

DEVELOPMENT OF DYNAMIC  
PROGRAMMING ALGORITHM FOR  
MAINTENANCE SCHEDULING PROBLEM

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## **SUPERVISOR'S DECLARATION**

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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## **STUDENT'S DECLARATION**

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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## ABSTRAK

Penyelenggaraan merupakan salah satu kaedah yang boleh digunakan untuk memastikan mesin dan peralatan dapat beroperasi dalam keadaan yang baik. Jadual penyelenggaraan merupakan salah satu kaedah penyelenggaraan dan perancangan penyelenggaraan yang boleh digunakan untuk mengkoordinasi kerja-kerja penyelenggaraan supaya proses penyelenggaraan dapat dilaksanakan dengan baik dan selesai tepat pada waktu yang sepatutnya. Apa, bila, di mana dan bagaimana operasi tertentu akan dijalankan akan ditetapkan bagi memastikan pelaksanaan berjalan dengan lancar. Walau bagaimanapun, keadaan yang tidak menentu yang berlaku semasa penyelenggaraan akan menjejaskan jadual asal dan menyebabkan kelewatan atau penundaan tugas yang telah dijadualkan. Oleh itu, kajian ini adalah untuk membangunkan algoritma pengaturcaraan yang dinamik bagi masalah penjadualan penyelenggaraan yang boleh mengambil kira keadaan yang tidak menentu ketika penyelenggaraan dan menghasilkan jadual penyelenggaraan optimum yang lain. Penyelidikan mengenai masalah ini bermula dengan mengkaji semula penyelidikan sebelumnya untuk mencari jurang dan mencari penyelesaian bagi jurang tersebut. Kemudian, data pasukan penyelenggaraan dari salah satu syarikat penyedia utiliti di Malaysia telah dikumpul untuk digunakan dalam pembangunan algoritma pengaturcaraan dinamik tersebut. Model pengaturcaraan dinamik yang dibangunkan untuk penyelidikan ini refleksi kepada aliran aktiviti penyelenggaraan syarikat dan mengimplimentasikan model oleh Lieberman dan Hillier (2010). Kemudian, dari model yang dibangunkan, formulasi telah dirumuskan. Model ini kemudiannya disimulasikan dengan menggunakan data yang dikumpulkan untuk mengesahkan sama ada model ini beroperasi seperti yang diinginkan dan boleh digunakan untuk mencapai matlamat penyelidikan ini. Setelah model itu dibangunkan, pengiraan untuk menentukan jadual penyelenggaraan optimum telah dilakukan dengan menggunakan formulasi pengaturcaraan dinamik yang digubal. Pengiraan dilakukan dengan menggunakan perisian Microsoft Office Excel dan jadual untuk setiap pasukan penyelenggaraan yang diperolehi dipaparkan dalam jadual. Model ini kemudiannya diperakui dapat menghasilkan penjadualan semula walaupun berlaku keadaan yang tidak menentu ketika proses penyelenggaraan. Kombinasi jadual yang banyak dapat dihasilkan dari model pengaturcaraan dinamik dan fleksibiliti model dapat ditingkatkan dengan meningkatkan variasi pilihan untuk memilih jadual mengikut keutamaan penyelidikan yang meminimumkan jumlah masa untuk menyelesaikan aktiviti penyelenggaraan. Model ini juga mampu untuk menjadualkan semula dengan menggantikan pasukan yang tidak tersedia dengan pasukan lain untuk mengelakkan kelewatan menggunakan algoritma pengaturcaraan dinamik yang dihasilkan. Jadual penyelenggaraan optimum kemudiannya dijana dengan membandingkan semua jumlah masa yang telah dikira dan memilih jumlah masa paling minimum. Pengoptimuman jadual penyelenggaraan ini dapat menjimatkan masa dan mengelakkan kelewatan untuk aktiviti penyelenggaraan pasukan penyelenggaraan yang serentak akan mengurangkan kos untuk membayar jam kerja tambahan pasukan yang terlibat.

## ABSTRACT

Maintenance is one of the important methods that can be used to ensure machines and equipment can operate at the best condition. Maintenance schedule is one of the maintenance management and planning methods that can be used to organize and coordinate timely maintenance work. What, when, where and how the certain operation will be done will be stated to make sure that the planned activity is going smoothly without any delays. However, the uncertainty that happened during maintenance or inspections will affect the original schedule and lead to delays or suspension of the task that had been scheduled. Thus, the original schedule proposed will be useless and rescheduling needs to be done. The objectives of this research are to develop a dynamic programming algorithm for the maintenance scheduling problem that can deal with the uncertainty and to determine the optimum maintenance schedule that will change according to the uncertainty that happened. This research starts with reviewing the previous researches to find the gap in knowledge and find the possible solutions of the gap found. Then, the data of the maintenance team from one of the utilities provider company in Malaysia was collected to be implemented in the development of a dynamic programming algorithm. The dynamic programming model developed for this research reflected the flow of the maintenance activity of the company and implemented the model by Lieberman and Hillier (2010). Then, from the model developed, a formulation was created based on the problem of the maintenance schedule proposed. This model was then simulated using the data collected to verify whether the model was operating effectively and can be used to achieve the objective of this research. Once the model was developed, the calculations to determine the optimum maintenance schedule were done using the dynamic programming formulation created for this maintenance scheduling problem. The calculation was done using the Microsoft Office Excel software and the schedules for each maintenance team obtained were displayed in the result section. The model was then tested by the assumptions to verify that the model can reschedule after dealing with the uncertainty. The dynamic programming model developed was capable to produce the possible combinations and is flexible enough to deal with the uncertainties during the maintenance activity by increasing the choice of scheduling varieties according to the preference of the research which was to minimize the total time of the maintenance schedule. Using the dynamic programming algorithm developed, the model was also able to recalculate alternative schedules by replacing unavailable teams with other teams to avoid delays. The optimum maintenance schedule was then generated by comparing all of the total time of all the possible outcomes and selecting the most minimum total time which simultaneously will reduce the cost to pay for the extra working hours of the teams involved.

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## **LIST OF ABBREVIATIONS**

MTBF	Meantime before failure
MTTR	Meantime to repair
AGAN	As good as new
ABAO	As bad as old
ROCOF	Rate of occurrence of failure
CLSP	Capacitate lot-sizing problem

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