Impact of ERP implementation on the Maintenance Management in the Manufacturing Sector of Pakistan

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Abstract

The study was conducted to understand the phenomenon of ERP implementation and its impact on the maintenance management in the manufacturing sector of Pakistan. The ERP implementation was actually operationalized through production efficiency, cost-optimization and spare parts inventory management in order to understand their impact on the maintenance management in the manufacturing sector. Moreover, the study included the scholarly work of various authors in order to understand the phenomenon in detail. Although, the research was conducted quantitatively through developing one close-ended questionnaire and then data was collected from 390 individuals presently working in the manufacturing sector of Pakistan. The researcher found through descriptive analysis that, most of the participants were between 25- 35 age bracket and belonged to either production or maintenance department. It was further found that data is considered to b e distributed normally and hence, can be used for further analysis. The researcher found ultimately that, there is a significant relationship between production efficiency, cost-optimization, spare-parts inventory management in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan. In addition to that, the strength of relationship was strong in nature in all three hypothesis and model fit suggested that, the independent variables are 84% related with the dependent variable.

Introduction

Rahman & Abu Bakar (2019) mentioned that, manufacturing sector is always remained a key sector especially for the under-developed economies as similar to the case of Pakistan. They further added that, manufacturing sector although contributes 14-15% in GDP but, it is still under-developed due to below par production efficiency and hence, insignificant contribution in global value chain (GVC). Moreover, Muscatello et al. (2003) added that, ERP is the software embedded program that encompasses all the activities within an organization ranging from production, management, logistics and customer service as well, hence improving the overall efficiency of an organization. They further added that, ERP has been quite successful in production planning, inventory management and improving maintenance system in any given manufacturing organization. However, Upadhyay et al., (2010) mentioned that, the ERP is actually a newly made version of older versions used in 90s in the manufacturing sector including material requirements planning (MRP) and manufacturing resource planning (MRP-II). Bamufleh et al. (2021) further added that, the ERP is different from its predecessors as it has made it possible to combine real-time information across multiple domains hence, improving efficiency of production and management and also enhancing organizational competitiveness as well. Hong & Kim(2002) added that, the success of ERP in manufacturing actually have three reasons, first, it has covered effectively all the manufacturing functions, second, the speed of data processing is amazing and third, the component of integration and coordination. Moreover, Eti et al. (2006) added that, organizations spent almost 40-60% of their operational budget on maintenance depending upon the type of industry involved, hence, automatic monitoring of equipments along with their spare parts inventory management has become crucial for the organizations to reduce their overall costs and improve efficiency and thereby compete in the market. That is why, this research is conducted to explain how ERP implementation can influence on the maintenance management of manufacturing sector in Pakistan with respect to its production efficiency, costs optimization and spare-parts inventory management.

Problem Statement

Klaus et al. (2000) argued that ERP is a complete packaged software solution that incorporates all the business functions within a singular IT architecture. Frazee & Khan (2013) on the other hand argued that, implementation of ERP especially in the manufacturing sector has been gaining importance as, fierce competition in the field has pushed the stakeholders to look for improved efficiency, less costs and better quality products. However, Akhter (2011) argued that ERP implementation has been quite successful across multiple industries in Pakistan as, the country is well equipped with enough human resource, internet architecture and other related resources. He further added that, there are a quite a good number of companies offering ERP complete solution to multiple industries because, it has been found to be successful for many industries in Pakistan. Although, the researcher of this study has found that, there is not much scholarly work done on the subject related to maintenance management in the manufacturing sector of Pakistan and how ERP can improve the maintenance management. Therefore, this study tries to fill the research gap empirically.

Research Hypothesis

H1= There is a significant relationship between production efficiency with respect to ERP implementation and maintenance management in manufacturing sector of Pakistan.

H2 = There is a significant relationship between cost optimization with respect to ERP implementation and maintenance management in manufacturing sector of Pakistan.

H3 = There is a significant relationship between spare parts inventory management with respect to ERP implementation and maintenance management in manufacturing sector of Pakistan.

