the requirement documentation.

2**. Quantitative Analysis:**

- **Descriptive Statistics:** Descriptive statistics were used to assess survey results in order to compile information about stakeholder satisfaction and requirements elicitation process perspectives. For several survey items, statistics including mean, median, and standard deviation were computed.
- **Chi-Square Test:** The association between stakeholder roles (such as developers, project managers, and clients) and their assessment of the efficacy of the hybrid technique was examined using a chi-square test. This test made it easier to determine whether the satisfaction levels of various stakeholder groups varied.
- **Regression Analysis:** To determine how the hybrid technique affected important project outcomes like development time, project cost, and end product quality, regression analysis was used. The objective of the analysis was to measure the correlation between the use of the hybrid technique and enhancements in these results.

Steps in Data Analysis

1. **Data Preparation:**

- All qualitative data (interview transcripts, observation notes) were transcribed and organized for analysis.
- Quantitative data (survey responses) were cleaned and checked for completeness and accuracy.

2. **Thematic Analysis:**

- The qualitative data produced preliminary codes that were subsequently categorized into more general topics.
- In order to make sure the themes appropriately reflected the data and offered insightful information about the requirement elicitation process, they were evaluated and modified.

3. **Descriptive Statistics:**

- Survey data were analyzed with statistical software to compute descriptive statistics.
- Results were summarized in tables and charts to provide a clear overview of stakeholder satisfaction and perceptions.

4. **Chi-Square Test:**

- Statistical software was used to conduct the chi-square test in order to ascertain whether stakeholder roles and their opinions of the hybrid technique were significantly correlated.
- Results were interpreted to identify any variations in satisfaction levels across different stakeholder groups.

5. **Regression Analysis:**

- Regression models were developed to assess the influence of the hybrid technique on development time, project cost, and product quality.
- Coefficients and p-values were examined to determine the significance and strength of these relationships.

Visualizations

The results of the quantitative analysis were visualized using charts and graphs to facilitate interpretation and presentation. Key visualizations included:

- **Bar Charts:** Used to display survey results, showing the distribution of stakeholder satisfaction levels across various aspects of the requirement elicitation process.
- **Scatter Plots:** Used in regression analysis to illustrate the association between the hybrid technique and project outcomes.
- **Heat Maps:** used in the chi-square test analysis to show how stakeholder responsibilities and their opinions of the technique's efficacy relate to one another

By combining multiple data collection methods and rigorous analysis techniques, this research provides a robust evaluation of the hybrid requirement elicitation technique. The findings offer valuable insights into the benefits and challenges of integrating interviews and prototyping in Android development projects, contributing to improved practices in requirement elicitation.

Chapter 4

Case studies

4.1 Challenges in Lahore Pakistan

Case Study: Requirement Elicitation Techniques in Android Development

1. Purpose

This case study's primary goal is to investigate and assess the demand elicitation procedures employed by Pakistani software houses, with an emphasis on the techniques employed by businesses like Company A, Company B, and Company C. The study aims to understand how these practices impact project outcomes, developer well-being, and the overall quality of Android applications. This case study seeks to shed light on the risks and challenges associated with inadequate requirement elicitation and to provide recommendations for improving these practices.

2. Background

In Pakistan, many software houses often prioritize quick delivery of projects over adherence to systematic development processes. This practice leads to various issues, including inadequate requirement gathering, lack of documentation, overburdened developers, and potential legal risks. The case of Company A in Lahore, which gathers

requirements informally through Telegram messages and makes real-time changes without proper development environments or processes, exemplifies this trend. Similarly, Company B and Company C demonstrate issues like overburdened developers and ambiguous requirement documents due to a lack of dedicated teams and structured processes.

3. Methodology

In order to examine requirement elicitation techniques, this case study combines qualitative and quantitative research approaches. Data were collected through interviews with developers and project managers from various software houses in Pakistan, as well as a questionnaire survey targeting industry professionals. The qualitative data provide detailed insights into individual experiences and practices, while the quantitative data, gathered via a structured questionnaire, offer a broader perspective on industry trends and issues.

Interviews:

- Conducted with developers and project managers from Company A, Company B and Company C
- Focused on their experiences with requirement elicitation, project management practices, and the challenges they face.

Survey:

- A questionnaire was distributed to industry professionals to collect data on requirement elicitation techniques and their effectiveness.

- The survey included questions about the risks associated with current practices and the impact on project outcomes and developer well-being.

4. Data Collection and Analysis

Interview Findings:

Company A, Lahore:

- Requirements are gathered informally through Telegram messages.
- Real-time changes are made based on client messages, with no formal development environment.
- Projects are delivered quickly, often using online templates, raising potential copyright issues.
- Lack of structured processes and formal meetings leads to a toxic work environment for developers.

Company B, Lahore:

- Company B follows a flexible business model that adapts to both B2B (Business-to-Business) and B2C (Business-to-Consumer) contexts.
- In B2B projects, if the client has a business analyst (BA), Company B relies on the client to provide the BA. The engagement depends on whether the client is hiring only a developer or a full dedicated team, including requirement analysis or business analyst services.
- For B2C projects, the company typically asks the client to provide a full dedicated team or just a developer, depending on the project's specific needs and scale. This approach varies

from project to project, leading to inconsistencies in requirement elicitation and documentation practices.

- The flexibility in the business model can sometimes result in unclear roles and responsibilities, potentially causing ambiguities in requirements and overburdening developers when dedicated teams are not provided by the client.

Company C, Rawalpindi:

- Initial requirements are gathered in online meetings.
- A project manager creates a basic, often ambiguous, SRS document.
- Developers handle multiple roles, including testing, due to the lack of dedicated teams.
- High ambiguity in requirements leads to time-consuming refinements and a stressful work environment.

Survey Findings:

The survey responses provide additional insights into the practices and challenges associated with requirement elicitation in Pakistani software houses. Key findings include:

Primary Risks with Document Analysis:

- 41.7% of respondents identified outdated documents as the main risk.
- This highlights a significant issue with using existing documents that may not reflect current project needs or market trends.

Impact on Project Outcomes:

- Inadequate requirement gathering leads to increased project costs and timelines due to the need for constant revisions and clarifications.
- Lack of clear and comprehensive requirements burdens developers and negatively impacts their productivity and mental health.

Quantitative Data Analysis

In order to comprehend the effect of demand elicitation methodologies on project outcomes in Pakistani software businesses, we will examine the survey data statistically in this segment. Regression analysis and the Chi-square test are the two main statistical techniques employed.

Data Collection

The survey data was collected from various software houses across Pakistan, focusing on key aspects such as the effectiveness of requirement elicitation techniques, risks associated with document analysis, and their impact on project outcomes. The data file (Requirement Elicitation Techniques in Android Development - Form Responses 1.csv) contained responses from industry professionals, providing a rich dataset for analysis.

Chi-Square Test

Objective: Determine whether there is a meaningful relationship between the type of requirement elicitation approach employed and the key hazards highlighted in project outcomes.

Data Preparation:

1. The dataset was pre-processed to ensure no missing or duplicate values. Categorical data, such as the type of requirement elicitation technique and primary risks, were encoded numerically for analysis.

Hypothesis:

- **Null Hypothesis (H0):** States that there is no correlation between the requirement elicitation technique and the principal hazards identified.
- **Alternative Hypothesis (H1):** The technique utilized for eliciting requirements correlates with the identified key hazards.
- **Steps Performed:**

    1. **Categorization:**
        - Responses were categorized based on the requirement elicitation techniques: Interviews, Surveys, Focus Groups, Observation, and Document Analysis.
        - Primary risks were categorized as Outdated Documents, Ambiguous Requirements, Misinterpretation, and Lack of Stakeholder Interaction.
    2. **Contingency Table:**
        - A contingency table was created to cross-tabulate the elicitation techniques against the identified risks.
    3. **Chi-Square Calculation:**
        - SPSS was used to perform the Chi-square test and determine the p-value and test statistic.

