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The Key Determinants of Implementing Lean Production System: Evidence from Egyptian Industry Context

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Abstract:
This study examines the key determinants of lean production system implementation by Egyptian pharmaceutical companies. For this purpose, a research model is proposed showing the relationship between three groups of factors (lean production attributes, external lean practices and managerial factors) and the implementation of lean production system. Based on data collected from 62 pharmaceutical companies operating in Egypt, statistical analysis was carried out. The results show that benefits of implementing lean production system, ease of use, perceived compatibility, result demonstrability, customer involvement, competitive pressure and tenure in position and in management are key elements influencing the implementation of lean production system by Egyptian pharmaceutical companies.

Keywords: *Lean production, leanness, TPS, JIT, Continuous improvement*

1. Introduction

The pace of dynamic change in the world economy has imposed challenges upon organizations with respect to their survival and growth. Currently, organizations strive to enhance their competitiveness in order to access national and international markets and meet the needs and expectations of diverse customers. Organizations are required to provide customers with quality products with competitive price in less time (Oliver and Qu, 1999). This can be achieved through designing, improving and managing the organization's processes effectively in order to improve them, to increase productivity, to minimize errors in products/services and to enhance organizational performance. In an effort to deal effectively with these challenges, organizations have sought to implement new systems of performing business to gain competitive advantage (Shao, 1999). Lean production system is one of means by which organizations can increase their cost effectiveness, optimize operations and competitiveness.

In order to become more competitive, Egyptian manufacturing companies -especially pharmaceutical ones- are interested in adopting lean notion and approach in their production system. The main objective of adopting this approach is eliminating wastes and enhancing operational efficiency and effectiveness. Moreover, there are very limited empirical studies regarding the lean production within the Egyptian context. Consequently, more research work is needed to explore and examine the key determinants that facilitate or hinder the process of lean production implementation.

This paper contributes to fill the above research gap through investigating the key factors that influence the implementation of lean production system by Egyptian pharmaceutical companies. For this purpose, a conceptual model is developed, identifying the key determinants of the implementation process. These comprise three groups of factors, namely attributes of lean production system (perceived benefits, ease of use, perceived compatibility and result demonstrability); external lean practices (supplier integration, customer involvement and competitive pressure); and managerial factors (top management support, Tenure in managerial position and company size). Then, statistical analysis is carried out to assess the relationship between these factors and the process of lean production implementation.

2. The Lean Production System

Organizations are continually seeking to maintain their systems, processes and procedures operating effectively and under control, to increase productivity and provide products/services in compliance with customer needs (Dale, 2000).

Over the past century, the world has witnessed rapid spread and implementation of advanced production technologies, methodologies and techniques. Lean production system is considered one of effective means by which organizations can increase their competitiveness to deal with dramatic environmental change. Organizations implementing lean production system are more capable of providing a wide range of products/services and maintain high degrees of quality and productivity (Krafcik, 1988). Accordingly, Rinehartet al. (1997,p. 2) state that *"lean production will be the standard manufacturing mode of the 21st century"*.

Lean production is defined as *"an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability"* (Shah and Ward, 2007,p. 791). Through implementing lean production system, organization can improve its operational performance, mainly, low inventory levels, improved quality, and short product life cycles times (Hofer et al., 2012; Marodin et al., 2017). For this purpose, lean production approach depends on continuous improvement of systems, processes and people in the organization to enhance performance in terms of quality, costs, lead times and competitiveness (Womack et al., 1990; Womack and Jones, 1996).

The notion of lean production is originated from Toyota Production System (TPS), which adapted the flow production method developed by Henry Ford, and regarded as an influential approach and strategy to manage factories more efficiently and effectively (Dilanthi, 2015; Villa and Taurino, 2013). The main focus of Toyota Production System is reducing costs by eliminating main seven sources of wastes involving (Ohno, 1988; Tappinget al., 2002):

- Overproduction: producing more units than needed; or producing earlier than customer demand.
- Waiting (Queues): delays in production including idle time, storage, and other aspects of waiting that add no value.
- Over processing: performing working steps not actually needed.
- Transportation: unnecessary movement of materials that not adding value.
- Motion: disruption movements of materials and/or people are sources of waste.
- Inventory: excess raw material, work in process, and finished goods are not adding value.
- Defects or correction: producing defective units and/or work leading to rework, returns, warranty claims, and scrap.