Review of Literature

Rashid et al. (2002) argued that, ERP development can actually dates back to the introduction of inventory control packages in 1960s when the first time automation was used to control inventory. The technological development happened every decade afterwards with the introduction of new programs for industrial automation like material

requirements planning (MRP) for production in 1970s and manufacturing resource planning (MRP-II) in 1980s. However, the ERP was firstly introduced in 1990s as an expensive but, quite efficient centralized database software that can integrate all the functions within an organization ranging from customers to suppliers for smooth flow of information and decision making. It was the first time in history when the program is commercially generalized for the industry and that can be tailored easily through "add-ons" with the requirement of specific industry. Nowadays the extended ERP has also been introduced. Ullah et al. (2018) added that, ERP that is in use today is better than any other older versions in at least three ways, first, it is more efficient and effective and offer multiple choices to the user, second, it can be connected with multiple systems inside and outside an organization and third, it is not as expensive either to install or to maintain than its predecessors.

However, Laurila (2017) defined that, maintenance management involves those activities either technically, administratively or through management in order to retain the optimal functionality of machinery or whole production system for maximum efficiency. Marquez et al.,(2009) added that, maintenance management actually involves maintenance planning as the organization plans, how to maximize its return on investment (ROI) while using the same resources optimally for maximum amount of time. They further added that, maintenance management is actually an optimization of all inputs including human resource, machinery, tools and equipments, processes in order to get the required output. There are usually two types of maintenance occurred in any manufacturing industry, corrective and preventive maintenance. Similarly, Kocaaga et al. (2019) added that, ERP implementation actually reduces the production cycle by producing optimal quality products with minimum fault ratio. They further added that, lean manufacturing along with ERP implementation is key to improve production efficiency. They further added that, production efficiency can improve significantly total asset turnover (TAT) and inventory turnover (ITO).Similarly, Kouki et al.(2015) added that, production efficiency is improved because of ERP implementation due to mainly two reasons, first, it reduces the coordination costs needed to carry out the operations efficiently and effectively, second, it improves the product quality through timely maintenance management.

Kumar (2015) argued that, there are multiple costs incurred in the production process so, until and unless, activity costing is used, the actual amount incurred on each task remains incalculable. Hence, he added that, ERP is the system that can separate each task and helps the managers to calculate the costing of each one. Hence, Kelle & Akbulut(2005) added that, transaction based accounting becomes efficient and effective due to the use of ERP in the manufacturing process because, it allows the management to decipher the costing of each transaction against its potential benefits. A Priori Whitepaper (2015) mentioned that, most of costs increased in the manufacturing due to problems like fragmented decision making, static information, and unavailability of past decisions and uncontrolled nature of systems. Moreover, ERP uses the asset optimization technique to make sure that, the maximum financial benefit can be achieved from the manufacturing machinery with optimal costs incurred (Elaswad & Ali, 2019). Holzworth & Walejeski, (2009) mentioned that, the major issue in the field of maintenance management was to create isolation between or among multiple systems in order to reduce the chance of one machine or equipment failure to cause problems for interconnected equipments. That situation not only create problems for the technical team but, also increase the overall expenses of the maintenance department. This has been significantly reduced due to the implementation of ERP in the manufacturing industry as the failure can be restricted and the minimum loss can occur as a consequence.

Conceptual Framework of the Study

This study is mainly guided theoretically by four studies including Beheshti & Beheshti (2010), Madanhire & Mbohwab (2016), Kumar (2015) and Holzworth & Walejeski, (2009). Beheshti & Beheshti (2010) and Madanhire & Mbohwab (2016) guided the researcher by examining that, how ERP can help the manufacturing organization to integrate all its operations and at the same time, improve production efficiency, reduce financial costs, reducing waste and provide timely products to their customers with minimum defect rate. However, Kumar (2015) supported the idea of the researcher by mentioning that, there are multiple costs incurred in the production process so, until and unless, activity costing is used, the actual amount incurred on each task remains

