EVALUATING THE RELATIONSHIP BETWEEN LEAN MANUFACTURING DIMENSIONS AND RADICAL PRODUCT INNOVATION IN THE JORDANIAN PHARMACEUTICAL SECTOR

Rima Al Hasan,
Zu'bi M.F. Al-Zu'bi
School of Business, the University of Jordan

Abstract

The purpose of this study is to evaluate the relationships between lean manufacturing dimensions and radical product innovation in the Jordanian Pharmaceutical Sector. These dimensions entailcontinuous improvement, waste minimization, lean job characteristics and employees' involvement.

In order to achieve this objective, this study used a survey-based questionnaire as a data collection method. 164 questionnaires were gathered from 10 Jordanian Pharmaceutical manufacturers, and multiple regressionswere used to evaluate the relationships between the dependent and the independent variables.The findings revealed that continuous improvement and waste minimization dimensions have no statistically significant effect on radical product innovation, while the other two dimensions; lean job characteristics and employees' involvement have statistically significant relationships with radical product innovation. Moreover, the analysis results showed that employees' involvement has the greatest effect on radical product innovation.These results highlighted the importance of the human side in radical innovation and clarify different direction of the relationships between lean manufacturing dimensions and radical product innovation. Based on theseresults, many recommendations were suggested, one of them is to increase employees' involvement in decision making process that is related to the production process, to enhance their ability to innovate.

Keywords: Lean Manufacturing, Radical Product Innovation, Jordanian Pharmaceutical Sector

Introduction

Intensive, hyper global competition, short product life cycle, and rapid technological development, force companies to find new ways in generating profit and increasingly rely on innovation,either internationally or locally (Dunk, 2011).

In order to sustain its competitive advantage and survive in such environment, companies should not rely on a specific bundle of resources and capabilities, they must continuously develop new capability align with the new changes; in other word, they should have a dynamic capability and innovation identified as a value creating dynamic capability (Zhang, 2011).

Through innovation and product development, companies can attract and retain customers, strengthen ties with distributors; therefore, gaining a competitive advantage is the reason innovation is considered as the "bloodline" of companies (Kotler and Keller, 2006).

Many companies tend to implement a range of techniques, exploit a variety of approaches and operate according to different philosophies because of the increasing pressure to be effective, efficient and competitive in their industry. These pressures consist of the need to diminish costs, elevate flexibility, improve quality, reduce variability and decrease lead time (shorten product time-to-market) (Radnor and Boaden, 2004).

Moreover, today customers demand a better quality with a shorter delivery time at the lowest cost, in addition to the increasing demand for new products and the accelerated technology which reduce the product lifecycle and challenge manufacturers all over the world to find an improvement strategy (Tsinopoulos and Al-Zu'bi, 2012; Taj and Morosan, 2011). Being better requires an excellent operation, and a comprehensive strategy, such as lean manufacturing strategy (Lind, 2008).

Different studies claim that process' performance improvement and innovation are negatively related with conflicting ambitions (Johnstone, 2011), thus one of the industries that face this challenge is the pharmaceutical industry. According to Hoffmann and Bishop, (2010), the highest tension in the research discovery industries is the pharmaceutical companieswhich arise from the opposing goals of being efficient and innovative at the same time;however, this has led some observers to state that the regular operating form for medicine / drug discovery and advancement has been diminished. Therefore, numerous strategies in improving the effectiveness and the efficiency of the drug's discovery and advancement have been explored across the businesses (Johnstone, 2011).

Therefore, lean manufacturing and innovation are two driving forces for today's business success. Lean manufacturing is about eliminating activities that do not add value to the product or service (Womack et.al, 1990), i.e. it is concern with efficiency, while innovation is about creating a

new product or improving an existing product (Baregheh et.al, 2009), which require in depth and costly researches. So, companies that adopt both lean and innovation at the same time will gain a competitive advantage in the long run (Chen and Taylor, 2009).

Despite the increased importance of both innovation and efficiency in today's uncertain business environment, and the need for further studies to achieve the balance between lean and innovation (Chen and Taylor, 2009), there is relatively little work that link lean manufacturing dimensions and radical product innovation.

Due to lack of researches and beginning from the importance of the pharmaceutical sector for Jordanian economy, with its opposite needs (to be efficient and innovative at the same time) (Global investment house, 2007), this study aims to evaluate the relationships between lean manufacturing dimensions and radical product innovation in Jordanian Pharmaceutical Sector and how does this relationship if existent, impact innovation and in what direction?

Previous studies suggested four dimensions to be further studied as parts of lean manufacturing. Hasle et.al, (2012), recommended future research to study lean as a socio-technical approach and its effect on working environment. However, it is important to go deeply in studying lean practices such as job characteristics, autonomy, social support, participation, and skills utilization. Haan et.al, (2012), recommended studying the effect of continuous improvement (Kaizen) on employees' creativity in term of ideas. Moreover, the effect of lean principles/practices on employees is controversial.On one hand, it demonstrates teamwork and employees participation, while on the other hand, it stress employees by time pressure, so it is important to clarify this impact (Seppälä and Klemola, 2004). Therefore, this study will take continuous improvement, waste minimization, lean job characteristics, and employees' involvement as four dimensions of lean manufacturing.

Consequently, the main objectiveof this study is to evaluate the relationships between lean manufacturing dimensions and radical product innovation in the Jordanian pharmaceutical industry. Thus, in order to achieve this objective, this research aims to answer the following questions:

1. What are the nature and the direction of the relationship between Continuous improvement, waste minimization, lean Job Characteristics, employees' involvement and radical product innovation?
2. To what extent lean manufacturing dimensions and radical product innovation are practiced?

Literature review and hypotheses development

While radical product innovation has been the main focus of the management researches, process innovation has led to the operations and quality management literature (O'Sullivan & Dooley, 2009).

Over the industry life cycle, the importance of both types of innovation product or process (including lean manufacturing) is extremely high for seeking and keeping competitive advantage. Companies develop processes to diminish costs, improve quality, shorten lead time and of course add value to customers. Moreover, product innovation occasionally occurs either by new product development or gradual improvement (Utterback, 1996).

Despite the above, few researchers studied the relationships between lean manufacturing dimensions and radical product innovation.

Mehri, (2006), observed the Toyota production system and found that lean design have a negative effect on workers' potential for creativity and innovation, through focusing on waste minimization, standardization and using benchmarking to improve existing product instead of brainstorming

Melnyk, (2007), studied the relationship between lean practices and the availability of resources required for radical and incremental innovation. He found a positive relationship with incremental innovation, and also found a negative one with radical innovation in term of the attitude toward variability, risk-taking and slack, and in term of culture. In other word, the attitudes and skills required for lean environment will not work effectively for radical innovation environment.

Chen and Taylor, (2009) added to Mehri, (2006) and Melnyk, (2007) in studying the impact of lean management on innovation capability in term of culture, lean design, lean supply chain and human resources. Thus, they found that there are negatively related. Therefore, in order to reduce the negative effect of lean manufacturing on innovation, they recommended companies to choose one of these strategies based on its characteristics and its products: implement lean innovation (which applies the lean concepts to the R&D facilities in order to get product differentiation with minimum resources), outsourcing (apply lean practices and outsource innovation), innovative Product Development Process technique, or separate innovation center which depends on the product and the company's characteristics.

Chen et.al, (2010) examined the pitfalls of lean automated so as to avoid it, embrace opportunities and discover a negative relationship between lean manufacturing and radical innovation in term of waste, human resources, distributed design, supply chain management, customer management, and the financial system.