2.1. Benefits of Lean Production System

Organizations can achieve several benefits through implementing lean production system such as (Melton, 2005,p. 663):

- Decreased lead times for customers;
- Reduced inventories for manufacturers;
- Improved knowledge management;
- Less process waste;
- Less rework;
- Financial savings; and
- Increased process understanding.

2.2. Principles of Lean Production

Womack and Jones (1996, 2003) specified five principles of lean production system including value to customer, value stream, flow, pull, and perfection (improvement).

2.2.1. Value to Customer

identifying the value gained by customer represents an essential point in implementing lean production system. According to Womack and Jones (1996, p. 19), value can be defined *"in terms of specific products with specific capabilities offered at specific prices through a dialogue with specific customers"*. Hence, organization needs to determine the value of product or service from the point of view of the customer. This can be achieved through designing and manufacturing a product with specific requirements and capabilities in accordance with customer needs and wants at specific time with specific price (Neha et al., 2013).

2.2.2. Value Stream

refers to set of all steps and actions required for producing specific product and/or service (Womack and Jones, 2003). It involves all processes from taking order to delivering finished product to customers. The main focus is to recognize all unnecessary steps and processes that add no value and eliminating these kinds of waste through the whole stream.

2.2.3. Flow

after identifying customer value and eliminating all facets of waste through all processes, manufacturer needs to ensure smooth flow of the product from one value adding stage to another without delays, interruptions or bottlenecks (Manea, 2013; Neha et al., 2013; Womack and Jones, 2003).

2.2.4. Pull

means that production should match customer demand (Hopp and Spearman, 2004). If organization produces less than demand, there will be delays in response to customer. On the other hand, if production is more than demand, overproduction will appear. These two cases represent waste. The core idea is organization*"only makes what is ordered when it is ordered"* (Neha et al., 2013, p. 57).

2.2.5. Perfection (improvement)

refers to an endless process of reducing time, efforts, costs, used space, and mistakes while providing the product in response to customer needs (Womack and Jones, 2003).

2.3. Lean Production Tools

The commonly used tools in lean production system are illustrated in Table 1.

Tool	Description
5 Ss	One of essential tools an organization can use to optimize efficiency of processes to produce high quality product at low costs with right delivery time. The term '5S' comes from the initials of five Japanese words that describe five-step process for implementing this tool as following: - Seiri (sort/separate): maintaining the needed items and removing the non-value ones in order to improve flow of the work. - Seiton (set in order/straighten): the right arrangement of items and tools to improve work flow and eliminating unnecessary movements of the work. - Seiso (sweep/shine): cleaning the workspace and eliminating all kinds of dirt and contamination. - Seiketsu (standardize): using standard operation procedures in order to remove process variations. - Shitsuke (sustain): periodically processes review to maintain achieved progress and motivate people to sustain the system.
Just-in-Time	A philosophy concerns with eliminating all waste in production environment. The focal point is ensuring smooth flow of material from suppliers to customers while minimizing inventory costs.
Kaizen	Japanese term refers to "change for better" or continuous improvement. It concerns with identifying and eliminating waste in machinery, labor or production methods and techniques. The basic principle of kaizen is *"a very large number of small improvements are more effective in an organizational environment than a few improvements of large value"* (Singh 2014, p. 144). It implies achieving incremental improvement on continuous base involving all managers and workers across the organization.
Value Stream Mapping	A visual presentation tool to map the flow of material and information through a value stream from supplier to customer.
Cellular Manufacturing	A tool based on grouping processes, equipment, and workstations that manufacture similar products into work center (cell). This grouping aims to optimizing the flow of material across the cell through smooth movement from a production stage to another in order to minimize cost of material handling and inventory, speed the work, and eliminate other kinds of unnecessary costs.
Kanban	"Sign board" or "visual card" passes through all processes of the production system. Kanban is a basic tool to control the flow of resources by indicating supply of materials or producing of parts at each stage of the production system. Kanban cards communicate information regarding demand for work or material between preceding and subsequent processes.
Poka Yoke	Mechanism designed to avoid inadvertent errors. It is a set of devices focuses on mistake proofing to detect unusual situations and prevent errors and defects from occurring in the production system while improving reliability and quality.

