A REVIEW AND COMPARISON OF LEADING LOGISTICS AND SUPPLY CHAIN MANAGEMENT SOFTWARE PACKAGES

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Abstract

This article aimed to present mathematical techniques and technological application for logistics and supply chain management. By applying quantitative statistics data regarding Transportation Problem and Linear Programming, a software package, QM for Windows, and Excel Solver tool were applied to identify appropriate models and the best alternative for decision-making procedure. Besides, this is to point out strengths and limitations of the program, along with the necessity of mathematical and statistical background knowledge, which would be applicable as solutions for quantitative data problems and to device the programs for faster solutions.

Keywords: Quantitative Statistics Software Package, Logistics and Supply Chain Management, QM for Windows, Solver Excel

Introduction

Economic and financial crisis and the floating exchange rate of the Thai Baht can be factors affecting manufacturing system globally. Therefore, cost reduction for efficiency manufacture to satisfy customers' need has been considered. Accordingly, logistics and supply chain play an important role for entrepreneurs. Accordingly, logistics activities including assembling, sourcing, moving, stocking, and transporting between the point of origin and the point of consumption by reducing cost and increasing profits occur. It is also expected to efficiently reduce cost by assembling raw material among channel partners and businesses' storage of goods, sourcing, manufacture planning, and distributing in order to gain highest benefit from natural resources (Watnaprasert, 2019: 7-16). Logistics management is that part of supply chain management which is advantageous for overall cost reduction in supply chain process (Sorat, 2007: 74-75). To achieve, logistics activities in institutes, organizations or companies should generate highest profits or lessen cost to promptly and thoroughly respond to customers' needs (Sangdee, 2017: 8-9). With these activities, quantitative and qualitative statistical data collection are conducted to analyze and establish strategic

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plan in relation to resources management, marketing and operation. These would assist decision-making process in running cooperation business and logistics management including route selection for inbound and outbound goods and daily manufacture control, for instance. To reduce cost and increase manufacturer value, data concerning investment from logistics activities such as cost of sales, inventory, warehouse management, purchasing process, order quantity, and transportation have been quantitatively collected to indicate an ultimate solution for cost reduction, profit upsurge and being in accordance with business plan.

By aiming at minimizing cost and rising profit, the logistics activities include manufacturing, storing and transporting which relate to Linear Programming because it can be the best problem-solving technique under certain conditions. Also, this can be applied to some other problem-solving techniques and become a fundamental tool in business, society, industry, and so on (Hillier & Lieberman, 1995: 67). Analytical guidelines and supply chain research would apply Linear Programming for optimizing delivery route and might experience limitations and significant values. Even though there are complexities in mathematical calculations, computer programs can greatly help analyze the data in nowadays (Bowersox, Closs, & Cooper, 2010: 353). Efficient and widely accepted tools used by companies for solving supply chain problems usually involve with linear techniques in operational plans as they generate good returns under certain conditions (Chopra & Meindl, 2002: 105). With economic factors and technological advancement, it is crucial to be competitive, credible and responsive. Besides, companies should be driven by new technologies in order to be more efficient and to reduce cost by applying data to Microsoft Excel under consideration of conditions or limitations to calculate certain values and opt for smart option and most economical route which is worth for delivery. It is concluded that the application of technology can accommodate and improve the speed in work process with more accuracy and credible (Vongsaroj & Rattanawong, 2020). Wonginta, Wangrungwichaisri, & Kantasa-ard (2020) investigated a Milk-Run of transport cost reduction and increase routing management efficiency in the case of auto parts manufacturing company. The study focuses on two routing management techniques; Saving Algorithm and sales staff transportation issues by applying Linear Programming and creating mathematical model to explore the ultimate protocol. This is one of the techniques that researchers and a great number of business organizations use to analyze quantitative data for prime alternative. It is also found that the model of sales staff transportation issues consumes less time in delivery by applying Linear Programming than Saving Algorithm method. Apart from device software program in the investigation, background knowledge of mathematics is also required in solving logistics and supply chains problems as a person who can analyze data should be able

to possess mathematical processes for an associative thinking, analytical and creative skills. Analysts should also explain and symbolically convey variables, equations, inequations, relations, and limitations, for example. With necessity of mathematics in daily life, employment and solutions for the future, it can also further comprehension and be employed for some other field study (Sangpom, 2015: 214).

