A Framework to Measure the Trustworthiness of the User Feedback in Mobile Application Stores

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This thesis is submitted to the Faculty of Computing at Blekinge Institute of Technology in partial fulfillment of the requirements for the degree of MSc in Software Engineering. The thesis is equivalent to 20 weeks of full time studies.

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ABSTRACT

Context. Mobile application stores like Google Play, Apple store, Windows store have over 3 million apps. Users download the applications from their respective stores and they generally prefer the apps with the highest ratings. In response to the present situation, application stores provided the categories like editor's choice or top charts, providing better visibility for the applications. Customer reviews play such critical role in the development of the application and the organization, in such case there might be flawed reviews or biased opinions about the application due to many factors. The biased opinions and flawed reviews are likely to cause user review untrustworthiness. The reviews or ratings in the mobile application stores are used by the organizations to make the applications more efficient and more adaptable to the user. The context leads to importance of the user’s review trustworthiness and managing the trustworthiness in the user feedback by knowing the causes of mistrust. Hence, there is a need for a framework to understand the trustworthiness in the user given feedback.

Objectives. In the following study the author aims for the accomplishment of the following objectives, firstly, exploring the causes of untrustworthiness in user feedback for an application in the mobile application stores such as google play store. Secondly, Exploring the effects of trustworthiness on the users and developers. Finally, the aim is to propose a framework for managing the trustworthiness in the feedback.

Methods. To accomplish the objectives, author used qualitative research method. The data collection method is an interview-based survey that was conducted with 13 participants, to find out the causes of untrustworthiness in the user feedback from user’s perspective and developer’s perspective. Author follows thematic coding for qualitative data analysis.

Results. Author identifies 11 codes from the description of the transcripts and explores the relationship among the trustworthiness with the causes. 11 codes were put into 4 themes, and a thematic network is created between the themes. The relations were then analyzed with cost-effect analysis.

Conclusions. We conclude that 11 causes effect the trustworthiness according to user’s perspective and 9 causes effect the trustworthiness according to the developer’s perspective, from the analysis. Segregating the trustworthy feedback from the untrustworthy feedback is important for the developers, as the next releases should be planned based on that. Finally, an inclusion and exclusion criteria to help developers manage trustworthy user feedback is defined.

Keywords: Mobile application stores, Trustworthiness, User feedback
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1 INTRODUCTION

Users can have a different experience which leads to diverse opinions while using a software application and users use the reviews as a channel to document their experience. The documented experience will be intern utilized by the users as a suggestion to make the decision of using the software, as well as developers to continuously develop and evolve the software. The feedback given by the user might be a bug report or a feature request that could help the developers in maintenance and evaluate the application [1]. The massive growth of the applications in the mobile application stores leads to more users giving feedback by different means. While developing usable software, various organizations take the documented user feedback into account [2].

With the rapid growth in the application industry, it has been estimated that there are about 3 million apps and the download count is about one billion applications per day [3]. In the scenario, it becomes prominent for both developers and users to analyze the reviews. Users are relying heavily on the feedback provided resulting in the number of downloads for the application with better reviews. With thousands of applications reviewed per day for the popular applications, it becomes a laborious task for the application developers and analysts to segregate and process the information. Some of the information provided in feedback forums might be produced from reliable sources as well as unreliable sources [3]. The reviews might have low-quality reviews, spam reviews or non-synching content, which is unreliable information. Manipulation of the reviews occurs from the unreliable sources such as the vendors, publishers and developers presenting the reviews as real customers [4].

![Figure 1: Causes of untrustworthiness](image)

Mobile application stores have evolved over the years and so has their application ranking algorithms, making the application reviews in their respective stores much more valuable. The benefit of producing fake reviews is growing, giving the application optimal chances of surviving in the top charts of the application stores [4]. The present situation raises the concept of trust in a user and trustworthiness in the user feedback. The untrustworthy feedback can be produced by the manipulation of the reviews by unreliable sources. As depicted in Figure 1, the user-provided reviews from various sources are utilized by both the mobile application users and developers, and a bad reviewer might influence the user or a developer by providing flawed reviews. In the situation, it is necessary to distinguish the flawed reviews from the genuine reviews.

“Trust is a psychological state comprising the intention to accept vulnerability based on positive expectations of the intentions or behaviors of another [5]”
The present literature has identified the importance of trust and trustworthy reviews in e-commerce, in various feedback forums such as eBay and Amazon. To determine the trust in the user feedback, several e-commerce websites like eBay, and Amazon uses reputation systems and quality content analysis [6]. The use of such systems in several e-commerce websites provided the user with better choices while choosing a product. Qualitative content analysis deals with the characteristics of language used to describe, while giving importance to the content or contextual meaning [7]. Content analysis has three distinct approaches which are useful in interpreting the meaning from the text data, i.e., conventional, directed, and summative. The three methods follow a systematic approach to derive the contextual meaning from the user provided feedback [7]. While the contextual analysis deals with determining the perspective of the review, the reputation system deals with the trust and reputations of the feedback provider thus evaluating the trust in the user-provided feedback. In internet related transactions the collaborative nature of every individual is important and so the reputation systems were introduced [5]. The idea of the reputation systems is letting the parties rate each other based on the smoothness in the transaction, and this determines the score of the party. The reputation score given to each party determines the trustworthiness in the user. In the context of mobile application stores since there is no involvement of two parties exchanging reputation systems determining the trustworthiness in the user or the user provided feedback through the reputation systems becomes difficult.

According to the research [6] on trust, determined that there are two kinds of trust in internet related transactions they are: reliability trust and decision trust. Reliability trust is the dependence to make decisions and the reliability. Decision trust is the extent to which one party show the reliance on the other. Both the trusts are influenced by the sources, which are classified as [5]: helpful source, malicious source, unknown source, and neutral source. Here the source could be other users, developers, and unreliable sources. In this context, the organizations tend to recruit online spammers or malicious source, which causes potential untrustworthiness to all the users.

Recent studies show that the users are more likely to consider feedback provided by those they are socially connected with them as trustworthy than the strangers [4]. Considering the case, the users are more likely to judge the trustworthiness in the review based on the social connections and interactions. Trustworthiness is defined as the ability to be relied on the source or deserving the trust of the source. It mainly depends on ability that the source possesses and the motivation provided by the source. Though ability and motivation determine the trustworthiness, the properties are not often observed directly but can be inferred from the actions or signals [8]. Factors that may influence trustworthiness shown towards a source could be named as expertise, competence, and professionalism.

Present literature defines the trustworthiness as three components: ability, benevolence, and integrity, each defined by subsumes components [9].

- **Ability**: Knowledge needed to perform a task along with interpersonal skills. The subsumes components defined in [10] are caring intentions and motives, honesty, openness, and predictability.
- **Benevolence**: The extent of belief in the trustee to do good for the trustor. The subsumes components are defined as openness, fairness, caring, loyalty, and supportiveness.
- **Integrity**: The extent of belief in the trustee to adhere the moral and ethical principles. The Subsumes components are defined as promise fulfillment, justice, fairness, and consistency.
Limitations of the state-of-the-art

Present literature has identified the need for user reviews in different application stores and the factors that might influence the user perspective. But the trustworthiness in the user reviews and factors that might influence the trust are unexplored. So there is a need to explore the factors that might affect the user feedback regarding the trust and managing the trustworthiness in the user feedback by knowing the causes of mistrust is important. Causes of untrustworthiness can be viewed from the user’s perspective as well as developer’s perspective; the following research focuses on both the perspectives.

Research aims and objectives

The main aim of the research is to understand how trustworthy is the feedback, that is collected from the application stores.

Following objectives were identified:
1. Explore the causes of untrustworthy user feedback for an application in the application stores.
2. Exploring the effects of trustworthiness on the users and developers.
3. Proposing inclusion and exclusion criteria for the developers to help segregate the feedback.

Expected outcomes

1. Causes of untrustworthiness towards the users’ feedback, provided in the mobile application stores from user’s perspective and developer’s perspective.

Thesis structure

The current master thesis is divided into 7 chapters,
• Chapter 1: Introduction of the research and aims and objectives are presented
• Chapter 2: Background in which the results of the literature review are presented
• Chapter 3: Research methodology is presented
• Chapter 4: Results are presented
• Chapter 5: Analysis of the results obtained
• Chapter 6: Discussions, limitations and future work are presented
• Chapter 7: Conclusions from the study are presented.
2 BACKGROUND AND RELATED WORKS

The following chapter provides a background for this thesis. It gives an overview on the present state-of-the-art combining with the ideas of improvement. Chapter 2.1 provides an overview of the mobile application stores and the ecosystem of the application store. The chapter also introduces the importance of feedback given by the user.

2.1 Application stores

Smartphones have revolutionized user experience and the way of using mobiles. With the massive growth in the mobile industry, the smartphones enable the users to track their day to day life activities. In this context, smartphones to keep up with the user experience vendors introduced mobile application stores. Since the introduction of mobile application stores, it provided an ecosystem for both the users and developers to exchange the information securely [11]. For the developers it provides a platform to deploy their software and the users can download the software and provide the feedback as well. The key success factor for the application stores is that the developers can review and analyze the feedback provided by the end user [12]. This forms a firm ecosystem which maintains the integrity and credibility of all the individuals involved in it.

Figure 2: Mobile application ecosystem

Figure 2 depicts the software ecosystem of the mobile application stores. The application provider or the application developer uses creation tools or development tools like Application Programming Interface etc. to develop an application. The application is released in various markets available i.e., google play store, iOS app store, and Windows store, etc. available and gets prioritized based on the ratings provided by the user [11]. Then based on the device and network used by the end user, they can download the application securely. This way the mobile application stores ensure the authenticity while providing security. The user provided feedback also plays a significant role in the ecosystem; the feedback is used by the developers to develop robust and stable applications, and it also helps other users to identify and download the applications[13].
2.2 Feedback mechanisms

Feedback mechanisms are being developed considering the importance of the feedback. Presently, feedback mechanisms are used widely in the online e-commerce websites. In e-commerce websites, the transactions mostly involved are economic related, i.e., they mostly involve cash. In this context, trust becomes the priority for both the exchange parties. Online websites use various feedback mechanisms for distinguishing negative ratings and positive ratings. Previously the feedback mechanism used for promoting the trust within the website was word-of-mouth networks [14].

Word-of-mouth or viva-voice is the spreading of information by oral communication. It is a bi-directional way of managing trust between the exchange parties [14]. With a generic growth in the industry, the feedback mechanism is no longer an option, and this indeed gave an opportunity to a new mechanism. Reputation systems are widely used and classified as the best feedback mechanism available. Reputation systems let the parties rate each other based on the smoothness in the transaction, which helps other users identify more trustworthy users based on the feedback.

Content analysis is also being widely used to classify the feedback provided by the user. Qualitative content analysis is a method to analyze the feedback provided by prioritizing the language of communication to the contextual meaning. The procedure follows a systematic approach to coding and identifying patterns for the subjective data interpretation [15]. Current applications follow three distinct approaches, that is conventional, directed and summative [7]. Defining the coding categories directly from the data is conventional content analysis. Picking a theory or a relevant research to extract codes is directed. The summative process involves counting and comparisons of codes. Content analysis is being used in research for determining the nature of reviews given by the users, i.e., trustworthy or not, “it provides knowledge and understanding of the phenomenon under study” [7].

2.2.1 E-commerce websites

Feedback mechanisms have been improved since the introduction of e-commerce websites like eBay, Amazon, yelp.com, and opinions. The paper [14] suggests that the eBay feedback mechanism is the best feedback mechanism followed in the recent times, due to its adoption of reputation systems.

The e-commerce giant is one of the leading marketplaces for the sale of goods and is one of the most popular site considering the number of individuals on the website and the number of hours each individual spends on the website. It follows the reputation system to incorporate the trust in the users. The website lets the two exchange parties rate each other based on the smoothness of the transaction. Based on the previous history the trustor will be able to make a decision on the trustee and so that the transaction can be as smooth as possible. The paper also specifies some relevant statistics about the feedback mechanism:

- Prizes and the probability of selling are both are affected by the feedback profile, and the also has ambiguous effects. This is relatively high for the riskier transactions.
- Among all the factors that influenced the user about the feedback, the critical component that is most influential is the number of positive and negative ratings, followed by the number of negative comments that are posted recently.

By the following statements, it is clear that users trust the profiles with the most number of positive ratings and the user’s gain confidence when there is a trustworthy relationship. Similarly, Amazon refers the customer with the tagline “Amazon verified purchase” and let only the reviewers with the tag line rate the product [4]. The study [16], proposed a framework based on the reviews posted in the Amazon. The paper studies on the spam reviews and spam reviewers, by their detection hints like “is the review unrelated to the product?” and “multiple
reviews for a single product by a single reviewer”. The paper concludes that having more knowledge on both the review and the reviewer is much precise to point fake reviews or spam reviews [16].

In the article [17], the author specifies that there are 4 basic characteristics of trust. That is word of mouth communication, standard expert reviews, reviewers on a regular basis and a good number of positive reviews. Further, the claim is strengthened by a survey.

2.2.2 Importance of user feedback in mobile application stores

As discussed above, the user generated feedback in the online mobile application stores is considered necessary by both the users and developers. Users look at the feedback to analyze and judge the application based on the online reviews. Unlike in e-commerce stores, there is a complexity in finding the useful and trustworthy reviews. In the e-commerce sites the user and his rating is judged based on the reputation of the user [6]. In the mobile application stores, the importance is given to the review provided by the user rather than his reputation. If a user finds a review to be helpful, then the reviewer could be trusted, but the validity could be limited to only that application. Hence the reputation system used in the e-bay or amazon couldn’t be implemented in mobile application stores. Users will look for the rating to cover all the functionality of the application and the negatives.