Table 1: Commonly used tools in lean production system
Source: Compiled by the author from
(Bayou and de Korvin 2008; Emiliani 2004; Goforth 2007; Heizer and Render 2014; Manea 2013; Neha et al. 2013; Singh 2014)

3. Research Model and Hypotheses Development

This study examines the impact of three categories of factors (attributes of lean production system, external lean practices and managerial factors) on the implementation of lean production system. The integration of three categories of factors, which are hypothesizedto influence lean production system implementation by Egyptian pharmaceutical companies, constitutes the conceptual framework of the present study as illustrated in Figure 1.

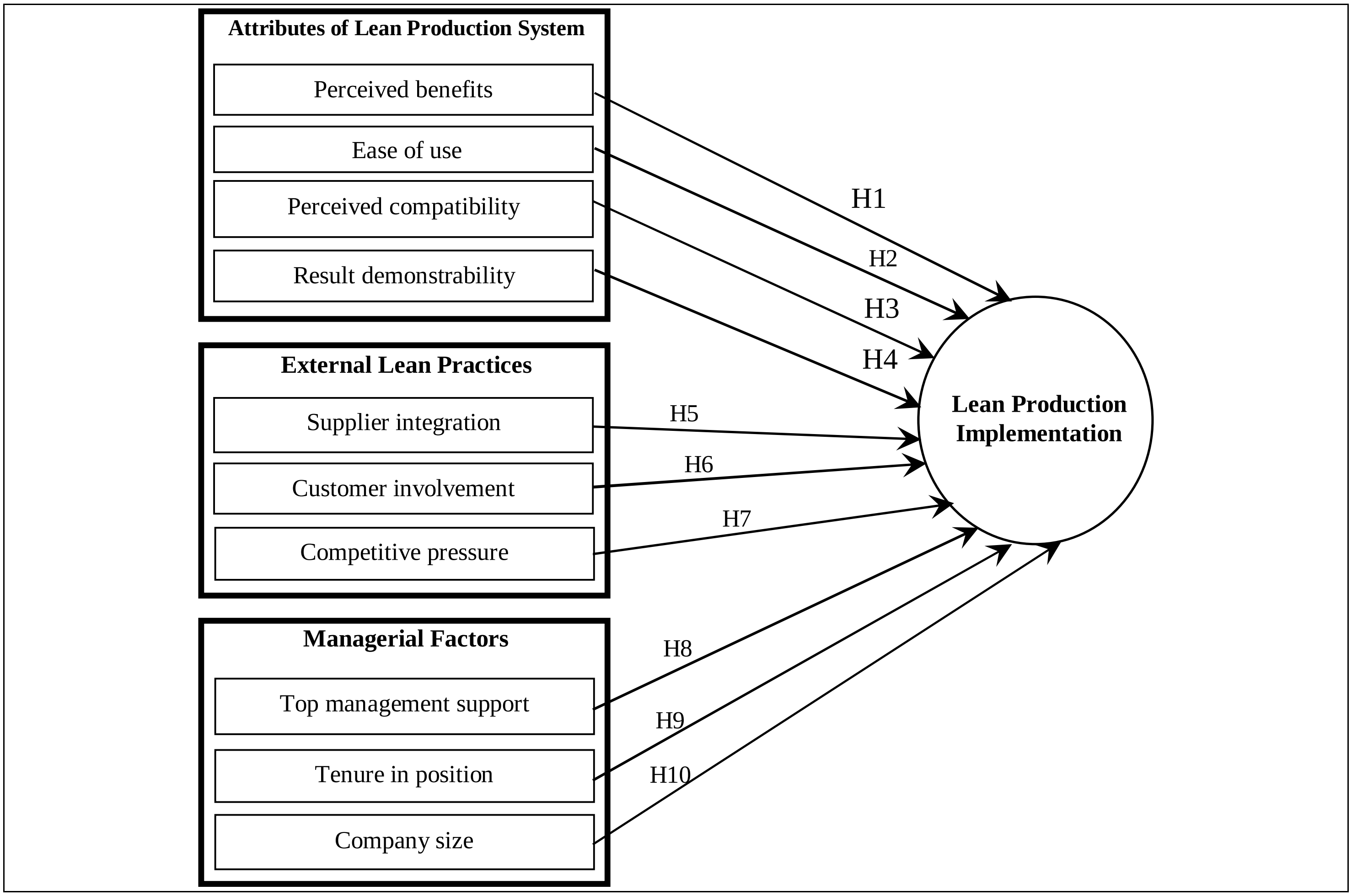

Figure 1: The research model

The study factors and hypotheses are investigated as follows:

3.1. Attributes of Lean Production System

An extensive literature review reveals that the most frequently employed attributes -even if they use different labels - include perceived benefits, ease of use, compatibility and result demonstrability (e.g. Chau and Tam, 1997; Gopalakrishnan and Bierly, 2001; Handfield and Pagell, 1995; Kim and Srivastava, 1998; Moore and Benbasat, 1991; Premkumar and Roberts, 1999; Premkumaret al.,1994; Ramamurthy and Premkumar, 1995; Rogers, 2003; Sultan and Chan, 2000; Tabak and Barr, 1998). Therefore, this study considers these four attributes, because of their perceived relevance to the implementation of lean production system.

<u>3.1.1. Perceived Benefits</u>

For a company working in a competitive environment, perceived benefits represent a crucial motivation for implementing a new system (Premkumar and Roberts, 1999). Consequently, companies anticipate gaining several benefits through implementing lean production system such as cutting costs; reducing prices; increased sales and profits; less process waste; reduced lead-time; less rework; reduced inventory; increasing process understanding; satisfying customers; and obtaining competitive advantages in the market. Many empirical studies have found a positive relationship between perceived benefits and implementing new systems such as lean production (Green et al.,2005; Milton, 2005; Premkumar and Roberts, 1999; Rogers, 2003; Totnatzky and Klein, 1982). Consequently, the following hypothesis is proposed:

- H1: Perceived benefits of lean production is more likely to positively influence its implementation.

<u>3.1.2. Ease Of Use</u>

System complexity produces a high degree of uncertainty about the likelihood success of its implementation (Premkumar and Roberts, 1999). Therefore, it is argued, an uncomplicated system is easier to implement than a complicated one (Rogers, 2003; Tabak and Barr, 1998; Totnatzky and Klein, 1982). Many empirical studies report a positive influence of ease to use on the implementation of new systems (Cooper and Zmud, 1990; Grover and Goslar, 1993; Premkumar and Roberts, 1999; Totnatzky and Klein, 1982). Accordingly, the following hypothesis is postulated:

- H2: Ease of use of lean production is more likely to positively influence its implementation.

3.1.3. Perceived Compatibility

A company seeks to implement systems, which are compatible with the nature of its work, processes and activities. Moreover, it is important that changes resulting from system implementation are compatible with the values and the belief systems of the company (Premkumar and Roberts, 1999). Prior empirical studies reported the positive effect of perceived compatibility on new systems implementation (e.g. Premkumar et al., 1994; Rogers, 2003; So and Sun, 2011; Totnatzky and Klein, 1982). Therefore, the following hypothesis is stated:

- H3: The perceived compatibility of lean production with the existing production systems and procedures is more likely to positively influence its implementation.

3.1.4. Results Demonstrability

It refers to *"the tangibility of the result of using the systems, including their observability and communicability"*(Moore and Benbasat, 1991, p. 203). Result demonstrability gives the implementing companies an opportunity to learn and assess the system, which may facilitate its implementation (Kim and Srivastava, 1998). It is posited that a company can better assess a new system through demonstrating the results of implementing it rather than observing the system itself (Rogers, 2003). Several studies report a positive relationship between result demonstrability and new system implementation (Rogers, 2003; Totnatzky and Klein, 1982). Hence, it is hypothesized that:

- H4: The extent to which the results of the implemented lean production are demonstrable, is more likely to positively influence its implementation.

