Decision Support System For Car Production Using Linear Programming Approach

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Abstract

Linear programming is the best known optimization model. It deals with the optimal allocation of resources among competing activities. Using special mathematical procedures, the LP approach applies a unique computerized search procedure that finds the best solution. In this paper, the optimal solution, that maximizes the profit for a car production plant is investigated using the LP technique. This paper intends to provide estimating the profit for car production. There is a trend toward providing managers with information systems that can assist them directly in their decision making processes for most important tasks. DSS allows managers and their staff to use the query capabilities of the computer in order to obtain requested information and retain control over the decision making process as changes occur. Computerized decision support systems are needed for speedy computation, increased productivity, technical support, quality support and competitive edge.

1. Introduction

Decision Support System (DSS) are a specific class of computerized information system that supports businesses and organizational decision-making activities. DSS is extensively used in business and management. DSS help such managers to solve problems that they typically face in real world. A properly designed DSS is an interactive software-based system intended to help decision makers with useful information from raw data, documents, knowledge, and/or business model to identify and solve problems and make decisions.

Linear programming helps in attaining the optimum use of productive resources. It can be able to improve the quality of required materials. A solution that satisfies both the conditions of the problem and the given objective is termed an ‘optimum solution’. A typical example is that of the manufacturer who must determine what combination of his available resources will enable him to manufacture his products in a way which not only satisfies his production schedule, but also maximizes profit. This problem has as its basic conditions the limitations of the available resources and the requirements of the production schedule, and as its objective the desire of the manufacturer to maximize his gain.

Modeling a motor vehicle is a very complex task. Many hard-to-predict variables need to be considered during the process. The profitability of a car manufacturing industry depends largely on how well it uses its capacity. This system will model a car manufacturer's work to flow over order-based model in order to fulfill the task of decision making process. This paper presents the decision support system for car production. Linear programming is used to model the production in order to maximize profit and minimize cost. Section 2 presents the related work that uses other approaches for decision support system and Linear Programming. Section 3 describes Proposed System. Section 4 illustrates how System Implementation is used in this paper. Section 5 deals with Conclusion.

2. Related Work

A critical decision companies are faced with on a regular basis is the ordering of products and/or raw materials. Poor decisions can lead to excess inventories that are costly or to insufficient inventory that cannot meet its customer demands. These decisions may be as simple as “How much to order” or “How often to order” to more complex decision forecasting models. This paper addresses optimizing these sourcing decisions within a supply chain to determine robust solutions.

In general, it is recognized that different types of products may need different types of supply chains by [2]. There is a need for evolving Multiproduct production scheduling for style goods with industrial as discussed in [5]. [6] has shown the need for a linear programming model for cash flow management in the Brazilian construction industry. [7] constructs planning for linear projects. For instance, There is time-cost trade-off algorithm for nonserial linear projects industry adoption of such models is often low despite their apparent usefulness in [8]. In [3] a dynamic programming model is developed of a linear project. His work ignored to incorporate the cost as decision variable in the optimization process. [4] formalized a N-stage dynamic programming solution into two state variable to determine the minimum project duration. In the optimization process, the developed model ignored the activities costs as a decision variable. In a dynamic programming formulation is presented for the scheduling of non sequential or nonserial activities to determine the project time-cost profile which determines possible project duration and their minimum project total cost.

3. Decision Support System

Decision Support Systems (DSS) are a specific class of computerized information system that supports business and organizational decision-making activities. A properly designed DSS is an interactive software-based system intended to help decision makers compile useful information from raw data, documents, personal knowledge, and/or business models to identify and solve problems and make decisions.

A DSS is a computer program application that analyzes business data and presents it so that users can make business decisions more easily. It is an "information application "that collects the data in the course of normal business operation. Typical information that a decision support application might gather and present would be-

- Comparative sales figures between one week and next.
- Projected revenue figures based on new product sales assumptions.
- The consequences of different decision alternatives, given past experience in a context that is described.

