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A Study On Effectiveness Measurement Of Halt And Lag In Container Handling Operation With Refernce To Lom Logistics

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Abstract:

The present research has been conducted to measure the effectiveness of halt and lag in container handling operation. The purpose of this research is to identify the factors that causes delay in container handling operation. By the use of Analytical Hierarchical Process(AHP) method the various delay factors are evaluated. This study contributes that 'Port' is one of the most significant factor that causes delay in the operation. Meanwhile, sub-criterion of 'Deficiency of loading and un-loading equipment' is selected as the most significant sub-cause of delay creation in the container handling operation. Also this study examines the applicability of the Job Shop Scheduling which includes branch and bound method to solve the berth scheduling problem. This study contributes the practical technique and valuable findings to the port as it helps to measure the factors that affect the operational performance of the container handling operation. Efficiency of ports in measuring the halt and lag in the container can create a remarkable influence in the decrement of the period of ship stay at the port, the period of sedimentation of goods and the decrement of freight payable to shipping companies.

Keywords: Delay factors, Halt and lag, Container Handling operation, Analytical Hierarchical Process(AHP), Berth Scheduling Problem, Branch and Bound method.

1.1 INTRODUCTION & PROBLEM STATEMENT

In the age of globalization, ports are involved in a critical part in the economic growth of the nation and region. Import and export companies situated close to a port are benefited from the convenience and efficiency of logistics services. In the port industry, productivity is one of the vital factors for ports to develop competitiveness and market potential.

Efficiency of ports can have a remarkable influence on decreasing the period of ships stay in ports, goods sedimentation period and reduction of the freight taken by shipping companies. Therefore ports efficiency can result in satisfaction of customers, increase of demand level and more profitability. Therefore optimization of ports

loading/unloading operation (hereinafter referred to as L/U operation) is considered as an important approach to decrease the period of transmission of goods from producer to consumer.

Delay factors frequently disrupt the cargo handling and affect the effectiveness of the cargo transfers. In general, the delay factors can be the situations or occurrences that hinder the successful completion or execution of an operation within the allocated time frame. They present themselves in a cargo transportation system and may threaten when a proper attention or action is not given to address or solve the vital issues that are the key roles of a smooth port operation.

Accordingly, the complexity of the berth scheduling problem in terminal is significantly increased and hard to cope with. However due to trend of upsizing ships, the huge expenses and environmental impact of channel widening and the physical limitations of natural waterways, more and more terminal operators will have to face this problem. The unnecessary waiting times of ships cause a negative economic and environmental impact related to fuel consumption and route timing. The job shop scheduling using Branch and Bound method is used to reduce berth scheduling problem with reduced time delays.

1.2 SIGNIFICANCE OF THE STUDY

This study will help to find out the delay factors that causes delay in container handling operation. In his study, the delay creation in cargo operation were caused by some crucial elements of the cargo operation such as document incompleteness, shortage of truck, deficiency of horizontal L/U equipment, unpreparedness of owners of goods and administrative and financial issues. The identified factors are also useful to assist the port decision makers to take decision making process.

The Berth Scheduling Problems like the lengthy period of ship stays in a port can be due to either strict handling procedures and requirements of the cargo and its carrier, especially when loading and unloading operation of cargo both from and into the ships or unpredictable disruptions in cargo operation, which causing delays. To avoid these issues the planning should be in such a way that the whole time take for the work should be calculated in advance and the duration period for the work should be allotted accordingly.

Nevertheless, this study believes that the factors to the delay creation in cargo operation of a port not only limited to the aforementioned factors. It is because the delay creations in a port are subjective as each port operational system is heterogeneous.In cases of improving the efficiency and avoidance of delay creation in a port operation, the respective port/terminal, ships, and cargo owners are basically shared a mutual responsibility. Also this paper aims to provide a cost-efficient solution and to improve the operational performance of container terminals that are enduring inefficiency caused by berth scheduling problems.

1.3 OBJECTIVES AND SCOPE OF THE STUDY

The study measure the effectiveness of halt and lag in container handling operation to minimise the transit delay occurring in this study. To identify and assess the factors causing reduction of performance in container handling operation the Analytical Hierarcical Process(AHP) is used. To provide cost efficient solution to improve the operational performance of container terminals the Branch and Bound method determines the best sequencing order and provides cost-effective solution.