In the paper [18], the research implied that the feedback stores would have fake reviews and fake reviewers or malicious reviewers who intend to degrade or boost the reputation of the application. Fake reviewers tend to replicate the usage of the application to be good or bad and thus adding a doubt of interest to the user in trusting or not. Authenticity and impact are jeopardized when considered the fake reviews by the average day-to-day users. The paper also identifies that some patterns in the fake reviews related to the stealth of the reviewers, coherence to the ratings and readability of the reviews [4].

Application success is based on the number of positive ratings and negative ratings acquired by the application. The research [19] suggests that online reviews focus on the quality of the product. Users prefer both the positive ratings and the negative ratings before proceeding to download the application. But the number of negative ratings has the edge when compared to the positive ratings of the application. The paper [19], identifies a pattern for the number of negative ratings and positive ratings considered by a user before deciding. It is based on personal experience of the user, situational factors such as communication and dispositional factors such as motives.

Software development methodology has evolved over the period, from the traditional waterfall model to the continuous delivery mechanisms [20]. In such case, developing according to the market trends and user satisfaction is vital for survival. The app developer could use the summaries of the feedback provided to distinguish and understand the user’s feeling about the application [12]. The paper [20] proposed a method called CRISTAL to evaluate and use the feedback efficiently, which determines that only 49% of the feedback is considered for next application release.

The paper identifies [1] the keywords as the given by the user and the categories according to the usefulness of the review. According to the model, there are four categories,

- Bug report- defect, crash and problem
- Feature request – need, wish and want
- User experience – support, and help
- Ratings – Great, nice, etc.

Application stores also could use the feedback provided to the applications to distinguish and differentiate the malicious applications, which can jeopardize the system [18]. The importance of the mobile application stores can be known from the summary,

- Used by the users- to judge an application
• Used by developers- for future development
• Used by allocation stores- to distinguish malicious applications.

2.3 Defining trust and trustworthiness

Trust is a belief that the parties involved will constrain themselves from an opportunistic behavior, even if the situation demands. Trust depends on the behavior of the involved personalities and situations. Trust has an impact on the relations, economic exchanges and customer values. Information asymmetry and disbelief are the identified causes for the dilemma of exchanging trust with a person [21]. In the paper [5], the sources of trust are mentioned as familiarity which is defined as communications leading to trust, accumulativeness which is defined as an assessment of cost and benefits, and values that encourage confidence. The experimentations conducted in the paper [22], resulted in showing that both partners and experience can express trust, time has a significance effect on trust.

Trustworthiness is the commitment shown to accomplish the expectations that are put forth by others [9]. Trustworthiness is encountered in our day-to-day lives; you trust someone because the user is trustworthy and the worthiness proves the trust [21]. The paper [23] predicts that concepts of trustworthiness is considered to be user centric and depends on the person’s perspectives. As long discussed in the papers [9][15], trustworthiness bases are ability, benevolence and integrity as described in the previous section. These are the core components and the results presented that the trust can be forecasted using the following bases. Ability resulted in showing a better strategy for the development of the selection strategies, and the benevolence and integrity have shown significant changes in the relations of the coworkers and team-building.

The paper [24] defines the trustworthiness among relations as a natural phenomenon, that if a socially connected person introduces you to some stranger, you interpret that the individual to be trustworthy based on your connection with the friend. Trustworthiness among the relations is weighed based on the past experiences with the trustee.

2.3.1 Trustworthiness in online feedback:

Many people seek advice in the online stores, as discussed in section 2.2. Trustworthiness is considered to be a major factor considering economic exchanges. Various online feedback mechanisms are discussed in Section 2.2 concerning e-commerce sites and mobile applications. In the paper [25], the causes envisaged for the untrustworthiness are expertise of the user providing the feedback, understandability of the message presented by the user, and language complexity in the provided feedback. Further the paper determines that the understandability is showing the feedback in a simple and clear order that any user could easily understand. Language complexity is providing the user with the technical terms and concepts that layman couldn’t understand.

In the paper [26], a theoretical framework is presented to understand the causes of high trustworthiness to low trustworthiness. The model was based on the concepts categorized by hope, confidence, and assurance for trust and fear, monitoring, and vigilance for the distrust. The concept provided a richer understanding of the relations between trust and distrust. Trustworthiness is important in the mobile application stores for the developers as well as users, as the feedback is used in a life cycle. Exploring further the causes of untrustworthiness from both the user’s perspective as well as developer’s perspective is important.
3 METHODOLOGY

The following section defines the research method for achieving the objectives of the study. The research questions are described and motivated in the section. The research method is motivated and described in detail for each question in the study. Further, the section describes in detail about the unit of analysis.

3.1 Research Questions

<table>
<thead>
<tr>
<th>RQ 1.1</th>
<th>What are the causes of untrustworthiness towards the users’ feedback, provided in the mobile application stores while downloading the applications, from user’s perspective?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim:</td>
<td>Explore the causes of untrustworthy user feedback for an application in the application stores, from the users perspective.</td>
</tr>
<tr>
<td>Table 1: Research question 1.1 and aim</td>
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<tr>
<th>RQ 1.2</th>
<th>What are the causes of untrustworthiness towards the users’ feedback, provided in the mobile application stores while developing or updating applications, from developer’s perspective?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aim:</td>
<td>Explore the causes of untrustworthy user feedback for an application in the application stores, from developers perspective.</td>
</tr>
<tr>
<td>Table 2: Research question 1.2 and aim</td>
<td></td>
</tr>
</tbody>
</table>

| RQ 2 | What is the inclusion and exclusion criteria required by the developers to update the applications in the mobile application stores with respect to the feedback gathered from the users? |
| Aim: | Proposing a framework that manages the user feedback trustworthiness.                                                                                 |
| Table 3: Research question 2 and aim |

3.2 Research process

Snowball sampling by Wohin [27] is considered for Literature review. The sampling method is chosen as it finds relevant citations from the literature that are selected. The snowball sampling continues till all the available papers are studied. The process starts with the selection of literature and then the references are analyzed. Snowball sampling helps when there is little research study on the topic, and so the snowball sampling is chosen. In the present study snowball sampling is done to find relevant literature for having background knowledge on trust and the mechanisms of trustworthiness.

3.2.1 Literature review

The literature review is done to find relevant research to gain background knowledge on the psychology of trust and feedback mechanisms currently employed.

Step1- In the first step, a search string is formed by identifying keywords based on the research questions RQ1.1 and RQ1.2. After a preliminary study, more keywords are identifying to constitute the basis for the research. The final phase of the step is to identify important or relevant keywords to improve the search string.

Step2- ACM Digital Library, Engineering Village and google scholar are used to search with the keywords and search string from the step1. The keywords identified are “trustworthiness, measure, user feedback, online stores and framework”. Using multiple combinations of the
keywords, relevant literature is obtained. Further refining of the articles was done by limiting the results to conference papers, journal articles and workshop papers.

Step 3 - The results were further analyzed and categorized according to the title and abstract. Relevant articles were selected on finding the relevance with the trust/trustworthiness and kept for review by the supervisor.

Step 4 - Selected literature were read based on the research context and discussions. Final decisions were based on the content relevancy to the objectives of the proposed research. The selected literature was then organized, categorized and documented.

Step 5 - Categorized literature was then processed for snowball sampling. The method is performed by chain-referrals for the literature obtained in step 4.

Again the same steps are repeated for obtaining the results. Selecting 15 articles as seeds, 65 articles was the result and by performing Steps 3 and 4, the final selection was 16 articles.

Findings of the literature review are described in the background and related works chapter.

3.3 Empirical research methods and choice of method

There are two main approaches for conducting an empirical research: Qualitative research and quantitative research [28]. Qualitative research deals with the interpretation of the situation based on the assessment given on the situation of the relevant people. Qualitative research is based on understanding the problem in the situation and deriving the causes that led to the problem. The data obtained can be in numeric form and can be interpreted using demographic representation, then deriving conclusions with cost-effect analysis.

As the empirical study is aimed to identify the causes by considering subjective matter discussed by the subject, qualitative research is chosen. It helps in understanding the user perspective of viewing things, and the reasons for the situation could be easily analyzed.

Empirical methods of data collection in the qualitative research can be stated as,

- Experiment is a statistical analysis technique, where statistical analysis for the case under study is performed in a highly controlled environment. The variables are to be defined at the beginning of the study and it is difficult to define at the start of the research. In the current study it cannot be replicated as identification of the causes is derived from the opinions of the users. And it is difficult to determine an experimental setup in a highly controlled environment [29][28].

- Case-study is analyzing a phenomenon in-depth and in a real-life context. Case-study might be confined to only one organization or one method, which doesn’t support the empirical investigation of the causes of untrustworthiness, which is a global phenomenon [28].

- Action research focusses on observing the effect of a real-world situation by introducing an intervention. The steps involved in an action research are intervention, collection of data and analysis of the collected data. Action research doesn’t match the research proposed [28].

- Simulation is considered as an inappropriate method as the proposed research focuses more on the global phenomenon and real-world situation.

- Survey is selecting a sample that represents a large group of the population and studying the phenomenon in the large group. The data collection is performed through online questionnaire or interviews. Thus collected data is represented in demographic and pictorial representation deriving conclusions [30].
Interview-based survey has been chosen as an appropriate method, as the research proposed should consist of deep understandings of both practitioners and users [31]. For finding the results for RQ1.1 and RQ1.2, interviews are conducted. A semi-structured interview is planned as the procedure suits the present research. It allows the researcher to acquire an acute understanding on the topic, as it is unstructured and observational method of approach.

3.4 Data collection

Interview-based survey was conducted aiming for the identification of the causes of untrustworthiness in both user’s perspective and developer’s perspective. Following steps are followed to obtain results:

3.4.1 Selection of the interviewee subjects

As the research aims to fulfill the objectives of understanding the causes of untrustworthiness from both the user’s as well as developer’s perspective. Interviewee subjects were categorized into two groups; that is user’s and developer’s. For deciding on the user subject selection, the users who had a minimum of three years of experience in using the mobile applications, were considered. Interview subjects were form different fields of study, but they all were aware of the software development process in the mobile application stores. Eight subjects were given dates for the user interviews. For the selection of developer interviewees, the subjects were all using the mobile application stores for a minimum of three years and had an experience of minimum one year in development. All the subjects had an adequate knowledge of the study. Number of interview participants were 13, and each interview lasted for 25-35 minutes, which is in accordance with Rowley’s principles [32].

3.4.2 Interview design

Semi-structured interviews were planned on a time interval of 4 weeks, depending on the availability of the participants. A checklist of the questionnaire was prepared, and the questions unfolded based on the inputs given by the interviewee. User’s questionnaire was different from the developer’s questionnaire. User interview was planned to last for about 25-35 minutes, and the developer interview was designed to last about 35-40 minutes. Knowing the developer’s insights are focused, as the proposed framework is intended to them. The Interview followed a simple design, that is

1. Introduction of the researchers to the interviewee.
2. Introduction of the interviewee.
3. Starting the interview with a clear introduction to the topic.
4. As the interview progresses, unfold the questionnaire
5. Interview last till all the questions prepared as a checklist are done.

3.4.3 Formulation of interview questionnaire

As the semi-structured interviews, consists of both the open-ended and close-ended questionnaire, the questions were formulated considering the research goals. As there was no support of literature, the initial literature review that was based on trust psychology and trustworthiness in various online feedback forums was taken as an input. Fundamentally the aim of preparing the questions was to answer the research questionnaire. Interview questions designed for the understandability and overall neutrality to the interviewee [33]. Initially, the research questions were based on these constraints, and later the questions were framed to be more open-ended to get more information from the user. The questionnaire was divided into two subsections, where each sub-sectioned focused on different topics. The first
subsection contains personal information of the user and the second subsection contained open-ended questions about the perceived trustworthiness.

After forming initial questionnaire, the questionnaire has been drafted to supervisor for a review. The step was considered because as a novice researcher, conducting interviews were difficult. Constraints like ambiguity and language complexity were not considered. In a face-to-face meet with the supervisor, proposed changes to include the close-ended questionnaire for better results. Hence the finalized questionnaire has been decided, the first section consisted of the personal details of name, organization and experience. The second section consisted of the closed-ended questions relating to the findings of the literature review. The third section consisted of the open-ended questionnaire, where user expresses his thoughts on the perceived trustworthiness. Questionnaire formed at the end of this step is attached in appendices.

3.4.4 Interview planning and setup

With a decision on interview subjects and interview questionnaire, the next step was to setup for the interview. All the interview participants were sent an invitation through e-mail asking for an appointment. Based on the availability of the interviewee, a mutually agreed time was setup. The responded subjects were provided with a skype id, and time as per the availability of the subjects. Express scribe tool was used to record the interview on Skype, with the knowledge of the interviewee.

3.4.5 Transcription

All the interviews were recorded, and for the conversion into written text, a word processor tool called ‘ExpressScribe’ was used. As soon as the completion of an interview, the Audio format was saved as ‘interview no.interviewee role’. The audio file was duplicated and stored in ‘Dropbox’ to ensure there is no loss of the data. The audio file was then converted to the word processor and saved the file with the same name as the audio file to ensure the ambiguity in the process. As the interview period ended, there were eight user interview documents and five developer documents. For further analysis, the obtained data is transferred into Microsoft Word, which removes any spell mistakes in the information provided by the subject.

