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Preface: 4th International Conference on Green Engineering & Technology 2022 (ICONGETECH 2022)

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The 4th International Conference on Green Engineering & Technology 2022 (ICONGETECH 2022), Seoul, Korea on 17-18 November 2022 is the premier forum for the presentation of new advances and research results in the fields of green engineering and related technology. The conference will bring together leading researchers, engineers and scientists in the domain of interest from all around the world. The primary goal of the conference is to provide the opportunities for academicians, professionals, practitioners and policy makers in the engineering and computing fields to share their thoughts and empirical works both to those involved in their field or those interested in the subject being researched.

The objectives of this Joint conference are:

1. To provide a forum for researchers, educators, students and industries to share and exchange ideas and research findings in both fields of research.
2. To give an opportunity to both academia and industries to communicate on problems faced in current research and the industries.
3. To create networks and stimulate potential collaborations between researchers in the same field of research.

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Analysis of the Optimization of Port Time for Improve Inter-Islands Port Performance during Pandemic COVID-19

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Abstract: Inter-island ferry services in archipelagic countries have their characteristics. Instability in the number of passengers is common at ports in the hinterland. This condition is reinforced by the COVID-19 pandemic, which has occurred globally in the last two years. Furthermore, to maintain performance, port-time service optimization is needed. This research was conducted at an inter-island port in Riau Archipelago, an archipelagic area directly adjacent to Singapore, Malaysia, and the South China Sea. The research method is to optimize port-time services using the simplex method. The results showed that the basic solution of the optimum solution with a value of $z = 65$ with $x_1 = 2.00$ and $x_2 = 0.75$. The most optimum port-time service is achieved within 65 minutes by reducing activities at risk of transmitting COVID-19. One of the new-normal approaches is by eliminating the face-to-face shipping administration management.

INTRODUCTION

The development of sea-based transportation has developed long ago. Transportation is unlimited to intercontinental logistics transport, but the movement of people and vehicles over short distances still uses sea mode. Until now, sea transportation is still a mainstay, especially in the inter-island area. Developed countries such as Japan have started to connect the islands with bridges or tunnels. This is different from developing countries such as Indonesia and the Philippines, which still rely on sea transportation as the backbone of inter-island transportation [1].

Indonesia is an archipelago with an unequal distribution of resources. This condition causes socio-economic strength, which is currently a national problem that has not been directed and integrated. Integration through a reliable and sustainable transportation sector is needed [2]. Each island in Indonesia has an essential role in various aspects such as social, economic, political, cultural, and security. Therefore, it must be ensured that integrated, safe, smooth, and efficient transportation is realized to support the dynamics of development [3].

Inter-island transportation in Indonesia is known as the crossing system. Despite many islands in Indonesia, this crossing is a business that must be maintained [4]. Several parts are very influential in the crossing system, including inland waterways service users who have the right to get security and comfort. An inland waterways service provider is a transportation mode provider company that should provide the best service [5]. The government is the party that regulates the provision and operation of crossing services to support order and security so that the optimum level of use of the components of the port system can be achieved.

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The level of service of the ferry port system can be said to be optimum if the service standards are met. Several factors that influence include waiting time for ships at the port. The waiting time for ships must be minimized according to the needs of service users and cargo capacity [6]. Furthermore, to minimize waiting time for ships, arranging the optimum ship departure schedule is necessary. Port inefficiency often occurs due to too long all business processes and operations that must be run [7].

Efficient ship operation is closely related to shipping time at sea and ship time in port [8]. The problem that often occurs is that the docking time for ferry boats at the port is not optimal, which causes the accumulation of passengers and vehicles. The non-optimal docking time can also be caused by passengers' instability, which is a characteristic of small islands. In addition, current instability has a greater chance due to the COVID-19 pandemic [9]. Therefore, it is necessary to optimize the time-port service to respond to the instability of passengers and vehicles due to COVID-19.

LITERATURE REVIEW

The port is one of the marine transportation facilities located in the waters area protected from waves that serve to moor ships and carry out loading and unloading activities for both passengers and goods. In addition, the port can also be referred to as the main gate connecting one region to another. A seaport area is an area where there are facilities for anchoring or anchoring ships. In the Port area, facilities are provided to transfer cargo from ship to land and land to ship or ship to ship. The function of this port is to act as an interface between ships and land in the maritime intermodal transportation system [10].

