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A Model to Determine Optimal Composition of Production to Obtain Maximum Profit & Reduce Overhead Costs by Linear Programming

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Abstract

There are many factors which put emphasize on the importance of developing pharmaceutical industry such as human health, reduced rate of using medicines, improve healthcare to global level, influence of pharmaceutical industry on exchange market, creating job and etc. Growing improvements in production systems, appearance of mechanized systems and dynamic commercial markets have highlighted the requirements of planning. This study aims to provide a model for defining the optimal composition of production in Sobhan Darou Pharmaceutical Company to obtain maximum profits and reduce overhead costs by linear programming. Lingo application is applied to reach mentioned goals. The results showed that a mathematical planning model can be used to determine minimum of total costs and inventory control strategy. Using linear programming we can take into account all perceptible and imperceptible factors to have a choice, while output models only consider quantitative values. Another advantage of leaner programming is that it can calculate production weight and rate with a systematic method which increases the efficiency and helps to have a proper choice.

Keywords: commercial markets, leaner programming, overhead costs, profitability

1. Introduction

Growing improvements of production systems, appearance of mechanized systems and dynamic commercial markets have highlighted the needs of planning. According to the fact that competition plays an important role in todays' world, optimization of production systems is of great importance. Determining an optimal composition for productions based on research techniques is an important factor in optimization. The most important studies about analyzing optimal composition of production are conducted by applying the factor of profitability. Although profitability is an important factor in determination of composition production in industrial factories, analyzing it in long term and with a strategic perspective in dynamic markets by the factor of profitability is not enough and many other quantitative and qualitative factors are influential in this composition production among which we can refer to overhead costs (Rashidi et al., 2012).

In other words, overhead cost is one of the main factors in determining final costs and it is not involved in production process directly. This factor cannot be attributed to specific product and is a total cost. Overhead cost is an amount of money which is held in common among different agricultural sectors, service centers and other costly sections. It is neither spent on raw materials nor on wages, but it is spent on complementary materials, betterment, repair and maintenance, electricity, water, fuel and etc. If overhead cost is estimated prior and is applied in midterm according to specific rate, company may face over or under absorbed overhead. In this case over or under absorbed overhead should be shared between cost of goods sold, inventory and work in process (pifeh, 2009).

According to what we said, strategic studies are so crucial for managers of pharmaceutical company. Managers should understand that companies are changing and improving day to day. So it is necessary for them to take suitable strategies in future competitive markets. These companies are at risk of environmental threats. Pharmaceutical companies should recognize their current situation and analyze their strengths and weaknesses.

And by doing so they should be prepared to challenge difficulties. It is possible through setting strategic planning and taking actions based on it. Since the main target of strategic management is to allocate scarce resources to competitive activities, so applying methods and techniques which help meeting this goal is so necessary. An applicable method in optimize combination of production is leaner programming model. Using this model we can have an optimized pattern with maximum interest rate and minimum overhead prices according to the fact that overhead cost is the most important factor in reducing profitability. This study aims to provide a model to define the optimized combination of production for Sobhan Darou Pharmaceutical Company to maximize interest rate and minimize overhead cost by the application of leaner programming.

1.1 The Optimal Combination of Production Factors

Optimal application of resources and suitable allocation of these resources to production requirements lead to high quality and reduced costs. Having enough information about human resources, economic resources, raw materials, and equipment and machinery condition help managers to set plans for efficiency of production line quality (Sharifi H, 2014).

Production management is an operation thorough which we can have technical programing and strategies to handle resources and productions. It is an internal activity in organizations which make predictions, set plans and do marketing for production or services. Product management is always concern about product development because it leads to increased income, market share and profit margin (Naghshineh et al., 2007). Determine combination of production is very important in companies. It is one of the first issues in research and plans which are related to production. Mathematical programming has been the most applicable approach to solve relevant problems to optimization. A production program should be provided to determine combination of production, and by doing so obtained profit is maximized and resource constraints, marketing and sales is taken into account (Rashidi, 2012). Profitability is one of the most important source information that analyzes the performance of economic units and is a suitable criterion for investors to make decisions. Although profitability is a good indicator, no comprehensive definition is given for it. Generally, profitability is based on return on investment. Company has return on investment if its price is sustainable and returnable. So preservation of capital is applied to determine difference between return on investment, payback and interest rate. Preservation of capital has two concepts: physical capital and financial capital. Profitability refers to companies' ability to obtain profit and it is final result of all financial programs and decisions of company. Interest rate to sale is used to estimate profitability ratio (kimiagari et al, 2008).

