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Faculty of Computer Science and Information Technology

**HYBRID REQUIREMENTS PRIORITIZATION SYSTEM USING
CUMULATIVE VOTING (CV) AND PLANNING GAME (PG) TO
PRIORITIZE REQUIREMENTS IN SOFTWARE DEVELOPMENT
PROJECT (CVPG - PRIOSYS)**

Said Mohammad Inamul Hafizzan bin Sairsaripudin

Bachelor's degree in Computer Science with Honours (Software Engineering)

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This project is submitted in partial fulfilment of the requirements for the degree of Bachelor's Degree in Computer Science with Honours (Software Engineering)

Faculty of Computer Science and Information Technology
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2023

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Abstract

Requirement Engineering (RE) plays an important role in Software Development Life Cycle (SDLC). RE process helps software development team to deliver high quality system solution. Inside this process there are several key activities in order to develop a successful system. One of them is Requirements Prioritization (RP). The term “Requirement Prioritization” refers to the process of defining the ordering or scheduling for accomplishing requirements according to the priority or importance of those requirements from the viewpoints of the stakeholders. The execution of the RP process in system development may aid the development team in focusing on fulfilling the most critical requirements outlined by the stakeholders’ desires. Nowadays, there are many techniques that can be applied in prioritizing requirements. Unfortunately, development teams of software have no idea which technique will yield the best outcomes, or when to implement them, because prioritizing could give poorly result if the wrong technique is used. Plus, it is noticeable that there is no technique that excels in every possible scenario. Some techniques may fit well but may not fit for other factors. Scalability, precision, and computation time are just a couple of the parameters that must be fulfilled in order to determine the best method to use. Besides, most of the conventional techniques are implemented manually in which the process is difficult and time consuming like Analytical Hierarchical Process (AHP). Thus, the system solution that will be developed called CVPG – PrioSys. The system is fully automated RP system that will be able to identify the importance of requirements based on the stakeholders’ selections. The system developed based on the hybrid technique by implementing Cumulative Voting (CV) in Planning Game (PG) will aid the issues of the number of requirements, time-consuming in execution during RP and accuracy in producing the results of ranked requirements. Moreover, multiple stakeholders will be able to utilize in voting the requirements in one project means that many viewpoints from different stakeholders may be expressed in one place.

Abstrak

Kejuruteraan Keperluan memainkan peranan penting dalam Kitaran Hayat Pembangunan Perisian. Proses ini membantu pasukan pembangunan perisian untuk menghasilkan system penyelesaian berkualiti tinggi. Selain itu, proses ini mempunyai beberapa aktiviti utama untuk membangunkan sistem yang berjaya. Salah satunya ialah Keutamaan Keperluan. Istilah "Keutamaan Keperluan" merujuk kepada proses mentakrifkan urutan atau penjadualan untuk mencapai kehendak mengikut keutamaan atau kepentingan keperluan tersebut dari sudut pandangan pihak berkepentingan atau pelanggan. Pelaksanaan proses Keutamaan Keperluan dalam pembangunan sistem boleh membantu pasukan pembangunan dalam menumpukan kepada pelaksanaan keperluan paling kritikal yang digariskan oleh keinginan pihak berkepentingan. Pada masa kini, terdapat banyak teknik yang boleh diaplikasikan dalam mengutamakan keperluan. Malangnya, pasukan pembangunan perisian tidak tahu teknik mana yang akan menghasilkan keputusan yang terbaik, atau bila untuk melaksanakannya, kerana keutamaan boleh memberikan hasil yang tidak tepat jika teknik yang salah digunakan. Tambahan pula, adalah jelas bahawa tidak ada satu teknik yang mampu memberi kepuasan yang maximum dalam setiap senario. Seseengah teknik mungkin sesuai pada sesuatu faktor tetapi mungkin tidak sesuai untuk faktor yang lain. Kebolehskalaan, ketepatan dan penggunaan masa hanyalah beberapa parameter yang mesti dipenuhi untuk menentukan Teknik yang terbaik untuk digunakan. Selain itu, kebanyakan teknik konvensional dilaksanakan secara manual di mana prosesnya sukar dan memakan masa seperti Analytical Hierarchical Process (AHP). Oleh hal yang demikian, penyelesaian sistem yang akan dibangunkan dinamakan CVPG – PrioSys. Sistem ini adalah sistem Keutamaan Keperluan automatik sepenuhnya yang akan dapat mengenal pasti kepentingan keperluan berdasarkan pilihan pihak berkepentingan. Sistem yang dibangunkan ini berdasarkan teknik hybrid, dengan melaksanakan Pengundian Kumulatif (CV) dalam Permainan Perancangan (PG), ia akan membantu isu kebolehskalaan, masa pelaksanaan dan memberi ketepatan untuk menghasilkan keputusan keperluan peringkat. Sistem yang dibangunkan di projek ini, ia dapat membolehkan pelbagai pihak berkepentingan untuk menggunakannya dalam mengundi keperluan dalam satu projek bermakna banyak sudut pandangan daripada pihak berkepentingan yang berbeza dapat diungkapkan di tempat yang sama

