بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

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MONA MAGHRABY

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Public Works

Derivation Models to Maximize Railway Track Operation in Egyptian National Railway (ENR)

A Thesis submitted in partial fulfillment of the requirements of the degree of
Doctor of Philosophy in Civil Engineering
(Public Works)

By

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Master of Science in Civil Engineering
(Public Works)
Faculty of Engineering, Ain Shams University, 2014

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Date: / / 2021

Statement

This thesis is submitted as partial fulfillment of Doctor of Philosophy in Civil Engineering Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract

Railway capacity improvement is considered the base of railway network developments; so, it needs extensive planning to optimize the limited resources. Due to the continuous increase in the number of population in Egypt, it is expected that the railway capacity will be increased to accommodate the traffic demand.

Decision-makers do not have a tool for determining how to increase the current capacity reaching the maximum possible capacity under the current operating conditions.

The present thesis estimated the network performance by evaluating the Egyptian railway network based on the official timetables data then determining the practical railway capacity using artificial neural network techniques. Based on the neural network parametric model, the capacity of 56 out of 95 studied ENR network links can be increased under the current operating conditions. The practical capacity of the remaining 40 links is less than the used capacity. This means that these links are over-saturated and should be improved to safely accommodate the official number of trains. It was noticed that the largest zones with linkages that could be improved were in Middle and Southern zones, with an improvement ranging between (9 to 56%) of the used capacity. Also, the maximum percentage increase in used capacity was in the West Delta and reaches 83%.

The proposed models investigated many factors regarding their impact and assigned them according to their importance as follows: the longest block section, type of signal system (mechanical or electrical), operating speed (for passenger and freight trains), track type (single or double), number of blocks, number of level crossings, and traffic composition ratio respectively. This arrangement is suitable for the operating conditions in Egypt.

Analytical models have been derived to calculate the railway capacity in terms of the current operation conditions (track types and signaling and interlocking systems) based on the most significant factors obtained from the neural network model which are considered the longest block section, operating speed of passenger and freight trains. Then, iteration techniques were applied to obtain the optimum value of capacity effective factors reaching the maximum railway capacity. Thus, more than 65% of 56 links

that can increase their capacity can reach maximum capacity under some changes through decreasing the block length and or increasing operating speeds of passenger and freight trains within the current operating conditions. Decreasing the block length must be studied separately in detail that is out of scope of this research. The Egyptian railway network has been studied as links; further juctions capacity study must be also studied in detail because it was also out of scope of this research. The links that can be maximized are concentrated in the West Delta zones and their capacities can be improved about 88% of the used capacity.

An evaluation framework has been developed using a specially tailored software tool to examine alternatives for improving the railway capacity based on the cost-benefit analysis.

This tool can assist the decision-makers in obtaining the most appropriate alternative for improving the railway capacity links. The four alternatives tested were as follows:

- Track doubling (from single to double track line)
- Electro-mechanical signaling and interlocking system (form mechanical to electro-mechanical signal system)
- Combination of electro-mechanical signaling and interlocking system and track doubling.
- Modification of block sections length (dividing the longest blocks sections to be less than or equal to the optimum length as extracted from iteration techniques)

The suggested methodology has proved its efficiency in transforming a single track into a double one or switching signals from mechanical to electrical or making a combination between the two alternatives. Based on the increased traffic demand in Egypt, it is preferable to change first the type of signal and find out how appropriate it to the expected traffic demand, then duplicate the track as the cost of the signaling system is less than tracks doubling. Additionally, the modification of block length is recommended when the length of the line track is greater than 30 km as it produced a benefit-cost ratio of more than 1, thus the proposal is effective.

Keywords:

Railway Capacity, Capacity Factors, Capacity calculation, Egyptian Railway Network, Official Timetable, Neural Network, Regression analysis, Analytical methods, Benefit/cost ratio.

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Last but not least, I want to dedicate this thesis to the soul of my dear brother. Rest in Peace.

Diana M.S. Rahoma

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