Measuring optimal production is the first step to estimate profitability ratio by which profitability ratio is defined and estimated. The final result of this process is to recognize ratio of profitability to systems' efficiency. Then in following steps efficiency is analyzed. Profit indicators can be used in estimating efficiency in a system. The indicator of optimal production should be defined in a way that shows systems' capabilities (Ganji, 2012).

In other words, combined production is one of the most important issues which different industries challenge with; and it is when they are able to produce some kinds of products but they cannot decide to produce which of them. Or when a company can produce different products but cannot decide to what extent for each should be produced. Time value of money should not be ignored in combined production method which is an influential factor in profitability especially in Iran. Since inflation in Iran is increasing the factor of time value of money is more significant.

Leaner programming in combined production is one of the issues which have been always in center of attention in production systems. Making decision about determination of optimal production according to resource capacity and its balance is so important in product management and for managers, in a way that it is applied in midterm product planning and it is more applicable than complex optimization models despite the fact that their results are not as optimized as complex models results (Najafi & Abdollahzadeh, 2014).

1.2 Leaner Programing

Leaner programming model for production is one of the most common models for optimizing midterm planning in firms. According to different resources, profitability ratio and resource constraints it determines optimal combination of production. This combination and the obtained benefit are estimated regardless of current money value in different periods. With regards to high inflation rate in our country paying attention to this issue is so important and getting more profits in early stages brings more value (Adel & Toghyani, 2014).

Leaner programming as a mathematical model was created during World War II to organize expanses and financial returns with purpose of increasing military spending.

First in 1979, Leonid Khachyan proved that leaner programming can be solved in polynomial time order. But

more progressed advanced were appeared when Narendra Karmarkar introduce the new method "Interior-point approach" to solve this problem. Leaner programing is a traditional approach for solving related matters to combination of production. Combination of production includes making decisions about number and type products based on restrictions. Leaner programming has many advantages such as analyzing behavioral assumptions, applying technology changes and marketing issues (Pigout, 1975).

1.3 Profitability and Overhead Costs

Profitability is companies' ability to obtain profit. It is final result of all programs and financial decisions and it is estimated based on profitability ratio to sales (Kimiagari et al., 2008; Weston, 1975).

Although profitability is a main factor in determining combination of production, if we want to analyze a companies' benefits in long term strategically this factor is not enough. Some other factors such as production safety, capacity, investment rate, sale market and etc. can be influential in determining optimal combination of production. In many research in different fields various subjects were studied based on different quantitative and non-quantitative factors (keramati, 2013). As it was mentioned, determining the best combination for production which maximizes interest rate is an important decision for companies. Companies should make suitable decision in proper time to be successful in competitions (Sharifi, 2014).

Resource constraints and various influential factors lead organizations to make decisions and take action according to mathematical models to analyze situations and determine the importance of each factor to make best decision. One of the important multi-criteria decisions which attract researches attention is determining optimal combination of production. It is because in competitive environments making decisions about optimal combination of production and economic production is very important and it influences obtained profits of economic units. Determining optimal combination of production requires taking into account many factors. Multiple attribute decision makings (MADM) are strategies which rank and chose the products that should be manufactured among a wide range of products. MADM provide an effective framework to compare products based on different criteria (Wang et al., 2007).