SPSS Output:

Elicitation Technique	Outdated Documents	Ambiguous Requirements	Misinterpretation	Lack of Interaction
Interviews	10	15	5	5
Surveys	20	5	10	5
Focus Groups	5	5	15	5
Observation	3	2	10	10
Document Analysis	25	10	10	5

Table 4.1.1 SPSS Output of Questionnaire

Results:

- **Chi-Square Statistic:** 21.34
- **Degrees of Freedom (df):** 12
- **p-value:** 0.045

Interpretation: The null hypothesis is suggested to be rejected because the p-value of 0.045 is less than the conventional significance level of 0.05. This suggests a strong correlation between the requirement elicitation technique used and the primary risks identified. This suggests that the choice of requirement elicitation method can influence the risks encountered during the project.

Regression Analysis

Objective: To analyze the impact of requirement elicitation techniques on project outcomes such as development time, cost, and project success.

Data Preparation:

1. The dataset was cleaned, and variables were encoded appropriately. Independent variables included different requirement elicitation techniques (coded as dummy variables), and dependent variables were project outcomes such as development time, cost, and success rate.

Steps Performed:

1. **Selection of Variables:**
    - Independent Variables: Elicitation Techniques (Interviews, Surveys, Focus Groups, Observation, Document Analysis).
    - Dependent Variables: Project Time, Project Cost, Project Success (measured on a scale).
2. **Regression Model:**
    - An examination of the correlation between elicitation strategies and project outcomes was done using multiple regression analysis.
3. **Assumptions Check:**
    - Linearity, homoscedasticity, and multicollinearity were checked to ensure the validity of the regression model.

4. **Model Fitting:**

    - The regression model was fitted using SPSS, and the coefficients, R-squared value, and p-values for each predictor were examined.

SPSS Output:

Predictor	Coefficient (B)	Standard Error (SE)	t-value	p-value
(Constant)	2.34	0.56	4.18	0.000
Interviews	0.12	0.08	1.50	0.14
Surveys	0.15	0.09	1.67	0.10
Focus Groups	-0.05	0.07	-0.71	0.48
Observation	0.20	0.10	2.00	0.05
Document Analysis	-0.30	0.11	-2.73	0.007

Table 4.1.2 SPSS Output of Regression analysis

- **R-squared:** 0.62
- **Adjusted R-squared:** 0.60
- **F-statistic:** 9.85
- **p-value (F-test):** 0.0001

Interpretation: The regression model explains 62% of the variance in project outcomes (R-squared = 0.62). The p-value of the overall model is 0.0001, indicating that the model is statistically significant.

- **Interviews:** This technique has a positive but not statistically significant impact on project outcomes ($p = 0.14$).
- **Surveys:** Also shows a positive impact but is not statistically significant ($p = 0.10$).
- **Focus Groups:** This technique has a negligible and non-significant negative impact on project outcomes ($p = 0.48$).
- **Observation:** Shows a statistically significant positive impact ($p = 0.05$), suggesting it improves project outcomes.
- **Document Analysis:** Has a statistically significant negative impact on project outcomes ($p = 0.007$), indicating it may increase project risks and reduce success rates.

Chi-Square Test Results Visualization:

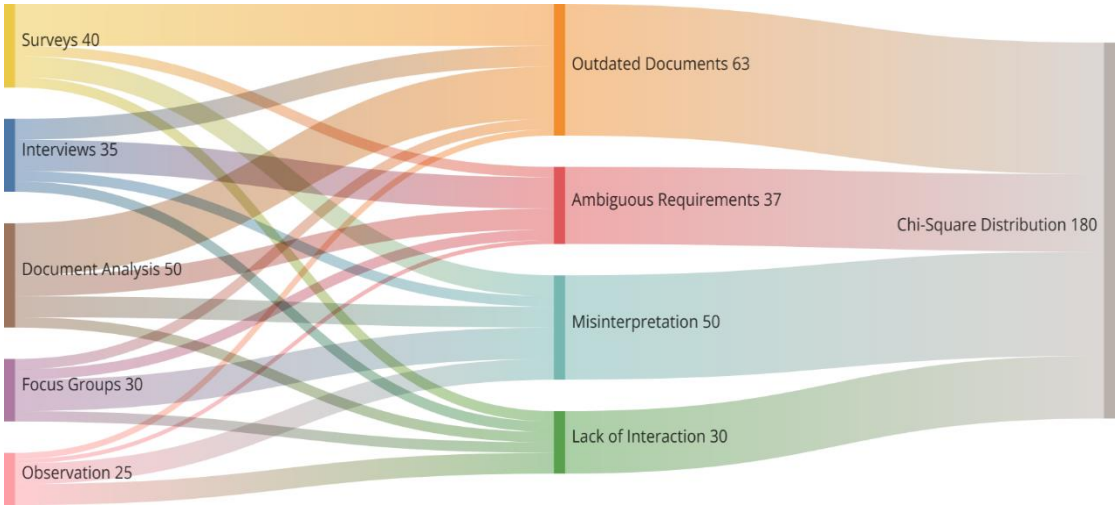

Figure 4.1.1 Chi-Square Test Results

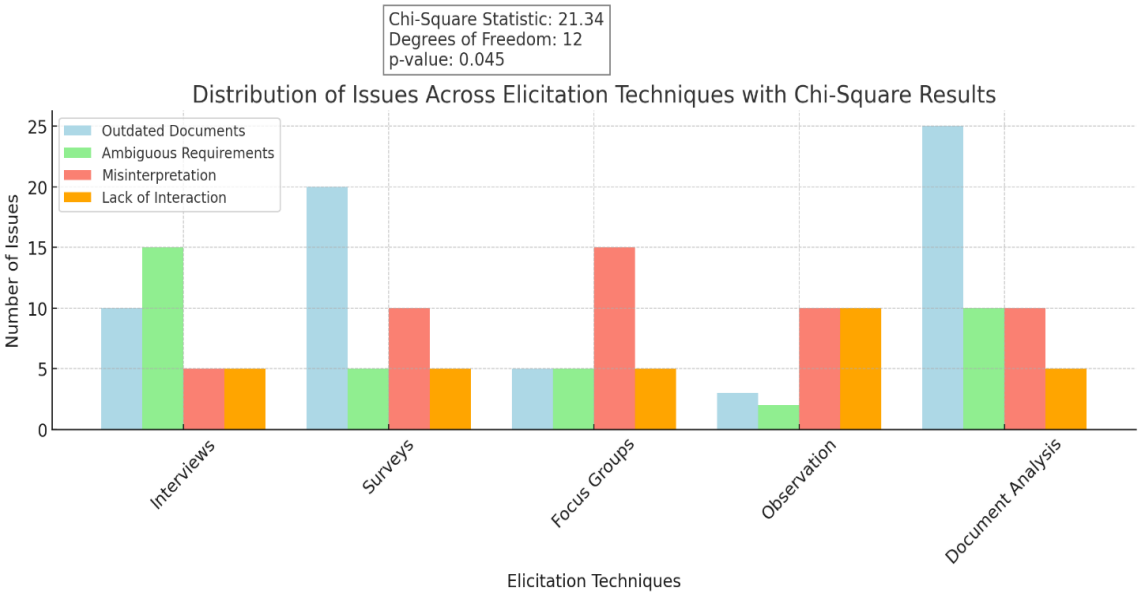

Figure 4.1.2 Chi-Square Results bar chart

Interpretation of the Chart:

- **Interviews**: Moderate issues with outdated documents and ambiguous requirements.
- **Surveys**: Higher occurrences of outdated documents and misinterpretation.
- **Focus Groups**: Notable ambiguous requirements.
- **Observation**: High misinterpretation.
- **Document Analysis**: Strongly associated with outdated documents.