While the port is all related to port-management activities and other activities to implement, the port functions as a supporter of various activities. These activities are security and order in the flow of passenger and goods traffic, shipping security and safety, as a place for intra- and intermodal transfers, and a driving force for the national and regional economy without neglecting regional spatial planning.

Inter-Island Port Performance

Indonesia is an archipelagic country consisting of more than 16,056 large and small islands separated by 12 seas and 47 straits. These separate islands need sea transportation [11]. Sea transportation is an integral part of economic growth both regionally, nationally, and internationally. The port is also a critical infrastructure to develop the regional economy, especially for equitable development. The Indonesian government's policy encourages all seaport infrastructure to be improved through the' Sea Toll' program. All facilities related to the seaport must be immediately prepared following applicable standards.

A jetty is a facility located in a port that serves to moor ships that are berthing both passengers and goods. In addition, the pier serves to withstand the force due to collisions during loading and unloading. The size of the jetty is made based on the type of port. In calculating the size of the pier, it must be based on minimum standards so that ships that will lean or cast off can do berthing safely. Berthing is one of the main factors in maintaining sea transportation service time [12].

In addition to technical problems such as berthing at the pier, the port is a commercial complex with marine draft and feeder services. Ports are designed to incorporate every type of information network to provide easy and efficient port users. Ports must provide transparent customs services, straightforward documentation procedures, and fast loading/unloading facilities. Container loading and cargo distribution should have a well-organized logistics service. In order to improve performance and productivity, ports must adopt the latest and advanced technology to provide more professional services to port users with fast port operations [13].

Port services in the inter-island are the focal point of maritime intermodal transportation in the hinterland. In this view, port performance plays an essential role in inter-island trade and economic growth. There is currently a rapid change in sea transportation. These changes must be able to be adopted by existing ports, including inter-island ports. Although it looks simply, measuring port performance is complicated [14]. The complexity of port assessment is due to providing products and services together by creating different service products.

Each port is unique and cannot be compared with other ports. Assets, land area, water distribution areas, functions, organizational structure, port roles, management policies differ from one port to another [15]. Performance measurement is one way to compare and differentiate between ports. Therefore, an extraordinary approach is needed to evaluate port performance and decide on corrective actions for inter-island ports. Key Performance Indicators as a reference in port operations have not been fully utilized in this type of port. A single parameter cannot be used [16]. Multi-parameter performance indicators provide a better picture of the overall performance of port activities.

Inter-Island Port Time

Measuring the performance of inter-island ports is quite complicated because many stakeholders carry out many activities to provide services to ships at the port location. One of the performance indicators that are easy to measure is port time [17]. In general, port time consists of late arrival, waiting time, and turnaround time. Combining these various parameters can be a measure of the success of seaport management in managing activities. The performance of a port can be measured by its service time [18]. Port-time is the first question when port stakeholders ask about the company's performance.

Port managers must pay attention to port-time and cost. Indirectly, the cost of the site itself is strongly influenced by port-time. Port-time consists not only of cargo handling time but also all non-productive time the ship spends in port. The port must provide time for waiting to dock, waiting for the tide, manoeuvring and docking at the side, waiting to start work, waiting for the end of work, equipment breaking down, documentation, waiting for tugboats, and pilots [19]. Failure to control port-time will result in additional port service fees. Port-time controls can result in more significant incentives to reduce turnaround times at ports.

Port Time Optimization

Port time is one of the main variables determining port performance. Therefore, an appropriate optimization step is needed to develop the current port time fix. As an inter-island port in the hinterland, optimization is required with simple steps. Optimization options can be done linear programming, which is easy to implement. Linear programming is one of the methods in mathematics to distribute specific resources to achieve a target. In transportation, linear programming is used to solve problems related to transportation, such as goods and people, from one place to another with minimal transportation costs. As for ports with a larger scale, it would be better to use a non-linear approach [20].

Linear Programming is an optimization method to create the optimum value of a linear objective function under certain constraints. The limitations in question are usually related to simple sources. The application of linear programming in daily activities is usually used for resource reallocation, scheduling, logistics, transportation problems, mixed production, and others [21]. Distribution problems in linear programming will arise if one chooses a certain level of activity that is racing to utilize both rare and non-rare resources needed to implement these activities. So, linear programming, in this case, uses a mathematical model to explain the problems encountered.

Linear programming is a mathematical method that can assist in planning and decision-making in resource use [22]. Linear programming includes planning activities to get optimal results, which achieves the best goal (according to the mathematical model) among all possible alternatives. The characteristics of linear programming are the objective function (to maximize or minimize something) and the limiting function limiting the level of goal achievement. With the availability of several alternative actions that can be chosen, the objective function and constraints in the problem can be expressed in linear equations or inequalities.

