The Role of ERP in Supply Chain Integration

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Abstract
Many firms are deploying ERP systems in supply chain applications. Recently Jordan has embarked upon an ambitious plan to make full use of the IT capabilities. In Jordan, the application of the ERP systems is relatively immature. In addition, it is evolving, and the number of organizations involved is growing. Raising awareness and knowledge is essential for adopting ERP systems in supply chain in Jordan, at both the organizational and inter-organizational levels. Firms need to identify and understand the critical factors that affect the using of ERP systems successfully in SCI, and address them effectively to ensure that the promised benefits can be realized and failures can be avoided.

1. Introduction

1.1 ERP and Supply Chain Management

Since suppliers are located all over the world, it is essential to integrate the activities both inside and outside (including on extended enterprises) of an organization (Esteve, Pastor, 2001). This requires an enterprise-wide information system for sharing information on various value adding activities along the supply chain (Al-Mashari, 2003). Though the relationship between ERP and SCI has been studied to some extent, still considerable amount of research needs to be conducted in order to facilitate the client companies and software vendors to assist in developing an integrated SC.
According to (Stephen 2000), ERP is a system that effectively integrates all information required by the operating process functions including finance, accounting, human resources, production, material management, quality management, allocation and distribution, and sales by organization or process reengineering and information technology. ERP is an integrated information system that integrates enterprise internal function working processes, Standardizes internal data processing procedures, and combines the operational data generated by different functions (Stephen 2000, Buckhout, Nemec, 1999). Future ERP will integrate supply chain management (SCM) to provide enterprise management more accurate information (Nah et al., 2001; Parr and Shanks, 2000, Cooper et al, 2000).

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SCM (Supply Cain Management) is concept which look at a business as a chain of will inter connected entities and thus providing a see through perspective of the entire business. The supply chain can be modeled to reduce inventory, lead times and cost at each link under the given constraints. The relationship between ERP and SCM have been studied by Akkermans et al, 2003 who produced a research in 23 separate firms about the results and future expectations of ERP systems implementations in a SCM perspective. The authors inferred that many firms deploying ERPs considered extending system scope mainly to integrate their suppliers, customers or both to the system, to provide additional e-commerce or e-business operations and to increase supply chain functionalities.
The relationship between ERP and SCI has been studied to some extent. The challenge for organizations today is to understand the factors that play a critical role in utilizing ERP systems capabilities and their implications on SCI to enable them to compete successfully and using their outcomes to improve firm performance. The findings of previous studies can be described as fragmented, and have not been holistic. In Jordan, using ERP systems is relatively immature. In addition, it is evolving, and the number of organizations involved is growing. Successful deployment of ERP applications requires smooth integration of a number of factors.
The study aims to (1) Identify the CSFs and sub factors of ERP systems, (2) better understand of Jordanian manufacturing managers and employee's perceptions of ERP systems success dimensions (3) offer a comprehensive review of the literature on enterprise resource planning systems (ERPs), supply chain integration (SCI).The results showed that ERP systems have a positive impact on two supply chain integration type (internal, external).

2. ERP/Supply Chain integration

ERP systems success (synonymous with ERP success) refers to the use of such systems to enhance organizational effectiveness (Gable, Chan, 2003; Ifinedo, 2006a), which is different from the technical implementation success of such systems wherein measurement indicators such as cost