Chen, (2012) concluded in his study of the relationship between lean design practices on an organizations' radical innovation, that there is a

negative relationship between organizations' radical innovative capability and standardization in lean design practices.

Accordingly, the **main hypothesis** of this study is described below:

H0: There are no significant relationships between lean manufacturing dimensions and radical product innovation

The objective of this study is to evaluate the relationships between lean manufacturing dimensions and radical product innovation in Jordanian Pharmaceutical sector. Thus,Haan et.al, (2012), recommended studying the effect of continuous improvement (Kaizen) on employees' creativity in term of ideas. Moreover, the effect of lean principles/practices on employees is controversial; on one hand, it demonstrates teamwork and employees participation, while on the other hand, it stresses employees by time pressure and so it is important to clarify this impact (Seppälä and Klemola, 2004). Based on the fact that this study will take continuous improvement, waste minimization, lean job characteristics, and employees' involvement asthe dimensions of lean manufacturing and study their effect on radical product innovation, the following section shows the relationships of each variables and radical product innovation as mentioned in the literature.

Continuous improvement and radical product innovation

One of the main practices of lean manufacturing is continuous improvement that maintain perfection, (Abdullah, 2003; Engum, 2009), which leads companies to focus on short-term activities that add value to customers. In other word, the focus is on current needs without looking at building long-term competitive capabilities that can meet customers' needs in the future. Therefore, they focus on incremental (market-pull) innovation, instead of radical (technology-push) innovation (Chen et.al, 2010; Rae, 2007; Chen and Taylor, 2009). Being a type of disruptive innovation, radical product innovation depends on pushing the product into the market (Markides, 2006), while lean production and continuous improvement focus on the improvement on what they get from the customers (market-pull) (Womack and Jones, 2003). Over time, the enabling of incremental and continuous change has become an inhibitor for radical innovation (Chang et.al, 2012). This leads to hypothesis one:

H0.1: There is no significant relationship between continuous improvement and radical innovation

Waste minimization and radical innovation

Lean culture focus on the elimination of different types of waste (idle time, materials, equipments and parts) and non-value-added activities (Taj and Morosan, 2011; Chowary and George, 2011; Eswara-moorthi, 2011) which might eliminate the extra time and resources needed for innovation

and creativity. Tight resources can push and lead employees to use their creativity in finding additional resources, instead of generating new ideas for product (Amabile, 1998; Chen and Taylor, 2009, Chen et.al, 2010).

Furthermore, production pressure limits employees' ability to learn (Sterling and Boxall, 2013), and reducing available time can negatively affect the creativity of employees. Generating new creative ideas need highly motivated employees (Amabile, 1998), and too much time elimination can stress employees and frustrate them, thereby reducing their motivation (Chen et.al, 2010; Chen and Taylor, 2009; Amabile, 1998; Amabile et.al., 2002).

Moreover, lean concepts / principles focuses on "doing things right" (Rae, 2007; George, 2002; Engum, 2009; Abdullah, 2003), thus reducing the risk of failure (Chen and Taylor, 2009), while radical innovation happen suddenly and require risk taking and accepting failure for a certain degree.In other word, it is based on trial and error which is regarded as a waste according to lean thinking (Rae, 2007; and Taylor, 2009; Sehested and Sonnenberg, 2011). So, waste minimization negatively affects radical product innovation (Chen and Taylor, 2009; Rae, 2007). This leads to hypothesis two:

H0.2: There is no significant relationship between waste minimization and radical product innovation.

Lean job characteristics and radical product innovation

Job characteristics are important factor / predictor of employees' motivation (Haan,et.al, 2012). According to Sterling and Boxall, (2013), employees who exert less control over their job (Job control refer to workers' job autonomy (Oeij et.al, 2006)) and encounter a stressful situations, are less likely to have the motivation to learn.

In parker, (2003) study of the lean UK factories implementation of lean, she found that although the work speed improved, the workers' autonomy went back.Also, Lorenz and Valeyre's, (2005) survey showed that assembly line workers job autonomy, participation in decision making, and skills utilization reducedalso.

Lean practices focus on improving products' quality and reducing product variability through standardization (Abdullah, 2003; Engum, 2009; Chen and Taylor,2009; Chen, 2012), i.e. low task variety which negatively affect employees motivation (Treville and Antonakis, 2006). Also, lean jobs have increased work speed and demands, with low job control, freedom and autonomy (Hasle et.al, 2012). However, reducing the job characteristics / dimensions (task variety, and autonomy) therefore negatively affect employees' motivation and companies' radical innovation capability; and routine which kill creativity (Chen and Taylor, 2009; Amabile, 1998; Chen, 2012).

This leads to hypothesis three:

H0.3: There is no significant relationship between lean Job characteristics and radical innovation.

Employees' involvement and radical product innovation

For lean employees' ability to learn new things, participation in problem-solving teams and empowerment are increased (Lorenz and Valeyre, 2005; Sterling and Boxall, 2013).

A fundamental strategy in lean is the bottom-up strategy in which employees are involved in continuous improvement process in discovering the sources of waste so as to discard them. Thus, this increases employees' creativity (Haan, et.al, 2012).

Furthermore, lean manufacturing focus on involving employees in problem solving and self management teams that enhance their opportunity to participate in decision making process (Sterling and Boxall, 2013).

According to Sterling and Boxall, (2013), a key variable that affect employees' learning is employees' empowerment for solving their problems and organize their work. Therefore, it encourages self-directed and cross-functional work teams (Womack et al., 1990).

Moreover, radical innovation requires new abstract original creative ideas that require lateral and informal communication between employees,culture that support decision making and teamwork (Mehri, 2006; Chang et.al, 2012) to generate a large variety of ideas and involving and integrating the employees in problem solving process which is one of lean manufacturing practices (Hasle et.al, 2012). Moreover, Bikfalvi, (2011), found a positive relationship between new product, flexibility and teamwork. This leads to hypothesis four:

H0.4: There is no significant relationship between employee involvement and radical product innovation

The previous discussion result in the following model **figure 2.1**

The Conceptual Model

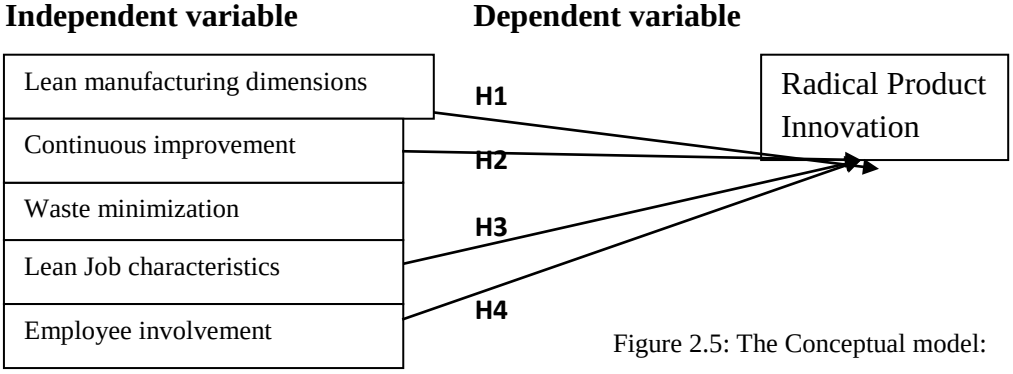

Figure 2.5: The Conceptual model:

Research Method

The objective of this study is to evaluate the relationships between lean manufacturing dimensions (continuous improvement, waste minimization, lean job design, and employees' involvement) and radical innovation in Jordanian Pharmaceutical sector. However, based on that,there are five variables to be measured.The four independent variables (measure lean manufacturing dimensions) are Continuous improvement, Waste minimization, Lean Job Characteristics, Employee involvement; while the one dependent variable is Radical Product innovation.