By applying AHP in this study, Port was determined to be the most significant factors causing the delays in container handling operation. This paper also highlights the delay factors that causes halt and lag in container. The deficiency of loading and unloading is the most significant delay factor which takes the place of rank 1in the evaluation of Analytical Hierarchical Process (AHP) method results in halt and lag in the container .The findings of this study helps to strengthen the shipping and port system through scientific analysis. It contributes an insight to reduce the burden of extra cost of shippers and shipping companies as well as to maximize the profit by taking proper decision with consideration of the core factors. This study contributes the practical technique and valuable findings to the port where it may alert the port to measure the factors that affects their operational performance. This technique is also useful to assist the port decision – makers in their decision-making process. Hence port can prepare the potential solution to control the influence of the contributors. Job shop scheduling using branch and bound method is used so that the transit delay can be reduced by selecting the best sequencing order.

1.4 REVIEW OF LITERATURE

Arbia Hlali(2018),The study states that the technical efficiency of container port has been evaluated using DAE method and stochastic frontier analysis. Using this method comparison can be done between ports to identify which port is efficient and which is inefficient. Container halt and lag occurs frequently if port is inefficient. To avoid inefficiencies the DAE method gives best result.

Homayon Yousefi ,Hassanjafari(2018),The research paper explores to identify the causes of halt and lag in container handling operation. The identified factors in this study is that the halt and lag arises due to improper storage of goods, improper packing, vehicle breakdown. To minimize these kind of issues the proper planning should be done in advance. The neck of the moment planning is not advisable. The data gathering is used has the main resource.

YaXu,KeleiXue(2018),The study reveals that due to unsustainable environment the berthing problems occurs. The main aim of the research is to improve the operational performance of container and should be cost efficient. Some inefficiencies causes traffic

limitations which is due to channel width or due to bad weather. This may leads to container halt and extra charges are claimed during halting period.

Kumar, T. P., Priyadarsini, M. K., & Soundarapandiyan, K. (2019) conducted a study on impact of students perceived service quality on brand performance of self-financing engineering institutions.

Soundarapandiyan K, Kumar TP (2018) made an attempt to explore the effects of workplace fun on employee behaviors.

Miguel Hervas-Peralta, Sara poveda-Reyes (2019),The main aim of the study is to improve the performance of the operation and to improve the functionalities of terminal operating system. If the terminal operating system performance is better ,then the overall operation goes in the smooth manner. Thus terminal operating system functionalities should be improved frequently. The main aim of the study is to reduce the port congestion.

Noorul ShaifulFitri Abdul Rahman, Mohammad khairuddin Othman(2019),The study examines that the delay factors could affect the effectiveness of the cargo operartio due to some uncertainities. Miscellaneous factor is the one of the most significant factor in causing the delay operation. To avoid these delays the major contribution is towards the practical technique and valuable findings which is used to measure the factors that affect the operational performance.

Peter Shobayo and Edwin van Hassel (2019),The study reveals that the coordination problem in inland barging exist in different ways like , the first one being the long stay that exist at the port and the second one deals with the inadequate optimum terminal planning of sea vessels and barges. This study contributes the effective measures to reduce the barge congestion problem in large sea ports.

T. Jonker , M.B. Duinkerken (2019), The study focus on the determination of performance of container terminal. Hybrid flow shop model is used in this research since it provides the coordinated schedule to achieve productivity. Simulation Annealing algorithm is used to balances the solution quality and computational time.

Mohammad Khairuddin Othman, Noorul Shaiful (2020), The study aims to identify the main factors that are contributing to the imbalance to the cargo. Imbalance in cargo flows whether it is deficit or surplus it might cause severe impact in the operation and port performance. According to the result ,researchers says economic factors are the main contributors to these imbalances,followed by other factors

Kuo-Cheng Kuo,Wen-Min Lu (2020),The study reveals that the productivity is the one of the vital factor for port to develop competitiveness and market potential. To measure the performance the Data Envelopment Analysis technique is used to measure the inefficiencies caused due to some sudden instabilities.

Qi Zhang, Adjei Courage Kwabla (2020), The study focus on minimising the working time of loading and unloading equipment and the stay time.To solve these kind of issue the genetic algorithm with chromosome feasibility is designed to obtain the optimal schedule time for trucks. And also this thesis states the types of container and solves the complexity of connection problem occurring in the container terminal.