The simplex method is one of the methods in iterative linear programming. The simplex method is also used to find a feasible basic solution to another feasible basic solution. This is done iteratively, which in the end, will reach optimal solutions. Each stage of completion will produce an optimal objective function [23]. The simplex method is very effective and systematic which is equipped with parameter tests. After the parameter tests are completed, it can be seen that the calculation must be continued or stopped until an optimal solution is obtained. Thus, the simplex method systematically starts from a possible basic solution to another basic solution. This is done step by step called iteration (with a limited number of iterations) to achieve an optimal basic solution in the end. Each step produces a value of the objective function, which is always more optimal or the same as the previous steps.

RESEARCH METHOD

This research was conducted through the implementation of this system divided into two stages. The first stage is forming a mathematical model of a linear problem that aims to prepare all the data needed in the next stage, and the second stage is the iteration of finding optimal results. For the implementation of the optimization data, 23 domestic inter-island ports were selected in Riau Island-Indonesia.

The optimization method is linear programming using the Simplex Table Method algorithm. Linear programming is one of the methods in mathematics to distribute specific resources to achieve a target. For example, in transportation, linear programming is used to solve problems related to transportation, such as goods and people, from one place to another with minimal transportation costs.

The first part models the optimization objectives. The objective mathematical model always uses the form of an equation. The form of the equation is used because later, it is desired to get the optimum solution at one point. Only one objective function is optimized; it does not mean that the optimization problem is only faced with one goal. The purpose of a business can be more than one. The second part is a mathematical model that represents limiting resources. The limiting function can be an equation (=) or an inequality (≤ or ≥). The constraint function is also known as a constraint. Constants in the limiting function as well as in the objective are called model parameters. Mathematical models can describe a problem more concisely so that the problem will be easier to understand. Mathematical models can bridge the use of mathematical techniques and computer technology to analyze problems. Although it can be modelled with mathematical functions, sometimes the solution is difficult to obtain due to its complexity and required techniques. The general form of linear programming is objective function: Maximize or Minimize

$$z = c_1x_1 + c_2x_2 + \cdots + c_nx_n \tag{1}$$

Constraints:

$$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n =/\leq/\geq b_1 \tag{2}$$

$$a_{21}x_1 + a_{22}x_2 + . + a_{2n}x_n =/\leq/\geq b_1 \tag{3}$$

$$a_{m1}x_1 + a_{m2}x_2 + . + a_{mn}x_n =/\leq/\geq b_1 \tag{4}$$

$$x_1, x_2, \dots x_n \geq 0 \tag{5}$$

$x_1, x_2, \dots x_n$	decision variable
$c_1, c_2, \dots c_n \geq$	contribution of each decision variable to the goal
$a_{11}, a_{12}, \dots a_{1mn}$	use per unit of the decision variable of the constraining resource
$b_1, b_2, \dots b_n$	the amount of each available resource
$x_1, x_2, \dots x_n \geq 0$	non-negative limit

RESULTS AND DISCUSSIONS

The Riau Archipelago is located in a strategic position between Singapore, Malaysia's Johor Bahru, and Malacca. This area is an international shipping area that is always crowded and has unique natural conditions with thousands of islands scattered. Therefore, the role of ports and sea transportation is indispensable to support progress in various fields. This strategic location makes the ports in the Riau Archipelago be taken into account. Furthermore, the development of industry, mining, and tourism has made the ports in the Riau Archipelago a transit point for passengers, both business people, workers, and tourists. The role of ports in the economy, social, political, and culture is extensive.

From the 23 domestic ports in the Riau Archipelago, one port was selected as the modelling data. The Punggur-Port, as the main gateway to Bintan Island, is indirectly able to revive the community's economy. One of the supports for smooth sea transportation between islands in Batam is Punggur Port. This was followed by the development of sea freight shipping companies and loading and unloading companies. Batam Island, close to Singapore and Malaysia, certainly influences Batam, Bintan, and surrounding areas.

Passenger Data During a Pandemic

The inter-island transportation mode in Riau Archipelago experienced a percentage decrease in the number of passengers due to the impact of the Covid-19 pandemic. The alleged decline in passengers can be seen in figure 1. There was a significant decline in the production year 2020. Of course, this will have a significant business impact. The decline in the number of new passengers occurred after the COVID-19 pandemic occurred. Although globally, this phenomenon of passenger decline occurs in all transportation sectors, it must still be appropriately addressed. Port management must rethink port operational efficiency and maintain business continuity for all stakeholders.