3.2. External Lean Practices

Scholars of production and operations management have highlighted the role of external practices in implementing lean production system. The external practices within the environment in which a firm conducts its business affect the company's performance capability (King and Anderson, 1995). This paper examines the influence of these practices on the lean production system implementation by Egyptian pharmaceutical companies drawing on three key practices: supplier integration, costumer involvement and competitive pressure.

3.2.1. Supplier Integration

The increased competitive pressure urges companies to integrate their suppliers into the overall value added processes (Olhager and Prajogo, 2012). Hence, chain supply is considered one of the key elements of lean production. According to (Bozarth and Handfield, 2008), manufacturing companies spend 55% of revenue on purchasing products and services. Supplier integration has been found to play an important role in implementing lean production system. Caglianoet al.(2006) found a significant relationship between lean production and information flow with external supplier. Moreover, So and Sun (2011) found that supplier integration is positively associated with perceived usefulness of lean production implementation. Consequently, it is proposed that:

- H5: High integration between the company and its suppliers is more likely to positively influence the implementation of lean production.

3.2.2. Customer Involvement

The ability to meet customer needs and expectations is essential for company survival and growth (Oliver and Qu, 1999). Customer involvement provides the company with information and feedback about needs, satisfaction, complaints and suggestions arising by customers. Accordingly, company management needs to develop and maintain strategic relationship with customers through involving and listening to them in order to identify and fulfill their current and future needs (Bortolotti et al.,2015; Chin et al.,2002). Since customer involvement represents a key component of any production system, the following hypothesis is postulated:

- H6: High level of involvement between the company and its customers is more likely to positively influence the implementation of lean production.

3.2.3. Competitive Pressure

Scholars have drawn attention to the influence of competitive pressure on the implementation of new systems (Robertson and Gatignon, 1986); highlighting that high competition within a business community encourages companies - belonging to that community - to implement value added systems (Chau and Tam, 1997; Gatignon and Robertson, 1989; Premkumar and Roberts, 1999). Accordingly, the following hypothesis is proposed:

- H7: Where the company is in a highly competitive environment, it is more likely to implement lean production system.

3.3. Managerial Factors

Recent research on business field has discussed organization characteristics that enhance or inhibit the implementation of new systems (Damanpour, 1991). This paper examines three key managerial characteristics which previous research has shown to be pertinent to the process of new systems implementation within organizations. These characteristics are management support, tenure in managerial position and company size. The related hypotheses are addressed below:

3.3.1. Management Support

Top management plays an essential role in the process of new systems implementation since it possesses the power and authority to make decisions concerning the implementation process. Moreover, it can create a supportive climate and provides the required resources for enhancing this process (Ramamurthy and Premkumar, 1995; Sultan and Chan, 2000). Many studies consider management support to be a key determinant for implementing novel systems (e.g. Alefariet al.,2017; Belhadiet al., 2016; Grover and Goslar, 1993; Larteb et al.,2015; Marodin and Saurin, 2015; Premkumar and Roberts, 1999; Rogers, 2003; Worley and Doolen, 2006). Thus, it is proposed that:

- H8: Top management support for lean production is more likely to positively influence its implementation.

3.3.2. Tenure in Managerial Position

The more time spend in managerial positions, the more experience gained. This might represent an advantage for new system implementation, since it needs more skills in integrating the system into company's processes (Damanpour and Schneider, 2006). Longer tenure in managerial position gives company's members opportunity to gain knowledge and experience of critical situations that may appear during the implementation process of new systems (Finkelstein, 1992; Mumford, 2000). In light of the above mentioned, the following hypothesis is stated:

- H9: Tenure in managerial position is more likely to positively influence the implementation of lean production system.