This research used primary and secondary data collection methods. The researcherreferred to publications, case studies, periodicals, companies' websites and others as a secondary method. A questionnaire based survey was disseminated to the targeted companies, and all the questionnaire's items were taken from prior researchers who studied the lean manufacturing dimensions variables (continuous improvement, waste minimization, lean job design, and employees' involvement) and radical product innovation.

The questionnaire consists of 41 statements which measure the study's variables, both the independent variables (lean manufacturing dimensions) and the dependent variable (radical product innovation). However, table 3.7 presents the items numbers for each variable.

The statements from (1-20) will be used to measure lean manufacturing dimensions, and statements from (21-41) will be used to measure radical product innovation. As mentioned before, the rating scale of this questionnaire consists of five points which are strongly disagree, disagree, Neutral, agree and strongly agree.

Therefore, the statements of waste minimization (7-10), lean Job Characteristics (11-17) and statements of Radical product innovation (27, 28, 32, 34, 36, 37, and 38) were given a reverse coding.

Data Collection

To achieve the study's main objective in evaluating the relationships between lean manufacturing dimensions and radical product innovation in Jordanian pharmaceutical sector, this research targeted the pharmaceutical manufacturers that are registered in the JAMP which are 13 companies. Due to the small population, the sample n and the populations N was the same. In other word, this study considers a field study. Data was gathered from this sample using a questionnaire. The data collection process was conducted as follows; first of all, the researcher communicateswith the pharmaceutical manufacturers by telephone in order to contact the department responsible for gaining approval for distributing the questionnaires. Thus, most of the time,the human resource department was the one responsible for it. Then small interviews were conducted with the human resources mangers and

other mangers from the targeted departments (production, quality, R&D, supply chain management, and technical support). These small interviews were conducted in order to gain an understanding of the company's information in term of their departments and the number of product lines to determine the number of questionnaires to be distributed in each company (this number depends on the departments they have and the number of the product lines).

Questionnaires were directly delivered to most of the companies. However,only two companies questionnaires were sent by e-mailwhich was followed by continuous reminders. Moreover, the questionnaires were personally administrated in one company, and the overall process of data collection took around two months.

Measurement analysis

Content and face validity

As mentioned before, the questionnaire's items for each variable were taken from previous researches. The items that measure the dependent variable, radical innovation were taken from Stanley (2012) and Tellis et.al (2009), thus the items that measure the independent variables were adopted from different sources. For instance, for continuous improvement, items were taken from AlKhalil, (2011); for waste minimization, items weregotten from Eswaramoorthi et.al (2011); for lean job characteristics, items were taken from Morgeson&Humphbrey (2006); and for employees' involvement, items was obtained from Hofer et.al, (2012) and Oslen (2004). Because all items were taken from published papers in a scientific Journal, this questionnaire have content and face validity (Sekaran and Bougie, 2011).

Internal Validity

In order to test the internal validity of the study's instrument (the questionnaire), pilot study was conducted for 60 respondents in managerial positions from different branches of the Jordanian Pharmaceutical Manufacturers. Pilot study is a small study carried out prior to the main study, in order to check deficiencies in the study's design, and at the same time improve the efficiency and the quality of the research (Altman et.al, 2006). Based on this pilot study, factor analysis was conducted in 41 items; 21 items for the dependent variable (radical product innovation), and 20 items for the independent variable (lean manufacturing dimensions). Therefore according to the analysis results, 20 items were excluded because they do not align with the other items and do not demonstrate an internal validity. This analysis results with the second questionnaire (appendix 2) which was used to measure the study's variables for the study's sample. The next chapter of this study shows the factor analysis with further details.

Reliability

Reliability in this case means the consistency of the measure of the research questionnaire (Field, 2011; Sekaran and Bougie, 2011). Cronbach's alpha α is the most frequently used measure of reliability (Field, 2011). **Table 3.1** presents the Cronbach's alpha α for each variable. All values of Cronbach's alpha α are above 0.69 which is close to one, which mean that the measurement (questionnaire) is more reliable.

Table 3.1
The results of reliability test: Cronbach's Alpha

Construct	Cranach's Alpha
Independent variables	
Continuous improvement	.768
Waste minimization	.830
Lean job characteristics	.864
Employees' involvement	.797
Dependent variables	
Radical product innovation	.695

Hypotheses Testing

In order to examine the study's hypotheses, regression analysis was conducted. Multiple regression analysis is a method that predicts the value of dependent variable or outcome from the independent ones (predictors) (field, 2011). So, it was used to predict the value of radical product innovation (dependent variable) from lean manufacturing dimensions,continuous improvement, waste minimization, lean job characteristics, and employees' involvement (independent variables). The following section shows the results of the main and the sub hypotheses testing.

First of all, the goodness of fit of the model was calculated. The coefficient of the determination (R square) "is a statistical measure of how well the regression line approximates the real data points. R square, is the percentage of variance in the dependent variable that is explained by the variation in the independent variable" (Sekaran and Bougie, 2011: 349). If R square is close to 1, this means that the model can explain the variation in the dependent variable, while if it is close to zero (0), the variation in the dependent variable cannot be clarified by the regression model (Sekaran and Bougie, 2011).

Table 3.2 (A) presents the statistics of the multiple regression models, taking into account the effect of the company size, company age, employees' role duration, and the department and position of radical product innovation in model one in order to determine whether the addition of the

independent variables (lean manufacturing dimensions) will improve the explanatory power of the model or not. R square in model one is only 0.008 which is very small, while in model two, R square is equal to 0.333. So R square increased by 0.325 which means that model two has a higher explanatory power than model one by 0.325. In other words, 33.3% of the variance of the change in radical product innovation can be explained by lean manufacturing dimensions,and so the addition of the independent variables (lean manufacturing dimensions) improves the explanatory power of the model. ANOVA table (table 3.2 B) shows that 33.3% of the variance which can be explained is only a significant amount.

Table 3.2 (A)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.088[a]	.008	-.024	.72435
2	.577[b]	.333	.294	.60137

a. Predictors: (Constant), COMPANYAGE, DEPARTMENT, POSITION, ROLEDURATION, COMPANYSIZE b. Predictors: (Constant), COMPANYAGE, DEPARTMENT, POSITION, ROLEDURATION, COMPANYSIZE, LEANJOBCAR, WMIN, EI, CONTIMP

Table 3.2 (B)

ANOVA[c]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	.647	5	.129	.247	.941[a]
	Residual	82.899	158	.525		
	Total	83.546	163			
2	Regression	27.852	9	3.095	8.557	.000[b]
	Residual	55.694	154	.362		
	Total	83.546	163			

a. Predictors: (Constant), COMPANYAGE, DEPARTMENT, POSITION, ROLEDURATION, COMPANYSIZE

b. Predictors: (Constant), COMPANYAGE, DEPARTMENT, POSITION, ROLEDURATION, COMPANYSIZE, LEANJOBCAR, WMIN, EI, CONTIMP c. Dependent Variable: RI

The hypotheses were suggested to evaluate the relationships between lean manufacturing dimensions and radical product innovation. The main hypotheses were proposed based on four dimensions (independent variables) which are: continuous improvement, waste minimization, lean job characteristics, and employees' involvement.