incalculable and ERP is the main centralized database that can make it happen. Holzworth & Walejeski(2009) finally supported the relationship of ERP based spare- parts inventory mechanism with the maintenance management through investigating thoroughly SAP-PM in his research.
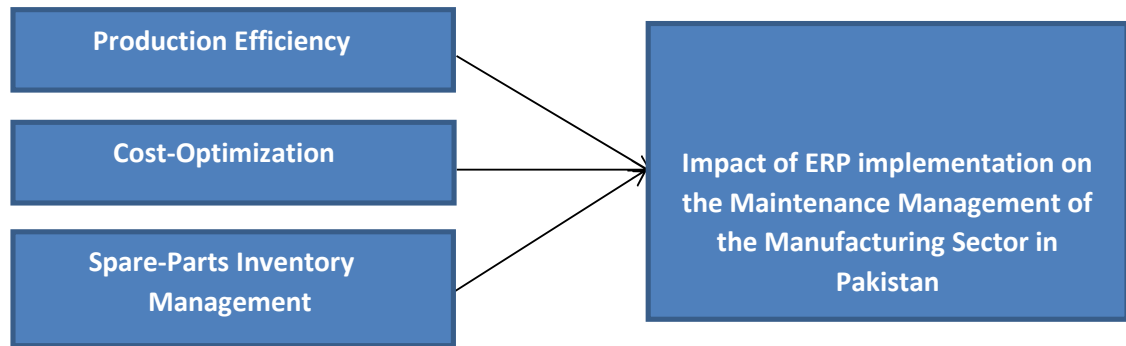

Figure 1: The conceptual framework of the study

Research Methodology

Research methodology usually starts with ontological philosophical stance and by that means, researcher decides whether to approach the problem objectively or subjectively, afterwards, epistemological paradigm is chosen, it implies that, whether the study would be quantitative or qualitative in nature (Mishra & Alok, 2019). This study is basically a quantitative study as it suits the research overall objective and quantitative research is a kind of research that is used to understand the phenomenon objectively through the use of numerical data with or without the support of the theoretical framework (Kabir, 2016). This study is also correlational in nature with cross-sectional and non-contrived settings. Although, Correlational study is normally conducted to find significant relationship between or among variables and it is not as same as cause and effect study (Gravetter & Wallnau, 2013). The targeted population of this study is total number of employees working in the manufacturing sector of Pakistan. However, it is not possible for the researcher to get the exact documentation of the targeted population. Hence, this researcher has chosen 390 executives through judgmental sampling mainly related with respective production and maintenance departments in order to understand the phenomenon of

maintenance management and how it is being impacted by the implementation of ERP.

Reliability and Validity

This study will use SPSS Cronbach's alpha in order to measure the validity and reliability of the research instrument. Hence, it is found that, Cronbach's alpha of the research instrument being used is above 80% and it implies that, research instrument is valid and reliable.

		N	%
Cases	Valid	390	100.0
	Excluded	0	.0
	Total	390	100.0

a. List-wise deletion based on all variables in the procedure.

Cronbach's Alpha	
.811	17

Results Analysis

Sharma (2018) argued that, data analysis is the technique used to convert data into meaningful information through pattern generation or finding correlation. He further insisted that, data can be analyzed either quantitatively or qualitatively depending upon the data being collected. Loeb et al., (2017) although highlighted that, normally there are two data analysis techniques being used in quantitative research descriptive and inferential statistics.

Hypothesis 1

H1= There is a significant relationship between production efficiency with respect to ERP implementation and maintenance management in manufacturing sector of Pakistan.

Pearson Correlation Test

		P.E	M.M
P. E	Pearson Correlation	1	.719**
	Sig. (2-tailed)		.000
	N	390	390
M. M	Pearson Correlation	.719**	1
	Sig. (2-tailed)	.000	
	N	390	390

**. Correlation is significant at the 0.01 level (2-tailed).

Spearman Correlation Test

			P.E	M.M
Spearman's rho	P. E	Correlation Coefficient	1.000	.677**
		Sig. (2-tailed)	.	.000
		N	390	390
	M. M	Correlation Coefficient	.677**	1.000
		Sig. (2-tailed)	.000	.
		N	390	390

**. Correlation is significant at the 0.01 level (2-tailed).

Analysis: The two tests Pearson and Spearman were conducted to find the relationship between production efficiency in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan. Hence, it was found at the end that, there is a significant relationship between the both as p value is less than 0.05(95% confidence level). Moreover, the strength of relationship is strong in nature as both tests showed the strength more than 65%.