3.3.3. Company Size

Stream of empirical studies identifies the importance of company size, as a managerial factor, in the new system implementation (Kimberly and Evanisko, 1981;Premkumar and Roberts, 1999; Rogers, 2003). However, there is no agreement as whether large or small sized companies favor new systems implementation. Some studies argue that larger companies are more capable of implementation process due to their superior access to resources (Baldridge and Burnham, 1975; Lai and Guynes, 1997; Marodin et al., 2016; Premkumar and Roberts, 1999; Thong and Yap, 1995); others report that smaller companies are more able to implement new systems as a result of their structural flexibility and ability to adapt (Hage, 1980). On the other hand, several studies have reported that company size is not significantly associated with the new system implementation (Aiken et al.,1980; Boeker and Huo, 1998). In the Egyptian context, the following hypothesis is postulated:

- H10: Company size is more likely to positively influence the implementation of lean production system.

4. Research Methodology

4.1. Measures

The hypotheses of this study were tested based on using survey instrument directed to pharmaceutical companies. The research variables were developed based on extensive literature review. The survey instrument (questionnaire) consists of questions with closed-form responses using a five-point Likert scale. Operationalization of the study variables is summarized in Appendix A.

4.2. Data Collection and Sample

The study draws on collecting data from pharmaceutical companies operating in Egypt. The questionnaire was directed to persons within these companies who are knowledgeable and able to understand the focus of the research. Therefore, two respondents from each company (production manager and the head of the quality department) were targeted, since they are considered to be the most suitable subjects. Moreover, short meetings were conducted with the respondents, while dropping off the questionnaires, in order to clear any ambiguity regarding the questions and to ensure a full understanding of the questions, as well as to improve the response rate. Then, questionnaires were collected after two or three days.

4.3. The Response Rate

The questionnaire was distributed to 314 respondents in 157 pharmaceutical companies that have factories in Egypt. These companies involve both public enterprises sector (9 companies) and private sector (148 companies)[1]. 146 questionnaires were collected representing an initial response rate equals 46.5 %. This rate is considered reasonable. 22 questionnaires were excluded from the sample for being largely incomplete. The remaining 124 usable questionnaires constitute a final response rate of 39.5%.

4.4. Validity and Reliability of the Measures

In order to assess the validity of the study measures, several procedures were carried out: first, previous related studies were extensively examined to identify the constructs and items that have been used. Then, a range of items were selected and refined to construct the measures of the present study. The items used for measuring the constructs were derived from prior empirical studies, and were adapted to satisfy the particular needs of this research context. Consequently, an initial version of the questionnaire was developed in English and then translated into Arabic. Finally, the instrument was subjected to a two-phase pilot test. Through the first phase, the questionnaire was administered to some academic staff in Egypt with significant experience with lean production. Through the second phase, the questionnaire was directed to 12 production managers in different pharmaceutical companies located in Cairo.

[1] Federation of Egyptian Industries, Pharmaceutical Chamber.

As a result, some items were modified or reworded to ensure that the instrument reflected the investigated concepts, as well as establishing a reasonable confidence in the general appropriateness of the instrument.

Variables	Number of items in scales	Cronbach alpha
Perceived benefits	10	0.95
Ease of use	3	0.89
Perceived compatibility	3	0.93
Results demonstrability	3	0.91
Supplier integration	6	0.91
Customer involvement	5	0.96
Competitive pressure	4*	0.92
Management support	8	0.96
Tenure in managerial position	2	0.81
Company size	1	NA

Table 2: Cronbach's Alpha Coefficients
** One of the question items has been dropped due to improving the reliability test*

Cronbach's alpha was used to assess the internal consistency of the variables used in the present study. The recommended value of Cronbach's alpha coefficient of a scale is 0.7 or above (Pallant, 2001). The results, illustrated in Table 2, indicate that the alpha coefficient of all variables are in good range between 0.81 and 0.96 (Items with low correlation were dropped). Therefore, the study variables exhibit a satisfactory level of reliability.

5. Results and Discussion

Standard multiple regression was performed to test the research hypotheses. This technique can be used to assess the relationship between multi independent variables and one dependent variable (Pallant, 2001). When examining the assumptions of standard multiple regression, no serious violations were found. As well, the correlation matrix (Appendix B) shows that correlation coefficients between independent variables are well below 0.90. Therefore, no multicollinearity problem is recognized in collected data (Field, 2002). The details of standard multiple regression for testing the research hypotheses are summarized in Table 3.

