An Approach to Elicit Trustworthiness Requirements in Blockchain technology

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Abstract. The leading Blockchain technology facilitates in many sectors including finance and healthcare. However, some technical challenges such as fraud and hacking arise may impact trust of users towards this technology. Requirement elicitation is one of requirement engineering activities to determine system requirements through discussion with stakeholders from documentation and underlying domain before executes it to development stage. The available methods for eliciting requirements, such as interviews and brainstorming are found to be time-consuming, and they fail to identify trustworthiness requirements. Further, eliciting requirements for Blockchain application is found to be challenging, as the properties of Blockchain application are different from the common technology. Moreover, the common elicitation practices are lacking on considering trust elements when eliciting requirements. Therefore, this research aims to propose a new automated elicitation approach which is a library for trust requirements of Blockchain application. A new trust taxonomy will be identified to classify and analyse the association between trust factors and its attributes. A proof concept prototype tool will be developed to realize the approach. Finally, this new approach is expected to enhance the acceptance of people towards application developed using Blockchain technology. Furthermore, this study will provide positive results in producing sustainable Blockchain application or software.

1. Introduction
Blockchain is a revolutionary technology functioning as distributed ledger of an event that have been executed by an application and shared among participated parties across the network as in [1]. The adaptation of this technology empowering in both public and private sector including finance firm [2], medical records management [3] and cloud computing [4]. Despite that, increasing hype such as hacking and fraud cases related to new technologies including Blockchain technologies create trustworthiness gap for user acceptability [5]. According to [6], trustworthy software application becomes a concern in order to adapt modernization computing experience and to promote a high-quality software product. Hence, requirements engineer must give more attention to trustworthiness aspect during requirements elicitation activities.

Requirements elicitation gain prominent attention in recent years as it has been found that the failure of software application is due to requirements error. According to [7] requirement elicitation is not a straight forward task and the most crucial and ambiguous step of the development process is requirements elicitation activity where a small mistake can cause disaster later. The commonly available methods for eliciting requirements, such as interviews and brainstorming are found to be
time-consuming, and they fail to accurately identify trustworthiness requirements. Therefore, eliciting requirements using the present approaches and techniques are prone to be inaccurate, inconsistent and incomplete, leading to instances of insecure software and application development [8]. It is also found that eliciting requirements for Blockchain application is challenging, as the properties of Blockchain application are different from the common software or application technology. In addition, the common elicitation practices are lacking on considering trust elements when eliciting the requirements. Currently, there is non-existing automated approach for requirement elicitation in Blockchain technology. Hence, by developing such automated approach may help as a guidance and facilitate the requirements engineer to elicit the critical trustworthiness requirements in Blockchain technology.

In this paper, we propose an automated approach that facilitates the elicitation of trustworthiness requirements for the development of application using Blockchain technology. We believe that the use of a domain library consisting of collections of trustworthiness requirements able to help requirements engineers to elicit requirements. Our work is focusing to develop the trustworthiness requirements which are the trust factors and its attributes library. In this work, the domain library is integrated with a proof concept tool called BChainReq for requirements engineer to verify their textual requirements. As an output, score, percentage and suggestion of trustworthiness requirements will be displayed by BChainReq to improve their requirements.

This paper is organized into four main sections: After the introduction, the second section presents the background of the study conducted in eliciting trustworthiness requirements for Blockchain technology. The third section presents the overview of our approach. The fourth section presents the discussion and conclusion.

2. Background

We developed a review protocol to explore for relevant studies by applying Kitchenham [9] systematic review approach. The essential phases of Kitchenham are divided by three stages which are planning, conducting and reporting. In the planning stage, we designed research questions which are:

1. What are the important trustworthiness requirements for Blockchain technology?
2. What are the existing works in requirements elicitation?
3. What are the trustworthiness requirements that are being considered during requirements elicitation?

The empirical studies were conducted by utilizing search engines, namely, Springer, IEEE Xplore, ScienceDirect, Scopus, Google Researcher, ACM Computerized Library, and Springer. The search keywords were used for different significant topics to ensure that all related papers are included. (Trustworthiness OR Trustworthy AND (Requirements OR Attributes OR Properties) AND (Elicitation OR Collecting) AND (Approach OR Method OR Techniques OR Model OR Pattern OR Template) AND (Blockchain) to gather all the relevant papers.

