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Study on cross-border fresh order and transport model based on profit maximization principle

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Abstract

This research focuses on the delivery of fresh fruits and veggies via a third-party carrier. Despite the fact that the major concern is transportation, a different fitness function was presented to maximize the transporter's revenues by taking into account specific constraints. The major goal of this study is to figure out how much vegetables and fruit should be bought in order to transport them to various locations at the highest potential profit. Traditional problem-solving techniques are used to address the issue. Furthermore, the simplex approach used allows for the identification of restrictions and the determination of the best solution to the issue that meets transportation needs while also generating the most profit. Overall, the findings show that the greatest profit that can be made in a single trip is $1,840.00, fulfilling three distinct firms' requirements. Research has discussed several ways to solve maximization and transport problems. Nevertheless, this research views them as two separate elements since the transportation method is normally used for minimization. Hence, both this method and the simplex method are coupled to maximize resources.

Keywords: transport; fresh fruit; maximize the profits; optimal arrangement.

Practical Application: We aimed to figure out how much vegetables and fruit should be bought in order to transport them to various locations at the highest potential profit. This research views ways of solving maximization and transport problems as two separate elements since the transportation method is normally used for minimization. Hence, both this method and the simplex method are coupled to maximize resources.

1 Introduction

The food trade has been expanding rapidly in recent decades. Food products are no longer limited to the place of production and are distributed throughout a country and internationally. Today, with the increasing development of the transportation industry, the food produced can be sent from one point to the farthest point on the planet (Mao et al., 2018; Pastor et al., 2019; Qian et al., 2020). Food is now transported thousands of miles by more efficient means of transportation. In the past, food was difficult to transport and maintain quality and health. Because food is perishable and can quickly lose its quality, in other words, most foods could not last long under normal conditions due to the possibility of spoilage and deformation. In addition, it was somewhat impossible to move some foods to distant places. But today, human beings have been able to solve this problem to a large extent with their advances in technology. Today, other foods, fruits, vegetables, etc., are found around the world by various means of transportation (Kinnunen et al., 2020; Loske, 2020; Moturi & Florkowski, 2019). Because the equipment and machinery used are equipped with facilities that can maintain the quality and health of food.

Because food contamination is a serious health hazard that can even lead to consumer death, ensuring health standards and cleanliness is one of the most important food transportation and logistics industry goals. Companies must follow best safety practices and hire employees who are trained in food safety (Guo et al., 2019; Pang et al., 2020; Yousefi et al., 2018). Without such attention, the food transportation industry could quickly lose customers, and companies operating in it could go out of business. Damage and damage during transportation cause a lot of damage to the food industry every year. Therefore, special care must be taken when packing, loading, unloading, and transporting to ensure that no damage occurs. Providing appropriate climate control facilities is an important part of paying attention to the transportation and logistics of the food industry. Because to maintain freshness, prevent contamination, and maintain quality, any food product must be stored at the desired temperature (Guo et al., 2020a; Guo et al., 2020b; Wu et al., 2021). The challenge that a private transporter faces when transporting vegetables and fruits is described in this paper. A different goal function was presented to increase the transporter's earnings while taking into account product sale prices, costs and capacity. Because it does not count on a strategy to determine the amount of merchandise that is beneficial to its operation, the independent transporter suffered financial losses. As a result, the primary purpose of this

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research is to determine the best arrangement of commodities that must be acquired and then carried in order to maximize profit. The research depends on transportation and simplex approaches to do this. Demand is calculated weekly, biweekly, and monthly (Dora et al., 2020; Galford et al., 2020; Mao et al., 2019; Verma et al., 2019; Walker et al., 2019).

