A Statistical Study to Determine the Production Capacity of Jordanian Pharmaceutical Companies based on the Number of Working Hours Using the Assignment Problem

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Abstract

This study sheds light on the productive capacity of the worker an important component at work. In this research, the worker's production capacity was studied and linked to the time factor (number of working hours per worker). A group of Jordanian pharmaceutical companies was selected and you choose a sample size of 30 workers with a stratified sample. We have adopted the Assignment problem to find the optimal solution to produce each factor and compare it with the actual results obtained. Also, we presented the analysis of this study in the method of analysis of variance to reach the following hypotheses; there are significant differences between production averages, and there are no significant differences between production averages.

Keywords: production capacity, pharmaceutical companies, assignment problem

1. Introduction

The productive capacity of workers is a key factor in the growth of firms and their acidification in terms of producing the time at which they are close to deflation at present. The focus of researchers will be on all fields of productivity. It is noted that many researchers link the worker's efficiency to his productivity, but all previous studies have not presented a mathematical pattern to determine the worker's productive capacity when linked to the time factor. In this study, we presented a mathematical model (Assignment problem) to determine the production capacity of the worker, which is the amount produced by the worker during the period that works.

2. Literature Review

Firm performance is a key issue in today's business world (Obeidat et al., 2013; Tarhini et al., 2015; Abualoush et al., 2018), and its impact on firms effectiveness (AlHarrasi & AL-Lozi, 2015; AlHrassi et al., 2016; AL-Syaidh et al., 2016; Mikkawi, 2017). Productivity is a term that is used very often in economic literature and research (Khalayleh et al., 2017; Al-dalahmeh et al., 2018; Masa'deh et al., 2008). Also, productivity can be seen as a measure of efficiency by which resources are used. Samuelson & Nordhaus (2007) define productivity as the ratio of some measure of output by an index of inputs. Diewert & Lawrence (1999) emphasize its role as a key determinant of economic growth and prosperity of an economy according to Sharpe (2000), labor productivity is the most commonly used measure of productivity. Also, we will consider the history of operation research to explain the main idea of our study by different studies. In Dantzig, (1949) developed a method of problem solving in the Simplex Method, which had the greatest effect in obtaining results in a clear mathematical style, also in Dantzig, (1951) discussed a Proof of the Equivalence of the Programming Problem and the Game Problem. In 1952, the Society of Research published its first journal of operations research and the publication of another journal, which helped to develop this area and its use in decision making. Then, Taylor, Fayol, Gilbert, and Mayo used scientific methods and applied the principles of assignment problems.

For most organizations the pressure on improved productivity is increasing. There are many change philosophies to choose from when working with change, such as Total Quality Management (TQM), Six Sigma, Lean

Management and Lean Six Sigma (Al Azmi et al., 2012; Alkandari et al., 2017; Obeidat et al., 2017). The popularity of these philosophies seems to change according to current fashions–one thing is more popular than the other without it being possible to claim that one fashion is better than the other. It might be that what drives the need for change in change management is the chase for the quick fix. The reality seems to be that hard work is always needed, following the fundamentals established in proven approaches, for example, TQM, such as focus on customer needs, focus on the processes that deliver the result, basing decisions on facts, improving continuously, and seeing that everybody, especially leadership, is committed to these principles see. e.g. Bergman & Klefsjö (2010).

Both relational and captive suppliers are interested in upgrading the quality of their products and production processes by learning from their production experience Humphrey & Schmitz, (2002); Pietrobelli & Rabellotti, (2011). However, captive suppliers have particularly favorable opportunities to learn process and product upgrading from lead firms, because they have incentives to instruct local firms to produce high quality inputs Humphrey & Schmitz, (2002); Giuliani et al., (2005); Schmitz, (2006); Altenburg et al., (2008); Pietrobelli & Rabellotti, (2011). In fact, some case studies such as Navas-Alemán (2011) and Ponte et al. (2014) find that captive suppliers are likely to achieve process and product upgrading. Since the applications remained separate and all studies discussed the evolution of simplex method, this study attempts to investigate the application of more than one mathematical model in problem solving and work on discussion.

3. The Problem of the Study and Questions

The research problem stems from the study of the production capacity of workers in the Jordanian pharmaceutical sector when they are linked to the number of working hours using a mathematical pattern to obtain more accurate results.

Does the number of employees leads to the control of the production capacity?

Does the number of working hours leads to the control of the production capacity?