Hypothesis 2

H2 = There is a significant relationship between cost optimization with respect to ERP implementation and maintenance management in manufacturing sector of Pakistan

Pearson Correlation Test

		C.O	M.M
C.O	Pearson Correlation	1	.789**
	Sig. (2-tailed)		.000
	N	390	390
M.M	Pearson Correlation	.789**	1
	Sig. (2-tailed)	.000	
	N	390	390

**. Correlation is significant at the 0.01 level (2-tailed).

Spearman Correlation Test

			C.O	M.M
Spearman's rho	C.O	Correlation Coefficient	1.000	.764**
		Sig. (2-tailed)	.	.000
		N	390	390
	M.M	Correlation Coefficient	.764**	1.000
		Sig. (2-tailed)	.000	.
		N	390	390

International Journal of Social Sciences and Entrepreneurship (IJSSE)
ISSN (Online): xxxx-xxxx , ISSN (Print): xxxx-xxxx

Vol 2, Issue 1
Jan to June 2022

**. Correlation is significant at the 0.01 level (2-tailed).

Analysis: The two tests Pearson and Spearman were conducted to find the relationship between cost-optimization in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan. Hence, it was found at the end that, there is a significant relationship between the both as p value is less than 0.05(95% confidence level). Moreover, the strength of relationship is strong in nature as both tests showed the strength more than 75%.

Hypothesis 3

H3 = There is a significant relationship between spare parts inventory management with respect to ERP implementation and maintenance management in manufacturing sector of Pakistan.

Pearson Correlation Test

		SP.IM	M.M
SP.IM	Pearson Correlation	1	.799**
	Sig. (2-tailed)		.000
	N	390	390
M.M	Pearson Correlation	.799**	1
	Sig. (2-tailed)	.000	

**. Corelation is significant at the 0.01 level (2-tailed).

Spearman Correlation Test

			SP.IM	M.M
Spearman's rho	SP.IM	Correlation Coefficient	1.000	.756**
		Sig. (2-tailed)	.	.000
		N	390	390

	M. M	Correlation Coefficient	.756[**]	1.000
		Sig. (2-tailed)	.000	.
		N	390	390

**. Correlation is significant at the 0.01 level (2-tailed).

Analysis: The two tests Pearson and Spearman were conducted to find the relationship between spare-parts inventory management in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan. Hence, it was found at the end that, there is a significant relationship between both as p value is less than 0.05(95% confidence level). Moreover, the strength of relationship is strong in nature as both tests showed the strength more than 75%.

Model Fit

The researcher has finally used regression analysis in order to visualize the relationship between all independent variables (production efficiency, cost- optimization, spare-parts inventory management in terms of ERP implementation) and dependent variable (maintenance management in the manufacturing sector of   Pakistan).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.842[a]	.709	.706	1.19105

a. Predictors: (Constant), SP.IM, P.E, C.O

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	T	Sig.
1	(Constant)	.392	.170		2.308	.022
	P.E	.224	.056	.174	3.969	.000
	C.O	.313	.047	.338	6.671	.000

SP.IM	.413	.052	.397	7.981	.000

a. Dependent Variable: M.M

Analysis: The above analysis shows that, the model fit is 84% implying that, independent variables (production efficiency, cost-optimization, spare-parts inventory management in terms of ERP) are strongly related with maintenance management in the manufacturing sector of Pakistan. Moreover, the beta shows that, more changes can be found in the maintenance management in the manufacturing sector by manipulating spare-parts inventory through ERP than through other two independent variables.

