Decision Support Systems and Their Role in Rationalizing the Production Plans: A Case Study on a Plant in Najaf

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Abstract

This research focuses on how to analyze production plans based on quantitative indicators, enabling managers to produce plans that produce the results that help make full use of resources to achieve the company's goals, maximize profits, and reduce costs to the lowest possible level. These concepts covered in this research, presented in three parts. The first part covers the scientific methodology and literature review, the second part describes the theoretical side, including presentation and analysis of DSS and the concepts of sensitivity analysis and production planning, and the third part covers the application side, applying the discussed measurements in an organization to achieve results, and recommendations.

1. Introduction

Production plans are of great importance in business productivity as a future course of action, determined by methods of confrontation against conflicts, rivalries, and the possibility of achieving competitive advantage in the market. The design of production plans is no longer linked entirely to inherited knowledge of the director or manager. Due to rapid changes and complexity in the business environment, it is becoming more difficult for decision makers to make the proper decisions inequality and quantity. Therefore, the role of decision support systems (DSS) have become important. DSS enable decision makers to rely on quantitative methods to make their decisions, giving them an edge over others who depend on experience (Yan, 2011). The same is applies in almost every field, from pharmaceutical to education where universities try to collect knowledge provide its students with better education as well be able to complete in the market. (Najim, Ghalib & Alnaji, 2013) (Alnaji, 2013).

2. Decision Support System concepts and theories

DSS emerged in the early 1970s as a concept by Morton who used the term Management Decision System as a step in the development of management information systems to aid in decision making (Filip, 2008). DSS are interactive systems enabling decision makers to interact with databases to generate a knowledge base that supports their decisions in finding appropriate solutions to problems facing the organization (Power, 2003). Furthermore, DSS are problem-oriented systems giving solutions to problems, replacing regular functional information systems that are process oriented.

They can be viewed as a philosophy or an entry point to a solution rather than a specific methodology, regardless of concepts. Characteristics and capacities of DSS can be summarized as:

- Systems that offer solutions at all levels of administration
- Systems that help provide successive and independent series of decisions.
- Systems that depend on predefined models (operational, statistical, or financial).

3. Linear Programming

Linear programming is a simple model to understand. It does not require more mathematics than a number of simple equations and a few variables. It can be used as a tool to determine the economic value of resources (Ridha, 2012). Researchers recently began exploring the role of mathematical models in decision making (Anderson, Camm, Williams, & Sweeney, 2013). The use of linear programming models for medium-term production planning is widespread. It may be used as a single-stage planning system to transform a yearly sales plan into a feasible production plan that indicates, for each item (or group of items), which subperiods and what amounts should be produced, such that a given objective function is at its optimum (Caixeta-Filho, vanSwaay-Nego, & Wagemaker, 2002; Hung & Cheng, 2002; Lawrence & Burbridge, 1976; Nichelson & Pullen, 1971; Stadtler, 1988).

4. Sensitivity Analysis

Sensitivity analysis plays an important role in linear programming. In some cases, knowing how an optimal solution changes relative to perturbations in the input data is more important than simply computing an optimal solution. Data for a given problem can never be absolutely accurate in real applications. Hence, it is crucial to keep track of how optimal solutions, or the optimal value, change if the data changes. Because of this, researchers have investigated the area of sensitivity analysis (Holder, Sturm, & Zhang, 2001;. Wendell, 2004; Julia L. Higle , Stein W. Wallace2003; Sitarz,2010).

5. Research Methodology

5.1 Research Problem

In practice, organizations need to continuously evaluate and monitor production-planning processes; these plans are supposed to be designed scientifically accurately and reflect the aspirations of the organization's future. To achieve organization objectives, it is very important for decision makers to support decision-making processes in production planning by applying quantitative methods that help produce the best results with minimal cost.

5.2 Research Importance

The importance of this research comes from demonstrating the role of quantitative indicators in decision management, as well as exploring the possibility of applying decision-support models in streamlining production lines.

5.3 Research Objectives

This paper explores the role of quantitative models in decision making to enable plan managers to produce optimal results. The objective of this paper is to shed light on two important models—linear programming and sensitivity analysis—and their role in making decisions in a company.

5.4 Research Data

Research data were collected from a tire factory located in Najaf, Iraq. The factory categorizes the types of tires to three categories:

1. Tires for small and medium-sized sedans.
2. Tires for small, medium, and large cars.
3. Tires for light and heavy tractors.