XiaohuanLv, Jian Gang Jin (2020),The study states that some unforeseen incidents like delay, equipment breakdown may affect the berth allocation probably. To avoid these kind of issues mixed integer programming model is developedto adjust these problems in container terminal. Also Optimization heuristic method is implemented in this thesis to find near-optimal solutions under large problem.

1.5 METHODOLOGY

Analytical research analyse relationship and explains how it occurs. It not only describes characteristics but also analyse and explain how it is happening. The past data is used in this research. It is a type of research that utilizes critical thinking to find out facts and from obtained solution it helps us to develop solutions in further more ways. The secondary data is used in this study. Data that has previously been collected (primary data) that is utilized by a person other than the one who collected the data. Secondary data is often used in social and economic analysis, especially when access to primary data is unavailable .It is time saving and it helps to improve the understanding of the problem.

1.6 RESULTS & DISCUSSIONS

Aimed to identify and prioritize the causes of halt and lag in container handling operation ,the present research has been conducted by use of Analytical Hierarchical Process method. The research was accomplished in seven steps which the main causes of halt and lag operation were identified. The identified main factors of halt and lag creation are as follows. The main criterion of 'Port' was determined to be the most significant factor that contributes the delay in container handling operation with the percentage weight of 66%. The dominant influence of the 'Port' factor was followed by the factors of 'Ships' with 21%,'Cargo owners' with 8%, and the 'Miscellaneous' with 5%,which took the last place. The sub-criterion of 'Deficiency of loading and loading equipment' was ranked to be the most significant sub-criterion that contributes the delay in container handling operation with the percentage weight of 38%. The leading position of the sub-criterion was then followed by the sub-criteria of 'Deficiency of ship's equipment (19%)', 'Improper storage of cargo allocation (12%)', 'Problems with

customs and formalities(11%), 'Administrative and financial issues(6%) ', 'Foul weather and tide prediction(4%)', 'late ship arrival at port(2%)', 'Unpreparedness of cargo owners(2%)', 'safety issue(2%)', 'Shortage of trucks(1%)', and 'Incompetence of transport(1%)', respectively, according to their percentage weights.

To minimise the transit delay occurring in the operation the job shop scheduling helps to find the total delay and in which to select best sequence order and to reduce delay time, the branch and bound method is used.

1.6.1 ANALYTICAL HIERARCHICAL PROCESS (AHP)

For data collection process, AHP method is incorporated with the pairwise comparison method to produce a rating scale format with the aim of getting qualified judgments on the particular elements evaluated. The qualified judgments are analysed using matrix mathematical structure where the judgments on pairs of attribute Ai and Aj are represented by a n x n matrix A as shown in Equation 1

$$A=a_{ij=}\ [1a_{12}a_{1n}1/_{a12}1a_{2n}1/_{a1n}1/_{a2n}1] \quad (1)$$

where i, j = 1,2, 3…, n and each aij is the relative importance of attribute Ai to attribute Aj. The weight vector indicates the priority of each element in the pair-wise comparison matrix in terms of its overall contribution to the decision-making process. Such a weight value can be calculated using the following Equation 2.

$$w_{k\,=}\ 1/n\ \sum_{j=1}^{n}\ \ \left(a_{kj}/\sum_{1=1}^{n}\ \ a_{ij}\right) \quad (k=1,2,3,\ldots,n) \quad (2)$$

wherea_{ij} stands for the entry of row i and column j in a comparison matrix of order n. Then, the consistency ratio (CR) can be calculated using Equation 3 for determining the consistency of the pair-wise comparison matrix. While, RI is the random index for the matrix size, A., and the RI value has shown in Table 1

$$CR = CI/RI \quad (3)$$

Table 1 Random index (RI) table (Satty table)

Table 1.1.1

n	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

Next, the Consistency Index (CI) will be computed using Equation 4 as follows

$$CI=\lambda_{max\text{-}n}/n\text{-}1 \ \ (n=1,2,3\ldots k,\text{matrix size}) \quad (4)$$

Then, the λ_{max} is a maximum eigen value of n x n comparison matrix A that is calculated as follows.

$$\lambda_{max\,=}\sum_{j=1}^{n}\ \ \left(\sum_{k=1}^{n}\ \ w_k a_{jk/}w_j\right) \quad (5)$$

where, wk = the weight value of specific criterion, a_{jk}= the pair-wise criterion base on specific row and column, $w_{j.}$ = the weight value of criterion. Then, the consistency of the pair-wise comparison needs to be evaluated. A consistency process can be performed by using a consistency ratio (CR). CR is designed in a way that a value greater than 0.10 will indicates an inconsistency in pair-wise comparison. However, if CR is determined 0.10 or less, the consistency of the pair-wise comparisons is considered reasonable.Meanwhile, if the consistency check fails to reach the required level, then the judgements to the comparison matrix need to be re-examined.