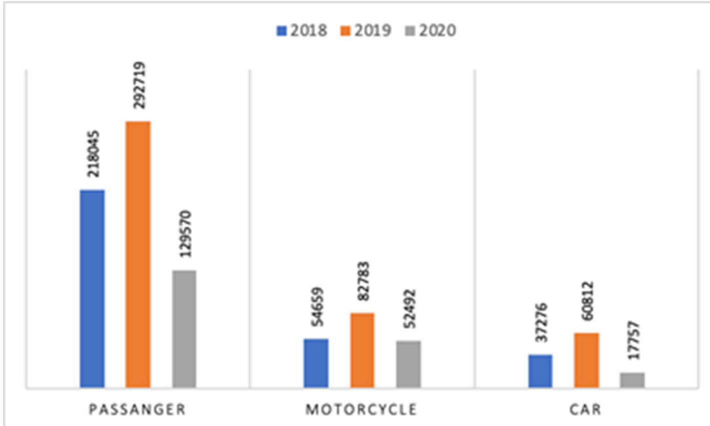

FIGURE 1. Annual passenger before and after a pandemic

Changes in the number of passengers at inter-land ports are common, but annual production is constantly increasing. Previously, changes in the number of passengers only occurred on average monthly passengers, as shown in the number of monthly passengers in 2019, as shown in figure 2. These changes usually occur following the phenomenon of the movement of people and goods. For example, when Eid al-Fitr is approaching, there is an increase in passengers for areas with Malay culture. Likewise, before Christmas and New Year's Eve, the average number of passengers will also increase. Meanwhile, in other months there will be varying number dynamics.

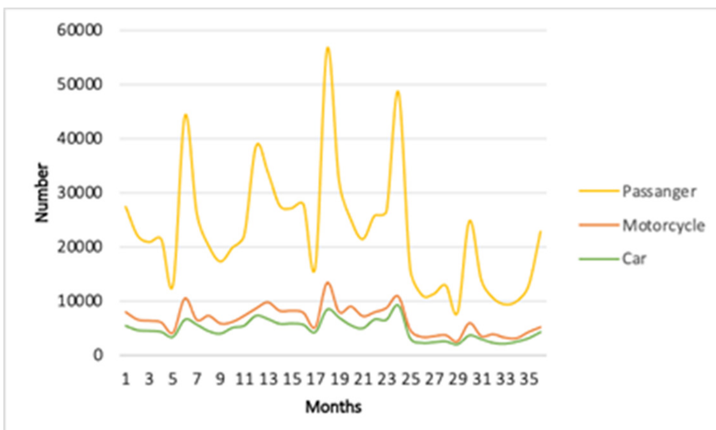

FIGURE 2. Monthly passenger (2018-2020)

The instability in the number of annual passengers due to the COVID-19 pandemic and changes in the number of monthly passengers going on for a long time must be used as reference material in the re-arrange of port management. Consideration of time efficiency in serving passengers and ships is the focus that must be chosen. Optimization of sealing time and port-time can help the company's expenses to be efficient. Likewise, determining the number of ships serving passengers can be adjusted according to the optimization results, which will be discussed below.

Case Study of Optimization Port Time

The simplex method is one of the algorithms of Linear Programming (PL). PL is one of the optimization methods used to find the optimum values of the linear objective function with certain limiting conditions. The software application is used in various aspects such as scheduling, transportation problems, logistics, and reallocation of resources. As is well known, the solution to the problem in Linear Programming can be recognized based on the decision variables, objective functions, and limitations which are formulated in mathematical form. So, after knowing the things above, these problems can be solved using PL algorithms such as the simplex method and the graph method.

For example, if a problem in Linear Programming only consists of two variables, then the graphical method can be used to solve these problems. However, suppose the problem has more than two variables. In that case, it cannot be solved again using the graphical method, so that another method is needed to solve the problem with more than two variables.

One method that can be used to solve problems with more than two variables is the simplex method. The simplex method is the iteration technique for solving problems in software that is most commonly used to solve problems to determine the optimal combination of three or more variables. In each iteration, solving the fundamental equations feasible in the Simplex method usually uses the simplex table method. The way to use the simplex table method is to solve PL problems, both maximum and minimum. In this simulation, Linear Programming Minimum will be used. The simplex algorithm (minimization form) can be summarized for optimization by the following steps:

Form a tableau corresponding to a basic feasible solution (BFS). For example, if we assume that the essential variables are (in order) x1, x2, ..., xm, the simplex tableau takes the initial form shown in Table 1 below.