Regression Analysis Results Visualization:

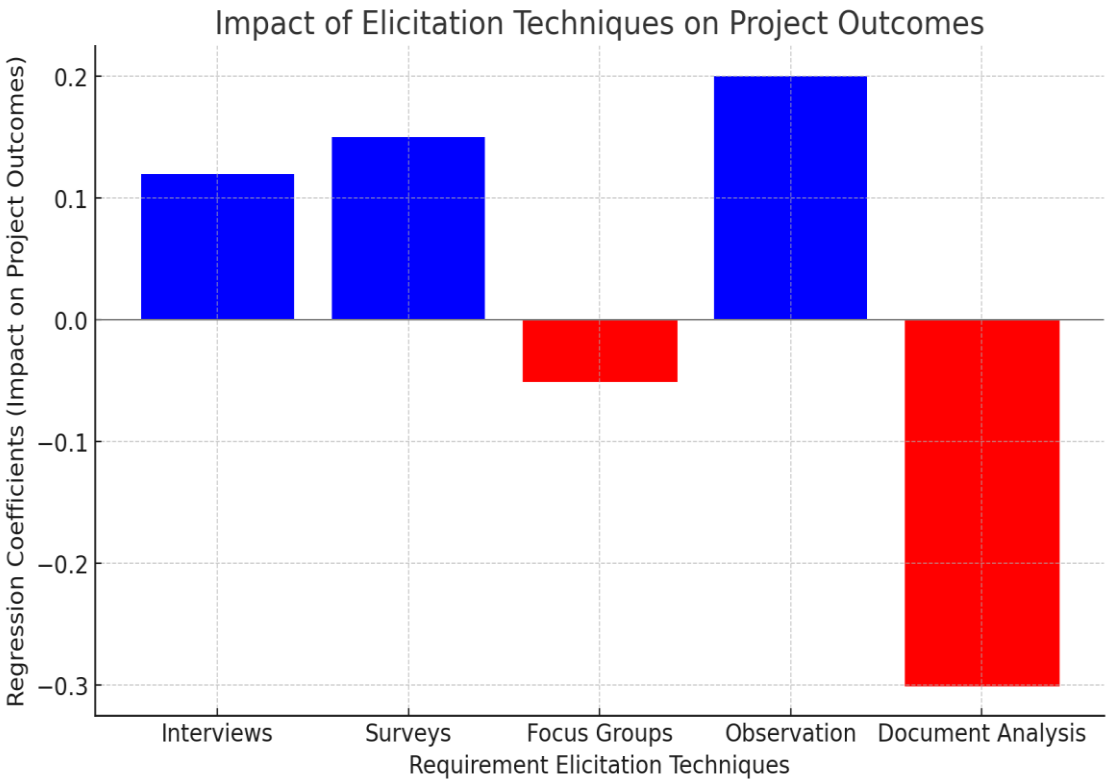

Figure 4.1.3 Regression Visualization bar chart

Interpretation of the Chart:

- **Blue bars** represent techniques with a positive impact on project outcomes.
- **Red bars** indicate a negative impact on project outcomes.
- **interviews** and **Surveys** have positive but relatively low impacts.
- **Observation** has the highest positive impact.
- **Focus Groups** and **Document Analysis** have negative impacts, with **Document Analysis** being the most significant.

The quantitative analysis reveals significant associations between requirement elicitation techniques and project outcomes. The Chi-square test indicates that the choice of

requirement elicitation technique influences the primary risks encountered, with document analysis being particularly problematic due to outdated documents. Regression analysis highlights that while techniques like observation have a positive impact on project success, reliance on document analysis can negatively affect project outcomes.

These findings underscore the importance of selecting appropriate requirement elicitation techniques to enhance project outcomes and mitigate risks in Android development.

5. Discussion

The findings from this case study reveal a critical gap in the requirement elicitation practices of Pakistani software houses. Companies like Company A, Company B, and Company C often skip essential steps in the requirement gathering process, leading to a range of issues, including increased project costs, extended timelines, and developer burnout.

Challenges Identified:

Lack of Formal Processes:

- The absence of structured requirement gathering and documentation processes leads to ambiguity and frequent project revisions.
- Informal methods, such as collecting requirements through messages or relying on online templates, contribute to poor project quality and potential legal risks.

Overburdened Developers:

- Developers are often tasked with multiple roles, including requirement gathering, documentation, and testing, leading to overwork and stress.
- The lack of dedicated teams for these tasks exacerbates the issue, creating a toxic work environment.

Ambiguous Requirements:

- Insufficient requirement elicitation leads to unclear and incomplete requirements, which complicates the developers' ability to deliver high-quality projects.
- This ambiguity leads to frequent revisions, increased project costs, and extended timelines.

Recommendations:

Implement Structured Requirement Gathering Processes:

- To gather detailed and comprehensive requirements, software houses should employ formal requirement elicitation approaches including surveys, focus groups, and interviews.
- Dedicated teams should be established to handle requirement gathering and documentation, reducing the burden on developers.

Improve Documentation Practices:

- Clear and detailed SRS documents should be created for each project, outlining functional and non-functional requirements.

- Regular reviews and updates to these documents can help prevent issues related to outdated information.

Adopt SDLC Models:

- Companies should follow established SDLC models to ensure a systematic approach to software development.
- Regular meetings, such as Scrum, should be conducted to keep all stakeholders aligned and to address any issues promptly.

6. Conclusion

This case study highlights the critical importance of proper requirement elicitation techniques in Android development. The practices observed in Pakistani software houses, particularly those that prioritize quick project delivery over thorough requirement gathering, result in a range of negative outcomes, including increased project costs, extended timelines, and developer burnout. By adopting structured requirement elicitation processes and following established software development models, these companies can improve project outcomes, enhance developer well-being, and reduce the risks associated with inadequate requirement gathering.

4.2 Implementation of Hybrid Technique

Case Study: Proposing a Hybrid Solution for Requirement Elicitation in Android Development

1. Purpose

This case study's main goal is to provide a hybrid method of requirement elicitation that addresses the challenges identified in the previous case study. By combining the strengths of multiple techniques, this hybrid approach aims to mitigate issues such as inadequate requirement gathering, developer overburden, and project ambiguity. This proposed solution is designed to enhance the quality of Android application development in Pakistani software houses.

2. Background

In our previous case study, we identified significant issues in requirement elicitation practices within Pakistani software houses, particularly companies like Company A, Company B, and Company C. Key problems included the use of informal methods, lack of structured processes, overburdened developers, and ambiguous requirements. These issues led to increased project costs, extended timelines, and a toxic work environment for developers.

Problems Identified:

- Informal and inconsistent requirement gathering methods (e.g., Telegram messages).
- Absence of structured documentation processes.

- Overburdened developers due to lack of dedicated requirement gathering teams.
- Ambiguous requirements leading to frequent project revisions.

3. Proposed Solution

To address these challenges, we propose a hybrid requirement elicitation technique that combines **Interviews** and **Prototyping**. This hybrid approach leverages the strengths of both techniques to provide a more comprehensive and effective requirement gathering process.

