



UNIVERSITI PUTRA MALAYSIA

**OPTIMUM TIME-COST TRADE-OFF STRATEGIES IN CRITICAL
PATH METHOD FOR PROJECT MANAGEMENT**

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IPM 2010 6



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PROJECT MANAGEMENT**

BY

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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**

October 2010



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

OPTIMUM TIME-COST TRADE-OFF STRATEGIES IN CRITICAL PATH METHOD FOR PROJECT MANAGEMENT

By

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October 2010

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Approach of Crashing Critical Activities (CCA) was originally developed along with the Critical Path Method (CPM) for planning and controlling large scale projects in the late 50s. The objective of crashing critical activities in CPM is to find which activities should be crashed with the use of additional resources if the duration of the project must be shortened. Crashing in CPM means crashing one time unit from critical activity that has smallest cost slope while ensuring that the critical path is still the longest path in the project network. This procedure is repeated until the project has been shortened sufficiently or the cost to shorten the project exceeds the benefits to be derived. Due to this complexity we develop some new procedures in this thesis, which enable us to solve the above problems alternatively. The procedures composed of an approach of Stretching Noncritical Activities (SNA) and the approach of Stretching Noncritical and Critical Activities (SNCA). The general methodology of SNA assumes many situations in CPM in which the owners or project managers are crashing all activities in the



project simultaneously to directly find the shortest possible duration for the project completion. Later it is possible to reduce the extra cost of the project by stretching noncritical activities without extending the project duration. The general methodology of SNCA is considered a complementary to SNA, it supposes various circumstances may be forced the owners or project managers to extend the completion of the project or reduce the total cost by stretching critical activities to meet the desired project completion time. When critical activity is stretched and the shortest possible of project completion is extended, other paths may also become noncritical, therefore, the noncritical activities can be stretched again until all the slack in the different noncritical paths is used up.

In addition, we have built some of Linear Programming models that have been of great value in analyzing project time-cost trade-offs problems. These models provide us the analysis of results that obtained from solving these models to give us some flexibility in planning and scheduling. Computational results are presented for the problems under study. We demonstrate that our algorithms produce consistently good results for all versions of time-cost trade-off problems.

In order to illustrate the usefulness of our approaches, we elaborate our algorithms on six cases of the well-known time-cost trade-off problem. These problems are designed to cope with more realistic setting: time-cost constraints. Proposed approaches provide greater opportunity for project managers in determining the appropriate strategy at the outset of project implementation.



Abstrak tesis dibentangkan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**STRATEGI PERTUKARAN MASA-KOS OPTIMUM KE ATAS KAEDAH
LINTASAN GENTING UNTUK PENGURUSAN PROJEK**

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Pendekatan Memendekkan Aktiviti Genting (CCA) pada awalnya dibangunkan bersama-sama dengan Kaedah Lintasan Genting (CPM) untuk perancangan dan pengawalan projek berskala besar di akhir 50-an. Objektif pemendekan aktiviti genting dalam CPM adalah untuk mencari aktiviti yang harus dipendekkan dengan penggunaan sumber tambahan sekiranya tempoh projek perlu dipendekkan. Pemendekan dalam CPM bermaksud memendekkan satu unit masa dari aktiviti genting yang mempunyai kecerunan kos terkecil di samping memastikan bahawa lintasan genting masih merupakan lintasan yang terpanjang dalam suatu rangkaian projek. Prosedur ini diulang sehingga tempoh projek telah dipendekkan secukupnya atau kos untuk memendekkan projek melebihi manfaat berbanding dengan yang diterbitkan. Disebabkan kerumitan tersebut, dalam tesis ini, kami bangunkan beberapa prosedur baru yang membolehkan kami untuk mengatasi masalah diatas secara alternatif. Prosedur ini terdiri daripada suatu pendekatan Pemanjangan Aktiviti Bukan Genting (SNA) dan pendekatan Pemanjangan Aktiviti Bukan Genting dan yang Genting.



Metodologi umum SNA mengandaikan bahawa banyak keadaan dalam CPM di mana pemilik atau pengurus projek memendekkan semua aktiviti dalam suatu projek serentak untuk terus mencari tempoh tersingkat yang mungkin untuk penyelesaian projek. Kemudian kemungkinan pengurangan kos tambahan projek boleh dilakukan dengan memanjangkan aktiviti bukan genting tanpa memanjangkan tempoh projek. Metodologi umum SNCA dianggap sebagai pelengkap untuk SNA, dan dipercayai pelbagai keadaan mungkin memaksa pemilik atau pengurus projek untuk melanjutkan tempoh projek atau mengurangkan jumlah kos dengan memanjangkan aktiviti genting untuk memenuhi masa penyelesaian projek yang dikehendaki. Apabila aktiviti genting dipanjangkan dan ini mungkin menyebabkan penyelesaian projek dipanjangkan, jadi lintasan lain juga boleh menjadi bukan genting, oleh sebab itu, aktiviti bukan genting boleh juga dipanjangkan lagi sehingga semua lalai dalam lintasan bukan genting yang berbeza habis digunakan.

Selain itu, kami telah membina beberapa model pengaturcaraan linear yang sangat berguna dalam menganalisis masalah pertukaran masa-kos projek. Model ini memberikan analisis ke atas keputusan yang diperolehi dari penyelesaian model ini dengan memberikan kami beberapa kelonggaran dalam perancangan dan penjadualan. Keputusan komputasi telah dipersembahkan untuk masalah yang diteliti. Kami menunjukkan bahawa algoritma kami secara konsisten menghasilkan keputusan yang baik untuk semua versi masalah pertukaran masa-kos.

Untuk memberi gambaran ke atas kegunaan pendekatan kami, kami telah menghuraikan algoritma kami kepada enam kes masalah pertukaran masa-kos yang terkenal. Masalah ini direkabentuk memberi gambaran yang lebih realistik dalam kekangan masa-kos.

Pendekatan yang dicadangkan dapat memberi peluang yang lebih besar untuk pengurus projek dalam menentukan strategi yang tepat pada awal pelaksanaan projek.

ACKNOWLEDGEMENTS

First of all, I would like to express my deep and sincere gratitude to my supervisor Dr. Leong Wah June for his advice, encouragement and support throughout my PhD studies.

I would like to extend my appreciation to my co-supervisory, Dr. Mohd Rizam B Abu Bakar. Thank you for your time, guidance, and advice.

I would also like to thank to Dr. Lee Lai Soon for serving in the supervisory committee. Thanks and appreciation to my parents whom inspired me love science, knowledge and ambition, God have mercy for my father and gives the health and wellness for my mother.

I would also like to thank all the staffs in Fao General Company, particularly the staffs in the department of Planning and Follow-up and the President of the department on assistance and facilities they have given to me.

Last but certainly not least, I am eternally grateful for the love and support of my wife. I truly could not have accomplished this without you. Your patience and dedication to our family are amazing.



APPROVAL SHEET 1

I certify that a Thesis Examination Committee has met on 9 December 2010 to conduct the final examination of WAKAS S. KHALAF on her thesis entitled “Optimum Time-Cost Trade-off Strategies on Critical Path Method for Project Management” in accordance with the University and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1988. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that the 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, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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Date: 20 October 2010



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