3.5 Data analysis

The data collected in the interviews generated a reasonable amount of the qualitative data. The raw data obtained from the transcripts may consists of keywords, statements and own deductions; the analysis must be performed systematically and efficiently.

After a careful analysis of the literature available on qualitative data and motive provided by the supervisor, thematic coding is considered appropriate. Although there are many qualitative data techniques like Grounded theory, the analysis is complicated, and a novice researcher might face difficulties in applying the theory[34]. Thematic approach is considered to be a generic approach to analyze the qualitative data [35]. By following the guidelines provided by Robson [35], thematic coding could be applied to the qualitative data.

The reason for choosing the analysis method is because the Robson defined advantages are in line with the research. Robson described the theory to be flexible to any qualitative data, easy to use for any novice researcher and quick consuming less time and efforts to understand.

According to the Robson [35], the theory is implemented in 5 phases,

- The first step is getting familiarized with the data; reading and understanding the data. The step involves transcribing of the data from the available audio format and getting familiarized with it.
In the second step, initial codes are generated from the transcribed data. The aim of the step is to interpret the data into meaningful groups. This following generated codes will serve as an input for the next step.

The third step is grouping the codes into themes. The aim of the action is to gather relevant data into a theme.

The fourth step is to arrange the themes into a network; identifying the interrelations by constant comparison. At the end of the phase, a hierarchical structure is formed for the themes obtained.

In the final step, integration and interpretation of the relations are made. Results are collected and summarized and then conclusions are depicted based on the relations.
4 RESULTS

This section presents an overview of the interview process and the results obtained from the conducted interviews.

4.1 Summary of the interviewees

A total of 13 interviews were conducted, out of which eight interviews were from the users, and five interviews were from the developers of the mobile applications. Eight user interviewees were experienced in software development but not mobile application development, and they have more than three years using the mobile application stores. Five developer interviewees were mobile application developers with more than one year of developing experience and more than three years of using mobile application stores experience. To generalize the findings to the overall population, column designation is provided in the tables. A brief description for choosing the participants as the interview subjects is presented in Table 4 and Table 5.

All the interviews were conducted through Skype, followed up by emails for a general understanding of the topic. As it is a semi-structured interview a series of questionnaire was prepared through the knowledge obtained from the literature review. The interview was carried by posing each question and posing spontaneous questions simultaneously.

4.1.1 Summary of the developer Interviewees

<table>
<thead>
<tr>
<th>Participant</th>
<th>Role</th>
<th>Designation</th>
<th>Experience</th>
<th>Application store</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee 1</td>
<td>Developer</td>
<td>Senior mobile application developer</td>
<td>5 years</td>
<td>3 years</td>
</tr>
<tr>
<td>Interviewee 2</td>
<td>Developer</td>
<td>Business analyst and developer</td>
<td>7 years</td>
<td>4 years</td>
</tr>
<tr>
<td>Interviewee 3</td>
<td>Developer</td>
<td>SEO application developer</td>
<td>8 years</td>
<td>3 years</td>
</tr>
<tr>
<td>Interviewee 4</td>
<td>Developer</td>
<td>Senior mobile application developer</td>
<td>7 years</td>
<td>2 years</td>
</tr>
<tr>
<td>Interviewee 5</td>
<td>Developer</td>
<td>Freelance developer</td>
<td>5 years</td>
<td>1 year</td>
</tr>
</tbody>
</table>

Table 4: Brief description of interviewee developer participants

4.1.2 Summary of the User Interviewees

<table>
<thead>
<tr>
<th>Participant</th>
<th>Role</th>
<th>Designation</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee 1</td>
<td>User</td>
<td>Senior Software developer</td>
<td>6 years</td>
</tr>
<tr>
<td>Interviewee 2</td>
<td>User</td>
<td>SEO</td>
<td>4 years</td>
</tr>
<tr>
<td>Interviewee 3</td>
<td>User</td>
<td>Professor</td>
<td>5 years</td>
</tr>
</tbody>
</table>
Table 5: Brief description of interviewee user participants

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>User Type</th>
<th>Occupation</th>
<th>Experience</th>
<th>Background</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>User</td>
<td>Assistant Professor</td>
<td>3 years</td>
<td>NONE</td>
</tr>
<tr>
<td>5</td>
<td>User</td>
<td>Computer science student</td>
<td>5 years</td>
<td>NONE</td>
</tr>
<tr>
<td>6</td>
<td>User</td>
<td>Freelance developer</td>
<td>6 years</td>
<td>NONE</td>
</tr>
<tr>
<td>7</td>
<td>User</td>
<td>Software engineer</td>
<td>5 years</td>
<td>NONE</td>
</tr>
<tr>
<td>8</td>
<td>User</td>
<td>Software engineering student</td>
<td>6 years</td>
<td>NONE</td>
</tr>
</tbody>
</table>

4.2 Interview process

Interview process consists of five steps from the transcription of the interviews to the validation of the coding. After forming and testing the interview questionnaire, the process consists of iterations of steps at various stages. Various tools were also used to make the process better visually and to avoid redundancies during the process. The steps are mentioned below.

4.2.1 Step 1: Transcribing

The interviews were conducted on Skype based on the availability of the participants. Most of the interviews were recorded for further analysis and recorded evidence. For recording a tool ‘ExpressScribe’ was used, as the tool provides a visual interface of the recorded evidence and a word processor. The tool also provides a visual experience of having the interviewee recorded evidence and the word transcription under the same name. The snapshot of the interface in ‘ExpressScribe’ tool is presented in figure 3.
4.2.2 Step 2: Post Interviews

On completion of an interview, immediately the information is imported in Microsoft word for better word processing and spell check. The next step was reading the transcripts carefully to note the theoretical implications and note any new questions derived from the interviewee. Hence, giving a potential advantage of removing any ambiguousness while conducting next interview. The interviews transcripts are formatted such that an overview about the interviewee can be obtained along with the information provided. The interface of the word can be seen in the picture presented in Figure 4.

![Screenshot of Transcript in Word](image)

**Figure 4: Screenshot of Transcript in Word**

4.2.3 Step 3: Pre-coding

After analyzing the transcripts in the word, the preliminary results from the manual transcripts are hard coded into Microsoft Excel, as snapshotted in figure 5. Coding is identified and then hard coded with the defined categories and their descriptions. The initial categories include the interviewee number followed by the selected feedback from the interview. Determined by the user the trustworthiness in the feedback, it is categorized to be trustworthy or untrustworthy. Then the “statement of the user”, as exactly posed by the user. “Feedback timing” describes the interviewee answer to the questions and the description given by the interviewee to the question. “Trust aggregation” is derived from the timing with which the interviewees deliver a feedback to the questions, based on the trust and distrust in the feedback selected. Figure 5 describes the interface for working with the coding with an example for the feedback timing and trust aggregation. The collected data is presented in the appendices.
4.2.4 Step 4: Open coding

To categorize the coding, the tool ‘MAXQDA’ was used. To keep track of the dependencies and eliminate the redundancies with the formed trust aggregation, Excel doesn’t provide support for identification of the dependencies. The tool ‘MAXQDA’ is a Qualitative Data Analysis tool, which has color coding for each of the categories identified and the tool also helps in keep track of the dependencies. The interface of the tool is presented in Figure 6.

Figure 5: Screenshot of codes in Excel

Figure 6: Screenshot of MAXQDA
The keywords that are relevant to the present research are identified from the transcripts by using a feature of MAXQDA. The keywords then are searched manually in each of the transcripts to understand the feedback timing and the relevance to the topic. According to the frequency of the codes, the words are prioritized and then searched for the further identification of the description and feedback timing.

After identification of the feedback timing, open-codes are created to satisfy the earlier generated codes and the description. The codes identified are tagged based on the relevance of the description and assigned carefully to a code. Coding is performed as a continuous process until the completion of every transcription. On completion of deriving the codes, each code is color coded uniquely to avoid any dependencies that may exist in the transcripts. The process is continued till there are no extra codes identified. The defined codes and their descriptions are given in the Table 6.

Note: Code Inclusion criteria is based on only the frequency of occurrence in the transcripts and relevance of the description with the code.

### 4.2.4.1 Causes of untrustworthiness in the user feedback from user’s perspective

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Understandable feedback is trustworthy</td>
<td>Understandability in feedback</td>
</tr>
<tr>
<td>2</td>
<td>Untrustworthy feedback depends on the understandability of the information</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Simple language is trustworthy in feedback</td>
<td>Language complexity</td>
</tr>
<tr>
<td>4</td>
<td>Language plays a key role in trust or distrust</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Language with technical terms are more often trusted</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Trust or distrust relates to the inapp experience</td>
<td>Experience of the reviewer</td>
</tr>
<tr>
<td>7</td>
<td>Trustworthy feedback comes from more experienced user</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Untrustworthy feedback is given by less experienced using the application</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Trustworthiness is considered by the taking only the latest feedback</td>
<td>Latency of feedback</td>
</tr>
<tr>
<td>10</td>
<td>Trustworthy feedback consists of both pros and cons of the application</td>
<td>Inclusivity in feedback</td>
</tr>
<tr>
<td>11</td>
<td>Trustworthy feedback has inclusive information</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Trustworthy feedback contains functionality of application</td>
<td>Applicability of information</td>
</tr>
<tr>
<td>13</td>
<td>Untrustworthy information will not specify the functionality</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Trust/Distrust depends on the user perspective of analyzing</td>
<td>Categorizing the user needs</td>
</tr>
<tr>
<td>15</td>
<td>Trustworthiness is based on the user producing feedback</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Trustworthiness is based on the socially related persons</td>
<td>Dependability on reviewers</td>
</tr>
<tr>
<td>17</td>
<td>Untrustworthy information comes from a unreliable source</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Untrustworthy feedback consists of unreliable information</td>
<td>Reliability of information</td>
</tr>
<tr>
<td>19</td>
<td>Trustworthy feedbacks are crisp and strict to the point</td>
<td>Compactness of reviews</td>
</tr>
<tr>
<td>20</td>
<td>Untrustworthy information is long</td>
<td></td>
</tr>
</tbody>
</table>
Trustworthiness is considered from more than one rating Consistency across ratings

Table 6: Code description with frequency of occurrence (user)

The derived codes from the transcripts have scales of measurement to measure the trustworthiness in the cause. The codes are derived from the frequency of occurrence and the relevance to the code description given in the interview transcripts. A nominal scale which consists of two values for each cause identified as codes is considered to measure the trustworthiness. Thus the scales are derived and mentioned in Table 7.

<table>
<thead>
<tr>
<th>No.</th>
<th>Code</th>
<th>Derived</th>
<th>Nominal Scale</th>
<th>Frequency of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Understandability in feedback</td>
<td>Frequency, Relevance</td>
<td>Low</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Language complexity</td>
<td>Frequency</td>
<td>Simple</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Complex</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Experience of the reviewer</td>
<td>Frequency</td>
<td>Low</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Latency of feedback</td>
<td>Frequency, Relevance</td>
<td>Latest</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Old</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Inclusivity in feedback</td>
<td>Frequency</td>
<td>Diverse</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Similar</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>Applicability of information</td>
<td>Frequency, Relevance</td>
<td>Applicable</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Non applicable</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>Categorize the needs</td>
<td>Frequency, Relevance</td>
<td>classify</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>misclassify</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Dependability on users</td>
<td>Frequency</td>
<td>Honesty</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dishonesty</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Reliability of information</td>
<td>Frequency</td>
<td>high</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>low</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>Compactness of reviews</td>
<td>Frequency, Relevance</td>
<td>Short</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Long</td>
<td>7</td>
</tr>
<tr>
<td>11</td>
<td>Consistency across ratings</td>
<td>Frequency, Relevance</td>
<td>consistent</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inconsistent</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 7: Codes with nominal scale

4.2.4.2 Frequency of occurrence

The inclusion of the quantitative data analysis along with the qualitative approach provides a motivation for the inclusion of open code categories derived from the feedback description from the transcripts. The presence of the feedback timing in the transcripts is considered to be an occurrence of the code. Hence the frequency percentage is calculated as the number of interviews in which the code is transcript divided with the total number of interviews conducted.