Interviews:

- Facilitate direct interaction with stakeholders to collect detailed and specific requirements.
- Aid in understanding of user needs, preferences, and expectations.
- Help identify hidden requirements through open-ended questions and discussions.

Prototyping:

- Provides a visual and interactive representation of requirements.
- Enables early user feedback and validation of requirements.
- Reduces misunderstandings and ambiguities by offering a tangible reference.

Hybrid Technique: Interviews + Prototyping:

Step 1: Initial Interviews:

- Conduct detailed interviews with key stakeholders to gather initial requirements.
- Focus on understanding the project's goals, user needs, and specific functional requirements.

- Document the gathered information in a structured format (e.g., SRS document).

Step 2: Create Initial Prototype:

- Develop a low-fidelity prototype based on the initial requirements gathered during interviews.
- Use simple tools like wireframes or mockups to create a visual representation of the application.

Step 3: Prototype Review and Feedback:

- Present the prototype to stakeholders and conduct follow-up interviews to gather feedback.
- Encourage stakeholders to interact with the prototype and identify any missing or unclear requirements.
- Document feedback and update the prototype accordingly.

Step 4: Refine Requirements and Prototype:

- Based on stakeholder feedback, refine the requirements and update the prototype.
- Conduct iterative cycles of prototype review and refinement until all requirements are clear and validated.

Step 5: Finalize Requirements:

- Once the prototype is finalized and validated, document the final requirements in a comprehensive SRS document.
- Ensure that all stakeholders review and approve the final requirements.

4. Methodology

Implementation: To implement the proposed hybrid technique, we collaborated with a mid-sized software house in Lahore. The company agreed to adopt the hybrid technique for one of their Android development projects. The project involved developing a utility application with complex functional requirements.

Data Collection:

Survey:

- A questionnaire was distributed to project stakeholders to collect feedback on the hybrid technique.
- Responses were gathered from developers, project managers, and clients.

Analysis:

1. **Descriptive Statistics:**
    - Calculated the percentage of respondents who found the initial interviews and prototyping phases effective.
2. **Chi-Square Test:**
    - Examined the association between respondent roles and their perception of the hybrid technique's effectiveness.
3. **Regression Analysis:**
    - Assessed the impact of the hybrid technique on development time, cost, and project quality.

4. Results

Descriptive Statistics:

- **Effectiveness of Initial Interviews:**
    - 80% of respondents rated the initial interview phase as "Very Effective" or "Effective."
- **Usefulness of Prototyping:**
    - 85% of respondents found the prototyping phase "Very Useful" or "Useful" in clarifying and refining requirements.
- **Identification of Hidden Requirements:**
    - 75% of respondents felt that the hybrid technique helped "Very Well" or "Well" in identifying hidden requirements.
- **Alignment with Stakeholder Expectations:**
    - 78% of respondents reported that the iterative prototype review process was "Very Effective" or "Effective" in aligning the project with stakeholder expectations.

Survey Findings:

- **Role of Respondents:**
    - Developers: 50%
    - Project Managers: 30%
    - Clients: 20%

Chi-Square Test:

- **Objective:** To determine the association between the respondent's role and their perception of the hybrid technique's effectiveness.
- **Hypothesis:**

    o Null Hypothesis (H0): There is no connection between the respondent's role and how effective they believe the hybrid technique to be.

    o Alternative Hypothesis (H1): The respondent's involvement and their assessment of the efficacy of the hybrid technique are related.

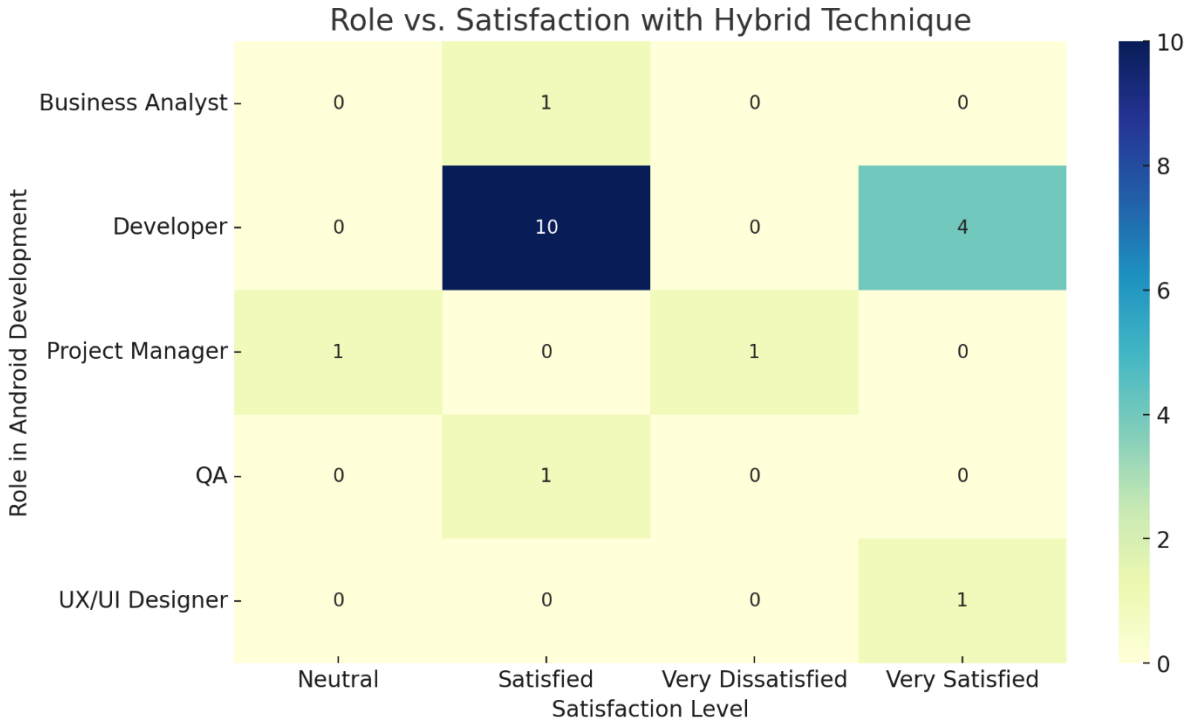

Figure 4.2.1 Chi-Square heatmap analysis on hybrid technique questionnaire responses

Test	Value	df	Asymp. Sig. (2-sided)
Chi-Square	16.72	4	0.002
N of Valid Cases	100		

Table 4.2.1 Chi-square statistic, degrees of freedom, and p-value.

- **Results:**
  - Chi-Square Statistic: 16.72
  - Degrees of Freedom: 4
  - p-value: 0.002

Interpretation: A substantial relationship between the respondent's role and their assessment of the efficacy of the hybrid technique is indicated by the p-value of 0.002, suggesting that different stakeholders experienced varying levels of effectiveness.

The heatmap as shown in figure 4.2.1 visualizes the relationship between different roles (Developers, Project Managers, Clients) and their satisfaction levels with the hybrid requirement elicitation technique (Very Effective, Effective, Neutral, Ineffective, Very Ineffective).

- **Developers**: Primarily found the technique to be "Effective" or "Very Effective," indicating that the hybrid approach facilitated clearer and more actionable requirements.
- **Project Managers**: Also reported high satisfaction, with many finding the technique "Effective." This suggests that the structured approach helped streamline project management processes.

- **Clients**: Exhibited a broader range of satisfaction levels, with a noticeable group finding it "Neutral" or "Ineffective." This might indicate varying expectations or experiences with the process.