Discussion

The research was conducted empirically in order to understand and explain an influence of ERP implementation in terms of production efficiency, cost-optimization and spare-parts inventory management and maintenance management in the manufacturing sector of Pakistan. The researcher used the post-positivist philosophy along with quantitative paradigm in order to conduct the study and hence, the close-ended questionnaire was developed and distributed to most relevant individuals by applying judgmental sampling. Then it was found that, most of the respondents participated in the survey were in the age bracket of 25-35, hence, it implies that, younger and middle-aged people participated more than older people. It was further explored that, more than 70% were either related to production or maintenance or ERP department hence, most relevant individuals participated in the survey.

However, the research was guided by four main studies. Hence, Beheshti & Beheshti (2010) mentioned that, ERP is an overarching system that encompasses all departments of the organization hence helping the organizations to improve production efficiency, reduce financial costs, reducing waste and provide timely products to their customers with minimum defect rate. That is why, when asked by the researcher regarding the impact of

ERP implementation in terms of cost-optimization, it was found that, more than 85% participants agreed on the notion that, ERP implementation reduces the production cost, while 8% had no idea and 5% disagreed with the notion as well. Moreover, Madanhire & Mbohwab (2016) narrated that, the main contribution of ERP in the manufacturing sector is its capacity to integrate all the operations within an organization that not only reduces time but, also other tangible and intangible resources as well. However, Kumar (2015) argued that, there are multiple costs incurred in the production process so, until and unless, activity costing is used, the actual amount incurred on each task remains incalculable. Hence, while asked from the participants, it was found that, more than 85% nodded their heads in agreement that, ERP implementation reduces operational, functional and strategic costs, while 6% disagreed with the statement. Moreover, Do Rego & de Mesquitab(2011) mentioned that, inventory control of spare- parts is a different job than usual inventory control of finished products because, demand and supply is not as definite in the latter as in the former. Hence, it has been found that, ERP is very useful in managing spare-parts inventory because, it can monitor the equipment being used and spare-parts being needed continuously in order to reduce spare-parts obsolescence. Moreover, the research was based on the validation of three hypotheses, the first hypothesis was that, there is a significant relationship between production efficiency in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan, and second was, whether there is a significant relationship between cost-optimization in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan and the third was, whether, there is a significant relationship between spare-parts inventory management in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan. It was hence found that, there is a significant relationship between all three independent variables (production efficiency, cost-optimization, spare-parts inventory management) and maintenance management in the manufacturing sector of Pakistan and the strength of relationship is strong in nature as well. It was further analyzed and observed that, the independent variables were found to be 84% related with the dependent variable and spare-parts inventory management in terms of ERP implementation was found to be more influential than production efficiency and cost- optimization.

Conclusion

The research was conducted in order to understand and explain the phenomenon of ERP implementation in terms of production efficiency, cost-optimization and spare-parts inventory management in order to visualize its impact on the maintenance management in the manufacturing sector of Pakistan. The researcher then followed a rigorous literature review in order to develop a conceptual framework for the study. Afterwards, the research had chosen research methodology including post-positivist philosophy, objective epistemology and quantitative paradigm along with cross-sectional nature in order to achieve the research objectives of finding relationship between ERP implementation and maintenance management in the manufacturing sector of Pakistan. The researcher had chosen the sample size of 390 executives by using judgmental sampling because of technical nature of the study. Moreover, the researcher had found that, more participants of this study were in the age bracket of 25-35 and most of them belonged to production, ERP and maintenance department. The participants agreed in answering the survey questions that, production efficiency, cost-optimization and spare-parts inventory management in terms of ERP play a vital role in the maintenance management of the manufacturing sector of Pakistan. The researcher found through data analysis that, research data is normally distributed as a whole and most of the respondents agreed with the statements that ERP implementation as a whole contribute positively in the maintenance management of the manufacturing sector of Pakistan. Moreover, the individual hypothesis was tested by using Pearson and Spearman correlation tests and it was found that, there is a significant relationship between production efficiency, cost-optimization, spare-parts inventory management in terms of ERP implementation and maintenance management in the manufacturing sector of Pakistan. It was also explored that, strength of relationship is strong in nature and the independent variables chosen are 84% related with the maintenance management in the manufacturing sector of Pakistan.

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