Basically, the preferences ranking order are the results from the AHP method which is ranked based on the weightage values calculated from the pairwise comparison scale in respect to the consistent judgements. Any inconsistent judgements can be detected using the AHP by calculating the consistency ratio of the pairwise comparison before the weightage is determined in order to ensure that the preference is consistent and valid. It is the reason why this method enables comparison of criteria with respect to a criterion in the nature of the pair-wise comparison mode.The reason of using AHP method in this study is that it is a clear, straightforward and well-documented method.Besides, AHP helps to capture both subjective and objective evaluation measures. AHP help to reduce bias in decision making by providing a useful mechanism for checking the consistency of the evaluation measures and alternatives. In addition, it supports group decision-making through consensus by calculating the geometric mean of the individual pairwise comparisons, which is the approach of this study.This study can be considered has a strong information that can reduce the level of uncertainty or errors in the analysis process. Despite of that, the study only incorporated a simple hierarchical model in which not contribute to any significant inconsistency of the evaluations.

STEP 1: DEVELOP A HIERARCHY MODEL OF THE STUDY

A test was conducted to evaluate the delay factors. Firstly, the factors of this study were structured by forming a hierarchical model for the analysis process. The model was basically consisting of three levels, named as goal (first level), the main factors (secondary level) and sub-factors (tertiary level). Based on the hierarchical structured model, each main factor was grouped with a number of sub-factors as the underlying elements that can influence the contribution of the main factor. The hierarchical model of this study is shown in Figure 1.Figure 1 generally indicates the links between the elements of upper level and those in lower levels. The links of the elements highlighted was basically identified by using the literature survey.