overruns, project management metrics, and time estimates are the main concerns (Martin, 1998). In the work of DeLone and McLean, 1992) concluded "By studying the interactions along these components of the model [dimensions of IS success], as well as the components themselves, a clearer picture emerges as to what constitutes information systems success." Moreover, other researchers (e.g. Akkermans, Van, 2002 have studied the interrelations among critical success factors in the early stages of ERP implementations; this study complements such efforts. Importantly, insights from this research may benefit both ERP practitioners and IS success evaluations researchers. Over the past three decades, evaluating the value and success of IT systems for organizations has been a recurring issue (DeLone and McLean, 1992; Gable, Chan, 2003), and various assessment approaches have surfaced, (Ifinedo, 2006b). In response, DeLone and McLean, 1992 developed an integrated, multidimensional, and inter-related IS success model that has become the most dominant framework for assessing IT systems success at the micro level (Ifinedo, 2006b). Drawing from the work of DeLone and McLean, 1992, Gable and colleagues (Gable, Chan, 2003; Sedera, Gable, 2004) developed an additive ERP systems success measurement model that redefines the dimensions in the original D&M IS success model. It is important to point out that ERP systems are different from other IT systems (Davenport, 1998, 2000) because ERP implementation includes technological, operational, managerial, strategic, and organizational related components (Davenport, 2000). As a consequence, success measurement models used for other typical IT systems' evaluation may not be adequate for ERP systems (Gable, Chan, 2003; Ifinedo, 2006b). Thus, it is illuminating when attention is paid to ERP systems particularly, rather than just lumping them together with other IT systems.

Indeed, DeLone and McLean, 1992 stress that researchers should take into account the specific characteristics of the IT system under investigation when evaluating its success. Given that ERP systems are a different class of IT systems, it is therefore vitally important for a specialized success measurement framework or model to be used when evaluating or measuring the success of such systems. Gable, Chan, 2003 eliminated (through multi-stage data collection and statistical analysis) the Use (UE) and User satisfaction (US) dimensions in the D&M model. Arguments against dropping them are also available in the literature (Ifinedo, 2006a, 2006b). The retained ERP success dimensions in Gable and colleagues' model are System Quality (SQ), Information Quality (IQ), Individual Impact (II), and Organizational Impact (OI). Through literature reviews and case studies, Ifinedo (Ifinedo, 2006a, 2006b) proposed an extended ERP system success measurement model to include Workgroup Impact (WI) not included in the Gable et al. model. The author argues that any ERP success measurement model should include a dimension related to (WI) because ERP systems are often adopted to enhance efficient cross-functional operations (Davenport, Brooks, 2005). Here, "workgroup" refers to the sub-units and/or functional departments of an organization.

Advanced information technology (IT), which has turned the world into a global village through ''speed of light'' transfers of information, data and files, is a major driver of supply chain integration. In addition, various functions and spatially distributed project units of companies require more coordination and integration. Supply chain integration seeks to enhance competitiveness by closely integrating the internal functions within a company and effectively linking them with the external operations of suppliers, customers and other channel members (Gryna 2001).

Supply chain integration categories have been studied by many authors, Stevens (2002) suggested that "the development of internal supply chain integration should precede the external integration with suppliers and customers. External integration defined as the integration of logistics activities across firm boundaries. It is to think of the manufacturing enterprise in terms of the entire supply chain, which increasingly consists of many separate firms banded together in network arrangements.

3. Research Design

The three common design of research used in social sciences research are exploratory, explanatory, and descriptive studies. Exploratory research is often employed to develop a preliminary understanding of some phenomena. Explanatory is carried out to discover and report relationships among different aspects of the phenomena. Descriptive studies are conducted to describe the precise measurements and reporting of the characteristics of the phenomena under investigation (Babbie, 2004). Explanatory research approach can be used when it is necessary to show that one variable causes or determine the value of the other variables. Therefore, the nature of this research is both exploratory and explanatory. This research aims to cover a wide variety of manufacturing firms from different industries in Jordan that use ERP systems to integrate with supply chain members. However, no comprehensive sampling frames of firms that use ERP systems were available. There were no specialized databases to identify the ERP systems user companies in Jordan. This has influenced the sampling method, the size of selected sample, and the gross response rate. Therefore, the sampling method used was judgment sampling. We took a survey of Jordanian manufacturing firms from various industries. The