Overhead cost is an important factor in evaluating final costs. Activities which are based on costs or overhead costs were introduced by Robin Cooper and Kaplan Robert S for the first time in 1980. According to Anderson and Kaplan ideas (2007), Activity-based costing (ABC) will improve deficiencies of traditional costing systems. In fact, traditional overhead costing systems put more emphasize on effective use of resources and focuses on activities instead of products. Generally, there are three major costs that ate taken into account: labor force, raw materials and overhead cost. The amount of money which is spent on raw materials and labor force are probable costs which are simple to calculate and factors such as pure working hour and direct working hours for machineries should be taken into account to calculate overhead costs which are based on traditional accounting system. When there is a probability of wrong estimation for a product price, the result affects the strategies which are applied to price products (Khataei et al., 2009). The most significant overhead costs are as follow: Betterment of building, Price rent for building, insurance costs, the companies fuel expanse, cost of electricity and employees salary.

The different between real production and expected production leads to predict overhead. In manufacturing companies production rate is predicted at first, but there are difference between real production rate and expected production and maybe real production rate is more than expected production or lower than it.

Therefore, because the real number of manufacturing is not specified in the beginning of the period, the proportion of the cost of an overhead in the manufacturing unit is also not specified. As a result, during a financial period, the finished price of a unit of good is not determinable according to this point that its third component (overhead) is not given.

The managers establish a criterion for comparing the real costs and what is predicted through predicting the overhead, i.e. indeed in the end of the financial period or each time, they can have a comparison between what should be carried out and what is really carried out. Therefore, with following up the differences and its analysis, they may observe the weak points and strength points of their activity.

Based on what was stated, as it is specified, the real overhead are the overhead costs which are actually realized during the financial period and their price is paid or their payment has been undertaken.

Note that also the overhead costs which are specified with carrying out the reformations in the end of the financial period, are also recognized as the real overhead. The real overhead costs are practically carried out and they are usually specified in the end of the financial period. Therefore, they are not merely appropriate for the managers in order to make decision and they are not appropriate criteria for manufacturing planning.

1.4 Introduction of Pharmaceutical Industry

The importance of pharmaceutical industry and its role in the economic development of countries has proposed it as one of the essential axes of development in the developing countries. Therefore, it reveals the necessity of better and more desired usage of accessible limited resources more than ever. The drug is among the most important goods in the human's modern trade in terms of its influence on the human's health. Today, the industry of pharmacy is proposed as one of the key and hugest industries of the world. The drug industry is as one of the strategic industries playing important role in the health and security of the society. The industry of drugs in Iran has passed different and full-fluctuation conditions over several past decades. Despite this, this industry is currently accounted as one of the important and strategic industries of country. Because of profitability of drug industry, this industry may be replaced with oil, gas and petrochemical in our country. A country such as Swiss has founded the basis of its development strategy on the drug, or in a country such as Japan, creation of national value due to selling the drug is as high as 1 percent of the total GDP which is produced in this country, is from the place of drug sale. If the drug industry is looked as a strategic industry, it may have appropriate products for the national economy which are replacements for selling raw oil, gas and petrochemical and it can supply the future of country in this sense.

In general, the industries of pharmacy require a great circulating capital. If the policies of budget adjustment and the required liquidity are not funded, the financial resources and bank facilities should be resorted which themselves have also reduction in the profit. In the governmental sector, profitability is not so important, but in the management of the private sector, profitability is of importance. Therefore, the problem of planning is proposed for the supply and the level of estimating the demand, and the manager endeavors for innovation and competition, and he/she attempts to stabilize his/her position in the market using internal and external marketing. With implementing the global trading in Iran, the corporations which have no innovations should get out of the scene. Establishment of a trading system beside the generic system causes competition between the producers and improvement in the qualitative and quantitative level of the pharmaceutical productions (Davari, 2003).

2. Research Method

According to the nature of the subject, the simulation method is used. Also, in this investigation, genetic algorithm method is used to solve the problem of balance of drug production line, and in order to achieve to the considered targets, Lingo software is used.

The data required for our problem are: number of tasks, number of workstations, prerequisite relations between the works, up and down limits for the operation time of each work, preparation matrices and the influence of learning on the standard operation times and the prerequisite relations of all problems are available in the research website.