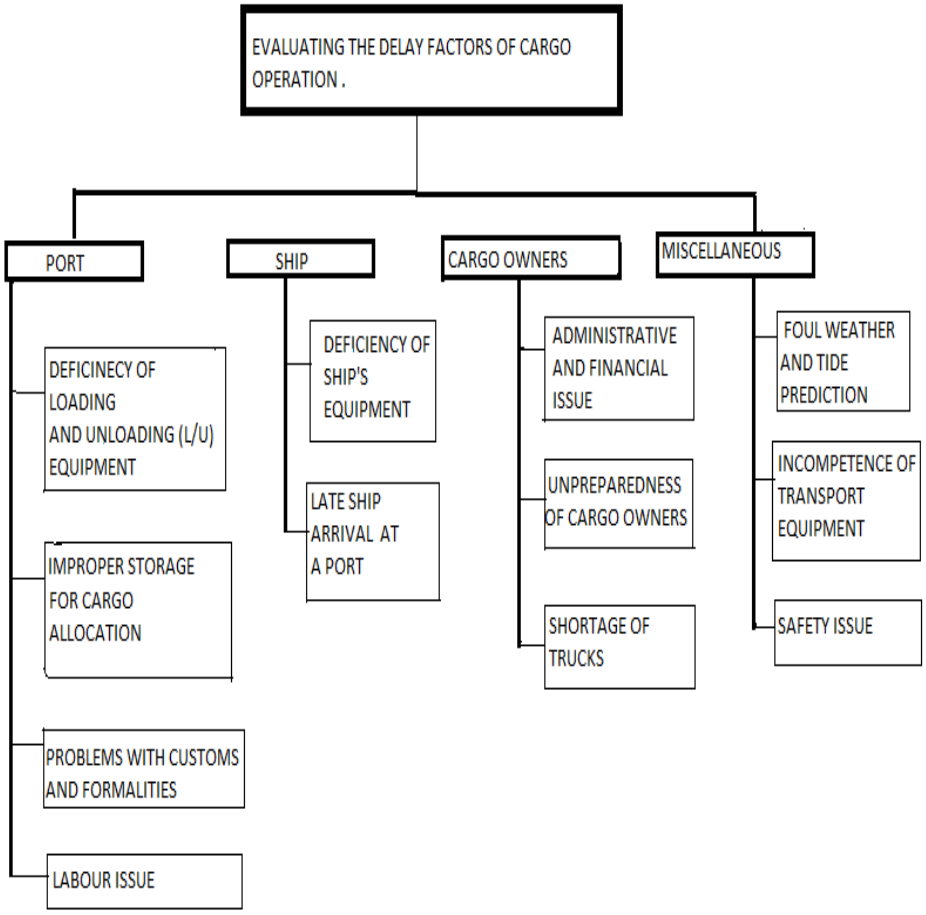


FIG 1: MODEL DEVELOPMENT ON STUDYING DELAY FACTORS OF CARGO OPERATION.

STEP 2: DATA COLLECTION USING PAIRWISE COMPARISON

By considering the critical success factors pair wise comparison is made and the priorities among the hierarchy is established. A pairwise comparison matrix for each criteria is developed. The criteria are evaluated using the rating scale as shown in the table 2.

Table 2 RATING SCALE FOR PAIRWISE COMPARISON

Table 1.1.2

SCALE	NUMERIC VALUE
Equally important	1
Fairly important	3
Moderately important	5
Strongly important	7
Extremely important	9
Values for inverse comparison	2,4,6,8

STEP 3 : TABULATE THE PAIRWISE COMPARISON VALUES OF CRITERIA INTO THE PAIRWISE COMPARISON MATRIX.

The pairwise comparison values of criteria evaluated in Step 2 were then determined. In this step, the values were averaged and tabulated into the pairwise comparison matrix as according to Equation 1.

Table 3

Table 1.1.3

CRITERIAS	PORT	SHIP	CARGO OWNERS	MISCELLANEOUS
PORT	1	9	9	9
SHIP	0.11	1	7	5
CARGO OWNERS	0.11	0.14	1	3
MISCELLANEOUS	0.11	0.2	0.33	1
TOTAL	1.33	10.34	17.33	18

Meanwhile in case of sub-criteria, the similar calculation was also applied to calculate their pairwise comparison values.

STEP-4 CALCULATE THE RELATIVE WEIGHTS OF THE CRITERIA AND SUB-CRITERIA

In this step, the relative weight (eigenvalue) of each criterion and sub criterion was calculated from the pairwise comparison matrix values (in Step 3) using Equation 2. The sample calculation of the relative weights of the criteria and sub-criteria is shown as follows, by taking main criterion 'Port' as the example.

Main criterion of Port =1/1.33=0.75

The relative weight values calculated for all criteria are summarized in Table 4.

Table 4 RELATIVE WEIGHTS OF MAIN CRITERIA

Table 1.1.4

CRITERIAS	PORT	SHIP	CARGO OWNERS	MISCELLANEOUS
PORT	0.75	0.87	0.51	0.5
SHIP	0.08	0.96	0.40	0.35
CARGO OWNERS	0.08	0.01	0.06	0.15
MISCELLANEOUS	0.08	0.01	0.02	0.05

In accordance to the calculation applied for the main criteria, similar calculation was also applied to calculate the relative weights of the sub criteria involved.

STEP 5: **DETERMINE THE NORMALIZED WEIGHTS OF THE CRITERIA AND SUB CRITERIA**

The normalized weight (eigenvector) of the criteria and sub-criteria basically indicates the relative importance of the criterion being evaluated. In that case, to determine the importance level of the criterion or sub criterion involved, the normalized weights of each criterion or sub criterion can be obtained by using Equation 2. Taking the main criterion 'Port' as the example, the normalized weight of criteria can be determined as follows.

Main criterion of 'Port'

=0.75+0.87+0.52+0.5/4=0.66

Similar calculation was applied to determine the normalized weights of all criteria and sub-criteria that involved in this study. The normalized weight values of all the criteria and sub-criteria calculated in this step are summarized in Table 5.