Several approaches for solving maximizing and transportation problems have been discussed in the literature. Nevertheless, because the transport approach is commonly utilized for minimization, this study regards them as two different aspects. As a result, this approach and the simplex method, are merged here to maximize resources (Das et al., 2017; Ho & Wong, 2006; Ohuchi & Kaji, 1984). Likewise, because they are both regarded as classic strategies for solving certain types of problems, they are both adaptable to and effective in real-world and contemporary settings. The paper's second section is organized into multiple subsections, each of which introduces basic topics from the review of the literature. They identified the benefits of these approaches as specialists; for instance, the Simplex method is a linear-programming technique that can resolve issues with more than two choice variables and generate a sequence of tabular solutions considerably quicker than most other methods (Gale, 2007; Pan, 1998; Smale, 1983). For computer programming, the efficiency of these methods is just as crucial as the necessity for less processing power when they're used. Furthermore, the transportation approach has the benefit of requiring only the main variables in the solution process, eliminating the need for artificial variables. When it comes to tackling programming issues, the simplex technique, on the other hand, has certain drawbacks. It can only be utilized in a limited number of linear programming applications and also is hard to apply to transportation issues (Tambunan & Mawengkang, 2016; Wang et al., 2008). When addressing issues with a high number of variables and restrictions also necessitates lengthy computations. The approaches utilized to resolve this issue are depicted in Figure 1 and the components considered for the given solution.

1.1 Transportation model

This approach attempts to establish a delivery system, the quantity of product produced, production centers, and the product destination by taking into account both resource restrictions and material holding and transportation costs. The major objective of this approach is to find the most cost-effective route for transporting commodities or products. The following data must be included in this model (Chen et al., 2019; Nakandala et al., 2016; Volpe et al., 2013; Zhao et al., 2020):