TABLE 1. Initial Form

x_1	x_2	$\dots$	x_m	x_{m+1}	x_{1m+2}	$\dots$	x_j	$\dots$	x_n	RHS
1	0	$\dots$	0	$\bar{a}_{1,m+1}$	$\bar{a}_{1,m+2}$	$\dots$	$\bar{a}_{1j}$	$\dots$	$\bar{a}_{1n}$	$\bar{b}_1$
0	1	$\dots$	0	$\bar{a}_{2,m+1}$	$\bar{a}_{2,m+2}$	$\dots$	$\bar{a}_{2j}$	$\dots$	$\bar{a}_{2n}$	$\bar{b}_2$
0	0	$\dots$	0	$\bar{a}_{i,m+1}$	$\bar{a}_{i,m+2}$	$\dots$	$\bar{a}_{ij}$	$\dots$	$\bar{a}_{in}$	$\bar{b}_i$
0	0	$\dots$	1	$\bar{a}_{m,m+1}$	$\bar{a}_{m,m+2}$	$\dots$	$\bar{a}_{mj}$	$\dots$	$\bar{a}_{mn}$	$\bar{b}_m$
0	0	$\dots$	0	$\bar{c}_{m+1}$	$\bar{c}_{m+2}$	$\dots$	$\bar{c}_j$	$\dots$	$\bar{c}_n$	z

1) Step 1 If each c¯_j≥0, stop; the current basic feasible solution is optimal.
2) Step 2 Select q such that c¯_q≤0 to determine which non-basic variable is to become basic.
3) Step 3 Calculate the ratios b¯_i/a¯_iq for a¯_iq>0,i=1,2…,m if no a¯_iq> 0, stop the problem is unbounded. Otherwise, select p as the index i corresponding to the minimum ratio, i.e.,
$$\frac{\bar{b}_p}{\bar{a}_{pq}} = min_i \left\{ \frac{\bar{b}_i}{\bar{a}_{iq}}, \bar{a}_{iq} > 0 \right\}$$
4) Step 4 Pivot on the pq-th element, updating all rows, including the z-row. Return to Step 1.

For implementing the model in this paper, interviews were conducted with the crew at Punggur Sea Port. From the results of the interview, it was found that the factors that affect the ship's motion. These factors, such as wind and currents and other natural factors, are called external factors. Wind and currents are external factors that are very dominant and often occur. At the same time, the internal factors are factors from the ship's engine itself, although these factors rarely occur. The next thing to do is to analyse the activities that will be used as decision variables. The decision variable in question shows the activities carried out by the company. These activities include ship activities that will dock at the port, such as navigation, unloading, loading, administration, and departing. Before entering the destination function, it is necessary to know the real dock service time and the assumption time needed to minimize the port time and the limitations used, as shown in Table 2. These figures are the modes obtained from 23 inter-island ports.

TABLE 2. Assumption model

	Navigation	**Vessel**	**Unload**	**Load**	**Admin**	**Depart**	**Avail**
Port-Service	0	5	7,5	7,5	7,5	5	30
Natural Factor	12,5	7,5	5	2,5	0	10	20
Machine	10	5	0	0	0	10	15
Δz	10	2,5	7,5	12,5	5	4	-

Let the decision variables of the problem be:
x_1 time to navigation, x_2 time to vessel, x_3 time, x_4 to unload, x_5 time to administration process, x_6 time to departure. Minimum function

$z = 10x_1 + 2{,}5x_2 + 7{,}5x_3 + 12{,}5x_4 + 5x_5 + 4x_6$
z is target to optimization of port-time

With the constraint are

$$5x_2 + 7{,}5x_3 + 7{,}5x_4 + 7{,}5x_5 + 5x_6 \leq 30$$
$$12{,}5x_1 + 7{,}5x_2 + 5x_3 + 2{,}5x_4 + 10x_6 \leq 30$$
$$10x_1 + 5x_2 + 10x_6 \leq 30$$
$$x_1, x_2, x_3, x_4, x_5, x_6 \geq 30$$

After the implicit function is formed, the next step is to add a slack variable. The slack variable is a variable that represents the decision level, which is the limits used. For example, the following are the addition of independent variables in this study.

