OPTIMIZATION OF READY-MIXED CONCRETE TRUCK SCHEDULING USING METAHEURISTIC APPROACHES

Biman Darshana Hettiarachchi

(168031N)

Degree of Master of Science

Department of Computer Science and Engineering

University of Moratuwa

Sri Lanka

January 2019

OPTIMIZATION OF READY-MIXED CONCRETE TRUCK SCHEDULING USING METAHEURISTIC APPROACHES

Biman Darshana Hettiarachchi

(168031N)

Thesis submitted in partial fulfillment of the requirements for the degree Master of Science in Computer Science

Department of Computer Science and Engineering

University of Moratuwa

Sri Lanka

January 2019

DECLARATION, COPYRIGHT STATEMENT AND THE STATEMENT OF THE SUPERVISOR

"I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books)."

Signature: Date:

The above candidate has carried out research for the Masters thesis under our supervision.

Name of the supervisor: Dr. H.M.N. Dilum Bandara

Signature of the supervisor: Date:

Name of the supervisor: Eng. Nishal A. Samarasekera

Signature of the supervisor: Date:

ABSTRACT

Ready-Mixed Concrete (RMC) is a perishable product; hence, specifications such as ASTM C94 recommend the delivery of RMC under 1.5-hours to ensure the quality. It is known that certain scheduling practices and driving behaviors lead to operational inefficiencies and poor-quality RMC. We propose a model to schedule RMC trucks while maximizing both the profit and job coverage, as well as meeting constraints such as ASTM C94 and continuous casting. The proposed solution consists of a rule checker and a scheduler. Rule checker enforces constraints such as deadlines, working hours, and ASTM C94 specification for travel time. The scheduler uses simulated annealing to assign as many jobs as possible while maximizing the overall profit. We consider two scenarios where trucks are attached to a given RMC plant, as well as allowed to move across plants as per job requirements. Using a workload derived from an actual RMC delivery company, we demonstrate that the proposed solution has good coverage of jobs while maximizing the overall profit. For example, compared to the manual job allocation, proposed solution in the fixed-plant scenario increases the average job coverage and profit by 13% and 9%, respectively. Moreover, the solution could automatically adjust the first unload time by a few 10s of minutes to reduce job conflicts, and this further enhances average job coverage and profit to 21% and 13%, respectively. Further, free-to-move scenario enhances the average job coverage and profit by 16% and 14%, respectively indicating that the scheduling could be further optimized by allowing trucks to move across the plants as per the job requirements.

Keywords: Fleet Management; Ready-Mixed Concrete; Scheduling; Simulated Annealing

ACKNOWLEDGEMENT

Foremost, I would like to pay my sincere gratitude to my research supervisor Dr. H.M.N. Dilum Bandara for his knowledge, motivation and commitment guiding me throughout the Research Degree program to research and write this thesis. Moreover, my heartfelt gratitude is extended to my co-supervisor Eng. Nishal A. Samarasekera for his immense assistance and guidance in making this study an authentic product.

Further, I would like to thank Nimbus Venture (Pvt) Ltd for providing dataset for the research and I would also like to gratefully acknowledge the Senate Research Grant No. SRC/LT/2016/14 of the University of Moratuwa, Sri Lanka for funding this research.

Finally, I would like to extend my gratitude to my parents and my wife for providing me with unfailing support and continuous encouragement throughout these years.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ACO	Ant Colony Optimization
ANN	Artificial Neural Network
ANS	Artificial Neural Systems
API	Application Programming Interface
DPSO	Discrete Particle Swarm Optimization
GA	Genetic Algorithm
GPS	Global Positioning System
HC	Hill Climbing
IBK	Instance Based Learner
ILP	Integer Linear Programming
J48	Decision Tree (Implementation of algorithm ID3)
ML	Machine Learning
NB	Naïve Bayes
PART	Rule based algorithm
RMC	Ready Mix Concrete
SA	Simulated Annealing
SMO	Sequential Minimal Optimization