Chapter 1: Introduction

1.1 Background of the study

Requirement Engineering (RE) is one of the phases in the software development life cycle (SDLC). Since the RE process is an iteration of interchangeable the functional requirements (FRs), non-functional requirement (NFRs) and project constraints of the projects should meet based on the stakeholders' need, it involves with multiple stakeholders that may conflict their interest (Lamsweerde, 2012). For example, the first iteration focuses on the user requirements and second iteration will step on the system requirements. The engineers spend extra efforts during the initial business and user requirements early in the process. Later, they will go through into comprehending the detail of system requirements (Elgabry, 2016). Therefore, the ultimate goal of every software developer is that stakeholders' demands, and expectations are satisfied (Karlsson and Ryan, 1997).

One of the important processes of RE in software development is requirements prioritization (RP). RP helps to prioritize the requirements in order for the developer teams to know which requirements has high priority for the customer and need to be implemented in the current release (Jahan et al., 2019).

In recent studies, there are numerous techniques for prioritizing requirements. The most popular used technique based on the studies are Analytic Hierarchy Process (AHP), Planning Game (PG), Cumulative Voting (CV), Binary Search Tree (BST) and Numerical Assignment (NA) (Upadhyay and Singh, 2020). Each technique has its own advantages and disadvantages. Therefore, engineers and stakeholders should know their aims at the first place before they start to develop a system. This is because each technique comes with its own purpose, such as the number of requirements, cost, accuracy, the number of stakeholders and so on (Hudaib, Masadeh, Qasem & Alzaqebah, 2018). For example, AHP is complex to execute and time consuming, BST does not allocate any priorities values (Sufian et al., 2018),

PG ranks requirements in ordinal in which cannot prioritize the requirements quantitatively (Jahan et al., 2019), CV is inefficient for a large number of requirements (Somohano-Murrieta et al., 2020), while NA groups the requirements which may confuse the stakeholders (Sufian et al., 2018). In order to solve the limitation of these single techniques, this project uses hybrid technique by combining both CV and PG because CV is good in accuracy (Hudaib, Masadeh, Qasem & Alzaqebah, 2018) while PG is good in scalability (Tufail et al., 2019). Therefore, the project will deliver a RP system called CVPG - PrioSys that is based on hybrid techniques to prioritize requirements.

1.2 Problem Statement

RP is considered as one of the major activities in the RE phase. Ignoring its' importance will create to various difficulties in software development (Hujainah et al., 2018). Most software projects contain a high number of requirements in which they need to be prioritized. This is because some of the requirements are difficult to be simultaneously executed (Qaddoura et al., 2017). Since requirements are many, engineers will face difficulties as they do not know which requirements have to be implemented first based on their importance (Hudaib, Masadeh, Qasem & Alzaqebah, 2018). Therefore, ensuring stakeholder satisfaction and expanding the product's business potential depends mostly on making the right requirements selection during RP. Avoiding this risk could prevent the project from failing. (Tufail et al., 2019).

In recent studies, there are numerous techniques for prioritizing requirements used for software development. Unfortunately, businesses and developers of software have no idea which technique will yield the best outcomes, or when to implement them, because prioritizing could give poorly result if the wrong technique is used (Somohano-Murrieta et al., 2020). It is noticeable that there is no technique that excels in every possible scenario.