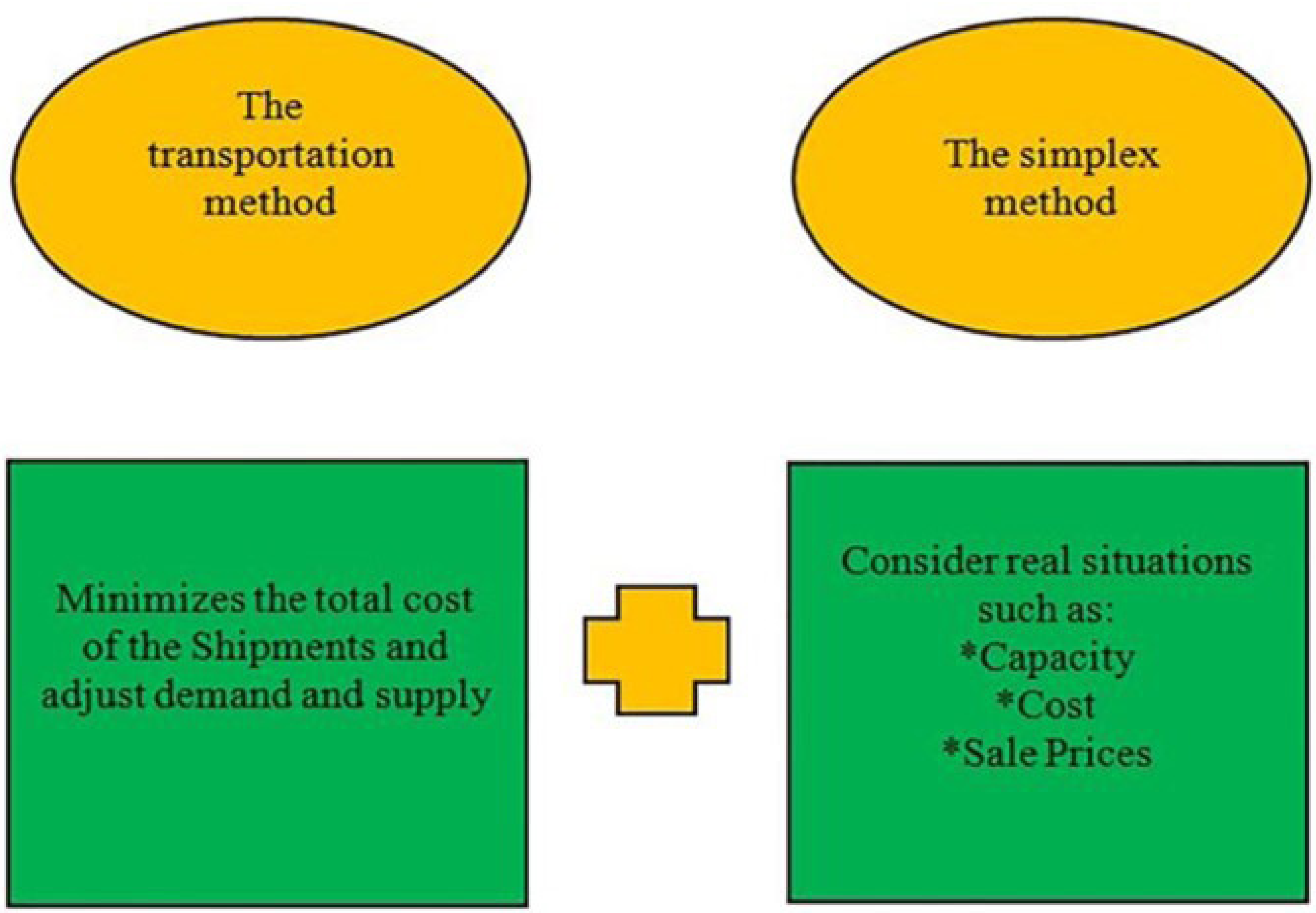

Figure 1. The simplex and transporting methods.

1. Product unit cost for each destination
2. Levels of supply from all sources and the quantity of demand demanded by each destination

Because there is just one type of product, a single destination's demand may come from one or more suppliers. This model aims to estimate the quantity of merchandise that should be transported to each destination to reduce overall transportation costs. The model's main premise is that shipping costs through one channel are proportionate to the number of units carried. The meaning of a transport unit is determined by the type of goods delivered (Weinhold & Reis, 2008).

Even without addressing the real physical environment, every problem stated may be considered a transportation challenge. As a result, one of the essential approaches in regression analysis is the transportation method (Redding & Turner, 2015). The transportation model is depicted as a network with m origins and n destinations in the diagram below (Figure 2). Nodes represent sources and destinations, while the arch linking a source to its destination represents the product's transportation path.

Source i's supply is represented by a_i, whereas order from endpoint j is indicated by b_j. C_{ij}, on the other hand, denotes the unit cost of transportation connecting origin i and endpoint j (Benjamin, 1989).

As a result, the linear programming (LP) model reflects the transportation model if X_{ij} represents the quantity of product carried from source i to destination j. The first group of restrictions specifies that the total number of shipments from a single supplier cannot exceed that source's supply (Shih, 1999). Similarly, the total number of shipments to a target must meet that destination's request in the second group. As a result, the entire supply needs to at least match the entire requirements according to the model. The resultant expression is regarded as a balanced transportation model in this situation. Despite the traditional transportation model, all restrictions are equations.

Nevertheless, while supply does not always match or exceed demand in real life, a transportation model may indeed be adjusted. Balance is necessary to design a solution technique that completely leverages the transportation model's specific structure, in addition to its usefulness when modeling certain real-world scenarios. Two examples below illustrate the concept of balance, including its practical consequences (Jana & Roy, 2007; Liang, 2008).

1.2 The method of simplex

George Dantzig first published this approach in 1947 (Dantzig, 1990; Nash, 2000). It entails an iterative algorithm that systematically reaches the optimal linear programming problem through iterations if there is one. It was also the first computationally solved problem in 1952, with 71 variables and 48 equations. It took 18 hours to solve such a challenge. In 1956, IBM released the RSLP1 code

