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Container Transportation in Marine Terminals and Marine Transportation Infrastructure on the Increase in Export Market Share

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Abstract

In order to achieve important policy goals like increasing global competitiveness, diversifying import sources, opening up new markets, and forging strategic partnerships, maritime transportation is essential. It also has a significant impact on reducing the economic vulnerability of nations that rely on the sale of gas and oil by carefully choosing its clients and growing the export of petroleum products, petrochemicals, and gas. This study develops a two-objective mathematical planning model to investigate container traffic in marine terminals. The main goals of this concept are to move containers as cheaply and quickly as possible. To verify the model's accuracy and viability, it was first used on a small scale with a precise methodology. After the model was successfully implemented, it was modified and used to larger-scale scenarios to evaluate its practicality and resilience. The findings showed that although the cost aim was relatively less influenced, changes in the model's parameters had a considerable impact on the amount of time needed for transportation. This result emphasizes how crucial accurate parameter management is to improving maritime container transportation efficiency. The paper provides a strong mathematical model that can help optimize container logistics in sea terminals and emphasizes the critical role that maritime transportation plays in economic strategies. The model provides a useful tool to industry stakeholders and policymakers to balance time and cost objectives, hence increasing operational efficiency and achieving wider economic goals.

Keywords: Container shipping, sea ports, export, chemistry, time

INTRODUCTION

Investigating sea transportation issues as the most widely used transportation method for transporting products, including food, pharmaceutical, chemical products, primary parts needed in factories and industries, raw materials, fuel and energy and other items, which has received the attention of many researchers today. According to the importance of the issue and the existence of various stages of unloading and loading of products in addition to the multiple problems of container ports, there is a need to optimize the existing problems not only individually but also by generalizing and integrating the tangible ones, if possible, together with each other, trying to improve the condition of storage and the movement of containers in the space It becomes real. Considering the limitations and uncertainty in the conditions of the issue of the necessity of developing past models and optimal use of existing equipment and machinery and their capacity, along with sufficient knowledge of the type and nature of imported and exported items, in order to satisfy customers and beneficiary companies, as well as reduce current costs. It shows more. In this research, an attempt has been made to fill research gaps such as the lack of full use of transportation and container handling equipment and a comprehensive look at container storage space, which is clearly more than

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one block, with regard to improved time and cost factors and problem solving conditions in examples. bigger should be provided. The productivity of a terminal depends on several factors, such as the time the vessel docks from the moment it enters the port; The time of unloading the cargo from the vessel, the time of transferring the cargo to the temporary storage spaces or the term blocks, the time of allocating and arranging the cargo in the blocks, the time of clearing the cargo from the customs, the time of loading the vessel, etc., depends on each of them in its place. Meanwhile, determining the optimal location of each input or output container among existing blocks to increase their storage and retrieval speed is one of the issues affecting the productivity of terminals, which is known as the storage space allocation problem (SSAP) in the literature. This problem is similar to the generalized allocation problem, with the difference that the allocation depends on the type and time of entry and exit of containers in addition to the capacity of the blocks.

RESEARCH BACKGROUND

In their analysis, Taghipour et al. [1] examined and projected Iran's container transport market from 2012 to 2019. The report highlights the fierce competition that exists in the marine transportation business to capture as much market share as possible and to strengthen its competitive position. Research has found a unique place in the meantime since failing to advance with strong and comprehensive knowledge and information will lead to the achievement of the stated aims.

In a study, Torabi Farsani [2] examined container transportation services and customer challenges in the maritime transportation sector. The study focused on the issue of transportation because it has a significant impact on the final price of goods in developing nations, which has garnered significant attention in the field today. Free trade and an atmosphere of intense competition among raw material and industry owners have become essential.

The effective elements that container transport companies can use to increase customer satisfaction have been studied by Khademi et al. [3]. This study examines the duration and timing of transportation, particularly maritime transportation, as a significant number of cargoes are transported in this manner and have to arrive to the production line and the end user on time, at the appropriate location, and in a timely manner.

The position of ports and maritime transportation has been described by Vedadi [4] in an article titled Future: The approach and predisposition to future conditions, as well as the implicit and direct components of this association, have all been explained as an attempt at a foresight in time and place. The study's findings highlight the necessity of include port development in the investment agenda to raise port infrastructure standards and make ports more compatible with the container model.