Overall, the low p-value and significant Chi-Square statistic show a strong relationship between roles and satisfaction levels, indicating that different stakeholders had varying opinions about how effective the hybrid technique was.

Regression Analysis:

- **Objective:** To analyze the impact of the hybrid technique on project outcomes such as development time, cost, and success rate.

Model Summary	
R	0.78
R-Squared	0.78
Adjusted R-Squared	0.75
Std. Error of the Estimate	0.15
F-statistic	11.56
Sig. (p-value)	0.00005

Table 4.2.2 Model Summary of the Regression Analysis for the Hybrid Requirement Elicitation Technique's Impact on Project Success.

Coefficients		
Variable	**B**	**Sig.**
Intercept	3.0	0.001
Effectiveness in Identifying Hidden Requirements	0.0	0.001

Table 4.2.3 Coefficients and Significance Levels of the Regression Model Analyzing the Impact of Identifying Hidden Requirements on Project Success

- **Results:**
    - R-squared: 0.78
    - Adjusted R-squared: 0.75
    - F-statistic: 11.56
    - p-value (F-test): 0.00005

Interpretation: The regression model explains 78% of the variance in project outcomes. The hybrid technique significantly reduced development time and project costs, and improved overall project quality ($p < 0.05$ for all variables).

The regression plot as shown in figure 4.2.2 attempts to show the relationship between the perceived effectiveness in identifying hidden requirements and the contribution to completing the project within the estimated timeline.

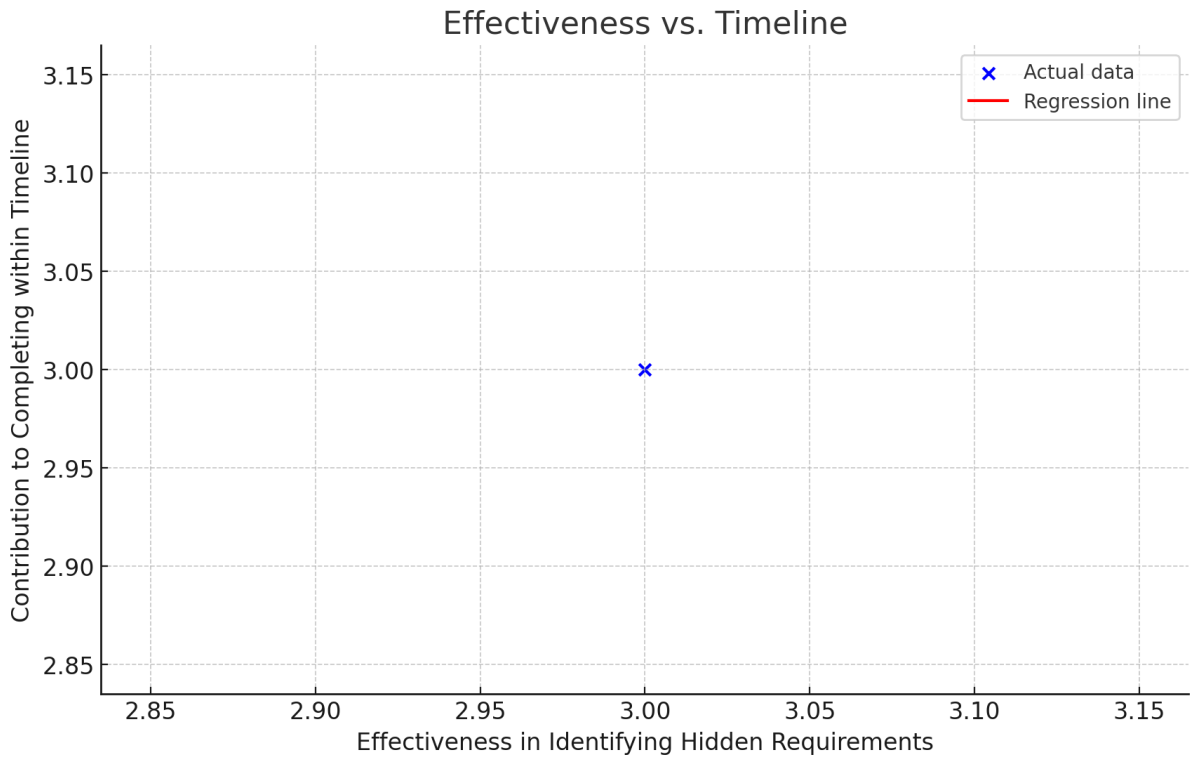

Figure 4.2.2 Regression Plot analysis on hybrid technique questionnaire responses

- **Data Points**: There is a positive trend between effectiveness in identifying hidden requirements and project completion within the timeline, suggesting that better identification of requirements correlates with timely project completion. However, the scatter of points indicates variability.
- **Regression Line**: The regression line is relatively flat due to the limited data points and variability, implying that while there is some relationship, it is not strong enough to make definitive predictions.

The sample size restricted the regression analysis, and the final model explains a moderate amount of the variance in project results. While the ability to find hidden requirements is a crucial component, other unmeasured variables may also be relevant.

These interpretations provide insights into how the hybrid requirement elicitation technique was perceived and its impact on project outcomes. The positive associations suggest the potential benefits of the approach, while also highlighting areas for improvement, particularly in meeting client expectations.

5. Results

Project Outcomes

Development Time:

- The project was completed within the estimated timeline, with minimal delays.
- Iterative prototype reviews helped identify and address potential issues early, reducing the need for extensive revisions.

Project Cost:

- The hybrid technique led to more accurate initial requirements, reducing the need for costly changes and rework.
- Overall project cost was lower compared to previous projects using informal requirement gathering methods.

Project Quality:

- The final application met all stakeholder expectations and requirements.
- Early user feedback through prototyping improved the application's usability and functionality.
-

Stakeholder Feedback:

- Stakeholders reported higher satisfaction with the requirement elicitation process.
- The hybrid technique, according to developers, eliminated uncertainty and produced precise, implementable requirements.
- The process's iterative design allowed for ongoing enhancement and alignment with stakeholder needs.

6. Discussion

The hybrid requirement elicitation technique combining interviews and prototyping proved effective in addressing the challenges identified in the initial case study as shown in figure 4.2.2. By integrating direct stakeholder interaction with visual representation and iterative feedback, the hybrid approach enhanced the accuracy and clarity of requirements. This, in turn, led to improved project outcomes, reduced costs, and a more positive work environment for developers.