The main hypothesis (H_0): There are no significant relationships between lean manufacturing dimensions and radical product innovation.

In **Table 3.2 (B**), ANOVA (analysis of variance) for model two of the F-ratio for the study's data is 8.557 which is significant at 95% confidence level, $p < 0.05$ (Alpha sig=.000). This means that there are statistically significant relationships between lean manufacturing dimensions and radical product innovation. Thus, rejecting the null **(H_0)** andaccepting the alternative hypothesis (there are statistically significant relationships between lean manufacturing dimensions and radical product innovation).

Table 3.3 explains the basic co-efficient for each variable. The standardized coefficient (β) shows the individual contribution of each predictor (independent variable) if other predictors are constant. The higher the beta coefficient, the higher the effect of that predictor; hence the significant value (Sig) determined whether or not there are any relationships between the dependent and independent variables.

Each lean manufacturing dimensions standardized coefficients β as follow; continuous improvement equal to (0.142), waste minimization equal to (-.065), lean job characteristics equal to (-.179), and employees' involvement equal to (.368)

The sub-hypotheses

H0.1: There is no significant relationship between continuous improvement and radical innovation

For continuous improvement variable (CONTIMP), the value of the t-test is not significant at 95% confidence level (0.103 greater than 0.05), which means that the variance in radical product innovation is not predicted by the change in continuous improvement. In other word, either with implementing continuous improvement or not, radical product innovation will not affected. Thus, the above result does not provide an evidence to reject the null hypothesis **H0.1,**in that there is no significant relationship between continuous improvement and radical product innovation.

H0.2: There is no significant relationship between waste minimization and radical product innovation

The same goes for waste minimization variable (WMIN), the t-test is not significant at 95% confidence level (0.370 greater than 0.05). The implementation of waste minimization has nothing to do with radical product innovation. Therefore, this result does not provide an evidence to reject the null **H0.2**in that there is no significant relationship between waste minimization and radical product innovation.

H0.3: There is no significant relationship between lean Job characteristics and radical innovation

On the other hand, lean job characteristics and employees' involvement variable got significant results. The value of the t-test of lean job characteristics variable (JOBCAR) is significant at 95% confidence level (0.033 less than 0.05), and the beta value has negative value (-0.179). Thus, this means that the radical product innovation decrease by 17.9% as the lean job characteristics implementation increase (negative relationship). So, **H0.3** will be rejected, and the alternative hypothesis in that there is a significant relationship between lean job characteristics and radical product innovationwill be accepted.Because the beta coefficient is negative, the relationship would be negative. In other word, the implementation of lean job characteristics negatively affects the radical product innovation by 17.9%.

H0.4: There is no significant relationship between employees' involvement and radical product innovation

Finally, for the employees' involvement (EI) variable, the t-test value is also significant at 95% confidence level (0.000 less than 0.05), with a positive beta co-efficient (0.368), which mean that the radical product innovation rises by 36.8% as employees' involvement goes up. Accordingly, **H0.4** will be rejected and the alternative hypothesis (that there is a significant relationship between employees' involvement and radical product innovation); and since the beta coefficient is positive, this relationship is positive. Therefore, this means that ~~as~~ employees' involvement has a positive effect on radical product innovation.

Table 3.3

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.416	.304		11.228	.000
	ROLEDURATION	-.033	.045	-.061	-.744	.458
	DEPARTMENT	.021	.048	.035	.428	.669
	POSITION	.010	.051	.016	.198	.843
	COMPANYSIZE	.017	.051	.033	.325	.746
	COMPANYAGE	.021	.072	.030	.291	.771
2	(Constant)	2.343	.610		3.844	.000
	ROLEDURATION	-.051	.038	-.093	-1.361	.176
	DEPARTMENT	.049	.041	.083	1.206	.230
	POSITION	-.011	.043	-.017	-.253	.801
	COMPANYSIZE	.013	.044	.026	.295	.768
	COMPANYAGE	-.020	.063	-.028	-.310	.757

WMIN	-.053	.059	-.065	-.900	.370
LEANJOBCAR	-.193	.090	-.179	-2.146	.033
EI	.374	.081	.368	4.638	.000
CONTIMP	.145	.088	.142	1.643	.103

a. Dependent Variable: RI

In conclusion, the overall model has significantly explained the variance of the dependent variable (radical product innovation). Two of lean manufacturing dimensions (lean job characteristics and employees' involvement) have a significant effect on radical product innovation, while the other two (continuous improvement and waste minimization) have no significant effect.

Discussion: Hypotheses testing Findings

As mentioned before, this study is aimed at evaluating the relationships between lean manufacturing dimensions and radical product innovation. Thus, this has been achieved through measuring lean manufacturing using four dimensions which are: continuous improvement, waste minimization, lean job characteristics, and employees' involvement. Based on the research model in chapter three which was built according to the conducted theoretical background and the literature review in chapter two, five hypotheses were proposed (one main and four sub-hypotheses). After that, data was collected from different pharmaceutical manufacturers in Jordan, and then multiple regressionswere used in order to test these hypotheses. The following section will show the study's findings including the extent to which lean manufacturing dimensions are practiced in the Jordanian Pharmaceutical Sector as well as the results of the hypotheses testing when comparing it with previous studies; while in the next section, the conclusion will interpret the results with further details.

The extent of lean manufacturing dimensions (continuous improvement, waste minimization, lean job characteristics, and employees' involvement) are practiced in the Jordanian Pharmaceutical Sector.

The study's findings revealed that all of lean manufacturing dimensions and radical product innovation are practiced in the Jordanian Pharmaceutical manufacturers. The descriptive analysis (section4.5) in the previous chapter showed that the mean of radical product innovation is 3.5549. Therefore, in addition to this result, the Jordanian Pharmaceutical products are registered in more than 60 countries around the world including different Arab countries, USA and EU (global investment house, 2007) which means they have developed new products and have a patentshow that

RI is practiced by the studied manufacturer. Regarding the lean manufacturing dimensions, the mean of continuous improvement was high (4.08330), which means that continuous improvement is highly implemented by the Pharmaceutical manufacturers. Waste minimization dimensions is also implemented, and the mean of this variable was 2.9924, which is between low and medium; in other word, the process of minimizing the waste is practiced by the studied manufacturers. Regarding the third dimension, lean job characteristics mean was 2.2159, which means that lean job characteristics and employees have relatively high job control and job variety. Concerning the last dimension which is employees' involvement, the mean was 3.3923, which means that the employeesparticipate in decision making. However, the employees' involvement dimension is highly practiced.

Lean manufacturing dimensions and radical product innovation
The main hypothesis:

H0:There are no relationships between lean manufacturing dimensions and radical product innovation.

Few researches have studied the relationship between lean manufacturing and radical product innovation, especially in Jordan. Therefore, there is a lack of studies that either investigates lean production or radical innovation.

This study revealed that there are significant relationships between lean manufacturing dimensions and radical product innovation. The regression analysis in the previous chapter showed that R square of the proposed model was 0.333 which means that 33.3% of the change in the radical product innovation can be explained by lean manufacturing dimensions and the f-test was significant, which gives an evidence to reject the null hypothesis that there are no significant relationships between lean manufacturing dimension and radical product innovation.. This result agrees with the studies of Mehri (2006), Melnyk (2007), Chen and Taylor (2009), Chen et.al, (2010), and Chen (2012).

As mentioned before, lean manufacturing was measured using four dimensions: continuous improvement, waste minimization, lean job characteristics and employees involvement. Thus, the overall directional effect of lean manufacturing should be determined according to these four dimensions, but since each of them got different direction and different result, it is unattainable to get the overall trend of the relationship. In order to get more elaboration, these dimensions were tested using four sub-hypotheses as follow.