Each type of tires comes in different sizes. For the purpose of our research, the first type of tires was selected; the first type is produced in the following sizes:

1. Tire size 145/13
2. Tire size 165/13
3. Tire size 175/70/13
4. Tire size 195/70/14
5. Tire size 195/75/14.
6. Tire size 185/75/14
7. Tire size 185/75/15

Table 1: The Cost and Profit Made From Each Type of the Tires

Tire size	Making cost	Expected profit	Sale price
145/13	15327	773	16100 Dinar
165/13	15857	9143	25000 Dinar
175/70/13	15123	6273	21396 Dinar
195/70/14	15120	9373	24493 Dinar
195/75/14	20181	7473	27654 Dinar
185/75/14	20573	10573	31146 Dinar
185/75/15	40426	7673	48099 Dinar

The material that goes into the making of the tires was divided into two types: primary resources and assistive resources. Some of the material is solid, and some is liquid. Table 1 demonstrates the cost and profit made from each type of the selected tires:

5.5 Applying a Mathematical Model

The mathematical model applied used j to represent the tire brand type taking values 1, 2, …, 7, x is the production amount of that brand type where:

- x_1 is production amount of type 145/13.
- x_2 is production amount of type 165/13.
- x_3 is production amount of type 175/70/13.
- x_4 is production amount of type 195/70/14.
- x_5 is production amount of type 195/75/14.
- x_6 is production amount of type 185/77/14.
- x_7 is production amount of type 185/75/15.

Table 2: The Variables and Constraints Entered Into the Model

		X1	X2	X3	X4	X5	X6	X7		
Maximize		773	9143	6273	9373	7473	10573	7673		
Constraint	1	1.794	1.92	1.92	2.598	2.645	2.503	3.222	<=	4545
Constraint	2	0.326	0.326	0.326	0.465	0.445	0.43	0.666	<=	949
Constraint	3	0.939	0.308	0.308	1.682	1.72	1.598	2.053	<=	1736
Constraint	4	0.375	0.419	0.419	0.515	0.526	0.508	0.601	<=	1112
Constraint	5	0.639	0.862	0.862	1.119	1.141	1.065	1.436	<=	1540
Constraint	6	0.679	0.72	0.72	1.015	1.03	0.961	1.305	<=	1859
Constraint	7	0.146	0.171	0.171	0.225	0.23	0.216	0.283	<=	349
Constraint	8	0.05	0.059	0.059	0.079	0.079	0.75	0.1	<=	129
Constraint	9	0.069	0.081	0.081	0.106	0.108	0.102	0.132	<=	120
Constraint	10	0.003	0.003	0.003	0.004	0.004	0.004	0.005	<=	8.5
Constraint	11	0.03	0.03	0.03	0.039	0.04	0.39	0.053	<=	67
Constraint	12	0.045	0.052	0.052	0.071	0.071	0.067	0.093	<=	103
Constraint	13	0.017	0.023	0.023	0.029	0.03	0.028	0.036	<=	27
Constraint	14	0.011	0.012	0.012	0.016	0.016	0.016	0.02	<=	18
Constraint	15	0.02	0.026	0.026	0.034	0.035	0.032	0.044	<=	23
Constraint	16	0.006	0.007	0.007	0.009	0.01	0.009	0.012	<=	14
Constraint	17	0.001	0.001	0.001	0.001	0.001	0.001	0.001	<=	6.5
Constraint	18	0.003	0.004	0.004	0.005	0.005	0.005	0.006	<=	70
Constraint	19	0.016	0.012	0.012	0.018	0.018	0.018	0.03	<=	29
Constraint	20	0.003	0.003	0.003	0.006	0.005	0.006	0.006	<=	5.4
Constraint	21	0.006	0.006	0.006	0.013	0.014	0.012	0.012	<=	10
Constraint	22	0.023	0.027	0.027	0.037	0.036	0.034	0.05	<=	37
Constraint	23	0.266	0.0327	0.0327	0.405	0.413	0.393	0.483	<=	411
Constraint	24	0.345	0.452	0.452	0.593	0.602	0.562	0.735	<	595

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Constraint	25	0.21	0.21	0.21	0.35	0.35	0.35	0.54	<=	474
Constraint	26	0.52	0.52	0.52	0.68	0.69	0.62	0.84	<=	947
Constraint	27	0.25	0.26	0.26	0.37	0.38	0.39	0.45	<=	412

To perform the analysis, Win Q.S.B and QM for Windows were used. Table 3 demonstrates the final results received from running the model:

Table 3: The Final Results Received From Running the Model

Decision variable	Solution value	Unit cost or profit (j)	Total contribution	Reduced cost	Basis status
X1	0	773.0000	0	-5,835.1250	at bound
X2	0	9,143.0000	0	-9,143.0000	at bound
X3	0	6,273.0000	0	-2,978.3750	at bound
X4	572.0000	9,373.0000	5,361.356.0000	0	basic
X5	0	7,473.0000	0	-4,091.2180	at bound
X6	111.0000	10,573.0000	1,173,603.0000	0	basic
X7	0	9,673.0000	0	-6,864.8740	at bound
Objective	Function	(Max.) =	6,534,959.0000		

As can be seen from Table 3, the most profitable products with limited resources are:

1. X4: 195/70/14
2. X6: 185/75/14

The highest profit calculated is:

Objective Function (Max. 2) = 6,534,559 Dinar

5.6 Data Analysis and Discussion

From Table 3, the following can be concluded.

5.6.1 Indicators for the Objective Function Coefficients (Profit)

Looking at the Reduce Cost column in Table 6, if you add this value to the objective function coefficients that reflect the expected profit in selling tires, especially for products that did not make profit with limited resources, this action will prevent the product from being an unattractive product to a product with good profitability.

5.6.2 Total Contribution

From the total contribution column, we notice that X4, X6 and total profits are as follows:

X4 = 5,361,356

X6 = 1,173,603

Objective Function (Max) = 6,534,939

5.6.3 Shadow Prices

Shadow prices represent the amount of increase in expected profit if available material were increased by one unit (Anderson et al., 2013). This measurement is of great importance for managers because it is used as an indicator when making any decision to increase the quantity of available resources.

It is clear from Table 4 that the shadow price for Supplier 15, the amount for time machines (G.21), is 330,406.200, but for other resources, the shadow price is zero, which means there is a surplus of these resources.

5.6.4 Lower Bound

The left-hand column in Table 4 represents the lower bound: the minimum of resources available. As can be seen from Table 4, the lower bound for the first resource is 1,763,884 and for the second resource is 313,710 and so on.

Table 4: Model Results for Determining the Shadow Prices and Quantity of Surplus Raw Materials

	Constraint	Left-hand side	Direction	Right-hand side	Slack or surplus	Shadow price
1	C1	1,763.8890	<=	4,545.0000	2,781.1110	0
2	C2	313.7100	<=	949.0000	635.2900	0
3	C3	1,139.4820	<=	1,736.0000	596.5181	0
4	C4	350.9680	<=	1,112.0000	761.0320	0
5	C5	758.2830	<=	1,540.0000	781.7170	0
6	C6	687.2510	<=	1,859.0000	1,171.7490	0
7	C7	152.6760	<=	349.0000	196.3240	0
8	C8	128.4380	<=	129.0000	0.6520	0
9	C9	71.9540	<=	120.0000	48.0460	0
10	C10	2.7320	<=	8.5000	5.7680	0
11	C11	65.5980	<=	67.0000	1.4020	0
12	C12	48.0490	<=	103.0000	45.9510	0
13	C13	19.6960	<=	27.0000	7.3040	0
14	C14	10.9280	<=	18.0000	7.0720	0
15	C15	23.0000	<=	32.0000	0	330,406.2000
16	C16	6.1470	<=	14.0000	7.8530	0
17	C17	0.6830	<=	6.5000	5.8170	0
18	C18	3.4150	<=	7.0000	3.5850	0
19	C19	12.2940	<=	29.0000	16.7060	0
20	C20	7.0980	<=	5.4000	1.3020	0
21	C21	8.7680	<=	10.0000	1.2320	0
22	C22	25.9370	<=	37.0000	11.0630	0
23	C23	275.2830	<=	411.0000	135.7170	0
24	C24	401.5780	<=	595.0000	193.4220	0
25	C25	239.0500	<=	474.0000	234.9500	0
26	C26	457.7800	<=	997.0000	539.2200	0
27	C27	254.9300	<=	412.0000	157.0700	0

6. Conclusion

From the analysis conducted above, it is clear that the mathematical model can be adopted as the overall plan and can be used to obtain quantitative indicators necessary to rationalize production plans for the future. Furthermore, DSS enable decision makers to determine which product made the most profit using limited resources; in this case, for example, the two products were Products 2 and 6. Finally, the analysis forms the basis for indicators enabling administrators to determine which products produce a greater profit with minimal costs. Having said that, it is very important for organizations to create technical and human requirements for the successful application of DSS necessary to rationalize production-planning decisions. A recommendation the researcher proposes is the adoption of a strategy by managers responsible for the operations of the production planning before launching the production plan into service, managers should also use sensitivity analysis as a basis to provide quantitative indicators in the rationalization of production plans.

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