Here, the quantitative data analysis is performed to know the level of awareness among the users for the trustworthy user feedback in mobile application stores, but not to analyze and determine the relative importance of each factor influencing trustworthiness. A graphical representation of the data is presented in the figure 7.
Figure 7: Frequency of occurrence of codes

4.2.4.3 Causes of untrustworthiness in user feedback form developer’s perspective

The process described above for generating the codes on user’s perspective, is also applied to the developer’s perspective and the results are presented in the table below. Unlike user’s developers had a different perspective of analyzing the feedback. The opinions generated through transcription is noted as the code description and further analyzed for generating codes, table 8.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technical language is trustworthy in feedback</td>
<td>Language complexity</td>
</tr>
<tr>
<td>2</td>
<td>Language plays a key role in trust or distrust</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Simple language is mostly considered untrustworthy</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Trust or distrust relates to the inapp experience</td>
<td>Experience of the reviewer</td>
</tr>
<tr>
<td>5</td>
<td>Trustworthy feedback comes from more experienced user</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Untrustworthy information may come from both the experienced and inexperienced users</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Trustworthy feedback consists of both pros and cons based on the experience</td>
<td>Inclusivity in feedback</td>
</tr>
<tr>
<td>8</td>
<td>Trustworthy feedback has similar feedback or information</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Trustworthy feedback contains functionality or may just present his experience</td>
<td>Applicability of information</td>
</tr>
<tr>
<td>10</td>
<td>Untrustworthy information will not specify the functionality</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Trust/Distrust depends on the user perspective of analyzing</td>
<td>Categorizing the user needs</td>
</tr>
<tr>
<td>15</td>
<td>Trustworthiness is based on the user producing feedback</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Trustworthiness is based on the socially related persons</td>
<td></td>
</tr>
</tbody>
</table>

![Codes frequency occurrence in interview data](chart.png)

<table>
<thead>
<tr>
<th>Codes frequency occurrence in interview data</th>
<th>percentage= x/13*100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consistency across ratings</td>
<td>62</td>
</tr>
<tr>
<td>Compactness of reviews</td>
<td>50</td>
</tr>
<tr>
<td>Reliability of information</td>
<td>37</td>
</tr>
<tr>
<td>Dependability on users</td>
<td>62</td>
</tr>
<tr>
<td>Categorized information</td>
<td>25</td>
</tr>
<tr>
<td>Applicability of information</td>
<td>50</td>
</tr>
<tr>
<td>Inclusivity in feedback</td>
<td>62</td>
</tr>
<tr>
<td>Latency of feedback</td>
<td>25</td>
</tr>
<tr>
<td>Experience of the user</td>
<td>75</td>
</tr>
<tr>
<td>Language complexity</td>
<td>75</td>
</tr>
<tr>
<td>Understandability in feedback</td>
<td>100</td>
</tr>
</tbody>
</table>

Understandability in feedback: 75% of the codes are related to user’s perspective, while 25% are related to the developer’s perspective.
Untrustworthy information comes from a unreliable source

Untrustworthy feedback consists of unreliable information

Trustworthy feedbacks are long containing technical terms

Untrustworthy information relates to the one words

Trustworthiness is considered from more than one rating

Table 8: Code description with frequency of occurrence (developer)

<table>
<thead>
<tr>
<th>No.</th>
<th>Code</th>
<th>Derived</th>
<th>Nominal Scale</th>
<th>Frequency of occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Language complexity</td>
<td>Frequency</td>
<td>Simple</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Complex</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Experience of the reviewer</td>
<td>Frequency</td>
<td>Low</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>High</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>Inclusivity in feedback</td>
<td>Frequency</td>
<td>Diverse</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Similar</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Applicability of information</td>
<td>Frequency,</td>
<td>Applicable</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
<td>Non applicable</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>Categorize the needs</td>
<td>Frequency,</td>
<td>classify</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
<td>misclassify</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Dependability on users</td>
<td>Frequency</td>
<td>Honesty</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dishonesty</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>Reliability of information</td>
<td>Frequency</td>
<td>high</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>low</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Compactness of reviews</td>
<td>Frequency,</td>
<td>Short</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
<td>Long</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>Consistency across ratings</td>
<td>Frequency,</td>
<td>consistent</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relevance</td>
<td>Inconsistent</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 9: Codes with nominal scale

4.2.5 Step 5: Exploring relations

Codes that are generated from the open coding are explored to find the relations that exist with each of the code with the trustworthiness. The studied connections form a basis for grouping the codes into themes. As the research objective is to explore the causes of the trustworthiness in the user’s perspective and developer’s perspective, the studied criteria form a basis of the theoretical model.

The nominal scale identified in the section 4.3.4.1 is used to establish the relation between the cause and the trustworthiness.

4.2.5.1 Causes and their effects on untrustworthiness:

For deriving a relation between causes and the trustworthiness, the nominal scale that is derived in the 4.3.4.1 is used.

- The number of respondents specifying each time about the relation between understandability and the trustworthiness is considered for plotting the graph. Understandability is a factor influencing the trustworthiness, and so by the
transcriptions, the number of people specifying the high understandability results to trustworthiness and low understandability results in the trustworthiness are compared.

The graph in Figure 8 shows a comparison between the frequency of occurrence of understandability in the transcripts and the trustworthiness. From the demographic representation, in the user’s perspective, the number of respondents in favor of highly understandable statements are mostly trustworthy are more than those saying the vice versa. In such case, low understandability caused untrustworthiness according to the transcripts. It could be concluded that the trustworthiness in the feedback increases as the understandability of the information provided in the feedback increases, the graph is linear and moving towards the origin.

Trustworthiness is directly proportional to the understandability in the feedback.

- The frequency of occurrence about the relation between language complexity and the trustworthiness is considered for plotting the graph. Language complexity is a factor influencing the trustworthiness, the nominal scale that is considered for language complexity for plotting the graph is simple and complex. The nominal scale is derived from the transcriptions saying that language complexity should be simple or complex to be trustworthy.

  - Figure 9 depicts the user’s perspective
Figure 10 depicts the developer’s perspective

From Figure 9 and Figure 10, it can be seen that from a user’s perspective, simple language is considered mostly trustworthy to download an application than the complex language. But from a developer’s perspective, it can be seen that the trustworthiness in the feedback increases with the complexity of the language of feedback. It implies that the untrustworthiness in the feedback increases with the increase in the language complexity from user’s but developers have a contradicting opinion.

As the graph is linear and moving away from the origin, trustworthiness is inversely proportional to the language complexity from user’s perspective.
As the graph is linear and moving towards the origin, trustworthiness is directly proportional to the language complexity from developer’s perspective.

- The frequency of occurrence about the relation between the experience of the reviewer and the trustworthiness is considered for plotting the graph. Experience of the reviewer is a factor influencing the trustworthiness, the nominal scale that is deemed for the metric to plot a graph is high and low based on the usage of the word ‘experience’ in a sentence in the transcripts.

Figure 11 is derived from user’s perspective

Figure 12 is derived from developer’s perspective
From Figure 11 and Figure 12, show that feedback coming from a highly experienced user is considered mostly trustworthy to download an application by both the user’s and developer’s perspective. And also it states that the untrustworthiness is caused by the low experience of the reviewer, as it is implied more than ten times in the transcripts. It can be concluded that the trustworthiness in the feedback increases with the experience of the reviewer, as the graph is linear and towards the origin.

Trustworthiness is directly proportional to the experience of the reviewer, from both the perspectives.

- The frequency of occurrence about the relation between latency of the feedback and the trustworthiness is considered for plotting the graph. The latency of the feedback is a factor influencing the trustworthiness, the nominal scale that is deemed for the metric to plot a graph is latest and old based on the usage of the word ‘latest feedback’ in a sentence in the transcripts.

From the demographic representation, Figure 13, it can be seen that only the latest feedback is considered to be trustworthy than the old feedback, it also implies that the old feedback is untrustworthy. Users think that latest feedback is only considered to download the application rather than the old feedback. The old feedback is seen as untrustworthy as motioned by many users in the transcripts. It can be concluded that the trustworthiness in the feedback increases with the latency in feedback, as the graph is linear and towards the origin.

Trustworthiness is directly proportional to the latency of the feedback.
The frequency of occurrence about the relation between inclusivity in the feedback and the trustworthiness is considered for plotting the graph. Inclusivity in the feedback is a factor influencing the trustworthiness, the nominal scale that is considered for the metric to plot a graph is, diverse and similar feedback as mentioned by the users in the transcripts.

- Figure 14 is derived the user's perspective

![](image1.png)

**Figure 14: Inclusivity in feedback (User)**

- Figure 15 is derived from the developer’s perspective

![](image2.png)

**Figure 15: Inclusivity in feedback (developer)**

From Figure 14 and Figure 15, it can be seen that feedback similarities are considered to be trustworthy by both users and developers. If an application review consists of similar feedback, the application is considered to be trustworthy. Similarly, the diverse feedback is deemed to be untrustworthy, as the feedback is ambiguous. It can be concluded that the trustworthiness in the feedback increases with the similarities in the latest feedback and as the similarities decreases the untrustworthiness increases, as the graph is linear and towards the origin.

Trustworthiness is directly proportional to the inclusivity in the feedback, from both the perspectives.

- The frequency of occurrence about the relation between applicability of the information and the trustworthiness is considered for plotting the graph. The information produced by the user in feedback contains the functionality of the application, is applicability as per the codes in the table 4.3.4.1. Applicability is a factor influencing the trustworthiness, the nominal scale that is considered for the metric to plot a graph is applicable and non-applicable feedback.
Figure 16 is derived from the user’s perspective

![Figure 16: Applicability of information (user)](image)

Figure 17 is derived from the developer’s perspective

![Figure 17: Applicability of information (developer)](image)

From Figure 16 and Figure 17, it can be seen that there is not much variance within both the perspectives. Users, as well as developers, think that applicable information is mostly trustworthy than the non-applicable information. It can be implied from the graph that the untrustworthiness increases with a decrease in the relevant information. The users and the developers think that the feedback must consist of the functionality of the application. If no functionality is specified, then the feedback is considered to be untrustworthy. It can be concluded that the trustworthiness in the feedback increases with the applicable feedback, as the graph is linear and towards the origin.

Trustworthiness is directly proportional to the applicability in the feedback, from both the perspectives.

- The frequency of occurrence about the relation between categorizing the user needs and the trustworthiness is considered for plotting the graph. Specifying the categorization of the requirements that help the users to attain day-to-day tasks provided by the application is deemed to be a cause the trustworthiness according to the transcripts. The nominal scale that is considered for the metric to plot a graph is classify and miss-classify feedback, as specified by the interviewees in the transcripts.
Figure 18 depicts the user’s perspective

From the Figure 18 and Figure 19, it can be seen that along with the classification of the information in the feedback, the trustworthiness increases in both the perspectives. Users and developers think that the review must classify the information to consider the feedback to be trustworthy. If the needs are misclassified in the feedback, then the feedback is considered to be untrustworthy according to the transcripts. So from the following statements, it can be concluded that the trustworthiness in the feedback increases with the detailed feedback, as the graph is linear and towards the origin.

Trustworthiness is directly proportional to the categorizing the information, from both the perspectives.

- The frequency of occurrence about the relation between dependability on reviewers and the trustworthiness is considered for plotting the graph. The likeliness with which a user prefers to download the application based on the review posted by a closely related person or a socially related person is the dependability on reviewers. Dependability is a factor influencing the trustworthiness, the nominal scale that is considered for the for the metric to plot a graph is honesty and dishonesty based on the usage of the word ‘dependable’ in a sentence in the transcripts.
Figure 20 depicts the user’s perspective

![Figure 20: Dependability on reviewers (user)](image)

Figure 21 depicts the developer’s perspective

![Figure 21: Dependability on reviewers (developer)](image)

From the Figure 20 and Figure 21, it can be seen that with an increase in the honesty of the information provided by the reviewer, trustworthiness also increases. Users and developers think that the review must be honest in the information provided to consider the feedback to be trustworthy, as the most of the interviewees suggested. It can be concluded that as the honesty in the information increases the trustworthiness also increases and as the dishonesty decreases, the untrustworthiness also decreases.

Trustworthiness is directly proportional to the dependability on reviewers, from both the perspectives.

- The frequency of occurrence about the relation between the reliability of information and the trustworthiness is considered for plotting the graph. The information presented by the reviewer could be based on the application or just the feelings of the user. The reliability of the information is, ‘how reliable is the information posted in the feedback?’. Reliability is a factor influencing the trustworthiness, the nominal scale that is considered for the metric to plot a graph is low and high, as per the occurrence of the word “reliable” in the feedback.
From Figure 22 and Figure 23, it can be seen that with a high reliability of the information provided by the reviewer, the trustworthiness also increases. Users and developers agree that the review must possess high reliability in the information provided to consider the feedback to be trustworthy. If the feedback is of low reliability in the information provided, then the feedback is deemed to be untrustworthy. It can be concluded that as the reliability in the information decreases untrustworthiness increases and as the reliability increases, the untrustworthiness also decreases.

Trustworthiness is directly proportional to the Reliability of information, from both the perspectives.

- The frequency of occurrence about the relation between the compactness of the reviews and the trustworthiness is considered for plotting the graph. Verifying whether, the information provided by the reviewer contains both the positives and negatives, with the length of the review is considered as compactness. Compactness is a factor influencing the trustworthiness, the nominal scale that is considered for the metric to plot a graph is short and long, as per the occurrence of the word “length” in the feedback.
From Figure 24 and Figure 25, it can be seen that as the length of the information provided in the feedback, which contains both the positives and negatives decreases, the trustworthiness also decreases. A review must be short to be considered by the users, and long to be considered by the developers. From a developer’s perspective, it can be seen that the trustworthiness in the feedback increases with the compactness of the review. It implies that the untrustworthiness in the feedback increases with the length of the feedback according to a user and according to the developer as length decreases the trustworthiness also decreases.

As the graph is linear and moving away from the origin, trustworthiness is inversely proportional to the compactness from user’s perspective.

As the graph is linear and moving towards the origin, trustworthiness is directly proportional to the compactness from developer’s perspective.

- The frequency of occurrence about the relation between the consistency across the ratings and the trustworthiness is considered for plotting the graph. Consistency is the number of reviews stating the same kind of ratings, as defined in the transcripts. Consistency is a factor influencing the trustworthiness, the nominal scale that is considered for the metric to plot a graph is consistent and inconsistent, as per the occurrence of the word ‘consistent’ in the transcripts.
From Figure 26 and Figure 27, it can be seen that along with the increase in consistency across different ratings, the trustworthiness also increases. Users and developers agree that the reviews must be consistent to consider the feedback to be trustworthy. If the reviews are inconsistent, then the feedback is considered to be untrustworthy. It can be concluded that as the consistency across the ratings decreases, untrustworthiness increases and as the cause increases, the trustworthiness also increases.

Trustworthiness is directly proportional to the consistency across ratings, from both the perspectives.