Several factors are influential on the suggested algorithm which each one of these factors have different levels. The value for some parameters of the algorithm is determined based on the suggestions which are suggested in the literature.

Table 1. Algorithm parameters

Descriptions	Parameters
0	W_{min}
1	W_{max}
2	c_1
1.5	c_2
0	V_{min}
1	V_{max}
0	X_{min}
1	X_{max}
(0, 1, 0)	(x(0), y(0), z(0))
(10, 28, 8/3)	(δ, ρ, β)

- **First Problem**

The drug production line of the corporation has 39 working elements and 14 working stations.

Limitations:

- Each working element can only be assigned to one working station and there is no possibility for breaking the work between two or more stations.
- The limitation of order and priority should be observed in assignment of the elements; i.e. an element can only be assigned to a station if its prerequisite elements are assigned to one of the previous or the current stations.
- The workload in a station, i.e. the total time of assigning the elements to a station should not exceed from the cycle time.

Table 2. Results obtained from solving the problem

Station	Assigned activities code	Station time	Idle time
1	60,55,10,5	14.58	0.78
2	40	15.36	0
3	70,65,45,30,20	13.98	1.38
4	105,85,80,75	12.99	2.37
5	110,100,25	14.21	1.15
6	50	14.63	0.73
7	95,35	13.43	1.93
8	155,140,120	14.99	0.37
9	150,90	13.51	1.85
10	170,165,130,115	14.41	0.95
11	160,125,15	14.19	1.17
12	180,175,145	14.75	0.61
13	135	14.74	0.62
14	195,190,185	13.14	2.22
	Total	198.91	16.13

- **Second Problem**

The tables which are associated with the operation time, product demand and the station length in different intervals of this problem are given in below:

Table 3. Sample problem based on the operation time, the product demand and the station length in the interval (Adel & Toghiani, 2014; Kimiagari & Ein, 2008)

Sample problem						
Station	2	3	4	5	7	9
Product	3	4	5	6	8	10
Sample problem						
Station	3	4	5	6	8	10
Product	2	3	4	5	7	9

Table 4. Sample problem based on the operation time, the product demand in the interval (Adel & Toghiani, 2014; Rashidi, Gholamzadeh & Shojaa, 2012) and the station length in the interval (Adel & Toghiani, 2014; Kimiagari & Ein, 2008)

Sample problem						
Station	2	3	4	5	7	9
Product	3	4	5	6	8	10
Sample problem						
Station	3	4	5	6	8	10
Product	2	3	4	5	7	9

Table 5. Results of solving the problem based on the operation time, product demand and station length in the interval (Adel & Toghiani, 2014; Kimiagari & Ein, 2008)

Solution with CPSO		Solution with Lingo		Solution with GA		
OFV	CPU time	OFV	CPU time	OFV	CPU time	T_{AVG}
9.4444	0	9.4444	0	9.4444	0.2812	0.1406
--	300	49.3067	311	49.3067	3.7344	157.3672
---	2912	---	3712	99.5714	16.312	156.1864
---	3096	----	3696	183.0609	75.9687	2022.4843
---	3850	---	4250	278.1969	42.4370	2146.2185
---	4050	--	4320	322.3099	222.3750	2271.1875
---	1	17.55	1	17.55	0	0.5
28.5	4	42.24	1	42.2399	0.4236	0.7168
29	24	67.3712	31	67.3712	0	15.5
35	3125	--	3690	199.8952	20.5156	1855.2578
	3055	--	3903	283.1499	41.5790	1972.2895
	3900	--	4109	364.6818	86.4839	2097.7419

Table 6. Results of solving the problem based on the operation time, product demand in the interval (Adel & Toghiani, 2014; Rashidi, Gholamzadeh & Shojaa, 2012) and the station length in the interval (Adel & Toghiani, 2014; Kimiagari & Ein, 2008)

