UNIVERSITI PUTRA MALAYSIA

CLASS COMPLEXITY INTERACTION POINT SIZE MEASURE FOR OBJECT-ORIENTED SOFTWARE DEVELOPMENT EFFORT ESTIMATION

KOH TIENG WEI

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DOCTOR OF PHILOSOPHY
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2012

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By

KOH TIENG WEI

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

July 2012

DEDICATION

To my beloved mother, Ng Kheng Hwa, my father Koh Chin Hin,

who taught me the true meaning and importance of forbearance, fortitude,

forgiveness and continues to teach me the meaning of servitude to the Creator,

I am and will always be grateful.

To my patient, loving wife, Lee Kah Min,

thank you for your patience and your understanding.

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Doctor of Philosophy

CLASS COMPLEXITY INTERACTION POINT SIZE MEASURE FOR OBJECT-ORIENTED SOFTWARE DEVELOPMENT EFFORT ESTIMATION

By

KOH TIENG WEI

July 2012

Chairman : Associate Professor Hj. Mohd Hasan Selamat

Faculty : Computer Science and Information Technology

Software development efforts estimation is a practical process of predicting the most realistic use of effort required to develop or maintain software based on incomplete and uncertain user requirements. Effort estimates may be used as input to project plans, budgets, pricing processes and bidding rounds. Many estimation approaches have been proposed to address the problem of effort estimation for software development projects since 1960s. Up to date published surveys show that most of the research has focused on the construction and refinement of formal software effort estimation models such as parametric models and size-based estimation models.

In this research, we focus on the size-based estimation models for object-oriented development paradigm effort estimation, where the quantification step is based on mechanical processes to overcome the four limitations found in most of the

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traditional size-based estimation models. As the name implies, software size measure is the core instrument for size-based estimation models, and its accuracy determines the reliability and usefulness of the effort estimation model. The Class Complexity Interaction Point (CCIP) size measure has been proposed for object-oriented development paradigm effort estimation from the three class level size measures. In particular, the Class Functional Weights (CFW) measure is derived from Number of Method (NOM) and Number of Attribute (NOA) defined in the classes, while the Interaction Weights (IW) measure is calculated based on the maximum number of possible interactions through method call between pair-wise classes.

As much as 68 system modules which are collected from the six different object-oriented software systems have been used in this research. The recruited software professional team from the local software industry has provided us the value of actual development efforts. Preliminary correlation coefficient analysis between both of these independent variables (CFW, IW, CCIP) and the actual effort (person hour) was investigated not only to identify the ability of these measures in predicting development effort but also to suggest the type of effort estimation model that should be proposed for CCIP size measure. The suggested models are further validated using formal statistical hypothetical tests. N-fold cross validation technique was used to measure the performance of the CCIP-based predictive models.

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The results show a significant accuracy for CCIP-based effort estimation models in predicting the development effort. The predictive accuracy results confirm that the CCIP size measure is reliable and useful as an indicator for early effort estimation under object-oriented development paradigm.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

PENGUKUR SAIZ KOMPLEK INTERAKSI KELAS UNTUK PENGANGGARAN USAHA PEMBANGUNAN PERISIAN BERORIENTASI OBJEK

Oleh

KOH TIENG WEI

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Pengerusi : Profesor Madya Hj. Mohd Hasan Selamat

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Penganggaran usaha pembangunan perisian adalah satu proses praktikal untuk meramalkan penggunaan usaha paling realistik yang diperlukan untuk membangunkan atau mengekalkan perisian yang berasaskan keperluan pengguna yang tidak lengkap dan tidak tentu. Penganggaran usaha boleh digunakan sebagai input kepada perancangan projek, belanjawan, proses penentuan harga dan pusingan bidaan. Banyak kaedah anggaran telah dicadangkan untuk menyelesaikan masalah penganggaran usaha bagi projek-projek pembangunan perisian sejak 1960-an. Setakat ini, kaji selidik yang dilaporkan menunjukkan bahawa kebanyakan penyelidikan telah diberi tumpuan kepada pembinaan dan penambahbaikan model penganggaran usaha perisian formal seperti model parametrik dan model anggaran berasaskan saiz.

Dalam penyelidikan ini, kami memberi tumpuan kepada model penganggaran

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berasaskan saiz untuk menganggar usaha dalam pembangunan pengaturcaraan berorientasikan objek, di mana langkah kuantifikasi berdasarkan proses mekanikal untuk mengatasi empat kekurangan yang terlibat dalam kebanyakan model penganggaran berasaskan saiz tradisional. Sebagaimana nama yang diberikan, ukuran saiz perisian adalah instrumen utama untuk model penganggaran berasaskan saiz, dan ketepatannya menentukan kebolehpercayaan dan kegunaan model penganggaran usaha. *Class Complexity Interaction Point* (CCIP) ukuran saiz untuk penganggaran usaha pembangunan pengaturcaraan berorientasikan objek telah dicadangkan daripada ukuran saiz tiga peringkat kelas. Khususnya, *Class Functional Weight* (CFW) merupakan ukuran peringkat sistem yang ditakrifkan daripada ukuran peringkat kelas *Number of Mehtod* (NOM) dan ukuran peringkat kelas *Number of Attributes* (NOA), manakala *Interaction Weight* (IW) adalah ukuran yang dikira berdasarkan jumlah maksimum interaksi yang melibatkan panggilan kaedah-kaedah di antara sesuatu pasangan kelas.

Sebanyak 68 modul sistem yang dikumpul daripada enam perisian sistem berorientasikan objek telah digunakan dalam penyelidikan ini. Nilai sebenar usaha-usaha pembangunan yang digunakan dalam penyelidikan ini diperolehi dari lapangan industri. Analisis awal pekali korelasi antara kesemua pembolehubah tak bersandar (CFW, IW, CCIP) dan usaha sebenar (orang jam) telah disiasat bukan sahaja untuk mengenalpasti kemampuan penggangaran usaha pembangunan tetapi juga mencadangkan jenis model penganggaran usaha untuk penganggar saiz CCIP. Model yang diterangkan telah disahkan dengan

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menggunakan ujian hipotesis statistik rasmi. Teknik pengesahan *N-fold* telah digunakan untuk mengukur prestasi CCIP model.

Keputusan telah menunjukkan ketepatan bererti bagi pengangar CCIP dalam meramalkan usaha pembangunan. Keputusan ketepatan ramalan ini juga mengesahkan penganggar usaha ukuran CCIP adalah boleh dipercayai dan berguna sebagai penunjuk bagi penganggaran usaha awal di dalam pengaturcaraan berorientasikan objek.

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I certify that a Examination Committee has met on 3rd July 2012 to conduct the final examination of Koh Tieng Wei on his thesis entitled "Class Complexity Interaction Point Size Measure for Object-oriented Software Development Effort Estimation" in accordance with Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not submitted for any other degree at Universiti Putra Malaysia or other institutions.

KOH TIENG WEI

Date: 3 July 2012

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