By analyzing the following, the next step in the thematic approach is generating themes of codes and then thematic mapping is done. From the above results, themes could be identified as trustworthiness relating factors to users and developers. The themes are constructed by the results obtained by exploring each of the codes. Figure 28 represents a thematic network of the identified codes and the identified themes combined.
Figure 28: Thematic network of codes identified
5 ANALYSIS

In the previous section, the obtained results are presented and analyzed in an abstract way. This chapter is aimed to analyze the results to answer the research questions, RQ1 and RQ2. The section seeks to analyze the causes of untrustworthiness from both user’s and developer’s perspective, thus paving the way to answer the RQ3. The section further aims to present a theoretical model, i.e., inclusion and exclusion criteria to developers that should be considered for developing an application.

5.1 Exploring the causes of untrustworthiness in the user feedback with respect to user’s perspective

RQ1: What are the causes of untrustworthiness towards the users’ feedback, provided in the mobile application stores while downloading the applications, from user’s perspective?

Analyzing the results obtained in the previous section there are 11 causes effects the trustworthiness of the user produced feedback in the mobile application stores. The description of the causes and the frequency of occurrence of each of the 11 causes in the transcripts are mentioned in chapter 3. The section explores the causes of untrustworthiness from the user’s perspective, Figure 29 shows a fish-bone diagram, to represent all the causes.

![Figure 29: Factors causing untrustworthiness (user)](image)

5.1.1 Cause 1: Understandability in feedback

The information posted by the reviewer in the form of the feedback should be understandable to be considered as trustworthy. To download an application generally users, look at the feedback produced by the reviewer to be able to judge the functionality of the application. According to the results retrieved from the transcripts, the information presented in the feedback should be clinical and should be simplifying to all types of audiences looking for the feedback. The review data should also not contain any of the technical terms so that users could understand the feedback. The usefulness or the usability of the review depends on the understandability of the feedback.

To study the concept of understandability, the frequency of occurrence of the word ‘understandable’ is scanned in all the transcripts. The results are examined for the description surrounding the word ‘understandable’. The following statement has been identified by
understanding the view of the practitioners, who faced the problem one of the interviewees said: “it is important to understand the review before downloading an application as it gives an overview of the application”. Most of the interviewees strongly agree that understandability is very important. A nominal scale is considered for better understanding the causes of the untrustworthiness,

![Figure 30: Low understandability cause untrustworthiness](image)

In the section 4.2.4.1, the causes are identified, and a nominal scale is considered to prove the linearity that exists between different causes and trustworthiness. In the cause-effect relations drawn above, low understandability is a factor that is affecting the untrustworthiness in the information, as shown in Figure 30.

According to the results presented in the section 4.2.5.1, the derived result for the understandability in relation with the trustworthiness is as follows, ‘as the understandability in the feedback increases, the trustworthiness also increases’. So this determines that the low understandability of the information in the feedback causes low trustworthiness or untrustworthiness. So, untrustworthiness in the reviewer provided feedback is caused by the low understandability in the feedback.

5.1.2 Cause 2: Language complexity

The information in the feedback should not be complex as all the users should be able to understand. To be read by all the users in the application stores, the information should be made clear and crisp. Users generally prefers the language to be English, as it is recognized around the world, the description is inferred from the statement “the fact that I have to translate the feedback to English gives me pain and so I wouldn’t want to waste my time on this, and I would like to move on”, this statement is given by an interviewee of experience more than five years of using mobile application stores. Some of the interviewees focused more on the statements that are grammatically correct and are pragmatic.

Considering a nominal scale for better analysis of the language complexity in relation with the trustworthiness,

![Figure 31: Complex language cause untrustworthiness](image)

As per the frequency of the occurrence calculated in the section 4.2.4, the most frequently occurred is that the trustworthiness depends on language complexity in the feedback. All the interviewees felt that the language complexity is a factor that affects the trust or distrust in the
feedback, as shown in Figure 31. The nominal scaled helped to prove the linearity that exists with the trustworthiness concerning the language complexity. The derived relation from the section 4.2.5 is, “simple language is considered mostly trustworthy to download an application”. As the complexity of the language increases, the trustworthiness gets lower or untrustworthiness increases. So, the untrustworthiness in the reviewer provided feedback depends on the language complexity in the information.

5.1.3 Cause 3: Experience of the reviewer

The review process is where a user can find some matched expectations, and avoid disappointments. The experience of the reviewer could be a major factor influencing the trustworthy feedback, as it should match the expectations. Here the experience of the reviewer is the, in application experience’ that a user has, rather than the application store experience. The in application experience of the reviewer determines the vision provided by the application, which helps other users to judge the application. The more the user has experienced the application, the better will be the review.

![Figure 32: Low Experience of the reviewer cause untrustworthiness](image)

Considering a nominal scale for analysis of the effect of experience on the trustworthiness, The experience is considered as a cause to the trustworthiness and the low and high are the effect, as shown in figure 32. From the section 4.2.5, the result states that “feedback coming from a highly experienced user is considered mostly trustworthy to download an application”. The above statement is in favor of many interview participants who coated that “if I am provided with an option to view the user’s previous history it would be really helpful to trust/distrust”. Another interviewee stated, “it would be really interesting to see how much time did a user spent on the application before writing a review”. From the above, it can be concluded that low experience is a cause for high untrustworthiness.

5.1.4 Cause 4: Latency of the feedback

While a user is looking for a good feedback that is reliable to judge an application, the top 10 to 15 feedback available for that application is mostly considered. In the transcripts, most of the users looked for the latest feedback to judge whether to download an application or not. Considering a nominal scale of old and latest for analyzing the relation with the trustworthiness.

![Figure 33: Old latency in the feedback cause untrustworthiness](image)
As specified in the section 4.2.5, a graph is plotted to show the linearity of the graph between the trustworthiness in relation with the latency of the feedback, as illustrated in the Figure 33. The resultant graph was linear, and towards the origin, this infers to the trustworthiness in the feedback increases with the latency in feedback. The trustworthiness is minimum when the old feedback is considered; that is untrustworthy feedback comes from the old sources. Therefore, the latency of the feedback has an effect on untrustworthiness.

5.1.5 Cause 5: Inclusivity in feedback

A user looking at the feedback might look for positive and negative statements about the application, which helps the user to classify the application, with which he may be able to judge the application. The transcripts were all in favor of similar feedback to be trustworthy. Considering a nominal scale of diverse and similar for analyzing the relation between the trustworthiness and the inclusivity in the feedback.

![Figure 34: Diverse inclusivity cause untrustworthiness](image)

Trustworthiness depends on the feedback that is similar to evaluate since the most practitioners consider similar feedback. From the transcripts in the section 4.2.5, a linear graph is presented to understand the relation between the inclusivity in the feedback and the trustworthiness, as shown in Figure 34. The resultant graph shows that the feedback increases with the similarities in the latest feedback. The diversity of the information of the feedback causes untrustworthiness, as the feedback doesn’t agree with any other feedback. So, Inclusivity in feedback is considered as a cause for untrustworthiness.

5.1.6 Cause 6: Applicability of information

A user wants to know about the functionality before downloading the application. User generally looks at the description of the application provided in the application stores. For a better understanding of the functioning of the application, the user tends to follow with the latest ratings. The application is judged based on the functionality given in the reviews, so the trustworthiness relies on the functionality provided by the reviews. The information produced by the user in feedback contains the functionality of the application, is determined to be applicability from the table 4.2.4.1.
A nominal scale is considered to analyze the effects on trustworthiness, represented in the figure below.

![Figure 35: Non-applicability cause untrustworthiness](image)
Exploring the above cause and effect relationships, the non-applicable information i.e., the feedback without containing any functionality of the application is considered mostly untrustworthy. The conclusion is derived from the transcripts stating the word ‘functionality’. One of the interviewee said that “I was bored and looked at an application, ‘playing poker’. I looked at the description of the application and the feedback, nothing really matched. I downloaded it anyway, but the application description was wrong”. Another interviewee mentioned that “when there is no description available, user provided feedback will be the description of the application”. By the statements it can be concluded that the non-applicable feedback is untrustworthy, as shown in Figure 35.

5.1.7 Cause 7: Categorizing the user needs

Different user’s look up for fulfilling their needs in the mobile application stores. An interviewee quoted as “I was looking for a good health application which keep tracks of my daily steps while jogging, and I have been looking for the application which fulfills my needs, and I found an application. I read the description provided and found the application is really helpful and so looked at the feedback. Found the first comment to be, this is a good application for keep track of swimming records, and so I moved on”. From the given explanation it is clear that finding a trustworthy feedback depends on the user needs and what user is looking for.

A nominal scale is considered for analyzing the relationship between the cause and the trustworthiness.

![Figure 36: Misclassify needs cause untrustworthiness](image)

By exploring the above cause and effect relation between categorizing the needs and trustworthiness, the defined nominal scale helps in determining the trustworthiness. Categorizing the needs is the cause, and it is affecting the trustworthiness, then the nominal scale obtained classify and misclassify. Elaborated information is considered to be mostly trustworthy as per the results obtained in the transcripts, as shown in Figure 36. As determined in the section 4.3.5, the relation is that along with the classification of the information in the feedback, the trustworthiness increases. By the graph, it is clear that the misclassifying the information is considered mostly untrustworthy. So it can be concluded that categorizing the needs effects the untrustworthiness.

5.1.8 Cause 8: Dependability on reviewers

Dependability on reviewers is the likeliness with which a user prefers to download the application based on the review posted by a closely related person, or a socially related person is the dependability on users. A recommendation may come from different reviewers to try the application; the user would like to make a choice based on the level of honesty of the person that is suggesting the application. Drawing a cause and effect relation determining the effect on trustworthiness is presented in Figure 37.
Considering the dependability as the cause that is affecting the trustworthiness, there could be two possible cases, honesty and dishonesty. Most of the interviewees preferred that the reviews from the socially connected people are more trusted. Honesty also means the honesty in the information provided by the user. The information provided by the user should be crisp and clear with at least two or more words to be considered trustworthy, as per the analysis of the transcripts, as shown in Figure 37. As shown in the section 4.2.5, the graph infers that the with an increase in the honesty of the information provided by the reviewer, trustworthiness also increases. The dishonesty of the source and the source provided information causes untrustworthiness. Hence, it can be concluded that the dishonesty is a cause affecting the untrustworthiness.

5.1.9 Cause 9: Reliability in information

The information presented by the reviewer could be based on the application or just the feelings of the user. A user looking for the feedback posted online user looks at the information more than the rating given to the application. The reliability of the information deals with the possibilities of information to be dependable to download the application. One of the interviewees stated that the “while looking for a good application, the number of negatives and positive ratings count but the information provided by the already used user matter a lot”. Another interviewee stated that “I have seen many feedbacks that gave a 5star rating but the posted review is just stating that ‘great application’, I will consider it's not trustworthy”. Considering a nominal scale as discussed on 4.2.4.1, as low, high and drawing a cause-effect relation.

From the figure above, the trustworthiness is the factor, and the reliability is the cause that is affecting the trustworthiness. Trustworthiness can be affected by the reliability in a nominal scale of high and low. According to the frequency of occurrence of the word reliable in the transcripts, the generated descriptions are followed, and the result is that the with a high reliability of the information provided by the reviewer, the trustworthiness also increases. The results are demographically shown in the section 4.2.5.1, according to which the conclusion is made that a low reliable information causes low trustworthiness, as shown in Figure 38.
5.1.10 Cause 10: Compactness of the review

When looking for the feedback and the review given in the feedback, the importance is given to the review which is short and strict to the point. According to the interviewee transcripts, “the information should not be so long that I have to skip it and also the feedback should provide the information about the application”. Satisfying the needs of the user by mentioning the functionality of the application and at the same time the feedback information should not be too long, is the compactness of the review. Nominal scale is considered to analyze the cause and effects on the trustworthiness.

![Compactness of the review](image)

Figure 39: Short Compactness cause untrustworthiness

From the figure 39, the trustworthiness is the factor, and the compactness of the review is the cause that is affecting the trustworthiness. From the results presented in 4.2.5, as the length of the information provided in the feedback, that contains both the positives and negatives decreases, the trustworthiness also decreases. From the above fish bone diagram, it is clear that the short complexity increases the untrustworthiness in the feedback.

5.1.11 Cause 11: Consistency across ratings:

User considers different ratings when looking for an application. All the Interviewees agreed that they look at more than one rating before downloading the application. One of the interviewees pointed that “I look for at least 10 to 15 reviews given for a particular application before downloading”. Along with the ratings, user looked at the consistency in the feedback, that is the number of negatives ratings and positives ratings the application has. Another interviewee said that “I most likely download an application seeing that the number of positive ratings the application has”.

![Consistency across ratings](image)

Figure 40: Inconsistent ratings cause untrustworthiness

A nominal scale is considered to analyze the relation of the cause to the untrustworthiness. Consistent and inconsistent is considered as two sub-factors affecting the trustworthiness. From the results presented in the table 4.2.5, it can be seen that along with the increase in consistency across different ratings, the trustworthiness also increases. Hence the inconsistent ratings have an effect on untrustworthiness, as shown in Figure 40.
5.2 Exploring the causes of untrustworthiness in the user feedback with respect to developer’s perspective

RQ 1.2: What are the causes of untrustworthiness towards the users’ feedback, provided in the mobile application stores while developing or updating applications, from developer’s perspective?

Analyzing the results obtained in the section 4.3.4, nine causes affect the trustworthiness of the user produced feedback in the mobile application stores. The description of the causes and the frequency of occurrence of each of the nine causes in the transcripts are mentioned above. The section explores the causes of untrustworthiness from the developer’s perspective, as shown in the Figure 41, as a fish-bone diagram.