Transportation, as an essential activity in merchandise distribution, knows a large range of approaches, destined to try to optimize the process. The main problems the logistics people are confronted with, in their attempt to achieve an optimal distribution of the products to the final clients are the following: to minimize the transportation distances, the costs and the last, but not the least, and the transportation time. The advantages of QM program package one can enumerate the following: Its reduced size, but also the fact that the computer it works on does not need to be of a great performance. The QM software package can be applied in order to solve a varied range of problems (Tatiana, 2009). The use of Excel Solver in solving such as linear and nonlinear programming, manufacturing, transportation, financial, and planning to find the optimal solution of optimization problems. Optimization problems in many fields can be modeled and solved using Excel Solver. It does not require knowledge of complex mathematical concepts behind the solution algorithms. This way is particularly helpful for students who are non-math majors and still want to take theses courses (Chandrakantha, 2014).

The Microsoft Excel Solver become the most widely distributed and almost surely the most widely used general purpose optimization modeling system and most often used to solve problems in industry. Use of the Solver in Education have become the preferred tool for teaching quantitative methods to course based on learning modeling by doing. They include many traditional examples from the operations management area of business: production and inventory planning, distribution inventory models, finance, and marketing (Daniel et al., 1998). In this globalization era all companies are trying to improve their competitiveness among others by optimizing their operational processes. This is made to increase their revenues and to reduce their costs. A logistics company engaged in export may optimize the space in the rack. In actual conditions, operators and the warehouse staffs use best practices in determining the items filled into the rack (puzzling), to decide what items to be filled into the rack. This study will use a software of Decision Support System (DSS) to calculate the optimization, namely, QM for Windows. QM software will be used to get the optimization. This is known as good software in calculating packing optimization in container. The target of this study will be a proof that by using the software the job will be easier and better results compared to using best practice (Purba, Indarto, & Aisyah, 2018). According to the curriculum for Logistics and

Supply chain management, especially the aspect of management and science, at Southeast Bangkok College there was a subject concerning data analysis for quantitative statistics (Southeast Bangkok College, 2020). For this subject, lecturers recommended books and software programs including technological tools for calculating. Each tool has different characteristics and ease of use. Lecturers also consider aptitude and competence of users with a different background in mathematics.

As aforementioned, this article; therefore, aimed to present the application of technology in data analysis of logistics management and supply chains with quantitative statistical data of Transportation Problem and Linear Programming, together with a software package, QM for Windows, and Solver Excel tool. This is to point out some benefits and necessities of mathematical background for quantitative data in order to diminish concerns and apply the program to faster solutions.

Quantitative Statistics and Software Package

To analyze quantitative data, mathematical background knowledge is required for calculation. Analysts should also be able to select the statistic which can solve the problems according to the objectives.

The author used an in-depth interview with lecturers who taught logistics and supply chain and other related subjects in regard to the selection of software used in teaching. It is found that the lecturers selected the fourth ranked software in accordance with the following factors: aptitude of the instructor, characteristics of the ease of use, limitations of the software usage on variable number (Solver in Excel can accept a maximum of 200 variables), suitability for the users' basic knowledge of mathematics, capability of adjusting or writing more as the user wants, and no cost to use the software. The teachers will supplement their operations by using software for learning, work and research. Additionally, the instructors introduced software which was convenient and easy to use. It was QM for windows. This software could be utilized with logistic and supply chain decision-making models. To use the software, the basic mathematical knowledge of the learners may not be necessary. For those who have a basic mathematical basis and know the agreement details of the model, Solver is preferred in Excel. This is because users must be able to write formulas or calculations as needed in cells. Both types of software are popularly used in logistics and supply chains, including administration and management science and engineering.

For this article, the quantitative statistic should reduce the concerns over Transportation Problem and Linear Programming with mathematical calculation. Thereby, lacking the background knowledge could be an obstacle on the investigation. However, at the present time, software packages are available to assist solving problems. This investigation has also applied a software package, QM for Windows, and Solver Excel tool for calculation.

Solutions for Transportation Problem

A transportation, or shipping, problem involves determining the amount of goods or number of items to be transported from a number of origins (or supply location) to a number of destinations (or demand location). The objective usually is to minimize total costs or distances. Constraints in this type of problem deal with capacities or supplies at each origin and requirements or demands at each destination. Therefore, quantitative data for solutions for Transportation Problem is presented in Example 1 and 2.