Table 5 NORMALIZED WEIGHTS OF CRITERIA AND SUB CRITERIA

Table 1.1.5

MAIN CRITERIA	NORMALIZED WEIGTH	SUB-CRITERIA	NORMALIZED WEIGHT
PORT	0.66	Deficiency of loading and unloading equipment(L/U)	0.58
		Problems with customs and formalities	0.16
		Improper storage for cargo allocation	0.18
		Labour issues	0.08

SHIP	0.21	Deficiency of ship's equipment	0.9
		Late ship arrival at port	0.1
CARGO OWNERS	0.08	Administrative and financial issue	0.76
		Unpreparedness of cargo owners	0.19
		Shortage of trucks	0.06
MISCELLANEOUS	0.05	Foul weather and tide prediction	0.73
		Incompetence of transport equipment	0.17
		Safety issue	0.10

STEP 6 :CHECK THE CONSISTENCY OF COMPARISON MATRIX

In this step, the consistency of the comparison matrix is checked to measure the level of reliability of the results. This is because comparisons made using AHP method are subjective and the acceptability of judgements is basically determined by checking the consistency value of the judgements received. The checking of the consistency value is referred to the consistency ratio (CR) value. According to Satty, the CR value is recommended to be below 0.1 in order to be acceptable as it is nearly consistent. If it is more than 0.1, then the inconsistency of the judgements is too large, and it could lead to error of the results. Before the CR value can be determined using Equation 3, the value of consistency index, CI, should be known in the first place. However, to get the CI value, the λ_{max} also need to be determined. Using Equation 5,λ_{max} of comparison matrix of the main criteria and sub-criteria calculated are shown in Table 6

Table 6

λ_{max}OF COMPARISON MATRIX OF THE MAIN CRITERIA AND SUB CRITERIA

Table 1.1.6

COMPARISON MATRIX	λ_{max}VALUE
Main criteria	0.99
Sub criterion for criterion 'Port'	1.02
Sub criterion for criterion 'Ship'	1
Sub criterion for criterion 'Cargo Owners'	1.01
Sub criterion for criterion 'Miscellaneous'	0.99

After obtaining the λ_{max} value, then the CI value can be computed using Equation 4 as follows, by taking the λmax value of main criteria as the example.

Consistency Index (CI) of main criteria

CI = λ_{max} **- n/ n-1**

= (0.99-4)/ (4-1) = -3.01/3 = - 1.00

Since the CI value has been known, then the CR value can be calculated using Equation 3, to check the level of consistency of the comparison matrix. The value of RI can be referred to Table 1.

Consistency ratio (CR) of main criteria = -1.00/0.9 = -1.11

The consistency ratio (CR) of main criteria calculated was -1.11, which is less than 0.1. Based on such value, the judgements provided by the experts was considered as reasonably consistent and acceptable. The CR values of all the sub-criteria were also recorded to have an acceptable consistency level, which is less than 0.1. The values of CR for all the sub criteria are summarised in Table 7.

Table 7 THE VALUES OF CR FOR CRITERIA AND SUB CRITERIA

Table 1.1.7

COMPARISON MATRIX	CR VALUE
Main criteria	-1.11
Sub-criteria for criterion 'Port'	-1.11
Sub criteria for criterion 'Ships'	-1
Sub criteria for criterion 'Cargo owners'	-1.72
Sub criteria for criterion 'Miscellaneous'	-1.73

Similar calculation steps applied to the main criteria have also been applied to check the CR values of sub-criteria' comparison matrixes.

STEP 7 : FINALISE THE GLOBAL NORMALIZED WEIGHT AND RANK OF THE MAIN CRITERIA AND SUB – CRITERIA

The global normalized weight values of the main criteria and sub criteria can be finalised once the CR values of criteria and sub-criteria have been considered consistent and at the acceptable level. In this step, the global normalized weights of the main criteria were similar to the local normalized weights determined in Step 5, as shown in Table 8.

Table 8 GLOBAL NORMALIZED WEIGHTS OF THE MAIN CRITERIA

Table 1.1.8

MAIN CRITERIA	GLOBAL WEIGHT	PERCENTAGE (%)	RANK
Port	**0.66**	**66%**	**1**
Ships	**0.21**	**21%**	**2**
Cargo owners	**0.08**	**8%**	**3**
Miscellaneous	**0.05**	**5%**	**4**

Despite of that, the global normalized weight values of the sub-criteria need to be finalised by multiplying the local normalized weights of main criteria and the local normalised weight of sub-criteria of each respective group. The example of the calculation is shown as follows:

Global normalized weight of sub-criteria 'Deficiency of L/U Equipment'

= local normalised weights of main criterion 'Port' x local normalised weight of sub-criterion 'Deficiency of L/U Equipment'

= 0.66 X 0.58

= 0.38

Similar calculation was done to all the sub-criteria and the weight values of the sub-criteria are summarized as in Table 9.