We applied inclusion and exclusion criteria as outlined in Table 1 to gather important studies. By analysing the title, abstract, and conclusion of the primary distinguished thinks about, we disposed of any irrelevant studies. After applying these steps, 80 studies were retained. Moreover, we accessed and evaluated the articles by checking the content of the articles. Irrelevant studies were rejected at this phase and the relevant studies will be examined. Out of 80 articles, there are only 10 articles are being considered for further review. The following stage was conducting the comparison analysis and reporting the related works.

| Table 1. Inclusion and Exclusion Criteria |
|------------------------------------------|
| Inclusion Criteria                      | Exclusion Criteria                        |
| Papers focusing on eliciting, gathering Blockchain | Papers do not focus on requirements elicitation |

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Papers focusing on tools, methods, approach and techniques used in requirements elicitation

We discovered 10 papers published between 2010 and 2018 that discussed on the topic of requirements elicitation approach in the beginning of software development. For each of the paper, we determined the type of contribution, and the domain of application of their approach.

2.1. Horspool's Algorithm
String-matching algorithms are important topics in the field of computer science in finding a place where one or a few strings are found in a huge body of content (e.g., information spilling, a sentence, a paragraph, a book, etc.). Its utilization covers a wide range especially in computer systems, applications in bioinformatics, recognizing copyright infringement, data security, pattern recognition, archive coordinating and text mining. Basically, the algorithms align the pattern with the starting of the text and continues shifting the pattern ahead till a match or the cease of the text is reached [10].

One of the commonly used string-matching algorithms is Boyer–Moore–Horspool algorithm or Horspool's algorithm. It is used in finding substrings in strings and was published by Nigel Horspool in 1980. This algorithm works by comparing each characters of substring to discover a word or the same characters into the string from left to right. When characters do not match, the search hops to the next matching position within the pattern by the value shown in the Bad Match Table [11].

2.2. Rule-based Algorithm
In this research, we constructed rule-based as a function to perform an exact pattern match on a string during string-matching process. It will return true if a match is found and false if a match is not found. This rule is constructed to calculate trust factors percentage and trustworthy percentage after the string-matching process ended. The rule is constructed as follow:

\[
\text{Trust factor score} = \frac{\text{Matched trust attributes}}{\text{Factor attributes}} \times 1 \tag{1}
\]
\[
\text{Trustworthiness percentage} = \frac{\text{Trust factor score}}{\text{Total Factor}} \times 100 \tag{2}
\]

The rule is used to calculate level of trustworthiness from the input (textual requirements). The input will be processed to get trust factor score. This trust factor score is formed based on string-matching of trust attributes. Trustworthiness percentage is gained based on matched trust factor. This rule functioning in BChain library to help requirements engineer calculate the percentage of trust requirements automatically and accurate results. With this formula, we can verify the percentage of the trust requirements with client-stakeholders. With this approach, client-stakeholders can further discuss on the quality of Blockchain requirements. Any disagreement can be highlighted during the discussion. Upon agreement, requirements engineers can resolve the result by modifying relevant requirements.

3. Overview of BChainReq Tool
BChainReq is a tool to support the analysis process of trust requirements for developing acceptable Blockchain application. This tool will help to assist requirements engineer to analysis the trust requirements or trustworthy level from client-stakeholder. Figure 1 illustrates the overview of the tool.
Figure 1. Overview of BChainReq Tool

Figure 1 illustrates the overview of BChainreq tool to be used by requirements engineer. The prototype has the ability to verify quality of trust requirements to have best fit of trust attributes and trust requirements of Blockchain trustworthiness requirements library based on the multiple test in real-time environment. The process involves:

1. Requirement return by stakeholders with requirements engineer to elicit the requirements of Blockchain application. These requirements return in textual form.
2. The requirements inserted into BChainReq tool to verify trust requirements.
3. The string-matching will be processed at this stage by comparing textual requirements with trust factors and its attributes that have been embedded in BChain Library by using Horspool’s algorithm.
4. Next, after the string-matching process ended, BChainReq will proceed to calculate trust factors level and trustworthiness percentage by using rule-based algorithm.
5. Further, BChainReq will proceed to calculate trustworthiness percentage by using rule-based algorithm.
6. The result of the string-matching process which are trust factors level and trustworthiness percentage will be displayed as an output to the stakeholders and requirements engineer.
7. Suggestion of missing trust requirements in the textual requirements will also be displayed.
8. From the result, requirements engineer and client-stakeholders can make change or end the process.

4. Discussion and Conclusion
The purpose of this research is to develop a new lightweight and functional proof concept tool to facilitates requirements engineer in analysing and verifying accurate Blockchain trust requirements. To achieve this goal, a trust requirements factors and its attributes are embedded in domain library which have been collected during systematic review phase. This tool will give benefits to reduce
human effort and time, cost, human interference in requirements elicitation stage. It also will help to
the gather the quality trust requirements from client-stakeholder’s requirements and aid the novice
requirements engineer to write accurate Blockchain trustworthy requirements.

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