3.1. Decision Making

Decision making is a process of choosing among alternative courses of action for the purpose of attaining goals. Managerial decision making is synonymous with the whole process of management. In the case of important managerial function of planning, planning involves a series of decisions what to do, when to start, how long to take, by whom, etc. Therefore planning implies decision making other functions in the management process, such as organizing and controlling, also involve making decisions.

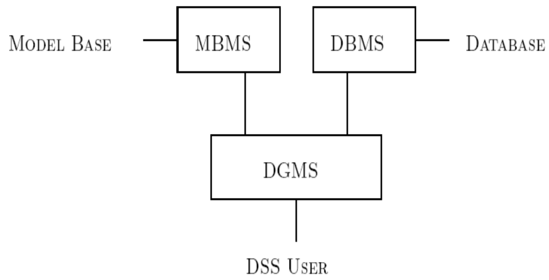

Figure 1. **Decision Support System Architecture**

3.2. Components of Decision Support System

Typical application areas of DSSs are management and planning in business, health care, the military, and any area in which management will encounter complex decision situations.

Database management system (DBMS). A DBMS serves as a data bank for the DSS. It stores large quantities of data that are relevant to the class of problems for which the DSS has been designed and provides logical data structures.

Model-base management system (MBMS). The role of MBMS is analogous to that of a DBMS. The purpose of an MBMS is to transform data from the DBMS into information that is useful in decision making.

Dialog generation and management system (DGMS). As their users are often managers who are not computer-trained, DSSs need to be equipped with intuitive and easy-to-use interfaces. These interfaces aid in model building, but also in interaction with the model, such as gaining insight and recommendations from it.

4. Linear Programming

Linear programming (LP) is the general technique of optimum allocation of scare or limited resources, labor, material, capital, energy, etc, to several competing activities, such as products, jobs, new equipment, projects, etc. In mathematics, LP problem involve the optimization of a linear objectives function, subject to linear equality and in equality constraints.

LP problems determine the way to achieve the best outcome (such as maximize profit or lowest cost) gives some list of requirements represented as linear equations.

More formally, given a polytype, and a real-valued affine function.

$F(x_1,x_2,\ldots..,x_n)=C_1+C_2+\ldots..+C_n+d$

Defined on this polytype, the goal is to find a point in the polytype where this function has the smallest (or largest) value. Searching through the polytype vertices is guaranteed to find at least one of them.

LP is problem that can be expressed in canonical form:

Maximize $C^T x$

Subject to $Ax \leq b$

X represents the vector of variables (to be determined), while 'C' and 'b' are vectors of (known) coefficients and A is a (known) matrix of coefficients. The expression to be maximized or minimized is called the objective function (CTx is this Case). The equations $Ax \leq b$ are the constraints which specify a convex polyhedron over which the objective function is to be optimized.

LP is an important field of optimization for several reasons. Many practical problems in operations research can be expressed as LP problems. A number of algorithms for other types of optimization problems work by solving LP problems as sub-problems. Ideas from LP have inspired many of the central concepts of optimization theory, such as duality, decomposition and the importance of convexity and its generalizations.

4.1. Standard Form

Standard form is the usual and most intuitive form of describing a linear programming problem. It consists of the following tree parts. A linear function to be maximized

e.g maximized $C_1x_1 + C_2x_2 + C_3x_3$

Problem constraints of the following form

e.g $a_{11}x_1 + a_{12}x_2 + a_{13}x_3 \leq b_1$

$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 \leq b_2$

$a_{31}x_1 + a_{32}x_2 + a_{33}x_3 \leq b_3$

Non-negative variables , $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$

The problem is usually expressed in matrix form

$$\begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} \leq \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix}$$

A standard mathematical modeling technique called LP is applicable. The tree components of the system are as follows:

Decision Variables

x_1=units of Jeep per week to produce

x_2=units of light truck per week to produce

x_3=units of Sloon per week to produce

Result Variables

Total profit=Z

The objective is to maximize total profit

E.g $Z=1000000\,x_1+1200000\,x_2+1500000x_3$

Uncontrolled Variable Constraints

Labour constraints : $-x_1+-x_2+-x_3 <$ (in days)

Budget constraints : $-x_1+-x_2+-x_3 <$ (in kyats)

Markteing Requirement for-x_1:-x_2:-x_3 > (in units)

5. Proposed System

This system presents decision support system for car production. Model-based decision support system is used to help decision support system. Linear programming model (LP) is applied in this system. Most extensively it is used in business and economic situation, but can also be utilized for some engineering problems. Some industries use LP models in transportation, energy consumptions, telecommunications, and manufacturing. It has provided useful in modeling diverse types of problems in planning , routing , scheduling , assignment and design.

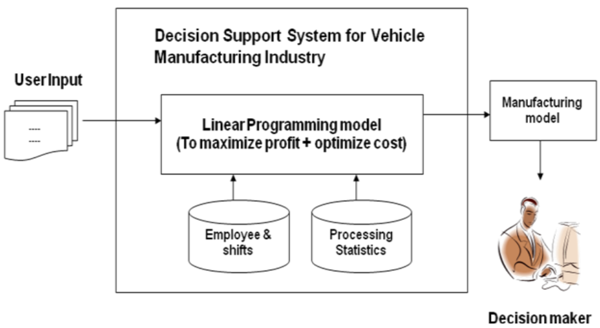

Figure 2. System Architeture

5.1. Process Flow of the System

In this system, the first stage of decision making process is the entry of user's problem statement, which includes number of car to produce and time available. Those data are converted to time (capacity) constraints and requirement constraints. Then it defines slack variables as the coefficient variables. Then those slack variables are applied into time constraint equation, requirement constraint equation and maximize profit equation. Then production model is produced for the optimized cost model.

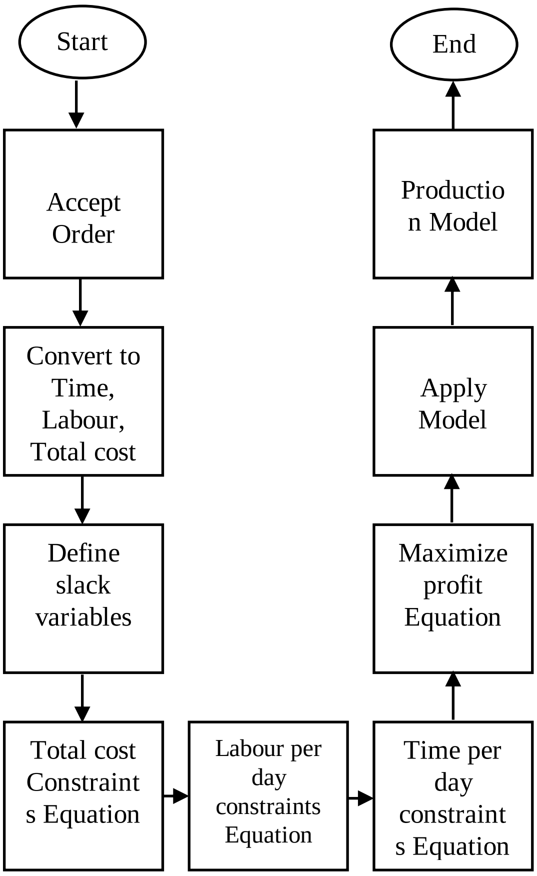

Figure 3. Process Flow of the System

6. System Implementation

This system is implemented with Java programming language. Jdk 1.5 is used to develop the system. Car production is used as case study for decision support system. User makes order entry and problem statements are stored as amount of time necessary for each department.

Sample Problem Statement

There are 3 product types in this system, x_1,x_2,x_3. Twelve parameter that the user needs to input are total cost each car type , labour variables and time per day of each car type.