The market structure of investment activities at container ports has been examined in this study by Ebrahimi Azandriani et al. [5]. This article uses Herfendal's quantitative index of the market structure from the perspective of monopoly or competition to analyze the current demand for private sector investment in the nation's ports with regard to port development and moving towards the third generation ports.

The statistical study of the variables influencing container clearance in Iranian ports has been examined in Kazemi Asiaber et al.'s research [6]. Comprehensive development in the nation's maritime transportation sector is necessary to compete at the global level, win more market share, and assist local industries in competing with their foreign rivals.

According to Heidari et al. [7], this study looked at the idea of development and a summary of the solutions employed from the managers of the Shahid Rajaei port container terminal. Using a local methodology and the technique of creating a mental map of the managers in this field, an attempt has been made to extract and convey a portion of the experiences in the development sector in this article.

By offering an approach based on statistics theory, Kim and Hong [8] attempted to estimate the number of displacements that remain for a block of containers in order to provide a straightforward solution. They achieved a significant reduction in the time it took to find the answer by utilizing a branch-and-bound technique, although they did not always decrease the number of transfers.

In order to handle problems of greater magnitude, Caserta et al. [9] devised a dynamic approach. They then contrasted their findings with the technique put out by Kim and Hong [8] in order to address the larger difficulties. This suggested a substantial advancement.

Forster and Bertfeldt's study [10] is among the most recent in this topic. Based on whether the containers obstructed the container path with a higher priority or not, they separated the containers into two categories: good and bad. Based on this classification, six displacements were defined. They provided an algorithm based on the branch-and-bound technique, moving the containers while looking for better solutions while paying attention to the priorities they took into account for the various movement scenarios.

Among the few studies that take into account the objective function of the issue of lowering the crane's operating time are Anluwert and Aydin [11]. They offered several novel algorithms to address the issue and assessed each one's effectiveness in relation to the best solution produced by a branching algorithm.

A local search algorithm was introduced by Lee and Chao [12] to address the container sorting problem. The algorithm generates an initial solution, generates numerous random paths through multiple iterations at each stage, and then uses a M mathematical heart to select the optimal combination of the generated routes.

MODEL

Sea transportation is very important from the point of view that it includes a high share of transportation. This type of transportation forms an important part of the global transportation system. The use of standard containers has led to the advantage of easy unloading, loading and transportation.

The problem investigated in the present research is the scheduling of container operations into three parts: transportation, accumulation, and loading on a crane. There are two types of containers, which include input and output containers. The incoming containers are first entered into the warehouse and the stacking is done on them, then the corresponding containers are transferred to the transportation department and then they enter the crane stage and their loading is done considering that the possibility of stacking, transportation and also Simultaneous loading of two containers does not exist, so we are faced with the limitation of preferring or choosing one container over another, which may be subject to a fee. But regarding the outgoing containers, the process is completely opposite to the incoming containers, in this way, first the loading operation is done, then the container is transferred to the warehouse by the transportation system, and there it is recovered or unloaded, and the corresponding outgoing container is again in the container queues. The input is placed. Here, the goal is to choose the best replacement of containers in all three stages of accumulation, transportation and loading in such a way that both the imposed cost is minimized and the time of the whole process is reduced.

SOLUTION METHOD

Nsgaii algorithm

The nsgaii algorithm is a multi-objective genetic algorithm designed based on non-dominant solutions. In this way, in the single-objective genetic algorithm, only one objective function is considered as the fitness function, and its decision variables are entered into the chromosome as genes and form the initial population, but in our nsgaii algorithm, it is faced with several objectives and this The algorithm is designed to solve multi-objective problems. In this algorithm, the results are compared between two or more answers for each chromosome and the best answers are obtained, and these answers lead to the formation of the half-tone front or the half-tone curve. In this curve or front, the best answers, which are considered the dominant answers and no answer of terms could defeat it, are placed, and there is no difference between the points obtained in this front Figure 1.