companies involved in this research meet the following criteria: Use the ERP systems to integrate with supply chain members, have strong and stable relationships with specific supply chain members, familiarity with supply chain integration concept (information sharing, joint problems solving, decision making, and planning, using EDI ….. etc). Based on the selection criteria; nine firms were selected to conduct this research. However, this was the best list available after strenuous efforts for the present research, which relied on multiple manufacturing firms in Jordan use ERP systems. These companies are: Arab Potash Company, Jordan Cement, Jordan, Phosphate Company, Arab Center for Pharmaceuticals and Chemicals Co (ACPC), Petra Aluminum Co, Pharma International, Hammoudeh Dairy Co, Jordan Ceramics, and Al-Razi Pharmaceutical Co. For the purpose of the present research, the target respondents group involved managers and employees in the fields of purchasing, distribution, sales and marketing, transportation, IT, inventory and warehousing, research and development, and financial and accounting.

The instrument used in this research was questionnaire to measure the research's different variables. The final version of the questionnaire consists of (51) statements with close ended questions. Individuals were asked to indicate the extent of importance with the questionnaire items on a five-point Likert-type scale ranging from 1 to 5. Cronbach's alpha was employed as the criterion to evaluate reliability of the constructs by examining their internal consistency. Estimate greater than 0.70 are generally considered to meet the criteria for reliability. Validity concerns with weather the researcher is actually measuring what he claims, this study uses the four different types of validity as follows: Face validity, Content validity, Criterion validity, Construct validity that testifies to how well the results obtained from the use of the measures fit the theories around which the test is designed (Sekaran, 2003). We used the two subcategories of construct validity: Convergent Validity and Discriminant validity. Exploratory Factor analysis was conducted to analyze the scale items of the research constructs, and to check the construct validity of the measurement scale. (Stevens, 2002; Maxwell, 2000).

4. Model Operationalisation And Data Analysis

4.1 Variables Operationalisation using EFA

Factor analysis was conducted to analyze the scale items of the 7 research constructs, and to check the construct validity of the measurement scale. For this research the result of reliability test are shown in table (1) in which the (α) value are grater than 0.6 for all variables. All of these percentages represent a significance amount of data explanation. Eigenvalues Also called characteristic roots was utilized to measure the amount of variation in the total sample accounted for by each factor (Stevens, 2002). Note that the eigenvalue is not the percent of variance explained but rather a measure of amount of variance in relation to total variance (since variables are standardized to have means of 0 and variances of 1, total variance is equal to the number of variables) (Shapiro, et al, 2002). For this research, the values of the 7 variables are grater than 1 which leads to keeping all the presented factor. The KMO Measure (Kaiser-Meyer-Olkin) was used to assess which variables to drop from the model because they are too multicollinear. KMO varies from 0 to 1.0 and KMO overall should be .60 or higher to proceed with factor analysis. (Some researchers use a more lenient .50 cut-off. To assess the suitability of data analysis, Bartlett's Test of Sphericity suggests that the intercorrelation matrix contains sufficient common variance to make factor analysis worthwhile. Referring to table (1), all KMO's values are grater than 0.6 or the 0.5 cut-of, which indicate that the data of the research support the use of factor analysis, and suggest the data my be grouped into a smaller set of underlying factor. And the Bartlett value (sig) is Zero for all that means all values are significant for all variables which specify the relationships between the variables. Total of Variance Explained (TVE %) was utilized considering these criteria: Some researchers simply use the rule of keeping enough factors to account for 90% (sometimes 80%) of the variation. Where the researcher's goal emphasizes parsimony (explaining variance with as few factors as possible), the criterion could be as low as 50%. Hair et al. (1998) suggest that for any factor to be meaningful, at least 5% of the total variance explained should be attributable to that factor. Keep as many factors as are required to explain 60%, 70%, 80-85%, or 95%. There is no general consensus and one should check what is common in the field. It seems reasonable that any decent model should have at least 50% of the variance in the variables explained by the common factors (Stevens, 2002). Summated scales are a collection of related questions that measure underlying constructs. The result of summated scale analysis can be shown in table (1). It shows that there are 7 constructs loaded in one factor. Items loading on all factors for each construct were higher than the 0.05.