![Figure 41: Causes of untrustworthiness (developer)](image)

5.2.1 Cause 1: Language Complexity

The information in the feedback should contain technical terms when specifying a problem to be well understood by the developers. The developers have to distinguish that the information in the feedback to be a bug report or feature request, to analyze the application. Developers prefers technicality in the language to identify the key concepts that their application is lacking. The sentence is inferred from an interviewee; he said “We look to get better over time, and that is by analyzing the feedback, the feedback should be technically sound and verbally correct. This gives us a better chance of exploring the possibilities for improvement”. Some of the interviewees focused more on the statements that are grammatically accurate and are pragmatic. All the interviewees felt that the language complexity is a factor that affects the trust or distrust in the feedback.

Considering a nominal scale for better analysis of the language complexity in relation with the trustworthiness, figure 42 is derived.

![Figure 42: Simple language cause untrustworthiness](image)
As per the frequency of the occurrence calculated in the section 4.2.4; The nominal scaled helped to prove the linearity that exists with the trustworthiness in relation with the language complexity, as shown in Figure 42. The derived relation from the section 4.2.5 is, ‘complex language is considered mostly trustworthy to download an application’. Like the simplicity in the language increases, the trustworthiness gets lower or untrustworthiness increases. So, the untrustworthiness in the reviewer provided feedback depends on the language complexity in the information.

5.2.2 Cause 2: Experience of the user

The review process is where a developer finds some major faults that will not arise at the testing level; hence it is critical to evaluate every single feedback. The statement is inferred from the transcript “we get reviews from different phone models since every model cannot be tested in labs. So the experience of the user in reviewing is highly considered for trust or distrust”. The experience of the reviewer could be a major factor influencing the trustworthy feedback as per the above statement. Having some in-application experience before giving a review, might help the user to analyze the application and the review will be trustworthy. The more the developer uses the application, the better will be the feedback given. Figure 43 can be drawn by considering a nominal scale for analysis of the effect of experience on the trustworthiness.

![Figure 43: Low experience cause untrustworthiness](image)

From Figure 43, the experience is considered as a cause to the trustworthiness and the low and high are the effect. From the section 4.2.5, the result states that ‘feedback coming from a highly experienced user is considered mostly trustworthy to download an application’. The developer interviewee’s said that “We always check the background of the user and previous reviews of him from google plus which is a great option to know the experience of the user”. From the above it can be concluded that low experience of the reviewer is a cause for high untrustworthiness.

5.2.3 Cause 3: Inclusivity in feedback

Developer’s working on an application might look for positive and negative statements about the application. This helps the user to classify the application, with which he may be able to judge the application. The transcripts were all in the favor of similar feedback to be trustworthy. The above statement is inferred from a transcript, “Both the positives in the feedback and negatives in the feedback are to be considered for better analyzing the results, we take negatives describes in the positive feedback and negative feedbacks to keep updating the applications”. Considering a nominal scale of diverse and similar for analyzing the relation between the trustworthiness and the inclusivity in the feedback.
Trustworthiness depends on the feedback that is similar to evaluate since most of the practitioners consider similar feedback. From the transcripts in the section 4.2.5, a linear graph is presented to understand the relation between the inclusivity in the feedback and the trustworthiness. The resultant graph shows that the feedback increases with the similarities in the latest feedback, as shown in Figure 44. The diversity in the information of the feedback causes untrustworthiness, as the feedback doesn’t agree with any other feedback. So, Inclusivity in feedback is considered as a cause for untrustworthiness.

5.2.4 Cause 4: Applicability of information

A developer wants to know exactly the missing gap that users expects an application should have. For a better overview of the feedback in the application stores, all the feedback provided by the user is considered. Applicable feedback should be in the context of the application; otherwise the feedback is not regarded trustworthy. The statement is inferred from the transcript stating that “we get daily 1000 of feedback, but when we are planning for the next release we will obviously consider all of them as every feedback is important, but the applicable information provided by the user is considered for requirements gathering”. The information produced by the user in feedback contains the functionality of the application, is determined to be applicability from the table 4.2.4.1.

Exploring the above cause and effect relationships between the applicability of the information and the untrustworthiness, from the section 4.2.5. The non-applicable information i.e., the feedback without containing any functionality of the application is considered mostly untrustworthy, as shown in the Figure 45. By the statements it can be concluded that the non-applicable feedback is untrustworthy.

5.2.5 Cause 5: Categorizing the user needs

While looking to update an application by adding some features, developer’s lookup to sustain in the market driven environment by considering the needs of the user. Developing organizations push the developers to understand the needs of the users and develop the application according to it. An interviewee mentioned that “there is a huge pressure on requirement engineers in the organizations to understand the needs of the user”. From the given explanation it is clear that finding a trustworthy feedback depends on the user needs and what user is looking for.
A nominal scale is considered for analyzing the relationship between the cause and the trustworthiness.

![Diagram](image)

Figure 46: misclassify needs cause untrustworthiness

The defined nominal scale helps in determining the trustworthiness for exploring the above cause and effect relation between categorizing the needs and trustworthiness. Categorizing the needs is the cause, and it is affecting the trustworthiness, then the nominal scale obtained classify and misclassify. Explained information is considered to be mostly trustworthy as per the results obtained in the transcripts. As determined in the section 4.2.5, the relation is that along with the classification of the information in the feedback, the trustworthiness increases. By the graph it is clear that the misclassified information is considered mostly untrustworthy. So it can be concluded that categorizing the needs effects the untrustworthiness.

### 5.2.6 Cause 6: Dependability on reviewers

Recommendations might come from all the sources, but some reviewers might be spam or biased reviews. In such cases, the dependability on the reviewers will be questioned, as the developers would prefer to work with the user reviewed information. The following statement is given by an interviewee, “I see a lot of reviews stating that the reviewer name is a ‘google user’ and the review consists of only one word. So we just move on saying that it is a dishonest opinion from the reviewer”.

Drawing a cause and effect relation to determining the effect on trustworthiness from the nominal scale derived in figure 4.2.4:

![Diagram](image)

Figure 47: Dishonesty cause untrustworthiness

Considering the dependability as the cause that is affecting the trustworthiness, there could be two possible cases, honesty and dishonesty. The information provided by the user should be crisp and clear with at least two or more words to be considered trustworthy, as per the analysis of the transcripts. As shown in the section 4.2.5, the graph infers that with an increase in the honesty of the information provided by the reviewer, trustworthiness also increases, as shown in Figure 47. The dishonesty of the source and the source provided information causes untrustworthiness.

### 5.2.7 Cause 7: Reliability in information

The information presented by the reviewer could be based on the application or just the feelings of the user. A developer would like to see the review of the application rather than just the rating given by the user. The reliability of the information deals with the possibilities of information to be dependable to follow up with the application. One of the interviewee
stated that the “More than the ratings provided by the user, the reviews matter”. Another interviewee stated that “the information provided must be reliable, the ratings that say it’s a great application doesn’t count”. Considering a nominal scale as discussed on 4.2.4.1, as low, high and drawing a cause-effect relation we get,

![Figure 48; Low reliability cause untrustworthiness](image)

From the figure above, the trustworthiness is the factor and the reliability is the cause that is affecting the trustworthiness. Trustworthiness can be effected by the reliability in a nominal scale of high and low. The results are that with a high reliability of the information provided by the reviewer, the trustworthiness also increases. The results are demographically shown in the section 4.3.5.1, according to which the conclusion is made that a low reliable information causes low trustworthiness, as shown in the figure 48.

### 5.2.8 Cause 8: Compactness of the review

Developers look for further developments in the applications, by viewing the reviews and so when the developers are looking for a bug report, feature request, or a crash, they look for long reviews. According to the interviewee transcripts, “Review should be long and understandable, if you are reporting a bug or a crash, the lengthy reviews will be more understandable if they are well written”. From the above statement, it is inferred that the process of developing involves coping up with all the reviews, but lengthy feedbacks are also studied for a better understanding. To analyze the cause and effects on the trustworthiness, a nominal scale is considered from section 4.2.4.

![Figure 49: Short compactness cause untrustworthiness](image)

From the figure above, the trustworthiness is the factor and the compactness of the review is the cause that is affecting the trustworthiness. From the results presented in 4.2.5, as the length of the information provided in the feedback decreases, the trustworthiness also decreases. From the above fish-bone diagram in figure 49, it is clear that the long complexity increases the untrustworthiness in the feedback.

### 5.2.9 Cause 9: Consistency across ratings

All the Interviewees agreed that they look at more than one rating for the development of an application. One of the interviewees pointed that “Generally for getting an idea of what is going on, we have to study at least 200 to 300 ratings before developing an application”. Along with the rating developers also look to maintain consistency in the feedback, that is the
number of negatives ratings and positives ratings the application gets. Another interviewee said that “Mostly when considering to update an application we look at the number of negatives ratings and positive ratings an application gets, so that the gap could be identified”. A nominal scale is considered to analyze the relation of the cause to the untrustworthiness.

![Inconsistent ratings cause untrustworthiness](image)

Consistent and inconsistent is considered as two sub-factors affecting the trustworthiness. From the results presented in the table 4.2.5, it can be seen that along with the increase in consistency across different ratings, the trustworthiness also increases. Hence the inconsistent ratings have an effect on untrustworthiness, as represented in figure 50.

## 5.3 Inclusion and exclusion criteria for the developers

**RQ 2:** What is the inclusion and exclusion criteria required by the developers to update the applications in the mobile application stores with respect to the feedback gathered from the users?

The above section shows the causes of untrustworthiness from both the user’s perspective and the developer’s perspective. The following section aims to present a model to propose the inclusion and exclusion criteria required by the developers to update the applications in the mobile application stores concerning the feedback gathered from the users. From the data collected, there are two extremes that is two nominal scales of every factor. By exploring the results, the two extremes can be matched to any one of the themes that are trustworthiness, or untrustworthiness.

The evaluation criteria for the developers is based on, how the application could sustain in the present market trends. The users look for better application for fulfilling their respective needs. Considering customer satisfaction as the main aim for development of the application, the commonly agreed points should be continuously churned to obtain an optimal state to sustain in the market. By considering the network created in the results, a theoretical model can be presented which results in an increased trustworthiness in the feedback from the developer’s perspective.

Venn diagram in figure 51 is for the causes of untrustworthiness in the user feedback for both the users and developers. The sub-causes that are considered in the nominal scale are considered as ‘a and b’. According to the analysis done in the previous section, the codes that affect the users and developers are determined. And so considering the untrustworthiness as the class and the users and developers as sets in the class the following demographic representation is made.

Form the representation, the following characteristics are determined

- Users = {1a, 2b, 3a, 4a, 5a, 6a, 7a, 8a, 9a, 10b, 11a}
- Developers = {2a, 3a, 5a, 6a, 7a, 8a, 9a, 10a, 11a}
- Users intersection developers = {3a, 5a, 6a, 7a, 8a, 9a, 11a}
Similarly considering a Venn diagram both the users and developers to determine the points of trustworthiness from the results obtained and the analysis done in the above sections.

Users = \{1a, 2b, 3a, 4a, 5a, 6a, 7a, 8a, 9a, 10b, 11a\}
Developers = \{2a, 3a, 4a, 5a, 6a, 7a, 8a, 9a, 11a\}
Users intersection developers = \{3a, 5a, 6a, 7a, 8a, 9a, 11a\}

The analysis states that the developers had a different perspective of analyzing and segregating the feedback that is presented by the user. Developers may exclude the untrustworthiness causing factors of users as they tend to develop the application. But knowing the customer value to the product and the unhappy ratings are equally important. Both the positive ratings and the negative ratings must be considered by the developers to maintain the stability with
the market. And so the common points are to be considered more trustworthy as both the user and developers agreed that to be trustworthy.

An Inclusion and exclusion criteria for the developers to evaluate the results obtained after mining for the user feedback can be drawn from the above Venn diagrams. The criteria proposed is intended to help the developers for the better segregation of the feedback obtained.

![Theoretical framework for inclusion and exclusion criteria](image)

Figure 53 represents a theoretical framework for inclusion and exclusion criteria, it can be interpreted into 4 quadrants,

- **Q1**: Maximum criteria for inclusion
- **Q2**: Minimum criteria for inclusion
- **Q3**: Minimum criteria for exclusion
- **Q4**: Maximum criteria for exclusion

Each quadrant is explained in section 5.3.1 and section 5.3.2.

### 5.3.1 Inclusion criteria:

Inclusion criteria are the characteristics that a developer must follow to achieve the maximum trustworthy reviews. Inclusion strategy helps in focusing on the reviews that are more relevant and reliable. The approach also enhances the process of gathering the feedback by segregating the feedback to very important, less important and not important. As every user provided feedback help in developing the application, by driving the development team towards the market needs and organizational needs. It helps the developer to distinguish between in obtaining the eligible feedback to develop the application further.
In quadrant 1: the causes that relate to the high trustworthiness are mentioned. From the trustworthiness Venn diagram, the intersection of the causes among the users and developers that are commonly stated in both the perspectives are taken. The step is done to keep track of the user’s, as they are the primary stakeholders of the life cycle. The thus taken perspectives can be applied to all the feedback that is available and can be segregated, this becomes the maximum priority for developers, as they might have intense discussions.