Example 1

Demand / Supply	1	2	3	a_i
1	8	5	6	120
2	15	10	12	80
3	3	9	10	80
b_j	150	70	60	280

1. There are 3 solutions from mathematics calculation.

1.1 A solution from Northwest Corner (N-W) Method.

Demand / Supply	1	2	3	a_i
1	8 120	5	6	120
2	15 30	10 50	12	80
3	3	9 20	10 60	80
b_j	150	70	60	280

The lowest transportation cost is reported by Northwest Corner (N-W) = 120x8 + 30x15 + 50x10 + 20x9 + 60x10 = 2,690.

1.2 A solution from Least cost (Minimum Cost) (L-C) Method.

Supply \ Demand	1	2	3	a_i
1	8	5 70	6 50	120
2	15 70	10	12 10	80
3	3 80	9	10	80
b_j	150	70	60	280

The lowest transportation cost is reported by Least cost (Minimum Cost) (L-C) = 70x15 + 80x3 + 70x5 + 50x6 + 10x12 = 2,060.

1.3 A solution from Vogel's Approximation Method (VAM).

Supply \ Demand	1	2	3	a_i
1	8 70	5	6 50	120
2	15	10 70	12 10	80
3	3 80	9	10	80
b_j	150	70	60	280

The lowest transportation cost is reported by Vogel's Approximation Method (VAM) = 70x8 + 80x3 + 70x10 + 50x6 + 10x12 = 1,920.

2. A solution from Software Package, QM for Windows, is presented in figure 1.

solution value = $1920	Destination 1	Destination 2	Destination 3
Source 1	70		50
Source 2		70	10
Source 3	80		

Figure 1 A result of the lowest transportation cost from QM for Windows is 1,920.

3. A solution from Solver Excel tool is presented in figure 2.

	A	B	C	D	E	F	G	H	I	J
1										
2	Demand	1	2	3	ai					
3	Supply									
4	1	8	5	6	120					
5	2	15	10	12	80					
6	3	3	9	10	80		Min	1920		
7	bj	150	70	60	280		constraint			limit
8							r1	120	=	120
9	Demand	1	2	3	ai		r2	80	=	80
10	Supply						r3	80	=	80
11	1	x11	x12	x13	120		c1	150	=	150
12	2	x21	x22	x23	80		c2	70	=	70
13	3	x31	x32	x33	80		c3	60	=	60
14	bj	150	70	60	280					
15										
16	Demand	1	2	3	ai					
17	Supply									
18	1	70	0	50	120					
19	2	0	70	10	80					
20	3	80	0	0	80					
21	bj	150	70	60	280					
22										

Figure 2 A result of the lowest transportation cost from Solver Excel tool is 1,920.

Figure 1 and 2 show that QM for Windows and Solver Excel tool reported the lowest transportation cost at 1,920 which is equivalent to a calculation from VAM. Even though analysts calculated with N-W, L-C or VAM, the result from the program showed the calculation at the lowest cost as in the requirement. However, the program did not indicate the calculation method, and different method of mathematical calculations show differences in the lowest transportation cost.

Example 2

Demand / Supply	1	2	3	a_i
1	3	5	25	300
2	7	4	5	200
b_j	100	150	250	500

From Example 2, the lowest transportation cost was calculated by N-W = 2,175, L-C = 1,725 and VAM = 1,650.

solution value = $1650	Destination 1	Destination 2	Destination 3
Source 1	100		200
Source 2		150	50

Figure 3 A result of the lowest transportation cost from QM for Windows is 1,650.

	A	B	C	D	E	F	G	H	I	J
1										
2	Demand	1	2	3	ai					
3	Supply									
4	1	3	5	2.5	300					
5	2	7	4	5	200		Min	1650		
6	bj	100	150	250	500		constraint			limit
7							r1	300	=	300
8	Demand	1	2	3	ai		r2	200	=	200
9	Supply						c1	100	=	100
10	1	x11	x12	x13	300		c2	150	=	150
11	2	x21	x22	x23	200		c3	250	=	250
12	bj	100	150	250	500					
13										
14	Demand	1	2	3	ai					
15	Supply									
16	1	100	0	200	300					
17	2	0	150	50	200					
18	bj	100	150	250	500					
19										

Figure 4 A result of the lowest transportation cost from Solver Excel tool is 1,650.

From Example 1 and 2, it is found that the lowest transportation cost can be calculated by each method (N-W, L-C and VAM), and it is possible to select the method that indicates the lowest cost.