Continuous improvement and radical product innovation

H0.1: There is no relationship between continuous improvement and radical product innovation

By testing this hypothesis using the multiple regression, it appears that there is no significant relationship between continuous improvement and radical product innovation. Hence, the p value was 0.103 which is greater than 0.05. This result does not provide an evidence to reject the null hypothesis that there is no significant relationship between continuous improvement and radical product innovation. This is in contrast with the previous literature studies of Chang et.al, (2012) and Chen (2012), both of them suggested that continuous improvement and radical innovation are related while it agree with Terzivoski (2002) and Harrington (1995).

Waste minimization and radical innovation

H0.2: There is no significant relationship between waste minimization and radical product innovation

The same was for waste minimization variable, the multiple regression analysis also revealed that waste minimization have no significant effect on radical product innovation; thus the P value was 0.370 which greater than 0.05. So, this finding does not provide an evidence to reject the null hypothesis that there is no significant relationship between waste minimization and radical product innovation. This result disagrees with Mehri (2006), Melnyk (2007), Chen and Taylor, (2009), Chen et.al, (2010), and Sterling and Boxall, (2013). All of them suggested that there is a negative relationship between waste minimization and radical product innovation.

Lean Job characteristics and radical product innovation

H03: There is no significant relationship between lean Job characteristics and radical innovation

The multiple regression tests revealed that lean job characteristics have a significant relationship with radical product innovation. However, the P value was0.033 which is less than 0.05, which gives an evidence to reject the null hypothesis that there is no significant relationship between lean job characteristics and radical product innovation. Also, the beta coefficient was -17.9% whichmeans that there is a negative relationship between lean job characteristics and radical product innovation. In other word, radical product innovation is predicted to decrease by 17.9% when lean job characteristics implementation increase. So the alternative hypothesis in which there is a significant relationship between lean job characteristics and radical product innovation will be accepted. However, this agree with Sterling and Boxall,

2013, parker (2003), Lorenz andValeyre's (2005), Chen and Taylor,2009, Treville and Antonakis (2006), Hasle et.al, 2012).

Employees involvement and radical product innovation

H0.4: There is no significant relationship between employees' involvement and radical product innovation

The hypothesis testing using multiple regressions showed there is a significant relationship between employees' involvement and radical product innovation; p value was 0.000 which is less than 0.05, and this gives an evidence to reject the null hypothesis. The beta coefficient was .368 revealing that there is a positive relationship between employees' involvement and radical product innovation. With further clarification, radical product innovation will be increased by 36.8% as the process of involving the employees in the decision making increases. Thus,the alternative hypothesis in which there is a significant relationship between employees' involvement and radical product innovation will be accepted. This result goes with Bikfalvi, (2011)**,** Hasle et.al, (2012),Mehri, (2006), Chang et.al, (2012**),** and Sterling and Boxall, (2013)

Conclusion

The results of this study are further analyzed to answer the research objectives and questions. The first chapter of this research defines the research question, and objectives, as well as the used methodology and data collection method in order to reach results that achieve these objectives.

The main purpose of this study is to evaluate the relationships between lean manufacturing dimensions and radical product innovation in the Jordanian Pharmaceutical sector. So the independent variable was represented using four dimensions. The studied lean manufacturing dimensions are continuous improvement, waste minimization, lean job characteristics, and employees' involvement. In order to get more understanding of each dimension and its relationship with radical product innovation, in-depth theoretical background and literature review were conducted and accordingly, four hypotheses were assumed to be tested. After that, data was collected using a survey-based questionnaire and analyzed using different statistical techniques to reach results that achieve the research's objectives. The previous section discussed the results with respect to the prior studies, while this section will give an explanation of these results.

Continuous improvement and radical product innovation

As discussed before in chapter two, continuous improvement is a gradual and systematic improvement in product and process. It depends on

standardization, and step-by-step procedures; in other word, it depends on planning (Johnston, 2011; Martinez-Jurado et.al, 2013). Moreover, it focuses on current customers' need instead of their future ones that is focused on incremental innovation as a replacement of radical innovation. For these reasons, it was assumed by Chen et.al, (2010); Rae, (2007); Chen and Taylor, (2009); Chang et.al, (2012)that continuous improvement and radical product innovation are negatively related.

On the other hand, Terzivoski (2002) and Harrington (1995) had different opinions;Terzivoski (2002) compared the effectiveness of radical and incremental continuous innovation strategy on the performance excellence of company, he studied each strategy separately and their integration, ~~h~~and found that each strategy work well alone and the integration strategy have the least explanatory effect on performance excellence. This means that each strategy which is either continuous improvement or radical innovation can be applied individually without affecting each other either positively or negatively, thussupporting this study result.

Furthermore, Harrington (1995) argued that continuous improvement or so called continuous incremental innovation and radical innovation are separate from each other. Continuous improvement is a strategy implemented to help organization to keep going or in other word,hold still; while radical or breakthrough innovation serves as a "Jump-start". Continuous improvement is important for the sustainability of the radical product innovation, and does not lead to it. Therefore, the results of Terzivoski (2002) and Harrington (1995) align with the result of this study in that there is no significant relationship between continuous improvement and radical product innovation.

Waste minimization and radical product innovation

Waste minimization dimension is the core of lean manufacturing (Womack, 1990; Cost and Daly, 2003; Engum, 2009; Womack and Jones, 2003; PutnikandPutnik , 2012).It is all about eliminating activities that do not add value to customers which are considered as a waste, such as; idle time, materials, equipment and parts (Taj and Morosan, 2011 ; Chowary and George, 2011; Eswara-moorthi, 2011). At the same time, radical innovation depends on creativity which requires time. According to the literature, production pressure limits employees' ability to learn and their motivation, as well as their creativity and innovation (Sterling and Boxall, 2013). Moreover, lean manufacturing focuses on reducing product variability i.e. the risk of product variability, while radical innovation happens suddenly and depends on trial and error, which leads to high risk of failure (Bakovic´ et.al, 2013). For these reasons, it was considered by the literature that there is

a negative relationship between waste minimization and radical product innovation (Chen et.al, 2010; Chen and Taylor, 2009). On the other hand, the regression analysis in chapter four showed that there is no significant relationship between waste minimization and radical product innovation, which contradict with the literature. This result might be due to the specialty of radical innovation, in that it something happened suddenly and cannot be planned as in waste minimization and continuous improvement dimensions. However, both of them are related to the process while innovation especially radical innovation is more human-oriented related to employees' creativity (Im et.al, 2013; O'Sullivan & Dooley, 2009). This is the reason the other two dimensions i.e. lean job characteristics and employees' involvement got a significant relationship with radical innovation.

Lean Job Characteristics and Radical Product innovation

As mentioned in chapter two, job characteristics (job autonomy and variety) are very important to employees' creativity (Massis et.al, 2013; Ohly et.al, 2006) as far as employees control their jobs and have the freedom to arrange and schedule their work as they become more motivated to learn and to be more creative. Moreover, the higher the job variety, the higher the employees' innovative ability (Treville and Antonakis 2006). Lean production was criticized in that it reduces these characteristics. Hence, it attempts to reduce variability by applying standardization, increased production speed which intensify the work while lessen employees' job autonomy (Parker, (2003); Lorenz and Valeyre's (2005); Sterling and Boxall, 2013) which lead to hypothesize that lean job characteristics and radical product innovation are inversely related. And the results of this study support this argument in that there is a significant relationship between lean job characteristics and radical innovation, and because the beta coefficient of this variable was negative. Therefore, it is a negative relationship which also aligns with the previous researches' results.