Table 9 GLOBAL NORMALIZED WEIGHTS OF THE SUB CRITERIA

Table 1.1.9

MAIN CRITERIA	SUB CRITERIA	GLOBAL WEIGHT	PERCENTAGE (%)	RANK

PORT	Deficiency of loading andunloading (L/U) equipment	0.38	38%	1
	Problems with customs and formalities	0.11	11%	4
	Improper storage of Cargo allocation	0.12	12%	3
	Labour issues	0.05	5%	6
SHIP	Deficiency of ship's equipment	0.19	19%	2
	Late ship arrival at port	0.02	2%	8
CARGO OWNERS	Administrative and financial issues	0.06	6%	5
	Unpreparedness of cargo owners	0.02	2%	9
	Shortage of trucks	0.01	1%	11

MISCELLANEOUS	Foul weather and tide prediction	0.04	4%	7
	Incompetence of transport equipment	0.01	1%	12
	Safety issue	0.02	2%	10

INTERPRETATION OF AHP:

Table 10 AHP SCALE AND ITS DESCRIPTION

Table 1.1.0

INTENSITY OF IMPORTANCE	DEFINITION	EXPLANATION
1	Equal Importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgement slightly favour one activity over another
5	Essential or strong importance	Experience and Judgement strongly favour one activity over another
7	Demonstrated importance	An activity is strongly favoured and its dominance is demonstrated in practice
9	Absolute importance	The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two	When compromise is needed

Applying AHP method ,the present research studied the main causes of halt and lag in measuring the effectiveness of the container. The research has accomplished in seven steps during which the halt and lag creation in Loading and Unloading operation is studied. Based on the Port, ship, cargo owners and miscellaneous criterias the

deficiency of loading and unloading equipment ,Deficiency of ship's equipment, Improper storage of allocation, Deficiencyof ship's ,Unpreparedeness of cargo owners, Financial and administrative matters have been identified as important factors in creation of delay in container handling operation which leads to halt and lag in the operation. The factors are ranked accordingly with the consideration of above table 1.1.0

Based on the preferences vector in table 08 and table 09 , the above 4 criterias and 12 sub-criterias are ranked and more preference is given for 'Port' and least importance for "Miscellaneous" in criteria and more importance is given for" Deficiency of Loading and Unloading equipment" and least importance is for "Incompetence of transport equipment" in sub-criteria.

According to this study, most of the events that causes delay were happened unpredictably in which it forces the container in halt and lag due to delay in cargos at port and accordingly to ensure the safety and cargo value aspects. Although standard measures have been taken out by using all available weather forecasted data. As it is a forecasted data, then the information can be true and also, can be untrue in all round .

Considering the current operational trend ,the followings are suggested to reduce the delays in Cargo operation. They are

- Deficiency of loading and Unloading equipment Should undergo the fulfilment of periodic inspections, repair and maintenance according to manufacturer's standards, purchasing new equipment's making the depreciated and old equipment's out of service and providing spare equipment's for emergency to a large extent can remove the existing problems.
- Unpreparedness of factors outside the port including owners of goods and agents of shipping lines are not directly under the control of port their control is very difficult and complicated. Owners have to take all required measures to make their agents prepared for implementation of loading and unloading operation without causing halt and lag in the container.

JOB SHOP SCHEDULING

Using job shop scheduling berth scheduling issues occurring in the container handling operations can be reduced. Berth scheduling consisting of berthing times and berthing positions of container ship in port container terminal.

Feasible solution refers to the set of values applicable for the decision variable.

MINIMISING TRANSIT DELAY BY SELECTING BEST SEQUENCE ORDER:

Considering an operation is performed on a single machine.

Table 11 JOB SHOP SCHEDULING FOR SINGLE MACHINE

Table 1.1.1

JOB	DURATION(DAYS)	DUE DATE

A	6	DAY 8
B	4	DAY 4
C	5	DAY 12

For the sequence (A, B,C)

DELAY CALCULATION

Table 1.1.2

JOB	COMPLETION DAY	DELAY
A	6	$d_1 = 6 - 8 = -2 = 0$
B	6+4=10	d_2 = 10-4 = 6
C	6+4+5=15	d_3 =15-12 = 3

A - Job has been completed on time

A, B - Job is delayed for 6 days

A, B, C - Job is delayed for 3 days

Total delay for sequence A , B , C is

$T = d_1 + d_2 + d_3$

T= 0+6+3 = 9

Total delay for sequence A,B,C is 9.