However, QM for Windows and Solver Excel tool can only present the lowest transportation cost without indicating the calculation method even though analysts used the programs to solve the problem.

Solutions form Linear Programming

The Structure of Linear Programming can be divided into 3 important parts including 1) Decision Variable means levels or values of variables used as options to optimize the solutions, and the value must be greater than or equal to zero; 2) Objective Function is a mathematical function of a Decision Variable function mostly found in cost and profit function, for example; and 3) Constraint or Restriction are used for Decision Variable when it is constrained or restricted in equation or inequation. Quantitative statistical data for solutions form Linear Programming is presented in Example 3.

Example 3: A product manufacturing company produces 2 merchandises, P_1 and $P_{2,}$ from 2 kinds of raw material, M_1 and M_2 To manufacture, P_1 is a mixture of 20 g. of M_1 and 40 g. of M_2 Also, P_2 is a mixture of 30 g. of M_1 and 30 g. of M_2 P_1 creates $1 profit, and P_2 creates $1.50 profit. If the company receives no greater than 1,200 g. of M_1 and no greater than 1,800 g. of M_2 per day, how would the company create a manufacturing plan to generate highest profit?

Graph Solution (Mathematical calculation) Set x_1 as the capacity of daily P_1 production, and x_2 as the capacity of daily P_2 production. From the data, the model for problems can be described as follow.

Objective Function Max. $Z = x_1 + 1.5\,x_2$

Constraint $20x_1 + 30\,x_2 \le 1{,}200$ $40x_1 + 30\,x_2 \le 1{,}800$ $x_1, x_2 \le 0$

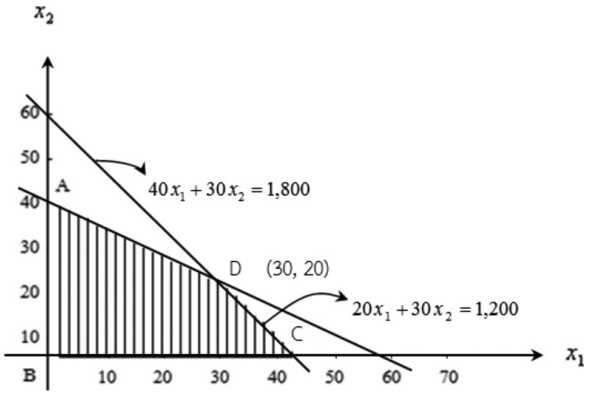

Figure 5 Solutions from Linear Programming with Graph

From figure 5, it is found that the ABCD square area is the possible answers. The points were set as A (0, 40), B (0, 0), C (45, 0) and D (30, 20) which are in accordance with the objective as to gain the most profit. When the value was added in Objective Function, the highest profits were shown in 4 points, 60, 0, 45 and 60, respectively. Therefore, point A and C make highest profit at $60 which indicate 2 ultimate cases.

1. P_2 will be the only product for manufacturing in the total number of 40 items.

2. 30 items of P_1 and 20 items of P_2 can be manufactured. These would generate $60 highest profit.

3. Solutions from Software Program, QM for Windows, have been reported in figure 6.

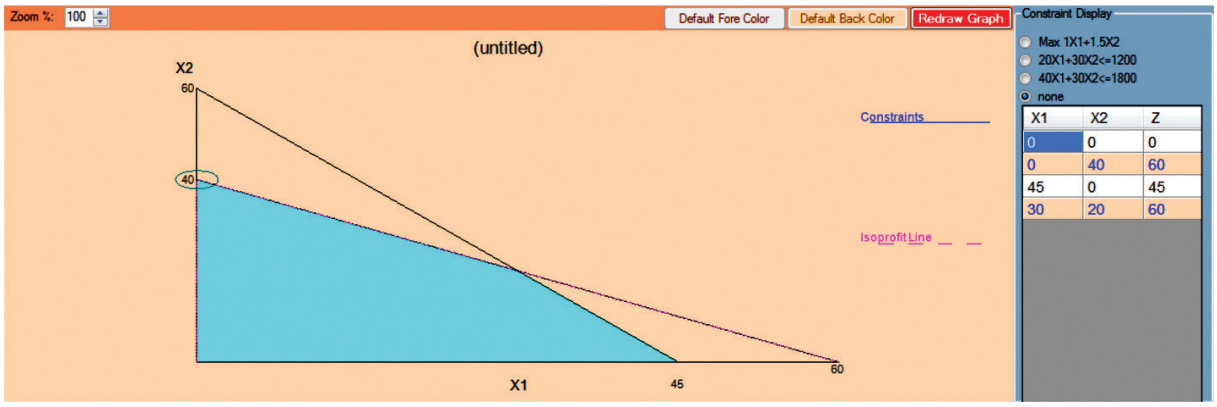

Figure 6 Solutions from QM for Windows

From figure 6, it is found that QM for Windows has reported all possibilities from which analysts can select the result with the highest profit of $60 by the following options.