Q1: Maximum Inclusion criteria:
1. Applicability of information (applicable)
2. Consistency across ratings (consistent)
3. Reliability of information (high)
4. dependability on reviewers (honest)
5. categorizing the needs (classify)
6. Inclusivity of feedback (Similar)
7. Experience of reviewers (high)

In quadrant 2: the causes that relate to minimum trustworthiness are mentioned. The minimum trustworthiness is obtained from the above drawn Venn diagram, considering the set of only developers. Considering the causes of user and developers may exclude some information for the further development of the application. As the user considers only the information which is helpful in downloading the application, the perspective combined with the developers may result in the optimum value. But looking at the causes of the trustworthiness in the developer’s perspective will lead to knowing relevent facts that might result in development if application.

Q2: Minimum exclusion criteria
1. Language complexity (Complex)
2. Compactness of the review (Long)

5.3.2 Exclusion criteria:
The defined exclusion criteria are the characteristics that a developer may follow in case of data insufficiency after inclusion criteria. The exclusion criteria make the process of selecting the feedback systematic thus achieving an optimal result while processing the data. The feedback search strategy is the process of selecting the optimal data to access the feedback, which generates the optimal results. After the application of the inclusion criteria, the left over feedback is processed for the exclusion criteria. Exclusion criteria also must be considered as, every feedback provided by the user is necessary for the organization. This helps the developers in knowing the feelings of the users for further enhancement of the application. The model defines exclusion criteria as two categories, i.e., Minimum exclusion and maximum exclusion.

In quadrant 3: the causes that relate to the minimum exclusion are defined. The minimum exclusion criteria are defined using the Venn diagram of untrustworthiness. For presenting the criteria, the set of only the developer’s considered untrustworthiness causes are assigned. As the user feedback is important and no feedback could be rejected, the minimum criteria are chosen. After applying the minimum inclusion criteria, the rejected feedback is considered into the exclusion criteria. As the exclusion criteria are not supported by the user’s, the exclusion criteria could still be considered by the developers but the priority given could be low.

Q3: Minimum exclusion criteria
1. Compactness of the review (short)
2. Compactness of the review (long)
**In quadrant 4**: the causes that relate to the high untrustworthiness are mentioned. From the untrustworthiness Venn diagram, the intersection of the causes among the users and developers that are commonly stated in both the perspectives are taken. The maximum exclusion criteria are presented as both the users and developers agreed that to be untrustworthy. It is the maximum exclusion criteria for the developers for a significant segregation of the data.

**Q4: Maximum exclusion criteria**

1. Applicability of information (non-applicable)
2. Consistency across ratings (inconsistent)
3. Reliability of information (low)
4. Dependability on reviewers (dishonest)
5. Categorizing the needs (misclassify)
6. Inclusivity of feedback (Diverse)
7. Experience of reviewers (low)
6 DISCUSSION

The chapter is aimed to discuss on the findings of the research. The chapter covers the contributions of the study and relation of the findings with related works. Then the chapter covers the implication to the practitioners and implications for the researchers.

6.1 Contribution:

The main contribution of the study is to explore the causes that are affecting the trustworthiness that might lead to untrustworthiness. The causes can be studied from different perspectives. From the analysis chapter, it is clear that the causes of untrustworthiness from the user’s perspective are different from the developer’s perspective. Users look for the feedback to get an overview of the application, but the developers look at the feedback for developing the application, so causes differ from both the perspectives. By the following conclusions obtained from the study, the author proposed a theoretical framework of inclusion and exclusion criteria intended for better understanding of the trustworthiness in the user feedback.

The research identifies the difference of evaluation criteria between the feedback forums and mobile application stores.

6.2 Comparisons with the related works:

In the paper [6], the authors implied that meeting people in person is a traditional form of allowing people to communicate and it helped to a much wider accepting the trustworthiness. But the present paradigm is shifting towards a culture where the people are talking in a mediated communication, and that becomes a major risk factor. The communication will depend on terms such as dependence and reliability on the trusted party. The communication also bears on the trust expressed by both the parties and could possess a change over time [22]. In this case, the fairness of the transaction depends on trust and trustworthiness [22]. Mobile application stores possess secure exchange of information through continuous delivery of the feedback [36].

The significant finding of the following study is that the user’s perspective of the defined trustworthiness differs from the developer’s perspective. The difference suggests that the developers tend to obtain reviews to develop the application and so they often concentrate on the reviews with negative feedback more than the reviews that a simple price [1]. The purpose of the user looking for the ratings is downloading the application.

The first cause of untrustworthiness identified in the present study is understandability in the feedback which has also been identified by the papers [16][25]. The cause is affecting the trustworthiness of the user but not the developer. A literature review conducted in the paper [17] identifies some of the hints for spam detection in the user reviews in the e-commerce stores such as the “review difficult to understand” and “review full of meaningless adjectives” etc. The effect of understandability on the user reviews in the mobile application stores can be viewed as detecting meaningless reviews as spam reviews. The case of understandability is significant with the research done on user reviews of various e-commerce stores [16].

The user tends to look at the feedback to know about the application, so to be understood by a novice user, the feedback should not consist of technical terms [37]. The present study identifies that the developers have contradicting opinions from the users considering language complexity, as they preferred the language to be complex consisting of technical terms. In the paper [25], the author reflected from the study that in some cases presenting numerous technical words could be misinterpreted by the lay client. Language shouldn’t be complex and
need to be understood by a novice user also to be considered trustworthy. This theory could be replicated for the use in various e-commerce websites also, as specified in the papers [38][39].

Most of the e-commerce sites use reputation systems [6], word-of-mouth [14] and content analysis [7][15] to determine the trustworthiness to the user. In the paper [40], the author identifies causes for the trust or distrust in online feedback forums. One of the causes is the experience, trustee should be able to identify the experience based on the reputation given. This has been defined in the feedback forums such as e-Bay feedback forum [15], where feedback is assessed by the reputation of the user. The paper [26], also identifies that perceived experience could be a significant impact on trustworthiness. Considering the mobile application stores the also the experience of the user matters, according to the present study. The cause of untrustworthiness according to the analysis is inexperienced reviewer posting the feedback. The in-app experiences should be reflected by the user, as 75% of the interviewed subjects have agreed. There is a limitation to the cause, as there are no tools to measure usage of a particular user on a particular application [3]. This could be implied to the users, that before posting a review have at least some experience using the application, further constraints are implied in the future study.

In reputation system or trust models, the system considers the previous reputation available to determine the trustworthiness [6]. In the case of the mobile applications, the reputation of the user cannot be known due to various restrictions. So the users have opted to consider at least 10 to 15 feedback provided by various users to determine the trustworthiness. Here instead of considering the reputation of the users, they rely on the consistency in the feedback that is, the number of positive ratings to the negative ratings. Having consistency along with the similar feedback is important as this could have a significant impact on trustworthiness [17][5]. According to the frequency of occurrence shown in Figure 7, 62% agreed the similar feedback has an effect on trustworthiness.

According to the analysis of the study, users considered only the latest feedback to determine the trustworthiness. A user stated that “reading all the feedback is a hectic task instead will consider only latest 10 feedbacks and judge the application”. During the study, it has been observed users tend to read only the latest 10 - 15 feedback. The developers did not consider that the latency of feedback has an effect on trustworthiness. Developers dependency varies according to the release planning and road mapping [20]. The possibility might be that the developer would want to consider every feedback available to develop the application [41]. The cause of considering the latest feedback can be worn into any feedback forum as the latency includes new feedback and the user perceptions tend to change over time [20]. This cause is not discussed in any of the previous literature, as the e-commerce websites or the online feedback forums may consider diverse opinions from the users to perform content analysis [40].

According to the codes obtained, applicability deals with the information containing the functionality of the application. In various e-commerce stores such as tripadvisor.com [38], providing an accurate review of the product is considered to be trustworthy. This determines the product experience of the user and thus differentiating the spam reviewers [4][42]. In the mobile application stores, the in-app experience should be reflected in the review to be considered as a trustworthy review. The applicability reflects the in-app experience had by the user while using the mobile application. Considering the various e-commerce sites, the reflection of the applicability of the products is important according to the papers [12]. Applicable information should be reliable information. That is the information should be concise and crisp and should cover all the pros and cons of the application. In the model presented [26], reliability is the keen observation. Any inappropriate information presented in the review is rejected.
Presenting applicable information with the categorization of the needs is significant. Different users had different perspectives of analyzing the feedback. Different users have different needs to follow up with the application. The two terms used in categorization in the study; classify and miss-classify. In the present context classify means the information should be presented in a categorized way. Presenting information in a categorized way is considered in qualitative content analysis, as referred in the paper [14]. The analysis clearly implies that the feedback should be classified to be trustworthy. In various feedback forums categorization is considered as a term affecting the trust, if the information is presented in a classified way then it is considered as trustworthy [14][6].

Likeliness with which a user can download an application suggested by a socially connected person is the dependability. Both users and developers identified this as a factor for increase or decrease in the trustworthiness. Dependability of the reviewers is measured by honesty scale and from both the perspectives dependability is considered to be trustworthy when the reviewer is honest and vice versa. The user with a name such as, “a google user” is not preferred as the subjects of the interview considered to be untrustworthy. Socially related person is suggesting, is identified as the cause for an increased trustworthiness in online feedback forums as discussed in the paper [43]. Only a limited impact is projected by online spammers but malicious sources manipulate the reviews considering the rating and the textual comments [37][23].

Compactness of the review is measured in scale short or long. Interestingly users and developers had a contradiction regarding the length of the review. User’s preferred the review to be short, crisp and concise to the point but the developers preferred longer reviews to be more trustworthy. The factor of influence might be user prefers the review to be short but containing the functionalities of the application, but the developer might like the review to be long as the review is used for the development of the application [13]. Compactness is not mentioned in any of the previous literature; the reason might be the reputation systems used in feedback forums doesn’t consider the length of the review as it takes every review into consideration [6].

Aim for presenting the inclusion and exclusion criteria was to present a theoretical framework required by the developers to update the applications in the mobile application stores concerning the feedback gathered from the users. According to the study done in the paper [20], developers on an average consider 49% of the user’s feedback to plan for the next release. In such case, some important information given by the user is ignored while developing which might reduce the market share of the application [11]. So considering the cause, inclusion and exclusion criteria which help the developers to segregate the feedback obtained from the mobile application stores is presented.

A model has been implemented that can detect and classify the user feedback considering the language processing and sentiment analysis to classify the information presented by application reviewers. But the existing models doesn’t focus on the trustworthiness in the review [2][24][20]. The framework proposed is a representation of the causes of trustworthiness and how user’s and developer’s view trustworthiness in the user feedback. As the causes mostly agree with the literature on e-commerce stores, the inline causes in the framework could be incorporated to the sites where the feedback is considered to be important. Websites like tripadvisor.com, e-bay.com, amazon.com and other e-commerce sites consider trust and trustworthiness as an important aspect when considered user feedback, as the websites, has huge economic transactions [22][44]. To some extent the causes might apply to the websites presented, knowing the causes that might be affecting the trustworthiness is implicated to researchers.

The idea was to develop a framework that utilizes all the feedback generated in the application stores. In the mobile application industry, the software development is done continuously
satisfying the customer needs and keeping trend with the market [11]. In such cases, the user feedback produced in the application stores help the application developers for continuous releases. All the user feedback must be considered with a priority, as every feedback is valuable.

- Maximum inclusion criteria were decided based on the user and developer agreed trustworthiness. The criteria were considered as the process of development must involve users and developer constraints. Recent literature suggested that involving the user might result in the development of application and organization [45].
- Minimum inclusion criteria were completely based on the developers thought on trustworthiness. The criteria were considered as including the developer thoughts, might result in the selecting better feedback for the development.
- Maximum exclusion criteria were completely based on the developer thoughts on untrustworthiness. The criteria were considered as no feedback should be left out and applying the developer thoughts is necessary.
- Maximum exclusion criteria were decided based on the user and developer agreed thoughts on untrustworthiness. The criteria were considered as; from both the perspectives they are untrustworthy.

### 6.3 Implications to the practitioners

The criteria are implied to the developers in the mobile application industry, as this could solve most of the problem practitioner faces while gathering the requirements for continuous release. But the success depends on the application of the model, as the constraints need to be assigned carefully. For instance, when the feedback arrives in the raw data form, the feedback needs to be segregated by applying the causes in quarter 1 and then in quarter 2, which consists of language complexity. According to the developer, language must consist of technical terms. So running a language processor will produce better results than manual reading. The step could be repeated till it reaches a saturation point. Applying all the causes are crucial for getting a successful result. However, as it is not automated, the process is recommended to be in a loop till a saturation point occurs.

The criteria also serve as a potential requirement of “how a review is written to be considered trustworthy”. While developing the framework it has been observed that, some of the causes couldn’t be identified by the developers as there is no tool support. So the framework presented is also implied to the reviewers, as other users and developers might be benefitted while reading the feedback.

### 6.4 Implications to the researchers

The user related reviews have been explored previously to study the trust in various e-commerce stores. The generated frameworks were all looking at trust as a factor influencing the economic exchanges. But, the present study focus on the trustworthiness in the user given feedback, which can be looked further for improving the causes by generalizing it to all the population. Further, it can be suggested for validating the implications of the research on a large group of people by performing a large-scale survey. The results can be presented statistically and can analyze the outcomes by validating the current research.

The framework could be validated by selecting a few feedbacks presented in the mobile application stores and interviewing the practitioners about the selected feedback. Thus the results obtained could be validated with the framework, and necessary improvements can be made. Further, a case study can be conducted in a mobile application company to implement the theoretical model and analyze the outcomes. The theoretical model could be further modified by considering the ideologies of members of the organizational structure.
6.5 Threats to validity

Validation refers to the credibility of the results to know the extent to be true and not biased [29]. Validation is necessary for any empirical research. The threat to the validity of the results must be investigated and mitigated at the design of the study. In the following section, such factors are identified and mitigated.