$$5x_2 + 7{,}5x_3 + 7{,}5x_4 + 7{,}5x_5 + 5x_6 + R \leq 30$$
$$12{,}5x_1 + 7{,}5x_2 + 5x_3 + 2{,}5x_4 + 10x_6 + S \leq 30$$
$$10x_1 + 5x_2 + 10x_6 + T \leq 30$$
$$x_1, x_2, x_3, x_4, x_5, x_6, R, S, T \geq 30$$

The equation added to the slack variable above is then compiled into the first simplex table, as shown in Table 3. The simplex method is performed step-by-step for this problem in the table below. Arrows indicate the pivot row and column; the pivot element is bolded. We use the greedy rule for selecting the entering variable, i.e., pick the variable with the most negative coefficient to enter the basis.

TABLE 3. First simplex table

Basis	Z	x_1	x_2	x_3	x_4	x_5	x_6	R	S	T	RHS
Z	1	-10	-2,5	-7,5	-12,5	-5	-4	0	0	0	0
R	0	0	5	7,5	7,5	7,5	5	1	0	0	30
S	0	12,5	7,5	5	2,5	0	10	0	1	0	20
T	0	10	5	0	0	0	10	0	0	1	15

Based on the first simplex table above, then several steps are carried out, namely.

1. Therefore, the determination of the key-column serves to change the simplex table. The key column can be found by looking at the objective function, which has the negative value with the most significant number.
2. Determine the key-row used to modify the simplex table by looking for the indexes in each row.
3. Determine the key-number obtained from the intersection of the key-row and key-column.
4. Change the key-row values obtained by dividing the key-row value by the key number value
5. If there are negative values in the table, it is necessary to improve the new table. The improvement in question is repeating the steps above until there are no more negative values.

After several repetitions, the simplex table, as seen in Table 4, no longer have negative numbers.

TABLE 4. Final simplex table

Basis	Z	x_1	x_2	x_3	x_4	x_5	x_6	R	S	T	RHS
Z	1	0	10,83	5	1,5	7,5	14,33	0,83	0	1	65
x_1	0	0	0,33	1	1	1	0,33	0,03	0	0	2
x_2	0	1	0,25	0	0	0	1	0	0	0,02	0,75
T	0	0	0	0	0	0	0	0	0	0	0

Thus, the optimal value of the minimization formulation is z = 65 with x_1=2 and x_2= 0,75. Furthermore, to help perform optimization with this simplex method, a tool in the R programming language can also be used. Packages used are 'linprog' packages. Linprog packages are obtained from open source di The Classical Simplex Method and calc in R [24]. The simulation results produce the same optimum results. In the R display, it can be seen that the primary solution has reached the optimum solution with a value of z = 65. From the two-LP approaches, the optimal solution for the port-time is 65 minutes. The time is calculated from the ship starting to navigate to depart. With the time that has been obtained, it is expected to fulfill the determinations related to services starting from filling in passenger data, loading and unloading, and others.

With the time that has been obtained, it is expected to fulfill the determination related to service. With sufficient port service time, the loading process can be maximized according to the transport capacity without neglecting the safety factor. In addition, dealing with service user data, especially passengers, is currently running well. It is just that the data for drivers, both motorbikes and cars, is not optimal. Because the service provider only counts the amount without knowing a complete identity.

Furthermore, for better service, it is hoped that the service provider and port manager will be able to pay attention to the wishes of service users and other factors such as the maximum amount of cargo to be transported without neglecting safety factors. As a form of new-normal activity, all face-to-face activities are limited. One of the limitations that will result in optimization is the elimination of direct administrative management. So that the simplex equation can be assigned a value of 0, of course, the omission of one component must be followed by better administrative management. Sometimes it is not easy to implement problems in the real world to apply to this tool. It takes little math skills to convert the problem into a mathematical model before the R tool approach can further produce a helpful decision for the user.

CONCLUSION

The linear programming method can be used to produce an optimal decision to optimize resources and limited conditions. Linear programming is very good for solving linear problems. The use of the simplex method and the revised simplex method will give the same result. The iteration process required to solve large-scale problems requires fewer iterations than using the simplex method. Using the R-tool can help save the time needed by the user to make optimal decisions quickly and precisely instead of using manual calculations. Simulation results using the simplex method with the help of R produce an optimal port time of 65 minutes. The current state of the COVID-19 pandemic can be circumvented by eliminating the time for completing face-to-face administration, replaced it with a technological approach.

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