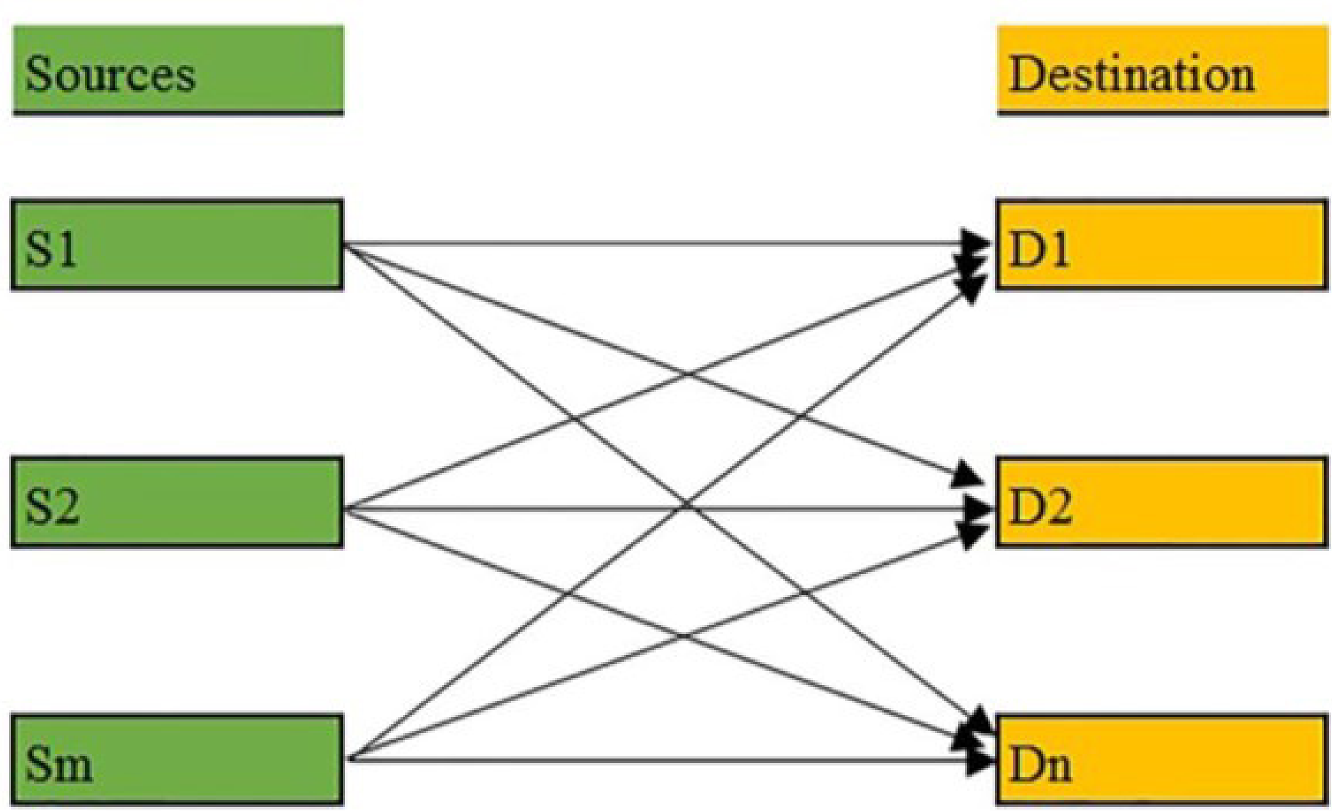

Figure 2. Destinations and sources.

that may manage LPs containing up to 255 restrictions and had 4Kb of RAM. The simplex technique assumes that the best outcome to an LP issue is found at a vertex or on the domain of viable points' boundary. As a result, the algorithm's sequential search is based on a gradual assessment of such vertices until the best one is found. However, a linear model must be supplied in a standard form before the simplex approach may be used to it.

2 Material and methods

The food and dairy industries depend on the smooth and timely supply of raw materials. Because the materials needed by the food industry are sourced from different geographical locations, transportation and logistics play an important role in ensuring the success of the industry (Sharma et al., 2019). Due to the short shelf life of raw materials and end products, the food and dairy industries face unique challenges not found in any other industry (Golden et al., 2002).

2.1 Fast delivery to prevent breakdown

Many raw materials spoil quickly. For example, vegetables such as tomatoes and cucumbers and fruits such as bananas and grapes are not very durable even if kept in climate-controlled facilities. Therefore, they must be delivered promptly. Most processed foods have an expiration date and cannot be eaten after that. Foods such as pizza, bread, and dairy products that are especially bad over the course of a few days are sensitive.

2.2 Maintaining quality

Of all the industries, the food and dairy industry is one that can never compromise on quality. Because when a product is substandard, it does not need to be from a non-standard specialist. Just as the quality of food depends on the producer, so does the supply of food. Food and dairy products must be stored in special climatic conditions during transportation and can deteriorate rapidly if these standards are not met.