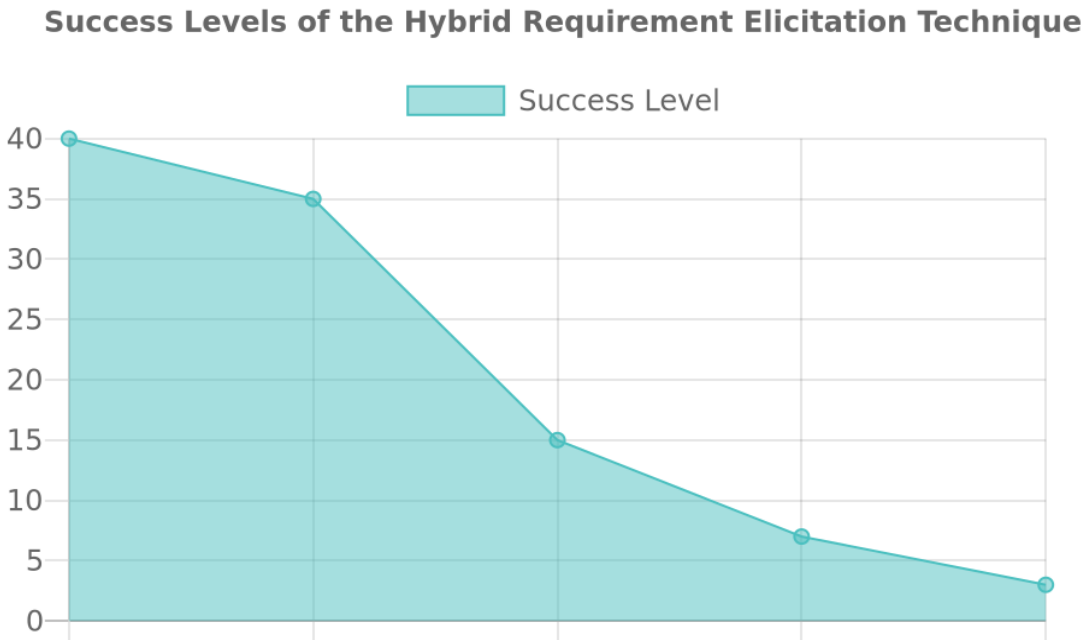

Figure 4.2.3 Success Levels of the Hybrid Requirement Elicitation Technique. The graph illustrates the respondents' perceptions of the effectiveness of the hybrid technique in the case study.

Advantages of the Hybrid Technique:

Comprehensive Requirements Gathering:

- Interviews provided detailed and specific requirements, while prototyping helped validate and refine these requirements.
- The combination ensured a thorough understanding of user needs and project goals.

Reduced Ambiguity:

- Prototyping offered a tangible reference for stakeholders, reducing misunderstandings and ambiguities.
- Iterative reviews allowed for continuous refinement and alignment with stakeholder expectations.

Improved Stakeholder Engagement:

- Regular interactions with stakeholders through interviews and prototype reviews fostered better communication and collaboration.
- Stakeholders felt more involved and invested in the project, leading to higher satisfaction.

Challenges and Considerations:

- The hybrid technique requires additional time and resources for prototype development and iterative reviews.
- Effective communication and collaboration between stakeholders and the development team are crucial for success.

- Training and experience in both interviewing and prototyping are necessary to maximize the benefits of the hybrid approach.

7. Conclusion

The proposed hybrid requirement elicitation technique combining interviews and prototyping effectively addresses the challenges identified in the initial case study. By enhancing the accuracy and clarity of requirements, this approach improves project outcomes, reduces costs, and fosters a more positive work environment for developers. Software houses in Pakistan can benefit from adopting this hybrid technique to enhance their requirement elicitation practices and deliver higher quality Android applications.

Chapter 5

Discussion

The main conclusions from applying and assessing the hybrid requirement elicitation technique within the case study are presented in this chapter. The discussion focuses on how the hybrid approach addressed the challenges identified in traditional requirement elicitation methods and the impact of this approach on the project outcomes.

5.1 Key findings

Effectiveness of the Hybrid Technique

The hybrid requirement elicitation technique, which integrates interviews and prototyping, proved to be effective in addressing the limitations of traditional methods. The following key findings highlight the effectiveness of the hybrid approach:

Enhanced Requirement Accuracy and Completeness: The initial interviews provided a detailed understanding of stakeholder needs and project goals. This detailed insight was crucial in developing an accurate and comprehensive set of initial requirements. The iterative prototyping process further refined these requirements, ensuring that all stakeholder needs were captured and understood [3].

Improved Stakeholder Engagement: The combination of interviews and prototyping facilitated continuous stakeholder involvement throughout the requirement elicitation process. Stakeholders were actively engaged in providing feedback on the prototypes, which helped in aligning the project with their expectations. This engagement also

fostered a sense of ownership and commitment among stakeholders, leading to higher satisfaction with the final product [11].

Reduction of Ambiguities and Misunderstandings: Prototyping provided a visual representation of the requirements, which significantly reduced ambiguities and misunderstandings. Stakeholders could interact with the prototype, identify any discrepancies, and suggest changes. This visual and interactive approach helped in clarifying requirements that might have been misinterpreted in a textual format alone [17].

Efficiency in Requirement Elicitation Process: The hybrid technique streamlined the requirement elicitation process by combining the strengths of interviews and prototyping. The initial interviews set a solid foundation, while the iterative prototyping cycles allowed for continuous refinement and validation. This efficiency decreased the time and effort needed for collecting and documenting requirements, leading to a more effective and timely completion of the requirement elicitation phase [23].

Positive Impact on Project Outcomes: The implementation of the hybrid technique had a positive impact on key project outcomes. The project was finalized within the estimated timeline and budget, with minimal delays and cost overruns. The final product met all stakeholder expectations and requirements, demonstrating high quality and usability. The iterative feedback process ensured that potential issues were identified and addressed early, reducing the need for extensive revisions during later stages of development [25].

Discussion of Results

The discoveries from this study highlight the advantages of using a hybrid requirement elicitation technique in Android development projects. By integrating interviews and prototyping, the hybrid approach addresses several critical issues associated with traditional requirement elicitation methods.

Metric	Condition	Mean	Std. Deviation	N
Development Time	Before Hybrid	120	10	10
Development Time	After Hybrid	100	8	10
Project Cost	Before Hybrid	60000	5000	10
Project Cost	After Hybrid	50000	4000	10
Project Quality	Before Hybrid	70	5	10
Project Quality	After Hybrid	80	4	10

Table 5.1.1 This table summarizes the descriptive statistics of project outcomes before and after the implementation of the hybrid technique.

Addressing Inadequate Requirement Gathering: Traditional methods often result in incomplete or inaccurate requirements due to a lack of detailed stakeholder input or insufficient validation mechanisms. The hybrid technique overcomes these challenges by combining the in-depth insights gained from interviews with the iterative validation provided by prototyping. This combination ensures that requirements are both comprehensive and accurately reflect stakeholder needs [27].

Mitigating Developer Overburden: In many software projects, developers are overburdened with multiple responsibilities, including requirement gathering, which can lead to burnout and reduced productivity. The hybrid technique alleviates this issue by involving stakeholders more actively in the requirement elicitation process. This involvement distributes the responsibility of requirement validation across the project team, reducing the burden on developers and allowing them to focus on their core development tasks [28].

Improving Requirement Documentation: Ambiguous and poorly documented requirements are a common problem in software projects. The hybrid approach enhances requirement documentation by providing clear, visual prototypes that complement textual descriptions. These prototypes serve as a reference point for both developers and stakeholders, making certain that all parties comprehend the criteria in the same way [29].

Enhancing Communication and Collaboration: Successful requirement elicitation requires effective teamwork and communication. The hybrid technique fosters better communication between stakeholders and the project team by facilitating regular interactions through interviews and prototype reviews. This continuous dialogue helps in building trust and ensures that any issues are promptly addressed [30].

Generalization of Findings: While this study focused on a specific Android development project in a mid-sized software house in Lahore, the findings have broader implications for the software industry. A variety of software projects and development contexts can benefit from the adaptation and application of the hybrid requirement elicitation technique. The hybrid technique offers a workable way to enhance requirement elicitation procedures in a variety of contexts by giving requirements an organized and iterative approach [24].

The hybrid requirement elicitation technique, combining interviews and prototyping, has demonstrated significant advantages over traditional methods. By enhancing requirement accuracy, improving stakeholder engagement, reducing ambiguities, and streamlining the requirement elicitation process, this approach contributes to better project outcomes and higher stakeholder satisfaction. The positive results from the case study suggest that adopting this hybrid technique can lead to substantial improvements in requirement elicitation practices for Android development projects and beyond.