Table (1): Major Indicators of the Factor Analysis

Construct	*No. of Items*	*KMO, BTS (Sig)*	*Loading*	*TVE (%)*	*α value*
System quality (SQ)	9	0.87, 1208.35 (0.0)	0.68-0.88	60.94	0.92
Information quality (IQ)	8	0.86, 1299.93 (0.0)	0.77-0.90	67.52	0.93
Individual impact (II)	4	0.77, 349.430 (0.0)	0.75-0.88	68.95	0.85
Workgroup impact (WI)	5	0.84, 667.184 (0.0)	0.78-0.91	73.71	0.91
Organizational impact (OI)	7	0.80, 945.997 (0.0)	0.79-0.87	68.07	0.92
Internal supply chain integration (ISCI)	6	0.82, 907.039 (0.0)	0.82-0.86	71.50	0.92
External supply chain integration (ESCI)	12	0.92, 2577.974 (0.0)	0.76-0.89	70.12	0.96

4.2 The Model

By using the exploratory Factor Analysis (EFA), there are two dimension of the study, the first five variables describe the ERP success dimension, and then the two variables describe the supply chain integration.

4.3 Multiple Regression Analysis

According to (Maxwell, 2000), Multiple regression attempts to find a relationship between a dependant variable and greater than one independent variables. Multiple regression analysis is used in more complex data analysis with more than one factor changing the dependant variable (Tabachnick, & Fidell, 2001). There are some values to report when using multiple regressions which are: Adjusted R square value and F- Value and its significance, Significance, Beta coefficient

4.4 The Path Variables

This model consists of five regression paths as shown below, and the relations are designed as the functions below:

$$Y' = \alpha + \beta\, 1X1 + \beta\, 2X2 + E$$

Where

Y' = A predicted value of Y (which is dependant variable).
α = the value of Y when X is equal to zero. This is also called the "Y Intercept".
β = the change in Y for each 1 increment change in X.
(X1 X2)= an X score on independent variable for which we are trying to predict a value of Y.
E= standard Error.

Regression Path: The Relationship between ERP and Supply Chain Integration (ERP → Supply Chain Integration)

- H1: ERP → ISCI
- H2: ERP → ESCI

4.5 Analysis of Regression Path:

The Regression Path concern with the existence of significant relationship between ERP variables and Supply Chain Integration. Two hypotheses were created to determine these relations.

Hypotheses Testing

1. Internal Supply Chain Integration

Internal Supply Chain Integration was hypothesized to be positively associated with ERP variables, stepwise method was used with settings at 0.05 α levels, based on the significance (Probability) of the F value and the F value itself which equal 74.77 ($p<0.001$), adjusted R Squared (represent the changes in R2) was investigated, it equal (0.278) that means the model is fit for each variable. Using the stepwise method, one variable of ERP was entered, because one variable of ERP have significant effect, namely (IQ). Beta was found to equal (0.530) which implies the existence of a positive significant relationship between ERP and (ISCI), and the t-value of the hypothesized model was significant with a value of (8.647). Other four variables namely (SQ, II , WI, and OI) was excluded because standardized estimation coefficient of Beta were close to Zero that mean it has little, if any, substantive effect. That means these relationship are not significant, and it was founded that the t-value of regression paths between the variables have no significant and less than (1.96 and 2.54) on the significance level (0.05 or 0.01). Collinearity statistics has been determined. The tolerance is equal (1) for the independent variables because one variable has a significant relationship. This means those independent variables are linearly related to one another (multicollinear). The (VIF) was also used and less than ten, that mean there are not multicollinearity in the independent variables. Durban-Watson test Values (1.313) less than 2 indicate that positive autocorrelation between variables.