2.3 Risk of contamination

Because foods are ready to absorb various types of contaminants, including bacteria and fungi, they can become contaminated quickly. Because food contamination is a serious health hazard that can even lead to consumer death, ensuring high standards of hygiene and cleanliness is one of the mainstays of the transportation and logistics industry. Occupations must follow best safety practices and hire trained food safety personnel. Without such consideration, the industry can quickly lose customers and go out of business.

2.4 Risk of fracture and injury

Due to their softness, food and dairy products have a high risk of breakage and damage during transport. For example, eggs and ice cream cones may break as a result of a minor impact, rendering them completely useless. Fractures and damage from transportation cause a great deal of damage to the food industry each year. Therefore, special care should be taken during packing, loading, unloading, and transportation to ensure no damage or breakage.

2.5 Climate controlled facilities

Because both raw and ready-to-eat foods can spoil quickly outside, they need to be stored in climate-controlled locations before, during, and after transportation. In order to maintain freshness, prevent contamination, and maintain quality, each food product must be kept at the desired temperature. Most foods stay perfectly fine from 1 to -4 degrees Celsius but spoil quickly at temperatures above 44 degrees Celsius. Ensuring climate-controlled facilities is an integral part of transportation and consideration for the food and dairy industry (Kipriyanov et al., 2021; Skrzypiec & Gajewska, 2017).

This section explains how to solve the challenge of transporting vegetables and fruit to an individual carrier. The various phases that contribute to the answer are thoroughly detailed. The Vogel approximation technique is first explored as a solution to the problem. Next, the three product targets are determined and the demand for each of them throughout the actual period. These shops specialize in groceries sales in various parts of town. Following that, suppliers are defined, albeit they are substituted in this case by items supplied. While modifying supply and demand to address the problem of transportation, one important factor to remember is that every target provides the same amount of demand, which does not fluctuate over the supply timespan. On the other hand, the supply of vegetables and fruit may be readily modified to satisfy total demand. Both producers and consumers have kilograms as their unit of measurement. An LP model is used to display data in order to optimize profits earned.

3 Results

The purpose of a manufacturer to produce or sell goods is to make a profit, and profit maximization is a way for the manufacturer to use various sales methods to maximize profits. If the total revenue is greater than the total cost, there will be a surplus, and this surplus is profit. It is worth noting that the profit mentioned here does not include the normal profit. The normal profit is included in the total cost. The profit mentioned here refers to the excess profit. If the total revenue is equal to the total cost, the manufacturer does not lose or earn and only obtains normal profits. If the total revenue is less than the total cost, the manufacturer will incur losses.

Manufacturers engaged in the production or selling goods require not only profit but also require maximum profit. The principle of maximizing the manufacturer's profit is that the marginal revenue of output equals the marginal cost. Marginal revenue is the revenue added by the final increase in sales by one unit, and marginal cost is the cost added by one unit's final increase in output. Suppose the marginal benefit of increasing the output of one unit is greater than the marginal cost. In that case, it means that increasing the output can increase the total profit, so the manufacturer will continue to increase the output to achieve the maximum profit goal. If the marginal revenue of increasing a unit of output, in the end, is less than the marginal cost, it means that increasing output will not only increase profits but will incur losses. At this time, in order to achieve the maximum profit goal, the manufacturer will not increase output but will reduce output. Only when the marginal revenue equals the marginal cost can the firm's total profit reach its maximum value. Therefore, MR=MC becomes a condition for maximizing profits, and this condition for maximizing profits applies to all types of market structures.

Maximizing profits is the ultimate goal of an enterprise. There are many factors affecting it. There are two main aspects. One is to expand product revenue. Profit is created by revenue. Without the guarantee of increasing revenue, profit is impossible to talk about. The second is to strictly control costs and expenses. While profits increase, the fewer costs and expenses are spent, the greater the profits.