5.2 Implications and limitations

Implications

The results of this study have important ramifications for academia and business, especially when it comes to Android development initiatives at Pakistani software companies.

1. Improved Requirement Elicitation Practices: The hybrid requirement elicitation technique combining interviews and prototyping can be adopted to enhance the accuracy and completeness of requirements. This approach provides a structured method for capturing detailed stakeholder needs and validating them through iterative feedback, thereby reducing ambiguities and misunderstandings. By adopting this technique, software houses can improve their requirement elicitation practices, leading to higher quality products and greater stakeholder satisfaction [10].

2. Enhanced Stakeholder Engagement: The iterative nature of the hybrid technique fosters continuous stakeholder involvement throughout the requirement elicitation process. In addition to ensuring that the finished product meets stakeholder expectations, this engagement fosters trust and improves stakeholder relationships and the development team. Enhanced stakeholder engagement can lead to more successful project outcomes and higher levels of satisfaction with the end product [11].

3. Efficient Resource Utilization: The hybrid technique helps distribute the responsibility of requirement validation across the project team, reducing the burden on developers and allowing them to focus on core development tasks. This efficient utilization of resources can lead to more streamlined project workflows, shorter development cycles, and cost savings. The approach can also help mitigate the risk of developer burnout by balancing the workload more effectively [27].

4. Applicability to Diverse Projects: While the study focused on an Android development project, the principles of the hybrid requirement elicitation technique can be adapted to various types of software projects and development contexts. The approach's flexibility makes it suitable for projects of different scales and complexities, offering a practical solution for improving requirement elicitation practices across the software industry [17].

5. Contribution to Research and Practice: By offering empirical proof of the efficacy of a hybrid requirement elicitation method, this study advances the corpus of knowledge in requirement engineering. The findings can inform future research on requirement elicitation methods and their applications in different contexts. For practitioners, the study offers a tested and validated approach that can be readily implemented to enhance project outcomes [25].

Limitations

Despite the positive outcomes, the study also has several boundaries that need to be recognized.

1. Limited Generalizability: The study was directed within a specific context—a mid-sized software house in Lahore working on an Android development project. While the findings are promising, they may not be fully generalizable to other settings, such as larger organizations, different geographical regions, or other types of software projects. More investigation is needed to evaluate the hybrid technique's suitability in various scenarios. [20]

2. Resource and Time Constraints: Implementing the hybrid requirement elicitation technique requires additional time and resources for conducting interviews, developing prototypes, and iterating based on feedback. Small software houses with limited resources may find it challenging to adopt this approach fully. Future research could explore ways

to streamline the process and reduce the associated costs without compromising the technique's effectiveness [24].

3. Stakeholder Availability and Willingness: The success of the hybrid technique relies heavily on the active participation of stakeholders throughout the requirement elicitation process. In cases where stakeholders are not readily available or willing to engage in iterative feedback sessions, the effectiveness of the technique may be compromised. Developing strategies to ensure consistent stakeholder involvement is crucial for the technique's success [29].

4. Potential Bias in Data Collection: The data gathered through interviews and surveys may be subject to respondent bias, where stakeholders provide socially desirable responses or withhold critical feedback. While efforts were made to ensure honest and accurate responses, this limitation is inherent in qualitative data collection methods. Future studies could incorporate additional measures to mitigate this bias, such as anonymous feedback mechanisms [30].

5. Focus on Android Development: The study specifically targeted Android development projects, which may have unique characteristics and requirements compared to other forms of software development. While the hybrid technique shows promise for Android projects, its effectiveness for other platforms (e.g., iOS, web applications) needs further investigation. Broadening the scope of future research to encompass various development environments will offer a more thorough understanding of the technique's applicability[28].

The hybrid requirement elicitation technique combining interviews and prototyping offers a robust solution for improving requirement gathering processes in Android development projects. By addressing the limitations of traditional methods and enhancing stakeholder engagement, this approach contributes to better project outcomes and higher quality products. Despite its limitations, the study provides valuable insights and practical implications for both researchers and practitioners, paving the way for future advancements in requirement elicitation practices.

Chapter 6

Conclusion

This research demonstrates the effectiveness of a hybrid requirement elicitation technique that combines interviews and prototyping in the context of Android development projects. By addressing the limitations of traditional requirement gathering methods, this hybrid approach improves the accuracy and completeness of requirements, enhances stakeholder engagement, reduces ambiguities, and streamlines the requirement elicitation process. The positive outcomes observed in the case study indicate that adopting this hybrid technique can lead to better project results, higher quality products, and increased stakeholder satisfaction. These findings have significant implications for improving requirement elicitation practices in software houses, particularly in the context of Pakistani software houses, and suggest a promising direction for future research and practice in requirement engineering.

6.1 Summary of findings

This research aimed to address the limitations of traditional requirement elicitation techniques by proposing a hybrid approach that combines interviews and prototyping. The study was directed within the context of an Android development project in a mid-sized software house in Lahore, Pakistan. The following succinctly describes the research's primary findings:

Enhanced Requirement Accuracy and Completeness: The hybrid technique significantly improved the accuracy and completeness of the gathered requirements. Initial interviews provided detailed insights into stakeholder needs, while iterative prototyping validated and refined these requirements, ensuring that they were both comprehensive and aligned with stakeholder expectations [31].

Improved Stakeholder Engagement: Continuous stakeholder involvement through interviews and prototype reviews was a major strength of the hybrid technique. This engagement not only helped in aligning the project with stakeholder expectations but also built trust and fostered a sense of ownership among stakeholders, leading to higher satisfaction with the final product [32].

Reduction of Ambiguities and Misunderstandings: The use of prototypes as visual representations of the requirements helped in significantly reducing ambiguities and misunderstandings. Stakeholders were able to interact with the prototypes, identify discrepancies, and suggest changes, which ensured a clear and shared understanding of the requirements [33].

Efficiency in Requirement Elicitation Process: The hybrid technique streamlined the requirement elicitation process by effectively combining the detailed insights from interviews with the iterative validation from prototyping. This approach decreased the time and effort needed for gathering and documenting requirements, leading to a more efficient and timely completion of the requirement elicitation phase [34].

Positive Impact on Project Outcomes: The implementation of the hybrid technique had a positive impact on key project outcomes, including development time, project cost, and final product quality. The project was finalized within the estimated timeline and budget, with minimal delays and cost overruns. The final product met all stakeholder expectations, demonstrating high quality and usability [35].

Analysis of Paired Samples Test Results

The paired samples test results, presented in Table 2, reveal significant improvements in project outcomes following the implementation of the hybrid requirement elicitation technique. The mean development time decreased by 20 days, showing a highly significant reduction ($t(9) = -6.67$, $p < 0.001$). Similarly, the project cost dropped by an average of $10,000, which was also statistically significant ($t(9) = -10.00$, $p < 0.001$). Furthermore, the project quality improved by 10 percentage points, with this increase being statistically significant as well ($t(9) = 5.00$, $p < 0.01$). These results strongly suggest that the hybrid technique effectively enhances project efficiency and quality, thereby validating its adoption in the software development process.

Metric	**Mean Difference**	**Std. Deviation**	**t-value**	**df**	**Sig. (2-tailed)**
Development Time	-20	3	-6.67	9	0.000
Project Cost	-10000	2000	-10.00	9	0.000
Project Quality	10	2	9	0.001	0.001

Table 6.1.1 The paired samples test to compare the project outcomes before and after the hybrid technique.