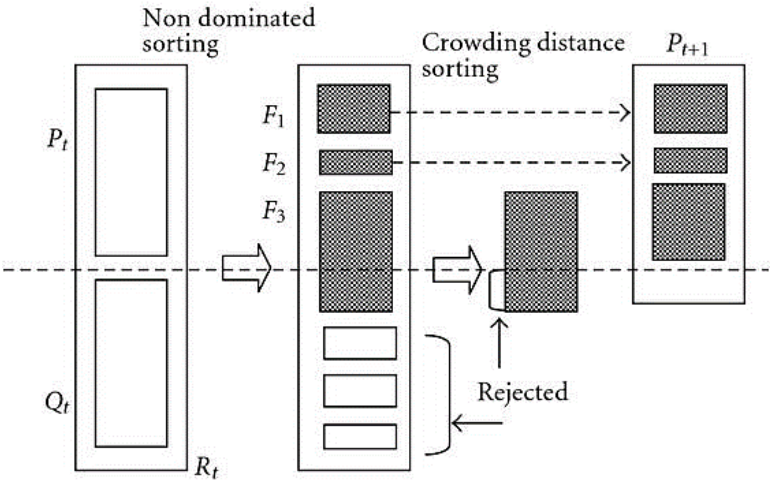

Figure 1. Outline of the Nsgaii algorithm.

MODEL VALIDATION AND SOLUTION

In the first stage of solving the model, it is validated, first the model is introduced in different dimensions and then the results of its solution are explained. The dimensions of the model are introduced in the Table 1 below.

Table 1. Dimensions of the model.

The issues	Incoming containers	Output containers	Store	Transportation department	Crane
1	5	5	1	1	1
2	6	6	2	1	3
3	7	6	3	1	5
4	8	7	4	2	7
5	8	8	5	2	9
6	9	8	6	2	10
7	9	9	7	3	11
8	15	15	8	3	12
9	20	20	9	3	13
10	25	23	10	4	14
11	28	25	11	4	15
12	30	30	12	4	16
13	35	30	13	5	17
14	37	33	14	5	18
15	40	35	15	5	19
16	45	40	16	6	20
17	45	45	17	6	20
18	47	45	18	6	20
19	48	46	19	7	20
20	50	50	20	7	20

As can be seen, in each example, the dimensions of the problem increase, and naturally, this can lead to an increase in the values of the objective functions and calculation time.

In the following, solving the model in large dimensions using the nsgaii algorithm is discussed and the difference between the two methods is explained. In fact, both the results of the exact method and the algorithm are presented in the Table 2 below.

Table 2. Comparison of the results of the exact method and the nsgaii algorithm.

	The exact method			**Algorithm Nsgaii**			**Contrast between the two methods**		
The issues	***Cost***	***Time***	***Calculation time***	***Cost***	***Time***	***Calculation time***	***Cost***	***Time***	***Calculation time***
1	1556458	6666	12	1556404	6663	5	54	3	7
2	1557459	6826	20	1569418	8101	15	53	3	5
3	1558928	6994	29	1569471	8104	20	65	1	9
4	1560206	7159	37	1569536	8105	27	87	2	10
5	1561743	7281	42	1569623	8107	32	56	7	10
6	1563226	7424	49	1569679	8114	42	11	3	7
7	1565178	7601	57	1569690	8117	52	16	7	5
8	1567007	7777	64	1569706	8124	59	45	7	5
9	1568526	7953	70	1569751	8131	60	80	9	10
10	1569831	8140	79	1569831	8140	69	32	3	10
11			low memory	1571817	8336	85	0	0	0
12			low memory	1573756	8470	98	0	0	0
13			low memory	1575756	8633	108	0	0	0
14			low memory	1576970	8769	120	0	0	0
15			low memory	1578691	8944	130	0	0	0
16			low memory	1580205	9110	146	0	0	0
17			low memory	1581933	9291	165	0	0	0
18			low memory	1582982	9457	177	0	0	0
19			low memory	1584304	9656	188	0	0	0
20			low memory	1586002	9827	206	0	0	0

As can be seen in the above Table 2, the problem has been presented up to the tenth example, and then from the eleventh example onwards, the problem has been solved with the nsgaii algorithm. Further, the discrepancy between the two methods has been obtained, the result of which is presented in the diagram below Figure 2.