Employees' involvement and Radical Product innovation

There is a consensus with radical innovation literature that Employees' participation in decision making, problem solving teams, and teamwork enhances employees' creativity and their ability to suggest new ideas and learn new things (O'Sullivan & Dooley, 2009; (Sehested and Sonnenberg, 2011; Johnstone et.al, 2011). According to lean manufacturing scholars, one of the most important dimensions of lean is to involve employees in the improvement process and take their suggestions into consideration (Womack et.al, 1990; Putnik and Putnik, 2012; Martínez-Jurado et.al, 2013). Because of that, it was considered within the literature that employees' involvement have a positive relationship with radical product

innovation. The results of this study align with the previous research in that there is a significant positive relationship between employees' involvement and radical product innovation.

These results are very logical ones,and it was clear that the relationships between dependent variable (radical product innovation) and the dimensions that are related to process were not significantly related to radical innovation, while the others which are directly related to employees were significantly related to radical innovation. Therefore, this comes from the specialty of radical innovation in that it depends on employees creativity (Im et.al,2013; O'Sullivan & Dooley, 2009).

Moreover, practically speaking, research and development department (R&D) is the department in charge of different pharmaceutical manufacturers for new product development, and as observed by the researcher, R&D departments are separate from other departments and that is why it is not affected by other lean production process' dimensions. According to Chen and Taylor, (2009); Lindeke et.al (2008), one of the solutions to eliminate the negative effect of lean manufacturing is to make an independent innovative center (separate R&D department from the others). Another important reason is related to the study's population in that most of the Jordanian pharmaceutical manufacturers are international ones, in other word; they are originally from outside Jordan (Global investment house, 2007). Therefore, the process itself does not affect the innovativeness of employees only (their creativity), but also agrees with the results of this study.

The following sections will present the study's implications, recommendations, and scope for future researches.

Implications of this study

This study has implications on both academia and practice. Thus, concerning the academic contribution of this research, it is important to take into consideration the extent to which the study add to the body of knowledge and the suggestions for future researches. The former will be discussed here, while the latter will be discussed in section 4.4

This research took four lean manufacturing dimensions; two human-oriented dimensions (lean job characteristics and employees' involvement), and two process-oriented ones (continuous improvement and waste minimization). Thus, these dimensions reflect lean as a socio-technical approach (Hasle et.al, 2012) which might enhance the understanding of lean manufacturing. Moreover, studying the human side of lean manufacturing is very important, because the effect of lean practices on employees is controversial and need more elaboration (Seppälä and Klemola, 2004).This is also important since this study considersemployees' involvement and lean

job characteristics separately which can help in clarifying the effect of lean on employees.

Furthermore, this research studied the relationships between lean manufacturing dimensions and radical product innovation. Also, there is lack of studies in this area, so, this might add to the body of knowledge and help in understanding how to achieve balance between these two extremes.

The practical implication of this study comes from the importance of innovation for the pharmaceutical industries in general and specifically in Jordan. The Jordanian Pharmaceutical Manufacturers export most of its production to different countries in the MENA region and Europe (Global investment house, 2007), so, they face intense global rivalry. And in order to sustain competition in such environment, it is important for companies to differentiate themselves from other, and have a competitive edge; thusinnovation is the core of competition in the pharmaceutical industry. Although, innovation requires researches and researches are costly, it is important for pharmaceutical manufacturer to innovate new drugs with high quality at the same time to reduce cost and product variability. Thus, management should foster innovation in their companies. As mentioned before, the study's results showed that two of lean manufacturing dimensions which are human-oriented got significant relationships with radical innovation, while the other process-oriented ones got a non-significant relationship with radical product innovation. Therefore, it is recommended to focus on employees and increasetheir ability to innovate by increasing their job control, variety, and their participation in decision making. And in order to reduce cost variability, it is recommended to apply waste minimization and continuous improvement dimensions since they do not affect radical product innovation.

Limitations and Future research

In order to enhance the finding's generalizability and avoid interpretation bias, it is important to look critically on the research as a whole and take limitations into consideration. As the research of this study face different constraints, the most noticeable one is the difficulty to gain access to the pharmaceutical manufacturers and gain approval for distributing the questionnaires. This may be due to the time sensitivity of the pharmaceutical companies, especially that this study mostly targeted employees in a managerial positions (such as; production manager, product line supervisor, Research development department manager, quality manager, and supply chain department manager) as well as departments considered to be a work-intensive departments.

Moreover, another constraint is that many manufacturers reject to cooperate in distributing the questionnaires

This study used questionnaire as a data collection method despite that it is an efficient mechanism and allow respondents to choose quickly from different alternatives. Sometimes, respondent need to give more elaboration to their answers instead of mutually exclusives alternatives (Sekaran and Bougie, 2011). Moreover, the respondents' answers may be bias according to their perception of the questionnaire's statement.

Another limitationtothis research is that, it limited to one industry; the pharmaceutical industry. Therefore, this study is recommended to expand to other industries in Jordan, such as the sewing industry, or food industry. Also, it is recommended to conduct this study in the service sectors, in order to see the difference in results between the industrial and the service sectors especially knowledge sensitive ones such as Information Technology (IT) sector (which consider one of the growing industries in Jordan). This research study one type of innovation which is radical product innovation; thus, it is suggested to evaluate the relationships between lean manufacturing dimensions and other type of innovation such as incremental innovation. Finally, it is recommended to study the effect of other dimensions of lean manufacturing, in order to present lean manufacturing from a different point of view.

References:

Abdullah, F., (2003), Lean manufacturing tools and techniques in the process industry with a focus on steel. Doctoral Dissertation, University of Pittsburgh.

AlKhali, S., (2011),Development of an assessment tool for the implementation of lean production principles in the Jordanian industries. Proceeding of the World Academy of Science, Engineering and Technology, 64, 1455 - 1461.

Altman, D., Burton, N., Cuthill, I., Festing, M., Hutton, J., and Playle, L. (2006), Why do a pilot study?.The NC3Rs Experimental Design Working Group.

Al-Zubi, Z. (2008), Suppliers versus lead users: examining collaboration in mass customization. Doctoral thesis, Durham University, Durham, U.K., Available at Durham E-Theses Online: http://etheses.dur.ac.uk/2510/

Amabile, T., (1998), How to kill creativity. Harvard Business Review, September-October.

Amabile, T., Hadley, C., and Kramer, S., (2002), Creativity under the gun: The innovation enterprise. Harvard Business Review, August.

Bakovic´, T., Lazibat, T., and Sutic´, I., (2013), Radical innovation culture in Croatian manufacturing industry. Journal of Enterprising Communities: People and Places in the Global Economy, 7(1), 74 – 80.

Baregheh, A., Rowley, J., and Sambrook, S., (2009), Towards a multidisciplinary definition of innovation. Management decision, 47(8), 1323-1339.

Batiz-Lazo, B. and Woldesenbet, K. (2006), The dynamics of product and process innovations in UK banking. International Journal of Financial Services Management, 1 (4), 400 - 421.

Beverly, K., Brockman, B., Jones, M., and Becherer, R. (2012), Influence of Risk-Taking, Innovativeness, and Opportunity Focus. Journal of Small Business Management, 50(3), 429–446.

