



Optimal Distribution of Multi-Skilled Labor among Construction Sites

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AUTHORIZATION FORM

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DEDICATION

*To my educator and breeder, who taught me the value of education and knowledge, **my father**, may Allah have mercy on him.*

*To my beating heart and the source of affection, who overwhelms me with her kindness, **my mother**, may Allah grant her long life.*

*To my lifetime companion and the rose of my life, who constantly supported me to follow and achieve my goals in life, **my dear wife**.*

*To my daily source of happiness and precious, **my kids**.*

*To the source of my pride, **my loved family**.*

I dedicate this work, asking Allah Subhanahu wa ta'ala acceptance and conciliation

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Optimal distribution of multi-skilled labor among construction sites

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ABSTRACT

The success criteria of projects are based on three main axes: cost, time and quality, which are known in the management discipline as the Iron Triangle. Therefore, the optimal use of resources to achieve these criteria yields to the success of projects. On the other hand, construction projects need a lot to be considered to achieve the success without many variation orders. One such consideration is to employ multi-skilled labor to improve the work productivity.

When construction companies deal simultaneously with different types of works, which have different productivity equations, then the problem of optimal distribution of multi-skilled labor among institutional construction sites is addressed. The optimality aspects are many; however, maximizing the work productivity in all sites is a rational optimal criterion. The objective of this research is to find the optimal number of labor that assigned to each site such to maximize different productivity equations, which yields to overall maximization of the productivity in all sites. Therefore, the problem is of a resource type, and hence the dynamic programming algorithm is an essential tool to solve this problem.

In this research, several hypothetical scenarios of multi-skilled multi-site cases respectively also multi-skilled labor multi-activity, are first considered to test the developed software capabilities in producing the labor distribution among sites. An actual case study is then considered to validate the proposed approach. Consequently, the multi-solution problem is conducted and illustrated. Finally, simple user interface software is developed to assert the usefulness for it for managers and simultaneously to be integrated with any similar software.

ABSTRACT IN ARABIC

التوزيع الأمثل للعمال متعددي المهارات على المواقع الإنشائية

تعتمد معايير نجاح المشاريع على ثلاثة محاور رئيسية: التكلفة، الوقت والجودة ، والمعروفة في مجال الإدارة بإسم المثلث الحديدي. لذلك ، فإن الاستخدام الأمثل للموارد من أجل تحقيق هذه المعايير يؤدي إلى نجاح المشاريع. من ناحية أخرى ، تحتاج المشاريع الإنشائية إلى أخذ الكثير من الأمور بعين الإعتبار من أجل تحقيق النجاح دون الحاجة لتغييرات كثيرة. أحد هذه الاعتبارات هو استخدام العمالة متعددة المهارات لتحسين إنتاجية العمل.

عندما تتعامل شركات المقاولات في وقت واحد مع أنواع مختلفة من الأعمال ، التي لديها معادلات إنتاجية مختلفة ، فإن مشكلة التوزيع الأمثل للعمالة متعددة المهارات بين مواقع البناء يتم معالجتها. تعتبر جوانب المثالية كثيرة ؛ ومع ذلك ، فإن زيادة إنتاجية العمل في جميع المواقع هو المعيار المثالي. الهدف من هذه الأطروحة هو إيجاد العدد الأمثل من العمال الذين ينبغي تخصيصهم في كل موقع لزيادة الإنتاجية المختلفة قدر الإمكان ، مما يؤدي إلى زيادة الإنتاجية بشكل عام في جميع المواقع. لذلك تعتبر هذه المسائل من نوع الموارد، وبالتالي تعتبر خوارزمية البرمجة الديناميكية هي الأداة الأساسية لحل هذا النوع من المسائل.

في هذا البحث ، العديد من السيناريوهات الإفتراضية لحالات متعددة المواقع ومتعددة المهارات العمالية، بالإضافة إلى نشاطات متعددة وعمال ذوي مهارات متعددة سيتم فرضها لاختبار امكانيات البرنامج المطور في توزيع العمال على المواقع. ومن ثم تم دراسة سيناريو واقعي للتحقق من صحة النهج المقترح. بالإضافة لتوضيح مسألة الحلول المتعددة. أخيرًا ، تم تطوير برنامج بسيط يحتوي واجهات للمستخدم ليتمكن المدراء من استخدامه والاستفادة من امكانياته. وفي نفس الوقت يتم دمج مع أي برنامج مشابه.

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List of Abbreviations

CP	Constraint Programming
FEP	Front-End Planning
GA	Genetic Algorithm
GCA	General Cognitive Ability
GUI	Graphical User Interface
HR	Human Resources
LNG	Liquefied-Natural-Gas
NPV	Net Present Value
PD	Dynamic Programming
PDRI	Project Definition Rating Index
PFP	Partial Factor Productivity
SA	Statistical Analysis
TFB	Total Factor Productivity
TOPSIS	Technique for Order Preference by Similarity to Ideal Solution