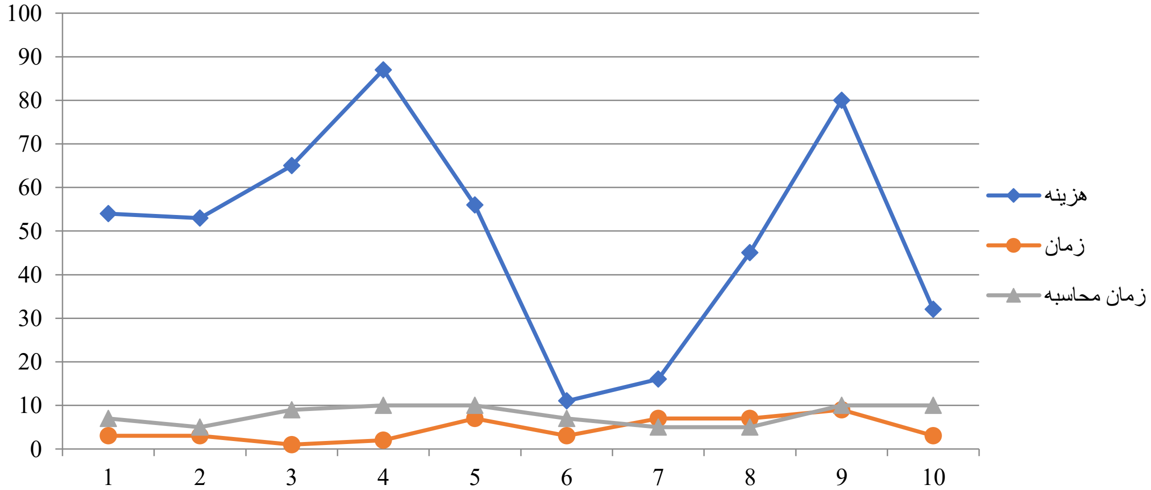

Figure 2. Comparison of the results of the exact method and the nsgaii algorithm.

The above diagram shows the difference between the two methods. Apparently, the calculation time is within 10 seconds until the tenth problem, but the objective function of time has the least difference with the exact method, but the biggest difference regarding the cost is in the blue diagram. It is observed.

DISCUSSION AND FINDINGS

In this section, the comparison and analysis of the obtained findings are discussed. According to the results obtained from the effects of different parameters, these effects are compared in the form of the following Table 3 and graph.

Table 3. Comparison of parameters affecting the cost.

	10%	20%	30%	40%	50%
Accumulation penalty	0.006673	0.016219	0.025261	0.031532	0.038864
Recovery penalty	0.010651	0.02295	0.031269	0.040707	0.045595
Inbound container shipping fine	0.009168	0.018127	0.025314	0.031992	0.040357
Outgoing container shipping fine	0.012104	0.02332	0.028982	0.035226	0.040784
Penalty for loading the incoming container	0.02457	0.047002	0.060238	0.075394	0.087887
Outbound container loading fine	0.013391	0.037338	0.050836	0.060498	0.068058
Accumulation time	0.021376	0.043661	0.061427	0.076764	0.087728
Recovery time	0.021622	0.038721	0.058463	0.068249	0.075663
Inbound container shipping time	0.02285	0.036392	0.049484	0.060844	0.069533
Outbound container shipping time	0.024447	0.038973	0.054363	0.064587	0.074242
Inbound container loading time	0.015233	0.02759	0.042864	0.054088	0.072094
Outbound container loading time	0.020516	0.039003	0.049936	0.061576	0.072453