1. P_2 (x_2) will be the only product for manufacturing in the total number of 40 items.

2. 30 items of $P_1(x_1)$ and 20 items of $P_2(x_2)$ can be manufactured. These would generate $60 highest profit.

3. Solutions from Solver Excel too have been reported in figure 7.

	A	B	C	D	E	F
1						
2						
3		A	B			
4	q prod	0	40			
5				TOTAL		LIMIT
6	PROFIT	1	1.5	60		
7	C	20	30	1200	<=	1200
8	D	40	30	1200	<=	1800
9						

Figure 7 Solutions from Solver Excel Tool

From figure 7, it is found that Solver Excel tool has reported a result which is consistent with the aim of $60 highest profit in 1) P_2 (x_2) will be the only product for manufacturing in the total number of 40 items. In sum, from Sample 3, mathematical calculation from graph and QM for Windows have reported all possibilities. Analysts are allowed to opt for the solution which best suits their strategic or business plan. However, Solver Excel tool has specifically indicated the result which shows the highest profit only.

Conclusions

In the models for logistics and supply chain decisions, the software can be used as a component of analysis. It was found that Solver in Excel software is popularly designed to find optimized solutions. It is widely used in business, industry, and education. It is usually used as a tool to teach basic quantitative analysis (Daniel et al. 1998). With this software a user has to write procedures. Using simple mathematical knowledge can help solve problems for learners or users who do not have the ability in basic mathematics (Chandrakantha, 2014). The other software which helps to calculate the operating time with accurate results is QM for Windows. It can be applied in order to solve a varied range of problems (Tatiana, 2009). As a result, the project manager can effectively control the timing of the operating resources, making the project to be successfully completed. (Nithikarnjanatharn & Sawang-Ngam, 2018).

The mathematical calculation and Software Package, QM for Windows and Solver Excel tool can be summarized as follow.

1. Employing Linear Programming and mathematical formula for transportation

problems assists analysts in decision making for results of all methods as conducted. However, analysts should have mathematical background for accuracy investigation by themselves.

2. For QM for Windows, analysts should insert the data, numbers of sources, numbers of Destination and Transportation. With or without solution selections, there will be single result indicated by the program without a specification of calculation method. For Linear Programming, analysts should insert Decision Variable, Objective Function, and Constraint or Restriction. All probabilities will be presented as shown by mathematical calculation.

3. For Solver Excel tool, analysts should prepare data and add to cells. They should recognize process of results calculation and source and destination limitation in order that one value will be reported without a specification of calculation method. For Linear Programming, analysts should prepare for Linear Programing structure and insert to Decision Variable, Objective Function and Constraint or Restriction to cells. There will be a single case which relates to the objective reported even though there are more than one case as in the table.

Table 1 A Summary of Usage, Strengths and Limitations of the Methods

Items	Mathematical Calculation	QM for Windows	Solver Excel Tool
1. Thorough Understanding for Model Calculations/ Solutions	Necessary	Unnecessary	Necessary
2. Limitations and Conditions of the Model/Solutions	Necessary	Necessary	Necessary
3. Results from Solutions for Transportation Problems	All results are reported with calculation methods.	Results are reported without calculation methods.	Results are reported without calculation methods.
4. Results from Linear Programming Solutions	All results relating to the objective is reported.	All results relating to the objective is reported.	A single result relating to the objective is reported.

Finally, nevertheless the analysts opt for, whether mathematical calculation or Software Programming, they should understand its foundation, difficulties, limitations and possess mathematical background and numbers of possibility. When the results are reported, the analysts might require all cases to make a decision which is suitable for the conditions or limitations in operation, or the program can offer one best solution based on objectives.

Therefore, knowing other options might assist in making decision and beneficial to market share or product lines creation to serve various groups of customers instead of having one target group, for instance. The writer hopes that this article would be useful to university students, researchers, those who have interest in Logistics and Supply Chain.

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