Explain differences in production capacity, if any.

4. The Importance of the Study

The research focuses on the lack of research that has been subjected to the study of productive capacity in a mathematical method, which contributes to linking the productive capacity with the number of working hours in order to reduce the effort and cost, which leads to increasing purchasing power and increasing competition between companies. Access to a mathematical pattern helps in determining the production capacity of workers and linking them to the time factor and analysis of variance to illustrate differences in productivity.

5. Research Objectives

This study aims to study the production capacity of the mathematical model to achieve the best results and to present the results of the analysis to provide recommendations that help improve the level of productivity in the medical sectors.

6. Hypothesis of the Study

Null hypothesis (H_0): There are no significant differences between the average capacity.

Alternative Hypothesis (H_1): There are significant differences between the average capacity.

7. Study Population and Sample

The study population consists of the Jordanian pharmaceutical industry in the Hashemite Kingdom of Jordan. The sample of the study was selected 30 workers from three companies specialized in the pharmaceutical industry and the sample was selected in the style of the class sample and the difference of the number of employees in each company.

8. The Results

The following table presents the quantity of production for each worker, working hours, and rest hours.

Q: The quantity of production, H: Working hours, and R: Rest hours.

	No. of Worker	Sat.			Sun.			Mon.			Tue.			Wed.			Thur.		
		Q	H	R	Q	H	R	Q	H	R	Q	H	R	Q	H	R	Q	H	R
First company	1	20	8	1	19	8	1	19	8	1	17	8	1	18	8	1	22	8	1
	2	18	8	1	20	8	1	18	8	1	19	8	1	15	8	1	18	8	1
	3	17	8	1	21	8	1	19	8	1	18	8	1	15	8	1	19	8	1
	4	18	8	1	16	8	1	20	8	1	19	8	1	17	8	1	20	8	1
	5	18	8	1	17	8	1	20	8	1	20	8	1	16	8	1	21	8	1
	6	19	8	1	17	8	1	18	8	1	20	8	1	19	8	1	18	8	1
	7	19	8	1	16	8	1	17	8	1	18	8	1	18	8	1	17	8	1
	8	19	8	1	19	8	1	19	8	1	17	8	1	18	8	1	19	8	1
	9	16	8	1	19	8	1	19	8	1	19	8	1	17	8	1	19	8	1
	10	18	8	1	18	8	1	18	8	1	19	8	1	18	8	1	18	8	1
	11	20	8	1	18	8	1	19	8	1	18	8	1	18	8	1	19	8	1
	12	20	8	1	18	8	1	18	8	1	19	8	1	17	8	1	18	8	1
	13	20	8	1	19	8	1	20	8	1	18	8	1	14	8	1	18	8	1
Second company	1	24	8	2	23	8	2	21	8	2	22	8	2	22	8	2	20	8	2
	2	23	8	2	23	8	2	20	8	2	21	8	2	21	8	2	20	8	2
	3	21	8	2	22	8	2	22	8	2	23	8	2	23	8	2	22	8	2
	4	20	8	2	21	8	2	25	8	2	22	8	2	22	8	2	21	8	2
	5	22	8	2	23	8	2	22	8	2	26	8	2	26	8	2	23	8	2
	6	25	8	2	22	8	2	24	8	2	26	8	2	26	8	2	22	8	2
	7	22	8	2	26	8	2	21	8	2	27	8	2	27	8	2	26	8	2
	8	24	8	2	26	8	2	22	8	2	25	8	2	25	8	2	26	8	2
	9	21	8	2	27	8	2	21	8	2	22	8	2	22	8	2	27	8	2
	10	22	8	2	25	8	2	20	8	2	21	8	2	21	8	2	25	8	2
Third company	1	25	8	0	14	8	0	11	8	0	11	8	0	14	8	0	11	8	0
	2	26	8	0	13	8	0	12	8	0	12	8	0	10	8	0	10	8	0
	3	24	8	0	12	8	0	14	8	0	14	8	0	14	8	0	10	8	0
	4	24	8	0	12	8	0	16	8	0	16	8	0	16	8	0	16	8	0
	5	23	8	0	15	8	0	16	8	0	16	8	0	16	8	0	16	8	0
	6	24	8	0	15	8	0	14	8	0	14	8	0	14	8	0	14	8	0
	7	25	8	0	11	8	0	13	8	0	13	8	0	13	8	0	11	8	0

Now we will use the previous data to find the average of all workers, and we will compare all results between companies to find a best result to determine a good way of production.