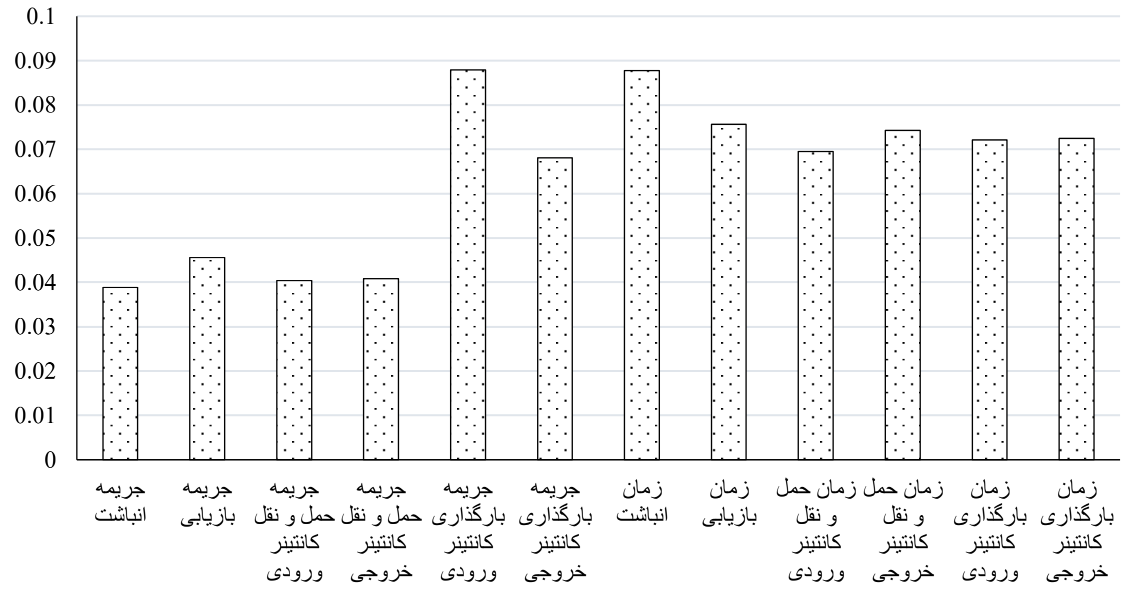

Figure 3. Comparison of parameters affecting the cost.

Accumulation Penalty
Retrieval Penalty
Container Transport Penalty
Container Loading Penalty
Container Transport Penalty

Container Loading Penalty
Accumulation Time Retrieval Time
Container Transport Time
Container Transport Time
Incoming Container Loading Time
Container Loading Time

As it can be seen, the most effective parameter on the cost of the entire system is the parameters of loading penalty of incoming containers and accumulation time, which together have an effect of nearly 8.5% on the cost, and therefore can increase the cost of the entire system by 8.5%, but the effect of other parameters is It is much less.

CONCLUSION

The aim of the present research was to increase the share of the export market of container transportation in marine terminals and marine transportation infrastructure. Research objectives and assumptions were extracted based on innovation. According to the established assumptions, a two-objective mathematical planning model was designed for container transportation in sea terminals, the first objective of which was to minimize the cost and the second objective was to minimize the time. Then parametric sensitivity analysis was performed on model parameters. The results of the research showed that the change in the parameters has the most effect on the time and has less effect on the cost goal.

REFERENCES

1. Taghipour sabri, M. Mirjalili, S. Shah Bakhsh, M. Saibani, M. 1392. Survey and forecast of the container transportation market in Iran until 1399, the fifth national conference of offshore industries, May and June 1, 1392, Tehran, Sharif University of Technology.
2. Torabi Farsani, F. 2013. Container transportation services and customer challenges in the maritime transportation industry, Ports and Maritime Organization Strategic Research and Studies Center, page 12.
3. Khadami, A. Naqoyan, b. Sadeghi, M. 2012. Effective factors in increasing the satisfaction of customers of container transport companies, Islamic Azad University, North Tehran branch, page 22.
4. Wadadi, H. 2012. The position of maritime transport and ports, Center for Strategic Studies and Investigations of Ports and Maritime Organization, page 62.
5. Ebrahimi Azandriani, A. Farjadi, G. Karmi, A. 2013. Investigating the market structure of container and oil terminal investment activities using the Herfendahl index, the 10th International Conference on Coasts, Ports and Marine Structures, November 29 to December 1, 2014, Ports and Maritime Organization, Tehran.
6. Kazemi Asiaber, A. Saidi, N. Nouramin, A. 1390. Statistical investigation of factors affecting container clearance in Iranian ports, scientific research journal of oceanography, second year, number 8, winter 1390, pages 61–68.
7. Heydari, J. Khairparast, M. Kandahari, P. 2015. Studying the concept of development and an overview of the solutions used from the point of view of the managers of Shahid Rajaei Port Container Terminal, the 12th Maritime Industry Conference, 27–29 October 2019, Anzali Port, Ziba Kenar.
8. Kim, K.H. and G.-P. Hong, A heuristic rule for relocating blocks. Computers & Operations Research, 2006. 33(4): p. 940–954.
9. Caserta, M., S. Schwarze, and S. Voß, A mathematical formulation and complexity considerations for the blocks relocation problem. European Journal of Operational Research, 2012. 219(1): p. 96–104.

10. Forster, F. and A. Bortfeldt, A tree search procedure for the container relocation problem. Computers & Operations Research, 2012. 39(2): p. 299–309.
11. Ünlüyurt, T. and C. Aydın, Improved rehandling strategies for the container retrieval process. Journal of Advanced Transportation, 2012. 46(4): p. 378–393.
12. Lee, Y. and S.-L. Chao, A neighborhood search heuristic for pre-marshalling export containers. European Journal of Operational Research, 2009. 196(2): p. 468–475.

