A SEMI-AUTOMATED REQUIREMENTS PRIORITISATION TECHNIQUE FOR SCALABLE REQUIREMENTS WITH STAKEHOLDER QUANTIFICATION AND PRIORITISATION

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DOCTOR OF PHILOSOPHY

UNIVERSITI MALAYSIA PAHANG
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We hereby declare that We have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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FADHL MOHAMMED OMAR HUJAINAH

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Saving the best for last, to my soul (my mother) – Obeidah “Thank you for being besides me throughout these years and I am thankful to have you, you always motivate me to struggle and work hard”.

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ABSTRAK

Salah satu cara untuk memastikan kualiti sistem aplikasi adalah dengan mengambilkira proses penentuan keutamaan keperluan perisian. Proses pengutamaan keperluan perisian selalunya dijalankan untuk memilih kerperluan perisian yang penting sebagaimana yang dinyatakan dan dihasratkan oleh pihak berkepentingan sesuatu sistem. Ini menjadikan proses ini adalah satu proses yang penting dalam memastikan kualiti dan kejayaan pembangunan perisian sistem tersebut. Proses kuantifikasi dan keutamaan pihak berkepentingan perisian dilaksanakan adalah dengan tujuan untuk mengenalpasti dan memberi keutamaan kepada senarai pihak berkepentingan berdasarkan pengaruh yang mereka ada dalam memilih keperluan utama aplikasi. Oleh itu, penelitian ini memfokuskan kepada kaedah kuantifikasi keutamaan pihak berkepentingan dan juga senarai keperluan didalam sesuatu projek pembangunan aplikasi. Dalam masa yang sama, ianya juga mengambilkira isu yang dihadapi oleh teknik-teknik semasa seperti isu berskala besar, kelemahan didalam proses kuantifikasi keutamaan pihak berkepentingan, kekurangan dalam penjelasan bagaimana proses pemilihan ini dilakukan, ketiadaan kriteria penilaian pihak berkepentingan dan keberkatan yang kuat kepada keperluan manusia didalam memastikan kejayaan proses-proses ini. Isu-isu ini menjadi motivasi utama didalam penyelidikan yang dirancang dan dijalankan. Oleh itu, teknik untuk penyenaraian keutamaan perisian yang berskala besar dan bersifat separa automatik (SRPTackle) dengan mengintegrasikannya bersama teknik baru untuk proses kuantifikasi keutamaan pihak berkepentingan yang dinamakan sebagai StakeQP telah dicadangkan untuk menyelesaikan masalah yang dinyatakan diatas. StakeQP berkeupayaan untuk melakukan proses kuantifikasi keutamaan pihak berkepentingan berasaskan atribut penilaian baru yang dengan menggunakan teknik kepelbagaian atribut membuat keputusan yang bernama TOPSIS. Manakala, SRPTackle yang dicadangkan akan menghasilkan nilai keutamaan keperluan perisian dengan menggunakan algoritma K-Means, K-Means++ dan carian pokok binary. StakeQP pula telah diuji dengan menggunakan data penanda aras RALIC dengan menunjukkan StakeQP berupaya untuk mencapai ketepatan sebanyak 89.69% dalam proses kuantifikasi keutamaan pihak berkepentingan pihak berkepentingan. Manakala, StakeQP telah dinilai dengan menggunakan data penanda aras dari sistem pembangunan perisian yang sebenar yang berskala sedemikian dan besar dari segi senarai keperluan sistem dan juga pihak berkepentingan dengan menjalankan sebanyak tujuh (7) set eksperimen. Keputusan pengujian menunjukkan SRPTackle berupaya untuk memberi keputusan kepada pihak atau keperluan keperluan aplikasi pada minimum 93% dan maksimum 94.65%. Kesemua keputusan yang didapati menunjukkan StakeQP dan SRPTackle berupaya untuk melaksanakan proses kuantifikasi keutamaan pihak berkepentingan dan penyenaraian keperluan aplikasi dengan lebih baik dan berkesan berbanding teknik yang sediada dengan menggunakan masa yang lebih sedikit dan lebih efektif dalam mengatasi malapun yang dibincangkan diatas. Pada masa hadapan, kajian ini boleh difokuskan untuk menambah baik prestasi SRPTackle dan StakeQP dalam mengendalikan keperluan sistem yang bergantungan dan juga mengelasan pihak berkepentingan dengan set data yang berbeza dari projek perisian sebenar.
ABSTRACT