-Total cost for a car type x_1 is 5,600,000.
-Total cost for a car type x_2 is 7,850,000.
-Total cost for a car type x_3 is 9,800,000.
-Labours per day for a car type x_1 is 3.
-Labours per day for a car type x_2 is 5.
-Labours per day for a car type x_3 is 7.
-Working hours per day for a car type x_1 is 5.
-Working hours per day for a car type x_2 is 8.
-Working hours per day for a car type x_3 is 10.

Table 1 shows the profit and working capacity for each product type.

Table 1: Problem Statement

PT	Car Type	Profit	Total Cost	Labor	Time	Constraint
X_1	Jeep	120000	c_{11}=5600000	c_{21}=3	c_{31}=8	b_1= 6800000
X_2	Light Truck	200000	c_{12}=7850000	c_{22}=5	c_{32}=5	b_2 = 20
X_3	Saloon	240000	c_{13}=9800000	c_{23}=7	c_{33}= 10	b_2 = 30

Subject to the constraints

(1)Input the total cost for a car type $5,600,000x_1 + 7,850,000x_2 + 9,800,000x_3 \leq 46,800,000$

(2)Input the labour for a car type $3x_1 + 5x_2 + 7x_3 \leq 20$

(3)Input the working hour per day for a car type $5x_1 + 8x_2 + 10x_3 \leq 30$

Slack variables = $s_1+s_2+s_3$

The result of the calculation are the units of Jeep, Light Truck, and Saloon. The system also show the total profit when can be obtained by the production of these units of vehicles. After applying in LP model to maximize the profit, the results are as follows:

Jeep = 26
Light Truck = 6
Saloon = 20
Profit = 8560000

7. Conclusion

Linear programming can be used in attaining the optimum productive resources. In this paper, decision support system for car production is implemented by using linear programming approach. We find the objective values of the car production system by simplex method. As a result, the system produces the maximum value of the profit for car production.

This system is useful in many organizations and many places to calculate the required objective values and to evaluate the quality of their objective values. This system can help to computerize other products in the future. Different conditions that can calculate to get maximum profit are like this system. New products come from time to time so this system can be extended with new products.

8. References

[1] Birrell G.S., "Construction Planning-Beyond the Critical Path", J. of the Construction Division, Vol. 106, N° Co3, (1980), pp 389-407.

[2] Fisher, M. and A. Raman, "Reducing the cost of demand uncertainty through Accurate Response to early sales", Operations Research, 44:1, 1996.

[3] Fluoria, M. and Wadhwa, S., "Demand Plan Constraints in Fashion Supply Planning, Canadian Operations Research Society Conference at Vancouver, 2003.

[4] Haysman, W.H., H.L. Lee and V.L. Zhang, "Optimal ordering for inventory systems with dual lead times", working paper, Department of UNICAMP, Av.Albert Einstein 951, CEP13081-970, Campinas, SP, Brazil, 18 January 2001. Limited Capacity, Forecast Revisions and Terminal Delivery (with R. Peterson), Management Science, March 1972

[5] Haysman, W.H., PeterSon, R., "Multiproduct Production Scheduling for Style Goods with Industrial Engg and Engf Mgmt", Standford University, 1995.

[6] PAULO S. F. BARBOSA and PRISCILLA R.PIMENTEL, "A linear programming model for cash flow management in the Brazilian construction industry", Dept. of Civil Engineering, State University of Campinas

[7] Selinger S., "Construction planning for linear projects", ASCE Journal of the Construction Division, Vol. 106, 2, (1980), pp.195-205.

[8] Senouci A.B. and Eldin N.N., "A time-cost trade-off algorithm for nonserial linear projects", Canadian J. of Engineering, Vol.23, (1996), pp.134-149.

[13] U. Meyer, and P. Sanders, D-stepping: "*a parallelizable shortest path algorithm*", Journal of Algorithms 49, 114–152, 2003.