Bikfalvi, A., (2011), Teamwork in Production: Implementation, Its Determinants, and Estimates for German Manufacturing. Human Factors and Ergonomics in Manufacturing & Service Industries, 21(3), 244–259

Cabrales, A., Medina, C., Lavado, A., and Cabrera, R., (2008), Managing functional diversity, risk taking and incentives for teams to achieve radical innovations. R&D Management 38(1), 35-50

Chamorro-Premuzic, T., (2013, April 2), Seven Rules for Managing Creative-But-Difficult People. Harvard Business Review Blog Network. Retrieve from: http://blogs.hbr.org/cs/2013/04/seven_rules_for_managing_creat.html

Chandra, M., and Neelankavil, J., (2008), Product development and innovation for developing countries: Potential and challenges. Journal of Management Development, 27(10), 1017 – 1025

Chang Y., Chang, H., Chi, H., Chen, M., and Deng, L., (2012), How do established firms improve radical innovation performance? The organizational capabilities view, Technovation, 32, 441–451

Chen, H., (2012), The Impact of lean design practices on an organization's radical innovation capability: An empirical study.Proceedings of PICMET' 12, Technology Management for emerging technologies (PICMET), 1917-1925

Chen, H., and Taylor, R., (2009), Exploring the Impact of Lean Management on Innovation Capability., Proceedings PICMET, August 2-6, Portland, Oregon:University of Minnesota, Duluth, MN – USA

Chen, H., Lindeke, R., and Wyrick, D., (2010), Lean automated manufacturing: avoiding the pitfalls to embrace the opportunities. Assembly Automation, 30(2), 117 - 123.

Cherry, H., (2012), Exploring lean production through the diffusion of innovation: Development of a new implementation effectiveness index. Doctoral Dissertation, Trident University International, California, United State of America.

Chowdary, B., and George, D., (2011), Improvement of manufacturing operations at a pharmaceutical company: A lean manufacturing approach. Journal of Manufacturing Technology Management, 23(1), 56 – 75

Christensen, C. (1997), The Innovator's Dilemma the revolutionary book that will change the way you do business, New York: Harper Collins Publishers.
Comm, C., and mathaisel, D., (2005), An exploratory analysis in applying lean manufacturing to labor-intensive industry in China. Asia Pacific Journal of Marketing and Logistics, 17(4), 63-80.
Cost, F., and Daly, B., (2003), Digital Integration and the kean manufacturing practices of U.S printing firms. A research Monograph of printing industry center at RIT, October No. PICRM-2003-2009
Damanpour, F., and Aravind, D. (2011), Managerial Innovation: Conceptions, Processes, and Antecedents. Management and Organization Review, 8(2), 423–454
Degirmenci, T., (2008), Standardization and Certification in Lean Manufacturing. Master Dissertation, The University of Waterloo, Ontario, Canada.
Dunk, A., (2011), Product innovation, budgetary control, and the financial performance of firms. The British Accounting Review, 43(2), 102–11
Engum, M., (2009), Implementing Lean Manufacturing into Newspaper Production Operations.The Rochester Institute of Technology
Eswaramoorthi, M., Kathiresan, G., Prasad, p., and, Mohanram, P., (2011), A survey on lean practices in Indian machine tool industries. International Journal for Advance Manufacturing Technology, 52, 1091–1101
Field, A. (2011), Discovering Statistics Using SPSS, (3rded), London: SAGE Publications Ltd.
Gassmann, O., Widenmayer, B., and Zeschky, M. (2012), Implementing radical innovation in the business: the role of transition modes in large firms. R&D Management, 42(2), 120-132.
Green, J., Lee, J., and Kozman, T., (2010), Managing lean manufacturing in material handling operations. International Journal of Production Research, 48(10), 2975–2993
Gunday, G., Ulusoya, G., Kilica, K., and Alpkanb, L., (2011), Towards High Performance Manufacturing Effects of innovation types on firm performance. International Journal of Production Economics, 133(2), 662–676
Haan, D., Naus, N., and Overboom, M. (2012), Creative tensionin a lean work environment: Implications for logistics firms and workers. International Journal of Production Economics, 13(7), 157–164
Hair, J., Tatham, R., Anderson, R., and Black, W. (2006), Multivariate data analysis. New York,:Prentice Hall.
Hajmohammad, S., Vachona, S., Klassena, R., and Gavronskib, L., (2013), Lean management and supply management: their role in green practices and performance. Journal of Cleaner Production, 39(January), 312–320.

Harrington, J., (1995), Continuous versus breakthrough improvement finding the right answer. Business Process Re-engineering & Management Journal, 1(3), 31-49.
Harris, R. (1985), A primer of multivariate statistics. (2nd ed.), New York: Academic Press.
Hasle, P., Bojesen, A., Jensen, P., and Bramming, P. (2012), Lean and the working environment: a review of the literature. International Journal of Operations & Production Management, 32(7), 829 – 849
Hofer, C., Eroglu, C., and Hofer, A., (2012), The effect of lean production on financial performance: The mediating role of inventory leanness. International Journal of Production Economics, 138(2), 242–253.
Hoffmann, T. and Bishop, C. (2010), The future of discovery chemistry: quo vadis? Academic to industrial – the maturation of medicinal chemistry to chemical biology. Drug Discovery Today, 15(7–8 April), 260–264
Hoppes, J., (1995), Lean Manufacturing Practices in the Defense Aircraft Industry. Master Dissertation, The Pennsylvania State University, Pennsylvania, United State of America.
Im, S., Montoya, M., and Workman, J. (2013), Antecedents and Consequences of Creativity in Product Innovation Teams. Journal of Product Innovation Management, 30(1), 170–185
Johnson, J., Whittingtonm R., and Scholes, K., (2011), Exploring strategy: Text and cases. (9thed), England: prentice hall
Johnstone, C., Pairaudeau, G., and Pettersson, J. (2011), Creativity, innovation and lean sigma: a controversial combination?.Creativity, Drug Discovery Today, 16(1/2 January), 50-57.
Kim, C.W. and Mauborgne, R. (2005), Blue ocean strategy: from theory to practice. California Management Review, 47(3), 105-121.
Kinki and Williams, (2006), Management: a practical introduction. (2nded), New York: McGraw-Hill.
Kotler, P., and Keller, K., (2006), Marketing Management. (12thed), New Jersy: Prentice-Hall, Upper Saddle River.
Landau, S., and Everitt, B.S. (2004), A Handbook of Statistical Analyses using SPSS. Boca Raton: Chapman and Hall/Crc.
Lind, M., (2008), Lean in Product Development Key Strategies to Successfully Implement Lean Development and the Synergies with Advanced Product Quality Planning. Aras corp.
Lindeke, R., Wyrick, D., and Chen, H. (2008), Effecting change and innovation in a highly automated and lean organization: the TemporalThink Tank™ (T3™). Robotics and Computer-Integrated Manufacturing, 25, 879–887
Lohmuller, B., (2004), Drivers of Product Innovation: An Investigation of German Manufacturing Companies. Cranfield University.