Some techniques may fit well but may not fit for other factors. Scalability, precision, and computation time are just a couple of the parameters that must be fulfilled in order to determine the best method to use today (Tufail et al., 2019). Therefore, to select the optimum technique is difficult as all of them have their own objective (Hudaib, Masadeh, Qasem & Alzaqebah, 2018). Besides, most techniques have to be manually executed and some techniques are difficult to carry out like AHP in which it needs the help from expert (Hujainah et al., 2018). As a result, the computation time become larger and tiring when there are a lot of requirements. Hence, supporting fully automated prioritization may reduce repetitive tasks (Hujainah et al., 2018).

Therefore, a web-based system will be developed by using the hybrid technique that is applying CV in PG. CV can cope the problem happens in PG because it able to rank requirements in ratio scale. Means that, the development team able to quantify how much requirement is important than others (Tufail et al., 2019). At the same time, PG can help to reduce the number of requirements for the stakeholders to vote. Instead of voting all the requirements in one place using CV techniques, stakeholders will classify the requirements into three classes such as optional, essential, and conditional. This will reduce the problem that exists in CV in which stakeholders have to divide \$100 between all requirements which become tiredness job when requirement becomes large (Jahan, et al., 2019).

1.3 Objectives

The objectives of this project are as follows:

- To investigate the existing RP techniques used during software development.
- To develop a web – based system (CVPG – PrioSys) of RP using the proposed hybrid techniques in prioritizing requirements during the system development process.

- To evaluate the proposed RP system, CVPG – PrioSys.

1.4 Methodology

This project would investigate about the techniques that are widely used in RP process during the software development before starting to develop the proposed system. The methodology, for the development of the system, used in this project is a conventional Software Development Life Cycle (SDLC) that is the Waterfall model. Winston Royce has introduced the model in 1970 in which the model is based on a sequential design process. The concept of the model is that one phase finishes before the next phase starts. There are six different phases such as:

1.4.1 Requirement Analysis

The aim of this phase is to understand the exact requirements of the client and document them appropriately. Developers usually spend more time in this phase because waterfall model demands that requirements be carefully documented before any other phase start. This phase includes two different activities such as:

- Requirement gathering and analysis

Firstly, all the requirements regarding the system to be developed are gathered from the clients or stakeholders. After that, the elicited requirements will be analyzed to provide a complete, precise, and consistent requirements. In this project, requirements are gathered from the existed literatures that are related to the subject domain, a system developed for prioritizing requirements.

- Requirement specification

These analyzed requirements are documented in the form of software requirement specification (SRS). The purpose of the document is to serve as a contract between development team and their customers.

1.4.2 System Design

In this stage, the development team analyze the specified requirements and transform them into a format that can be programmed using a programming language. It includes high-level design and detailed design. There are five diagrams with the Layout Design that are used in this project to do a modelling, such as Flowchart, Use Case diagram, Sequence Diagram (SD) Activity Diagram and Entity Relationship Diagram (ERD).

1.4.3 Implementation

During implementation phase, programmers do the actual coding to build the system based on the output of system design. Programmers will use any suitable programming language to develop the system. The programming language used to develop the RP system in this project is PHP, MYSQL and few scripting language such as HTML, CSS and JavaScript.

1.4.4 Testing

Testing phase is the process of verifying the system against the requirements documented in the first stage of SDLC. A group of testers will be selected to test the system. There are two types of testers such as alpha tester and beta tester. Alpha tester is a tester who in the development team while the beta tester is a tester that comes from the end user. If the

system does not meet the requirements, the system developed is send back to the developer team at the previous phase, the implementation phase, for further modification.

1.4.5 Deployment

If the testing phase approves the outcome, the development team will deploy the system into the production environment. In this project, the platform used is a web-based environment. Hence, the system will be launch online using suitable web hosting such as Infinity free after the verification is done and have been approved.

1.4.6 Maintenance

The last phase is called maintenance. This is the phase where the development team fixes the production bug or defect. If there is a bug found during the production, then the system will be maintained to solve any issues encountered.

1.5 Scope

This project focuses on the RP activity in SDLC. The target users of the proposed system along with the extent of functionalities that the project provides for respective users are as stated below:

- Stakeholders or clients

After the requirements are being classified, users would be given 100 points to distribute it to the requirements in each class. After the voting process done, the system would run the algorithm to rank the requirements and users able to view the ranked requirements shown by the system. The users will be given a time to accept the ranked requirements or reject.