Solution with CPSO		Solution with Lingo		Solution with GA		
OFV	CPU time	OFV	CPU time	OFV	CPU time	T_{AVG}
9.4444	0	9.4444	0	9.4444	0.79	0.89
--	300	49.3067	311	49.3067	3.7344	1906.6640
---	2912	---	3712	99.5714	16.312	1886.5156
---	3096	----	3696	183.0609	75.9687	2018.4843
---	3850	---	4250	278.1969	42.4370	2207.2185
---	4050	--	4320	322.3099	222.3750	2505.1875
---	1	17.55	1	17.55	0	0
28.5	4	42.24	1	42.2399	0.4236	0.7168
29	24	67.3712	31	67.3712	0	15.5
35	3125	--	3690	199.8952	20.5156	2063.2578
	3055	--	3903	283.1499	41.5790	2215.2895
	3900	--	4109	364.6818	86.4839	2386.7419

- **Third problem**

Table 7. Sample examples

Phenomenon	Example 1		Example 2		Example 3		Example 4	
	Time	Prerequisite	Time	Prerequisite	Time	Prerequisite	Time	Prerequisite
1	5	-	3	-	12	-	102	-
2		1	6	1	60	-	34	1
3	4	1	7	1	54	1	36	1
4	6	2	6	2	24	1	32	2
5	5	3	4	2	54	2	33	3
6	3	2	8	3.2	48	3	20	4,5
7	4	3	9	3	6	4	130	4,5
8	5	4 & 6	11	6	6	5	21	6
9	3	4 & 5 & 7	2	8, 4, 5	42	5	36	8
10			13	8, 11	72	6,7	78	7
11			4	7	60	8,9	20	10,7
12			3	10, 9	48	10	78	9,7
13					24	10	21	11
14					12	11	36	15,12
15					36	12,13	36	13

16			36	14	24	14
17			90	15,16		15,16
18			18	17		
19			48	17		
20			54	18,19		

Table 8. Results of using the model of Jahan and Fathi (Adel & Toghiani, 2014) on the sample examples

Station	Sample example 1			Sample example 2		
	Station time	Station operation	Station unemployment	Station time	Station operation	Station unemployment
1	11	1-2-6	1	20	1-2-3-5	0
2	9	3-5	3	19	6-8	1
3	10	4-7	1	19	4-7-11	1
4	8	8-9	4	18	9-10-12	2
5						
6						
7						
8						
9						
10						
	Sample example 3			Sample example 4		
1	60	2	0	102	1	0
2	54	5-8	6	66	2-4	36
3	60	1-9	0	199	3-5-7	1
4	60	3	0	77	6-8-9	25
5	54	11	6	78	10	24
6	174	4-6-7-10	6	77	11-13-15	25
7	60	12-14	0	78	12	24
8	180	15-16-17-18	0	60	14-16	42
9	48	19	12	-	-	-
10	54	20	6	-	-	-

3. Conclusion

Sobhan Darou Pharmaceutical Company includes costs and profits obtained from different parts of this company. This research has used a linear model in order to identify the optimum combination of each component. The optimum state is considered as the final ideal model. Drug production line is one of the most important matters in the process of mass production. The grouping process of mass production relies on particular principles and the environmental conditions depend on the simplicity or complexity of drug production line. If the production line considers and promotes different factors including the number of stations, cycle time, application of production line, employment, and the sequence of stations, the time and cost required for design and performance processes will be reduced and finally this promotion can have a positive effect on product management. Traditionally, the main economic attempts of human could be allocated to the mentioned matter. These measures provide these companies with best results even with least number of facilities. On the other hand, the development of economic institutes requires the improvement of value added. Therefore, it is necessary to use these sources in an optimal manner. According to the fact that the presentation of a new model for decision making can improve the financial performance of pharmaceutical companies, linear programming helps the researchers to identify the problems regarding the promotion of system's performance. Linear programming or LP has the capacity to not only analyze the optimum state of drug production but also maximize the production rate and reduce the overhead costs as one the most important decisions of this company. In fact, linear programming model considers both tangible and intangible factors for one particular choice. However, the output models can only consider quantitative factors. Another advantage of this model is that it has the ability to identify the production rate in a precise manner (weight & rank). This ability in itself promotes the function of these systems and leads to an appropriate decision making and choice.

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