Lorenz, E. and Valeyre, A. (2005), Organisational innovation, human resource management and labour market structure: a comparison of the EU-15. The Journal of Industrial Relations, 47(4), 424–442.
Macduffie, J. (1995), Workers' Roles in Lean Production: The Implications for Worker Representation. In: Babson, S. Lean Work Empowerment and Exploitation in the Global Auto Industry. (PP. 54-69), U.S.A, Wayne State University Press.
Markides, C. (2006),Disruptive Innovation: In Need of Better Theory. The Journal of Product Innovation Management, 23(1), 19–25
Martínez-Jurado, P., Moyano-Fuentes, J., and Gómez, P., (2013), HR Management during Lean Production adoption. Management Decision, 51(4), 742 – 760
Massis, A., Frattini, F., Pizzurno, E.,and Cassia, L., (2013), Product Innovation in Family vs. Non-Family Firms: an Exploratory Analysis.Accepted for publication in Journal of Small Business Management.
McGrath, W., (2007), Impact analysis of large-scale lean manufacturing initiatives upon manufacturing process innovation in Irish companies. Waterford institute of technology.
McLaughlin, P., Bessant, J. and Smart, P. (2005),Developing and organizational culture that facilitates radical innovation in a mature small to medium sized company: emergent findings. Cranfield School of Management working paper series, 4,retrieved October 6, 2012, from: http://www.cranfield.ac.uk/som/research/working_ papers
Mehri, D., (2006), The darker side of Lean: An insider's perspective on the realities of the Toyota Production System. Academy of Management Perspectives, 20(2), 21-42.
Melnyk, S., (2007), Lean to a fault?.CSCMP's Supply Chain Quarterly, 3.
Melton, T., (2005), The Benefits of Lean Manufacturing: What Lean Thinking has to Offer the Process Industries. Chemical Engineering Research and Design, 83(6), 662–673
Menard, S., (1995), Applied logestic regression analysis. Sage University paper series on quantitative applications in social science, 07-106, Thousand Oasks, CA:Sage.
Morgeson, F., and Humphrey, S., (2006). The Work Design Questionnaire (WDQ): Developing and Validating a Comprehensive Measure for Assessing Job Design and the Nature of Work. Journal of Applied Psychology, 91(6), 1321–1339
OECD, (2005), Oslo Manual: Proposed Guidelines for Collecting and Interpreting Technological Innovation Data. Paris.
Oeij, P., Dhondt, S. and Wiezer, N., (2006), Conditions for Low Stress-risk Jobs: Europe's Case. European Journal of Social Quality, 6(2), 81–108

Ohly, S., Sonnentag, S., and Pluntke, F. (2006), Routinization, work characteristics and their relationships with creative and proactive behaviors. Journal of Organizational Behavior, 27, 257–279.
Ohno, T., (1988), Toyota Production System: Beyond large scale production. productivity press, Cambridge, MA
Olsen, E., (2004), Lean manufacturing management: The relationship between practice and firm level financial performance. The Ohio State University.
O'Sullivan, D., and Dooley, L. (2009), Applying innovation. London: SAGE Publications, Inc.
Parker, S. (2003), Longitudinal effects of lean production on employee outcomes and the mediating role of work characteristics. Journal of Applied Psychology, 88(4), 620–634.
Post, C., and Slaughter, J. (2000), Lean Production: Why Work is Worse than Ever, and What's the Alternative?. A Solidarity Working Paper. Retried from: http://www.solidarity-us.org/leanproduction
Putnik, G., and Putnik, Z. (2012), Lean VS agile in the context of complexity management in organizations. The Learning Organization, 19(3), 248-266.
Radnor, Z., and Boaden, R., (2004), Developing an understanding of corporate anorexia. International Journal of Operations & Production Management, 24(4), 424-440.
Rae, J., (2007, February 27). Debate: Six Sigma vs. Innovation.Bloomberg: Business week.
Raymond, L., and St-Pierre, J., (2010), R&D as a determinant of innovation in manufacturing SMEs: An attempt at empirical clarification. Technovation, 30(1), 48–56.
Sainio L., Ritala P., and Hurmelinna-Laukkanen P., (2012), Constituents of radical innovation—exploring the role of strategic Orientations and market uncertainty. Technovation, 32, 591–599
Sandberg, B. (2007), Customer-related proactiveness in the radical innovation development process. European Journal of Innovation Management, 10(2), 252-267.
Sehested, C., and Sonnenberg, H., (2011), Lean innovation a fast path from knowledge to value. New York: Springer-verlag, berlin Heidelberg.
Sekaran, U., and Bougie, R. (2011), Research Method for Business: A Skill Building Approach, (5th ed), United Kingdom: John Wiley and Sons Ltd.
Seppälä*, P., and Klemol, S. (2004), How do employees perceive their organization and job when companies adopt principles of lean production?.Human Factors and Ergonomics in Manufacturing & Service Industries, 14(2), 157–180
Shah, R., and Ward, P., (2007), Defining and developing measures of lean production. Journal of Operation Management, 25(4), 785–805

Skorstad, E. (1994), Lean production, conditions of work and worker commitment. Economic and Industrial Democracy, 15(3), 429-55.
Stanley, K., (2012), *Antecedents* of radical innovation: Antecedents and Outcomes of Radical Innovation. Unpublished doctoral dissertation, Alliant International University.
Sterling, A. and Boxall, P. (2013 July), Lean production, employee learning and workplace outcomes: a case analysis through the ability-motivation-opportunity framework. Human Resource Management Journal, 23(3), 227–240.
Surya, G., (2004), Pull and lean manufacturing systems validation using simulation modeling. Unpublished doctoral dissertation, The University of Texas.
Taj, S., and Morosan, C., (2011), The impact of lean operations on the Chinese manufacturing performance. Journal of Manufacturing Technology Management., 22(2), 223 – 240.
Tellis, G., Prabhu, J., and Chandy, R. (2009), Radical Innovation Across Nations: The Preeminence of Corporate Culture. Journal of Marketing, 73(January), 3–23
The New Oxford Dictionary of English. (1998). New York: Oxford University Press.
Terziovski, M. (2002), Achieving performance excellence through an integrated strategy of radical innovation and continuous improvement. Measuring Business Excellence, 6(2), 5-14.
Treville, S., and Antonakis, J., (2006), Could lean production job design be intrinsically motivating? Contextual, configurational, and levels-of-analysis. Journal of Operations Management, 24 (2), 99–123.
Tsinopoulos, C., and Al-Zu'bi, Z., (2012), Clockspeed effectiveness of lead users and product experts. International Journal of Operations and Production Management, 32(9), 1097-1118.
Utterback, J. (1996), Mastering the dynamics of innovation.Boston: Harvard Business School Press.
Valencia, J., Valle, R., and Jime´nez, D. (2010), Organizational culture as determinant of product innovation. Journal of Innovation Management, 13(4), 466-480.
VanVoorhis, W., and Morgan, B. (2007), Understanding Power and Rules of Thumb for Determining Sample Sizes. Tutorials in Quantitative Methods for Psychology, 3 (2), 43-50.
Walton, M., (1999),Strategies for Lean Product Development. Massachusetts Institute of Technology.
Womack, J., .Jones, D., and Roos, D., (1990), *The* Machine That Changed the World, New York: Free Press a Division of Simon and Schuster Inc.

Womack, J., and Jones, D., (2003), Lean thinking: Ban waste and create wealth in your corporation, New York: Free Press a Division of Simon and Schuster Inc.
Yang, Y., and Konrad, A., (2011), Diversity and organizational innovation: The role of employee involvement. Journal of Organizational Behavior, 32, 1062–1083
Zhang, M., (2011), Firm-level performance impact of IS support for product innovation. European Journal of Innovation Management, 14(1), 118 – 132

Internet References:

Global Investment House, (2007), Available online:
http://www.globalinv.net/default.asp?lf=1
JAPM: Available online:
http://www.japm.com/Public/main_english.aspx?Lang=2&Page_ID=101
European Commsion Trade: Available Online:
http://ec.europa.eu/trade/creating-opportunities/bilateral-relations/countries/jordan/