Best sequence has to be found to reduce the delay in jobs. The Branch and Bound method is used to find best sequence in job with reduced delay.

BRANCH AND BOUND METHOD :

Branch and Bound is an algorithm design paradigm for discrete and combinatorial optimization problems, as well as mathematical optimization. A branch-and-bound algorithm consists of a systematic enumeration of candidate solutions by means of state space search. The set of candidate solutions is thought of as forming a rooted tree with the full set at the root. The algorithm explores branches of this tree, which represent subsets of the solution set. Before enumerating the candidate solutions of a branch, the branch is checked against upper and lower estimated bounds on the optimal solution, and is discarded if it cannot produce a better solution than the best one found so far by the algorithm.

Assuming

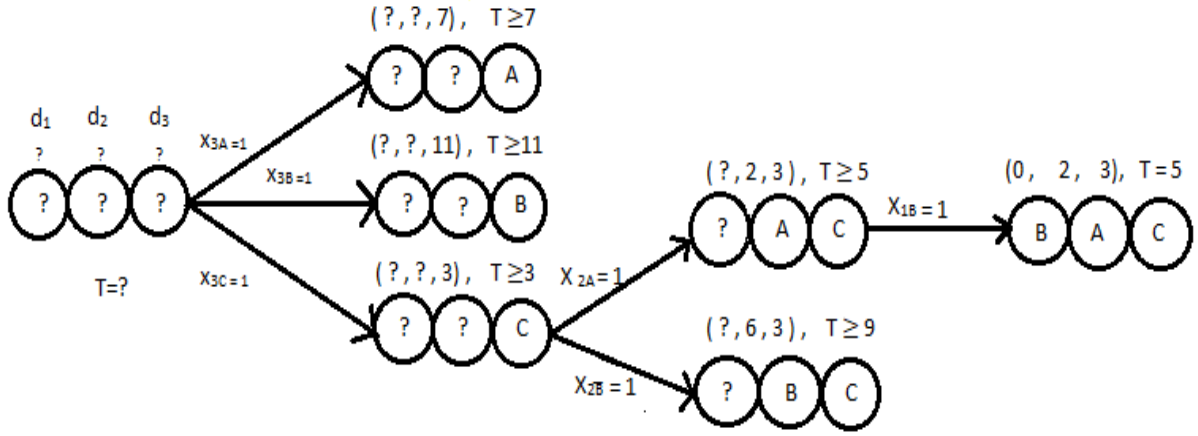
X_{ij} = 1 if job j is put in the i^{th}position

Xij = 0 otherwise i =1, 2 , 3 ; j = A ,B , C

JOB ORDER SEQUENCE

Table 1..3

JOB	DURATION(DAYS)	DUE DATE
A	6	DAY 8
B	4	DAY 4
C	5	DAY 12



The best sequence order is B A C

FIG. 2.2.1 BRANCH AND BOUND METHOD(TREE DIAGRAM)

INTERPRETATION OF JOB SHOP SCHEDULING IN BRANCH AND BOUND METHOD:

The present research has been done to reduce the time delay that occurs due to berthing issues. To address these kind of issue the Job shop scheduling is used in which total delay of the operation is known. When Job is performed on a single machine it able to meet the given due date without resulting in delays. But, by further combining the jobs the length of the job period that is ., its duration gets increased and within the given due date the job doesn't get completed such that it results in delay.

Though the delay occur the best way to reduce transit time is selecting the best ordering sequence of job is much important. Branch and Bound is used to select the best sequence order. It is shown in tree form and gives idea of placing delay in selected areas helps us to reduce the overall time taken to complete the job.

According to this research before the allocation of job ,the proper planning should be done meanwhile considering the duration of job, how efficient the worker's are and due date should be assigned accordingly. If proper planning is not done regarding the works that going to take up, then the huge loss occurs and the owner is the one who is to be answerable to the customers. So involving experts in planning job and scientific

analysis towards the work helps to achieve greater results and there is no delays occurring in jobs which helps to complete the work in time.

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