2. External Supply Chain Integration

External Supply Chain Integration was hypothesized to be positively associated with ERP variables, stepwise method was used with settings at 0.05 α levels, based on the significance (Probability) of the F value and the F value itself which equal 42.09 ($p<0.001$), adjusted R Squared (represent the changes in R2) was investigated, it equal

(0.176) that means the model is fit for each variable. Using the stepwise method, one variable of ERP was entered, because one variable of ERP have significant effect, namely (SQ). Beta was found to equal (0.425) which implies the existence of a positive significant relationship between ERP and (ESCI), and the t-value of the hypothesized model was significant with a value of (6.425). Other four variables namely (1Q, II , WI, and OI) was excluded because standardized estimation coefficient of Beta were close to Zero that mean it has little, if any, substantive effect. That means these relationship are not significant, and it was founded that the t-value of regression paths between the variables have no significant and less than (1.96 and 2.54) on the significance level (0.05 or 0.01). Collinearity statistics has been determined. The tolerance is equal (1) for the independent variables because one variable has a significant relationship. This means those independent variables are linearly related to one another (multicollinear). The (VIF) was also and less than ten, that mean there are not multicollinearity in the independent variables. Durban-Watson test Values (1.362) less than 2 indicate that positive autocorrelation between variables. A table (5.29) shows the result of testing the regression analysis for the relationships between ERP and SCI.

5. Discussion and summary

All variables were metric satisfying the conditions for multiple regression analysis. The significant results of the regression analysis are discussed. Internal Supply Chain Integration was hypothesized to be positively associated with ERP systems. One variables of ERP have significant effect, namely Information Quality (IQ). Beta was found to equal (0.530) which implies the existence of a positive significant relationship between ERP and (ISCI), and the t-value of the hypothesized model was significant with a value of (8.647), which implies a strong relationship between ERP systems and Internal Supply Chain Integration represented by Information Quality. External Supply Chain Integration was also hypothesized to be positively associated with ERP systems. One variables of ERP have significant effect, namely Information Quality (SQ). Beta was found to equal (0.425) which implies the existence of a positive significant relationship between ERP and (ESCI), and the t-value of the hypothesized model was significant with a value of (6.488), which implies a strong relationship between ERP systems and External Supply Chain Integration represented by System Quality.

6. Contributions of Research

The purpose of this research is to identify these above relationships, and address them effectively to ensure that the promised benefits can be realized and failures can be avoided. The research contributes to our knowledge of ERP systems and supply chain research. As a result, new constructs, and new multi-item measurement scales for measuring these constructs associated with the ERP systems dimensions and supply chain integration. The framework of the study provides a foundation for future research. In the future, new constructs may be added to provide in-depth understanding of ERP-SC theory.

7. Recommendations

The full benefits of ERP will not be visible or fully experienced by each supply chain member but overtime when the system has become stable and chain members had time to adjust to the new working practices the benefits will become more visible. Furthermore, ERP-SCM involves many intangible values that cannot be fairly measured in financial terms alone and thus the need arises for methods that consider not only the financial aspects of an investment but also the intangible benefits.

8. Recommendations for Future Research

Future research needs to continue the development of sound theoretical models and instruments. Future research needs to focus on the links between ERP success factors used in the research. Because our model has not examined the relationships among ERP systems success dimensions and didn't consider the interdependency links between these dimensions like (The links between System Quality and Organizational Impact or Individual Impact, and the links between Information Quality and Organizational Impact or Individual Impact…., etc). On the other hand, we need to consider another success dimensions like (User Satisfaction, System Use, and Net benefits).

Table (2): Regression Analysis (The Relationships): Analysis of the Hypothesized Regression Path (ERP → Supply Chain Integration)

Regression Path	*Variables Entered*	*Model Fit*		*Test Statistics*			*Collinearity Statistics*		*Durban-watson Test*
		Adjusted R squared	*F value (P)*	*Standardized Beta*	*t-value*	*Sig.*	*Tolerance*	*VIF*	
ERP→ISCI	**IQ**	0.278	74.77 (0.000)	0.530	8.647	0.000	1.000	1.000	1.313
ERP→ESCI	**SQ**	0.176	42.09 (0.000)	0.425	6.488	0.000	1.000	1.000	1.362

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