One of the gatekeepers of quality software systems is requirements prioritisation (RP) that is often used to select the most important requirements as perceived by system stakeholders. RP is considered as a vital role in ensuring the development of a quality system with defined constraint. Stakeholder quantification and prioritisation (SQP) is executed to quantify and prioritise the stakeholders of the system based on their impacts. The SQP plays a crucial role in identifying and selecting the most essential requirements to produce a successful system. Thus, this research mainly focuses on the RP and SQP domains. Although, the useful of the existing RP and SQP techniques, a close look discloses that these techniques face key challenges with respect to the scalability, shortage of SQP process, lack of low SQP implementation detail with respect to the non-existence of attributes measurement criteria and heavily need of highly professional human intervention in quantifying and prioritising the participating stakeholders and specifying priority value of each requirement in RP process, and lack of automation along time consumption in performing the SQP and RP processes. Hence, a new semi-automated scalable prioritisation technique (SRPTackle) integration with a new SQP technique (StakeQP) are proposed to address the reported key limitations. The StakeQP introduces new low-level implementation details to perform SQP automatically. The StakeQP is on the basis of the newly proposed new measurement criteria for each SQP attribute and using the multi-attribute decision-making method, namely, technique of order preference similarity to the ideal solution (TOPSIS). Furthermore, the proposed SRPTackle is based on the combination of the proposed StakeQP technique, the constructed requirement priority value formulation function and the employing of classifying algorithm (K-means and K-means++) and binary search tree. The effectiveness of SRPTackle and StakeQP are evaluated using a benchmark dataset of the actual software project (RALIC). Experimental implementation of the proposed StakeQP technique and comparative analysis against the existing SQP techniques have been conducted in order to evaluate the StakeQP performance. On other hand, seven experiments are conducted using the large sets of requirements with purpose of assessing the SRPTackle and comparing the SRPTackle performance results with other alternative techniques. The experiments show that StakeQP can produce accurate result of 89.69 %, while accuracy results of the SRPTackle are 93.0% and 94.65% as minimum and maximum accuracy, respectively, which are better than other existing SQP and RP techniques. Also, the findings demonstrate that the StakeQP and SRPTackle perform the SQP and RP process, respectively with less time consumption and are more effective in addressing the reported key limitations compared with other alternative techniques. Future research can dig deeper in improving the SRPTackle and StakeQP performance in terms of catering the requirements independencies and stakeholder classifications, respectively, along with extending the implication of the StakeQP and SRPTackle with different dataset of global software projects practices for better applicability.
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LIST OF SYMBOLS

\[ \Sigma \quad \text{Summation} \]
\[ \% \quad \text{Percentage} \]
\[ \geq \quad \text{Greater than or Equal to} \]
\[ \leq \quad \text{Less than or Equal to} \]
\[ \text{PIS} \quad \text{Positive Ideal Solution Value} \]
\[ \text{NIS} \quad \text{Negative Ideal Solution Value} \]
\[ S^* \quad \text{Separation Value of Stakeholder from the Positive Ideal Solution} \]
\[ S^- \quad \text{Separation Value of Stakeholder from the Negative Ideal Solution} \]
\[ \text{RC} \quad \text{Relative Closeness Value} \]
\[ h \quad \text{Hour} \]
\[ s \quad \text{Second} \]
\[ \in \quad \text{Element of} \]
\[ — \quad \text{Division} \]
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<th>Abbreviation</th>
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<tr>
<td>AMC</td>
<td>Attribute Measurement Criteria</td>
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<td>ASD</td>
<td>Agile Software Development</td>
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<td>AWV</td>
<td>Attribute Weight Value</td>
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<td>BST</td>
<td>Binary Search Tree</td>
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<tr>
<td>CD</td>
<td>Cognitive Driven</td>
</tr>
<tr>
<td>EA</td>
<td>Experience Attribute</td>
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<tr>
<td>EBA</td>
<td>Educational Background Attribute</td>
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<td>GRQE</td>
<td>Goal-Oriented Requirement Engineering</td>
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<td>IA</td>
<td>Interest Attribute</td>
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<td>KA</td>
<td>Knowledge Attribute</td>
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<td>MCV</td>
<td>Measurement Criteria Value</td>
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<td>MDSD</td>
<td>Market-Driven Software Development</td>
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<td>PPA</td>
<td>Power Position Attribute</td>
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<td>QAC</td>
<td>Quality Assessment Criteria</td>
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<td>RALIC</td>
<td>Replacement Access, Library and ID Card</td>
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<td>RCCD</td>
<td>Real-Client Custom Development Projects</td>
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<td>RCWV</td>
<td>Requirement Cost Weight Value</td>
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<td>RE</td>
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<td>RIA</td>
<td>Role Influence Attribute</td>
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<td>Requirement Priority Value</td>
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<td>SA</td>
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<td>SDOW</td>
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<td>SE</td>
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<td>SLR</td>
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<td>SNSD</td>
<td>Social Network System Development</td>
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<td>SPV</td>
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<td>Stakeholder Quantification and Prioritisation</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<td>SREP</td>
<td>Software Release Planning</td>
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<td>TOPSIS</td>
<td>Technique of Order Preference Similarity to the Ideal Solution</td>
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<td>Value-based Software Development</td>
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