The following table represents the mean and standard deviation for each company and workers.

	No. of worker	Max. production	Mean	Std. Deviation	Average of company	Std. Deviation of Company
First company	1	22	19.17	1.722	110	2.38
	2	20	18.00	1.673		
	3	21	18.17	2.041		
	4	20	18.33	1.633		
	5	21	18.67	1.966		
	6	20	18.50	1.049		
	7	19	17.50	1.049		
	8	19	18.50	.837		
	9	19	18.17	1.329		
	10	19	18.17	.408		
	11	20	18.67	.816		
	12	20	18.33	1.033		
	13	20	18.17	2.229		
Second company	1	24	22.00	1.414	138.2	7.57
	2	23	21.33	1.366		
	3	23	22.17	.753		
	4	25	21.83	1.722		
	5	26	23.67	1.862		
	6	26	24.17	1.835		
	7	27	24.83	2.639		
	8	26	24.67	1.506		
	9	27	23.33	2.875		
	10	25	22.33	2.160		
Third company	1	25	14.33	5.428	91.42	7.52
	2	26	13.83	6.080		
	3	24	14.67	4.844		
	4	24	16.67	3.933		
	5	23	17.00	2.966		
	6	24	15.83	4.021		
	7	25	14.33	5.317		

From previous table we note that the production quantity is depend on the number of rest hours, in the first and third company the value of mean is 110 and 91.42, respectively, while in second company was (138.2). So, the rest time is the main factor to achieve a maximum production. In the next tables analyses of variance is shown. We can see that the significance for the F value is very low (0,000) which means that the regression equation is statistically significant. The following table presents a statistical method to explain if there exists a difference between all means in all companies.

The hypotheses of interest in an ANOVA are as follows:

- H_0: Means are all equal.
- H_1: Means are not all equal.

ANOVA

First Company

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.333	12	.944	.438	.942
Within Groups	140.000	65	2.154		
Total	151.333	77			

In the first company, we can see that the significance for the F value is high. So, we accept H_0 because $p = 0.942 > 0.05$

ANOVA

Second Company

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	85.933	9	9.548	2.623	.014
Within Groups	182.000	50	3.640		
Total	267.933	59			

In the second company, we can see that the significance for the F value is low. So, we reject H_0 because $p = 0.014 < 0.05$

ANOVA

Third Company

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	56.619	6	9.437	.416	.863
Within Groups	793.000	35	22.657		
Total	849.619	41			

In the third company, we can see that the significance for the F value is low. So, we accept H_0 because $p = 0.863 > 0.05$.

9. Assignment Problem

The following table presents the maximum production for each company by assignment problem; by this way we can determine which one from the worker achieve the maximum production.

First Company		
Day	Worker	Production Quantity
Sat	11	20
Sun	3	21
Mon	4	20

Day		
Tues	5	20
Wed	6	19
Thur	1	22
Objective Function	Value = 122	

Second Company		
Day	Worker	Production Quantity
Sat	6	25
Sun	9	27
Mon	4	25
Tues	7	27
Wed	8	26
Thur	8	26
Objective Function	Value =156	

Third Company		
Day	Worker	Production Quantity
Sat	2	26
Sun	6	15
Mon	5	16
Tues	3	14
Wed	1	14
Thur	4	16
Objective Function	Value = 101	

From previous table, we note that if we used these result, each company will achieve maximum production. That means we can select some of worker to work in different sectors to achieve a maximum value.

10. Conclusion

Production capacity is one of the most important economic indicators of a company. So, in this study we discussed this issue in three medical companies to apply a mathematical model as assignment problem to achieve the maximum production. On a sample of 30 workers in production, the effect of rest hours on production. The model used in the research is assignment problem. The results of study show that the rest hour is the main factor in production. Significance level for F value indicates that the regression equation is statistically significant. Future research stressed on using Artificial Intelligence (AI) systems for job scheduling (e.g. Karajeh & Maqableh, 2014; Maqableh & Karajeh, 2014) among other fields such as on cloud computing (e.g. Tarhini et al., 2017a), e-government (e.g. Alenezi et al., 2017), e-learning (e.g. Almajali & Al-Dmour, 2016; Tarhini et al., 2017b), e-services (e.g. Almajali & Maqableh, 2015; Khwaldeh et al., 2017), and e-learning systems (Almajali et al., 2016). Consequently, further research is required to reach superior organizational productions.

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