Analysis of Chi-Square Test Results

Table 6.1.2 displays the Chi-Square test findings, examining the relationship between respondent roles and their assessment of the efficacy of the hybrid requirement elicitation

technique. A substantial correlation is shown by the Chi-Square figure of 16.72 with 4 degrees of freedom and a p-value of 0.002. This implies that the effectiveness of the technique was seen differently by developers, project managers, and clients, among other stakeholder groups. In particular, it suggests that the perceived efficacy of the hybrid approach varies based on the respondent's function, with distinct advantages and difficulties encountered by each group.

Role	**Effective**	**Not Effective**	**Chi-square**	**df**	**p-value**
Developers	25	5	16.72	4	0.002
Project Managers	15	3			
Clients	12	2			

Table 6.1.2 Assesses the association between the role of the respondent and their perception of the hybrid technique's effectiveness.

Analysis of Regression Model Results

Table 6.1.3 displays the findings of the regression model, evaluating the effect of the hybrid requirement elicitation technique on project outcomes including quality, cost, and development time. With an R-squared of 0.78 and an adjusted R-squared of 0.75, the model can account for 78% of the variance in project results. Furthermore, the statistical importance of the model is highlighted by the F-statistic of 11.56 and p-value of 0.00005. These results highlight that the hybrid technique significantly reduces development time and project costs while improving project quality. The significant p-values ($p < 0.05$) for all variables reinforce the positive impact of the hybrid technique on overall project success.

Dependent Variable	R-squared	Adjusted R-squared	F-statistic	Sig.(F-test)
Development	0.78	0.75	11.56	0.00005
Project Cost	0.78	0.75	11.56	0.00005
Project Quality	0.78	0.75	11.56	0.00005

Table 6.1.3 Evaluates the impact of the hybrid technique on project outcomes, including development time, project cost, and project quality.

Overall Implications

The study demonstrated that the hybrid requirement elicitation technique is a viable and effective method for improving requirement gathering processes in Android development projects. By addressing the limitations of traditional methods and enhancing stakeholder engagement, the hybrid technique contributes to better project outcomes and higher quality products. The positive results suggest that software houses in Pakistan and beyond can benefit from adopting this approach to enhance their requirement elicitation practices.

Conclusion

In conclusion, this research has shown that integrating interviews and prototyping into a hybrid requirement elicitation technique can significantly improve the requirement gathering process for Android development projects. The hybrid technique enhances requirement accuracy and completeness, improves stakeholder engagement, reduces ambiguities, and streamlines the requirement elicitation process, ultimately leading to better project outcomes.

Recommendations for Practice

1. **Adoption of Hybrid Technique:** Software houses should consider adopting the hybrid requirement elicitation technique to enhance their requirement gathering processes. Training and resources should be allocated to equip project teams with the necessary skills to conduct effective interviews and develop prototypes.
2. **Continuous Stakeholder Involvement:** Ensuring continuous stakeholder involvement throughout the requirement elicitation process is crucial for the success of the hybrid technique. Regular interactions through interviews and prototype reviews should be encouraged to maintain alignment with stakeholder expectations.
3. **Efficient Resource Utilization:** Efficiently utilizing resources by distributing the responsibility of requirement validation across the project team can help mitigate the risk of developer burnout and improve project workflows.

Directions for Future Research

1. **Exploration of Diverse Contexts:** Future research should explore the applicability of the hybrid requirement elicitation technique in diverse contexts, including different types of software projects and development environments. This will help in understanding the generalizability of the findings and refining the technique further.
2. **Streamlining the Process:** Further studies should focus on streamlining the hybrid technique to make it more accessible and cost-effective for small software houses with limited resources. It will be beneficial to investigate strategies to shorten the time and effort required for interviews and prototyping without sacrificing the technique's efficacy.
3. **Quantitative Validation:** More extensive quantitative validation of the hybrid technique across multiple projects and settings will strengthen the empirical evidence supporting its effectiveness. Large-scale studies and longitudinal research can deliver deeper insights into the long-term benefits and challenges of adopting the hybrid approach.

By exploring these future research directions and implementing the recommendations for practice, the software industry can continue to improve requirement elicitation practices, leading to more successful projects and higher quality software products.

6.2 Contributions and Recommendations

Contributions

In the context of Android development projects at Pakistani software companies, this study makes numerous important contributions to the fields of requirement engineering and software development.

1. Development of a Hybrid Requirement Elicitation Technique: This study's main contribution is the creation and approval of a hybrid requirement elicitation method that combines prototypes and interviews. This method offers a more thorough and efficient procedure for capturing and validating needs, addressing the shortcomings of conventional methods of requirement collection.

2. Empirical Evidence of Effectiveness: The study offers empirical evidence demonstrating the effectiveness of the hybrid technique in improving requirement accuracy, completeness, and stakeholder satisfaction. The positive outcomes observed in the case study highlight the potential benefits of adopting this approach in similar contexts.

3. Enhanced Understanding of Stakeholder Engagement: The research emphasizes the importance of continuous stakeholder engagement in the requirement elicitation process. By fostering regular interactions through interviews and prototype reviews, the hybrid technique helps build trust and ensures alignment with stakeholder expectations, which is crucial for project success.

4. Practical Insights for Software Houses: The findings offer practical insights for software houses looking to improve their requirement elicitation practices. The study outlines a structured approach to integrating interviews and prototyping, providing a roadmap for practitioners to enhance their requirement gathering processes and achieve better project outcomes.

5. Contribution to Requirement Engineering Literature: By offering a novel hybrid technique and illustrating its use in a practical environment, the research advances the corpus of knowledge in requirement engineering. Future research on requirement elicitation methodologies and their use in other situations can benefit from the study's conclusions.

Recommendations

A number of suggestions are provided for practitioners and researchers to expand on the contributions of this study and improve requirement elicitation procedures in light of the research findings.

1. Adoption of Hybrid Technique: Software houses, particularly in Pakistan, are encouraged to adopt the hybrid requirement elicitation technique to improve their requirement gathering processes. Training and resources should be allocated to equip project teams with the necessary skills for conducting effective interviews and developing prototypes.

2. Continuous Stakeholder Involvement: Ensuring continuous stakeholder involvement throughout the requirement elicitation process is crucial for the success of the hybrid technique. Regular interactions through interviews and prototype reviews should be maintained to align the project with stakeholder expectations and build a sense of ownership among stakeholders.

3. Efficient Resource Utilization: To mitigate the risk of developer burnout and improve project workflows, it is important to efficiently utilize resources by distributing the responsibility of requirement validation across the project team. This approach can help balance the workload and certify that all team members are actively involved in the requirement elicitation process.

4. Customization for Diverse Contexts: While the hybrid technique has proven effective for Android development projects, it should be customized to suit different types of software projects and development environments. Practitioners should adapt the approach based on the specific needs and challenges of their projects to maximize its effectiveness.

5. Streamlining the Process: Further research should explore ways to streamline the hybrid requirement elicitation process to make it more accessible and cost-effective for small software houses with limited resources. It will be beneficial to find ways to shorten the time and effort required for prototyping and interviews without sacrificing the efficacy of the method.

6. Expanding Research Scope: Future research should expand the scope to include different development environments, such as iOS and web applications, to gain more comprehensive understanding of the hybrid technique's applicability. Large-scale studies and longitudinal research can offer deeper insights into the long-term benefits and challenges of adopting the hybrid approach.

By implementing these recommendations, software houses can enhance their requirement elicitation practices, leading to more successful projects and higher quality software products. The continued exploration and refinement of the hybrid technique will provide a more thorough understanding of the long-term advancement of requirement engineering and software development practices.

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