- **Construction validity:**
The extent to which the intended operational measures accurately measures the measured [29]. In the conducted research there are possibilities of construction validity. The interview may be misinterpreted by the interviewees, that might lead to irrelevant data collected to the study. The risk was mitigated by, reviewing the interview questions with the supervisor to ensure the validity. On selection of the interview questionnaire, the questionnaire is peer reviewed before actual interviews and suggestions are noted. Data collection process was done simultaneously to interviews, so the risk is mitigated. Naming the codes might mean something else in a different context. To alleviate this, the code is given a tag such as ‘by the reviewer’ so the risk is mitigated.

- **Internal Validity:**
How the casual relations are explained and investigated to draw conclusions, is internal validity [29]. Possible risks involved in the present research are poor data analysis which might result in incorrect conclusions. The risk is mitigated by giving the best of abilities of the researcher, carefully following the guidelines provided by the supervisor. Moreover, there is no prior research to validate the relations among the causes. The risk is mitigated by replacing the literature with the view of the practitioners, who are facing the problems. Internal validity threat can also be mitigated by focusing on the future research for the application of the theoretical framework proposed in the research.

- **External Validity:**
The generalization of results to the whole set of the population [29], is the external validity. The threat was mitigated by selecting the set of the population for the study. The results could be generalized as the set of population considered was highly qualified and all of the participants know about the software development. The participants were from different categories, but the experience of using the mobile application stores was <3 years. Considering various sizes and various categories, the possibilities are getting more generalized data.

- **Theory validity:**
There is a possibility that the theory generated through the interviews possess a limitation. Some important causes that may affect the trustworthiness may be left out due to considering less number of interviews. As no prior research has been done on untrustworthiness in the mobile application stores, the research forms a base for the future researchers.

- **Other limitations:**
The codes are named by the author as per the sentences given in the transcripts. The codes are named based on the relevance and appropriateness.
7 CONCLUSION

The empirical research aims to propose a theoretical framework required by the developers to update the applications in the mobile application stores concerning the feedback gathered from the users. The model tries to incorporate trustworthy causing factors to provide the developer a better visibility by segregating the feedback obtained from the users. An interview-based survey has been implemented for the data collection and thematic analysis is followed by the analysis of the collected data. Various perspectives of viewing the user feedback in the mobile application stores have been the outcomes of the study.

User feedback in the mobile application stores is considered to be essential for both the users as well as developers. Users find the feedback helpful for downloading the application where the developer find the feedback useful for further development of the application. The study identifies that trustworthiness in feedback plays a critical role in choosing the application.

The goal of the study was to explore the causes of untrustworthy feedback in the mobile application stores. The causes of untrustworthiness in the user feedback has been explored, and the conclusions were both the perspectives were contradicting few causes, and both were agreeing in few causes. Based on the criteria the theoretical framework is presented.

A summary of the result is presented below;

RQ1.1: What are the causes of untrustworthiness towards the users’ feedback, provided in the mobile application stores while downloading the applications, from user’s perspective?
Untrustworthy causes identified in the study are – Understandability in feedback (low), language complexity (complex), experience of the reviewer (low), latency of feedback (old), inclusivity in feedback (diverse), applicability of information (non-applicable), categorize the needs (misclassify), dependability on users (dishonesty), reliability of information (low), compactness of reviews (long), consistency across ratings (inconsistent).

RQ1.2: What are the causes of untrustworthiness towards the users’ feedback, provided in the mobile application stores while developing or updating applications, from developer’s perspective?
Untrustworthy causes identified in the study are – language complexity (simple), experience of the reviewer (low), inclusivity in feedback (diverse), applicability of information (non-applicable), categorize the needs (misclassify), dependability on users (dishonesty), reliability of information (low), compactness of reviews (short), consistency across ratings (inconsistent).

RQ 2: What is the inclusion and exclusion criteria required by the developers to update the applications in the mobile application stores with respect to the feedback gathered from the users?
Using the perceived trustworthiness of the developers as well as users a theoretical framework has been discussed. The inclusion and exclusion criteria has been developed in four categories, Quadrant 1 discussed the maximum inclusion criteria, Quadrant 2 discussed the minimum inclusion criteria, Quadrant 3 discussed the minimum exclusion criteria and quadrant 4 discussed the maximum exclusion criteria.

The framework is implied to the developers, to help in knowing the trustworthiness in user feedback. The framework is also implied to the reviewers of the mobile application stores to understand better on writing a trustworthy review. Future work will be on performing a large scale survey to validate the findings and to generalize the causes to the whole population. Also, the theoretical framework presented could be validated by interviewing the practitioners, by explicitly selecting some feedback from the mobile application stores.
REFERENCES


Interview Questionnaire:

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1. Did you develop an application that is on the Google Play app store?

2. Have you ever given a feedback for a software application?

3. What is the name of the Android application for which you have given most feedback?

4. Please select a feedback that you think is interesting to evaluate for the application you mentioned above.

Please rate the following statements from 1 to 5, 1 being strongly disagree to 5 strongly agree: And please justify your answer in 1 or 2 statements

5. Do you agree with the feedback mentioned above? Why do you agree?

6. Is the feedback easy to understand? According to you how important is it that you should understand the feedback for downloading an application?

7. Do you think that the feedback is trustworthy? According to you define trustworthy.

8. Do you think that the feedback is important for other users? Why?
9. Anything else you would like to state about the feedback?

Thank you for your answers so far. We would appreciate more ratings. The more different types of feedback you are able to rate the better for the study.

10. I am doing research in the topic, trustworthiness in the user feedback and the importance of that in mobile application stores. Before knowing about this study, did you care about the feedback for software applications?

11. I now think that the quality of feedback is important.

12. In your eyes, what should be done to overcome the potential problems of feedback? You may be creative. Important is that you believe that your recommendation would really solve the problems.

13. In which year were you born?

14. How many feedbacks for software applications have you given in total in your life? An approximate estimate is ok if the number is large.
## Interview developer

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1. Did you develop an application that is on the Google Play app store?

2. What is the name of the most recent Android application you were involved in?

3. Please select a feedback that you think is interesting to evaluate for the application you mentioned above.

Please rate the following statements from 1 to 5, 1 being strongly disagree to 5 strongly agree: And please justify your answer in 1 or 2 statements.

4. Do you agree with the feedback mentioned above? Why?

5. Is the feedback easy to understand? According to you how important is it that you should understand the feedback for downloading an application?

6. Do you think that the feedback is trustworthy? Why?

7. Do you think that the feedback is important for other users? Why?

8. Anything else you would like to state about the feedback? Why?
9. I am doing research in the topic, trustworthiness in the user feedback and the importance of that in mobile application stores. Before knowing about this study, did you care about the feedback for software applications?

10. I now think that the quality of feedback is important

11. In your eyes, what should be done to overcome the potential problems of feedback? You may be creative. Important is that you believe that your recommendation would really solve the problems.

12. In which year were you born?

13. How many feedbacks for software applications have you given in total in your life? An approximate estimate is ok if the number is large.

14. What was your most recent role for the software application you have developed?

15. How many feedbacks for your software application have you studied?

16. How many feedbacks from other software applications have you studied for the development of your own application?

17. For how many years have you been working with software development?

18. What is your educational background?
Trustworthiness depends on the socially related persons.

A helpful feedback is usually one that has a clear message. It should be easy to follow and not too long, as long feedbacks are not even read completely. Understanding is very important to be able to depend on the feedback. If the feedback doesn’t make sense or it is not understandable, it is not considered trustworthy.

Trustworthiness is not obtained from just one feedback. An untrustworthy feedback will be ignored. Ununderstandable feedback is considered untrustworthy. The feedback should be short and straight to the point. Feedback that is not well organized is not considered trustworthy. Feedback that is categorized is considered as trustworthy.

Feedback should be clear and understandable, as there are no technical terms used. Feedback should be clear and understandable to be trustworthy. Feedback should be in English to be considered trustworthy. Trustworthiness is considered from more than one feedback. Feedback is considered trustworthy when it says anything about the application. Feedback should be understandable to be considered trustworthy. Feedback that is categorized is considered as trustworthy.

One trustworthy feedback is not enough to judge an application. Untrustworthy feedback contains no language quality. Understandable feedback is considered trustworthy. Trustworthiness is considered only with the latest feedback. Untrustworthy feedback is quality feedback. Ununderstandable feedback is not considered trustworthy.

To be trustworthy, information should be legible. To be trustworthy, information should be well written. Trustworthiness depends on the socially related persons. People check out the user who is writing the feedback.

If the person is related to you and you trust him then it is important. Inapp experience is important to be able to depend on the feedback. Feedback is considered trustworthy when it says anything about the application. Feedback is considered trustworthy when it is written by the socially related persons. Feedback that is categorized is considered trustworthy. Feedback that is well organized is considered trustworthy.

Feedback depends on the source and the application. Feedback that is written by the socially related persons is considered trustworthy. Feedback that is categorized is considered trustworthy. Feedback that is understandable is considered trustworthy. Feedback that is well organized is considered trustworthy.

User likes to skip untrustworthy feedback. Untrustworthy feedback contains no language quality. Feedback is considered trustworthy when it matches the user’s experience. Feedback is considered trustworthy when it is written by the socially related persons. Feedback can be skipped if it consists of some terms that the user doesn’t understand.

People are likely to trust the recommendations from socially connected persons. People check the user who is writing the feedback. If the user agrees with the feedback then it is considered trustworthy. People trust the feedback of the socially related persons.

Trustworthiness often depends on the source of the information. Dependence on the source must be avoided to be able to understand the feedback. Trustworthiness often depends on the person who is writing the feedback. Feedback can be considered trustworthy when it is written by the socially related persons. Feedback that is understandable is considered trustworthy. Feedback that is understandable is considered trustworthy.

Considering different perspectives might help in judging the application. It is important to know the perspectives of the users who are experienced in using the app. The persons should be trusted before considering their suggestions. People are likely to trust the recommendations from socially connected persons.

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Feedback is trustworthiness when it contains functionality of the application.

Users relate their experience to the feedback to find its trustworthiness. They may rely on the feedback provided, or they may not, based on the explanation presented.

User will not rely on the feedback provided, as it depends on his perspective. Feedback should be understandable to be considered trustworthy.

Trustworthiness in the feedback is measured with the feedback that is legible and clear. Trustworthiness is obtained from the number of downloads. Users look for first impressions in the feedback.

Trustworthiness is considered before downloading an application. It gives an overall opinion of the application and users experience in the feedback.

Feedback speaks about the internal features and it is considered to be trustworthy. It has few flaws and the feedback tells about them. Feedback should contain both the pros and cons to be trustworthy.

Trustworthiness is considered with the feedback that is legible and clear. Trustworthiness is based on the inapp experience. I would usually go with more personal reviews than positive or negative exaggerations and exclamations because it speaks about both personal interests as well as expenses involved. Trustworthiness comes by saying exactly what the application does.

I wouldn't rely on the feedback provided, as it depends on his perspective. Technical and hard to understand for a novice user. Untrustworthy feedback couldn't be understood.

Feedback contains of only basic language and vocabulary, and it's a good thing. Feedback consists of only basic language and vocabulary, and a logic. Trustworthy feedback consists of basic language.

It is very important to have higher and other feedback. Feedback should be understandable to be considered trustworthy. Feedback should be consistent with both the pros and cons.

Understanding feedback is essential to the user's experience. Feedback should be consistent with both the pros and cons.

Trustworthiness is due to persons writing information according to perspectives. Trustworthiness is not considered while trying an interesting application.

I would say this is a problem he has seen. Technical and hard to understand for a novice user. Untrustworthy feedback couldn't be understood.

I mean he is trying to explain his problem. Feedback wasn't stated clearly. Users look for first impressions in the feedback.

Users could rely on the feedback based on the information it contains. Untrustworthiness is due to persons writing information according to perspectives.

Because the flaws are explained and it is useful for customers using that scenario, feedback is considered trustworthy. If feedback is considered trustworthy, it is important to consider both the pros and cons.

Feedback should contain both the pros and cons to be trustworthy. Feedback should contain both the pros and cons to be trustworthy.

Feedback is considered before downloading an application. Feedback is considered before downloading an application. Trustworthiness is obtained from the number of downloads.

Because the user is experienced, feedback is considered to be trustworthy. Feedback is considered before downloading an application. Feedback is considered before downloading an application.

I wouldn't rely on the feedback provided, as it depends on his perspective. Technical and hard to understand for a novice user. Untrustworthy information always contains flaws.

I care about the feedback before downloading an application. Trustworthiness is based on the inapp experience. Trustworthiness is considered with the feedback that is legible and clear.

Feedback gives an overview of what the application does. It is very important to have legible and clear feedback. Feedback consists of only basic language and vocabulary, and a logic.

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Trustworthiness is based on the user's perspective of viewing the feedback. Trustworthiness is measured with the daily experiences. It is very important to have legible and clear feedback.

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Technical and hard to understand for a novice user. Untrustworthy feedback couldn't be understood.

Feedback is considered before downloading an application. Feedback is considered before downloading an application. It is similar to the feedback provided me.

Issues the users face in the app are considered be trustworthy information. Feedback can be trusted if the source used the application for a long time. Feedback can be trusted if the source used the application for a long time.

I would usually go with more personal reviews than positive or negative exaggerations and exclamations because it speaks about both personal interests as well as expenses involved. Trustworthiness comes by saying exactly what the application does.

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