Variables	Lean production implementation
Perceived benefits	0.171*
Ease of use	0.153*
Perceived compatibility	0.186*
Result demonstrability	0.160*
Supplier integration	0.002
Customer involvement	0.155*
Competitive pressure	0.221**
Management support	- 0.126
Tenure in managerial position	0.143**
Company size	0.65
R^2	0.76
AdjustedR^2	0.73
F	94.54**

Table 3: Multiple regression analysis for determining the relationship between the independent variables and the implementation of lean production system [a]

[a] Standardized (β) displayed
* Significant at 0.05 level
** Significant at 0.01 level

As shown in the above table, the results of the multiple regression indicate a good model fitness (F = 94.54, Sig. at 0.01 level). This indicates a statistically significant relationship between the independent variables included in the model and the dependent variable. The R^2 value is 0.76 demonstrating that the investigated variables in this study explain 76% of lean production implementation.

Results show that perceived benefits; ease of use; perceived compatibility; result demonstrability; customer involvement; competitive pressure and tenure in managerial position are positively related with the implementation of lean production system. These findings support hypotheses H1; H2; H3; H4; H6; H7 and H9; while: supplier integration; management support and company size, have insignificant relationships with lean production implementation. Accordingly, hypotheses, H5; H8 and H10 are not accepted. These findings provide empirical evidence that the attributes of lean production system, external lean practices and managerial factors, are significant determinants of the implementation of lean production system.

With respect to the attributes of lean production system, perceived benefits, ease of use, perceived compatibility and result demonstrability were found to be positively associated with lean production implementation. These findings are in agreement with prior studies related to new systems implementation (Premkumar and Roberts, 1999; So and Sun ,2011; Tornatzky and Klein, 1982; Ungan, 2004).

Concerning the external lean practices, the findings indicate that customer involvement and competitive pressure are the most important determinants of lean production implementation. Many studies suggest that competitive pressure is an important determinant of the implementation of new systems and technologies (Firth, 1996; Sultan and Chan, 2000). The basic argument is that if a company faces a high level of competition in the market, it is motivated to implement new systems in order to maintain or enhance its competitive position (Chau and Tam, 1997). In the same vein, the findings report a positive relationship between customer involvement and lean production implementation. Customer satisfaction is the ultimate aim for any organization. Since, its growth depends on the ability to meet and exceed customer expectations (Oliver and Qu, 1999). This finding is in agreement with prior research (e.g.Bortolotti et al., 2015; Ettlie, 1983; Grover and Goslar, 1993; Li and Atuahene-Gima,2002). This result indicates that Egyptian pharmaceutical companies tend to implement lean production as an effective system to face and respond to an increasing degree of competitiveness, which prevails within business communities in the Egyptian context as well as the rest of the world.

The findings showed, unexpectedly, that supplier integration is an insignificant predictor of the implementation of lean production. This result is inconsistent with the literature on lean production (Bortolottiet al.,2015; Bozarth and Handfield, 2008; Cagliano et al., 2006; So and Sun, 2011). An explanation for this result is the general trend the pharmaceutical companies towards ways and means of getting raw materials. Instead of developing strategic relationships with suppliers, they prefer to expand and diversify their source of supplying to insure the stability flow of raw materials. They want to avoid uncertainty and stress of single or few suppliers. Moreover, supply chain management is still at the beginning in the Egyptian context. However, this finding suggests that further research is needed regarding this variable.

Regarding the managerial factors, the findings showed that longer tenure in managerial position significantly influence the implementation of lean production. This result is in line with several studies (e.g. Damanpour and Schneider, 2006; Finkelstein, 1992; Mumford, 2000). This indicates that long period in managerial positions provides manager more knowledge, skills and experience to deal more effectively with manufacturing processes and abilities to handle bottlenecks and related problems.

Concerning company size, many studies report that organizational size is positively associated with the implementation of new systems (Gopalakrishnan and Bierly, 2001; Marodin et al., 2016; Thong and Yap, 1995). However, the findings of this study reveal that this is an insignificant predictor of lean production implementation, a result which is consistent with several studies (e.g.Aiken et al.,1980; Boeker and Huo, 1998; Germain, 1996; Grover and Goslar, 1993). The reasoning behind these results is that most Egyptian manufacturing companies (small, medium and large) tend to implement lean production system in order to enhance their capabilities; manufacturing efficiency and effectiveness; and cope with dynamic environmental changes.