The profit maximization principle of MR=MC can be proved by mathematical derivation:

Suppose π is profit, Q is the output of the manufacturer, TR is the total revenue of the manufacturer, and TC is the total cost of the manufacturer, then $\pi(Q)=TR(Q)-TC(Q)$

The necessary condition for profit maximization is that the first derivative of π with respect to Q is zero. The first derivative of TR with Q is the marginal revenue MR, and similarly, it is the marginal cost MC. Therefore, when MR=MC, the profit is extremely large when the marginal revenue equals the marginal cost. The sufficient condition for the second derivative of profit maximization also requires π is negative; it represents the profit maximization of the slope of the marginal cost function is greater than the marginal revenue function slope. In general, in the different market structures, the marginal cost function slope is positive, and the slope of the marginal revenue function in a perfectly competitive market is zero; the imperfectly competitive market is negative.

Due to the purposeful assumption of behavior, it is natural to introduce some mathematical models to solve the maximum value problem of a function containing several variables. We can assume that a company pursuing profit maximization sells products at a fixed unit price P and purchases two inputs x 1 and x 2 at fixed unit factor prices w 1 and w 2, respectively. Suppose the company we consider faces a competitive input and output market. The production process of an enterprise can be summarized by a production function: y = f (x 1, x 2). Here, the production function can be regarded as the technical state of the city with maximum output by combining two inputs or two elements x 1 and x 2: The objective function of a firm is total revenue minus total cost (that is, profit). We believe that the enterprise maximizes the function, that is, π = p f (x 1, x 2) − w 1 x 1 − w2 x 2 is maximized. The test condition of this model is the special value of factor price w 1, w 2, and product price P. The goal of the model is to cite falsifiable hypotheses for observable behaviors (such as changes in input levels) when testing conditions change (that is, changes in factor prices or product prices).

What are the economic explanations for these conditions? The first-order conditions of profit maximization indicate that a company pursuing profit maximization will increase resources until the marginal contribution of various factors (such as the marginal output value of factor i, which brings the income is p f i equal to the cost w 1 of the element for each additional unit. These are necessarily included in the profit maximization. However, to ensure that the maximum profit can be obtained after the element's input instead of the minimum profit, two more are needed Conditions. f 11 < 0, f 22 < 0 is the law of diminishing returns. Assuming that it is worthwhile to use a unit of factor initially if the marginal output of this factor is increasing, the firm will increase this factor endlessly because of the input. It brings more income than expenditure. The limited maximum value is contradictory to the increasing marginal rate. However, the marginal productivity of various factors is diminishing, and it cannot guarantee the maximum profit by itself. The condition f 11 f 22 − f 12 > 0. Although this relationship is not as intuitive as diminishing marginal productivity, it comes from the fact that a change in one factor affects the marginal output of another factor, just as it affects its own output, for all, the overall impact of marginal output must be consistent with diminishing marginal productivity.

The Excel Solver tool was used to introduce the issue. Data are provided in Tables 1 and 2.

Table 1. Costs, sale prices, and fixed cost.

	Cost	Sale Price	Fixed cost
Chili pepper	$1.80	$5.00	$2,100
Watermelon	$2.30	$6.00	
Mango	$3.20	$8.00	

Table 2. Results from the matrix.

	Location 1	Location 2	Location 3	Supply
Chili pepper	182	57	96	335
Watermelon	157	110	158	425
Mango	121	53	96	270
Demand	460	220	350	

4 Conclusion

When the simplex and transportation techniques are combined, it is possible to examine specific restrictions in order to discover the best answer to the issue that also meets transportation needs and creates the most profit. Restrictions guarantee that 1) the quantity of merchandise carried by each source matches the actual amount, and 2) the quantity delivered matches the amount requested by each recipient. As a result, based on the basic objectives, it can be stated that significant resource maximizing was accomplished, as the supply routes chosen for the distribution of vegetables and fruits were the most efficient.

Finally, the solo transporter who received assistance was pleased with the outcomes. Nonetheless, the most efficient approach to a transit issue is not always discovered because identifying and distinguishing the factors involved in each situation is a difficult process.

Furthermore, transportation-related issues might be difficult to solve. As a result, in order to accurately construct the model, it is critical to appropriately determine variables and perceptions from each outcome received. Furthermore, the benefits and drawbacks of both the simplex and transit techniques must be thoroughly visualized in order to evaluate whether or not they are appropriate in a specific circumstance and in what manner.

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