With respect to management support, a surprising result has shown that this variable is not a predictor of the implementation of lean production system. This result is inconsistent with the general trend of literature (Damanpour, 1991; Marodin and Saurin, 2015; Sultan and Chan, 2000; Thong and Yap, 1995; Worley and Doolen, 2006). A possible explanation for the insignificant relationship between management support and the implementation of lean production system is that top management may ‘talk-the-talk’ but not ‘walk-the-talk’, declaring their commitment to a lean production program without providing adequate resources or employees’ training required for its implementation. In the light of these contradictory results, it is suggested that this variable needs more research in order to establish its relationship with lean production implementation.

6. Conclusion

The main findings of the study emphasize that the implementation of lean manufacturing system within manufacturing companies could be better understood through the suggested conceptual model. The factors, which were found to be the most significant predictors of the lean manufacturing implementation, include perceived benefits; ease of use; perceived compatibility; result demonstrability; customer involvement; competitive pressure and tenure in managerial position.

The research on which this paper is based, like much social science research, is affected by several limitations. Firstly, this study has been conducted in one country (Egypt). Secondly, it focuses on one sector of industries, which is pharmaceutical companies. Hence, the generalizability of findings needs more examination. Testing the model developed for this research on different industries in different contexts may provide further insights into the implementation of lean production system.

The findings of the present study have several implications for manufacturing companies involved in implementing lean production system. For successful implementation, managers need to understand the main elements of lean production system and the key determinants affecting its implementation process. The research model developed for this study may assist managers to recognize the importance of integrating contextual factors in the process of lean production implementation. Moreover, the overall findings may guide them to identify and assess the influence of the key determinants that facilitate or hinder the implementation of lean production.

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Appendix A
Operationalization of the study variables

Variable	Operational Measure
Lean production implementation	five-point Likert scale indicating 1= No implementation, 2= Little implementation, 3= Some implementation, 4= Extensive implementation and 5= Complete implementation.
Perceived benefits	Mean of ten items on five-point Likert scale to assess the benefits related to the implementation of lean production system.
Ease of use	Mean of three items on a five-point Likert scale to assess the extent to which lean production is perceived as easy to understand and use.
Perceived Compatibility	Mean of three items on a five-point Likert scale to assess the extent to which lean production is compatible with the company's working practices, value systems and other existing production systems.
Results demonstrability	Mean of three items on a five-point Likert scale to assess the extent to which resultsof implementing lean production system are demonstrable.
Supplier integration	Mean of six items on a five-point Likert scale to assess the extent to which the company integrates its suppliers in production system requirements.
Customer involvement	Mean of five items on a five-point Likert scale to evaluate the degree to which the company involves its customers into its operations.
Competitive pressure	Mean of four items on a five-point Likert scale to assess the competitive environment of the company.
Management support	Mean of eight items on a five-point Likert scale indicating the managerial support for implementing the lean production system.
Tenure in managerial position	Mean of tow items on a five-point Likert scale indicating the number of years served in current position and in managerial positions.
Company size	Log of the number of company employees.

Appendix B
Correlations among variables of the study

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Lean production implementation	1										
2. Perceived benefits	.49	1									
3. Ease of use	.63	.39	1								
4. Perceived compatibility	.30	.16	.18	1							
5. Result demonstrability	.59	.41	.59	.19	1						
6. Supplier integration	.58	.42	.63	.27	.38	1					
7. Customer involvement	.51	.18	.54	.42	.58	.56	1				
8. Competitive pressure	.50	.09	.56	.15	.62	.46	.67	1			
9. Management support	.62	.20	.52	.19	.53	.62	.65	.54	1		
10.Tenure in managerial position	.56	.42	.54	.20	.66	.58	.58	.66	.67	1	
11. Company size	.35	.28	.30	.30	.23	.33	.33	.23	.32	.34	1