A nine-layer model of integration to develop enterprise resource planning system

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Abstract: Nowadays it is clear that Enterprise Resource Planning (ERP) system by integrating organizational processes helps them to fast improvement and overcome planning challenges. Moreover, organizations used this system to gain competitive advantages and decrease costs. In addition, most of previous researches focused on benefits of this system in the commercial organizations and less on developing ERP in the organizations. This research aims to propose a model for implementing ERP systems in organizations by solving challenges of other approaches. Proposed model includes 9 layers that combined current ERP development models with organization's operational processes. The model includes an infrastructure that integrates all layers for managing ERP's sub-system and managing organizational resources with ERP to insure the result of research (model). Finding of the research has been checked by information system experts and presented in this article.

Key words: ERP; Nine-Layer model; Integration; Implantation; Enterprise resources

1. Introduction

In the current competitive world, Large and commercial enterprises apply various strategies to be competitive and achieve sustainable improvement. These strategies have two perspectives: the first focuses on organizational exterior, to gain a comprehensive understanding of market place in order to set a competitive basket of products for customers and the second more focuses on organization's interior such as processes planning, structure of organization, and application of technological and managerial methods in the organization(Daft, 2012; Jiang, Lepak, Hu, & Baer, 2012; Kerzner, 2013; Rummler & Brache, 2012).

IT-based solutions with effective management during implementation and applying these solutions can cover both two perspectives of strategies.

Organizations according to their vision and mission start to design organizational structure and process which, rarely be redesign because of lack of knowledge in technology adoption and process optimization in the organizations(Ahmad, Francis, & Zairi, 2007; Chiarini, 2012; Muthu, Whitman, & Cheraghi, 2006). Therefore, Business Process Reengineering (BPR) should be more focused to improve compatibility of process and structure of organization with new technologies (Ahmad et al., 2007; Chiarini, 2012; Muthu et al., 2006).

ERP system is one of IT-Based solutions that can improve organizational ability in applying strategies based on both perspectives. Therefore, application of this system can improve organization ability in gaining competitive advantages and achieving sustainable improvement (Glenn, 2012; Nettsträter,

Geiben, Witthaut, Ebel, & Schoneboom, 2015; Shiau, 2015). The challenge is "how to develop ERP for enterprises" (Glenn, 2012; Nettstrater et al., 2015; Shiau, 2015). This research aims to develops a model for implementing ERP in organizations.

In order to figure out a model for ERP development in universities, this article in the second section the paper explains benefits of ERP for organizations. Third section describes current methods of ERP development. Fourth section figures out research methodology that applied in this research and fifth section propose the model that is suitable for ERP development, according to research findings then next section explains evaluation process of the model. The final section concludes the paper with proposing some approaches for future researches.

2. Enterprise resources planning

Organizations in order to perform activities and achieve organizational vision and goals need resources. Resources of organizations are limited. Therefore, managing them is a necessary (Daft, 2012; Jiang et al., 2012; Kerzner, 2013; Rummler & Brache, 2012). Planning is an important part of management. Thus, for managing resources organization should plan carefully on its resources. Nowadays, using information technology in the organization is a powerful opportunity to increase ability of managing and planning organizational resources. IT-based solutions such as Information Systems (IS) are main tools for perform this planning and managing (Daft, 2012; Jiang et al., 2012; Kerzner, 2013; Rummler & Brache, 2012).

2.1. Information Systems

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Information Systems are "computer-based" systems, which are used to improve manager's abilities in managing organizations. Data is the input of IS which, is manipulated and converted through processes to "information". In other words, Information systems are integrated set of components for gathering, storing, and processing data and for delivering information, knowledge, and digital products (Laudon & Laudon, 2011; Laudon, Laudon, & Brabston, 2012; Pawlak, 1981; Sangar & Iahad, 2013).

Organizations rely on IS for carrying out and managing organizational operations, creating effective relations with customers and suppliers, in order to gain competitive advantages in the marketplace (Laudon & Laudon, 2011; Laudon et al., 2012; Pawlak, 1981; Sangar & Iahad, 2013).

2.2. ERP system

The first usage of ERP's is 1960s. ERP integrates suppliers and customers with the manufacturing part of organization. In the literatures, there are several definitions for ERP systems. Watson (1999) defined ERP as packed software based system that deal with requirements of organization such as financial, human resources, manufacturing, sales, and marketing(Glenn, 2012; Nettsträter et al., 2015; Shiau, 2015).

ERP is defined as the ability to deliver an integrated suite of business common process and data model, covering broad and deep operational end-to-end processes, such as those found in finance, HR, distribution, manufacturing, service and the supply chain. In fact, ERP is a set of software applications that organize, define and standardize the business processes necessary to effectively plan and control an organization(Glenn, 2012; Nettsträter et al., 2015; Shiau, 2015).

2.3. ERP for organizations

Organizations move toward ERP systems to empower organizational abilities. Literatures proposed six general goals that make organizations to develop ERP (Laudon & Laudon, 2011; Laudon et al., 2012; Pawlak, 1981; Sangar & Iahad, 2013; Shiau, 2015). These reasons (Laudon & Laudon, 2011; Laudon et al., 2012; Pawlak, 1981; Sangar & Iahad, 2013; Shiau, 2015) are listed as follow:
I.   To synchronize and speed up organizational processes
II.   To integrate operational data
III.   To integrate financial data
IV.   To integrate customer's orders data
V.   To integrate human resources data
VI.   To figure out new opportunities for organization

3. Current enterprise modeling approaches for ERP development

Currently there are two base methods for enterprises modeling. The first approach is structure-based and second is process-based approaches. Other approached that applied in the organizations are developed based on one of these approaches. The first one is called Zeckman approach and other is called SAP approach, which is proposed by SAP Company.

3.1. Zechman's bi-dimensional approach

Zeckman for the first time proposed enterprise modeling in 1987(Lord, Zechman, & Arumugam, 2013; Pant & Ravichandran, 2001; Urbaczewski & Mrdalj, 2006). Zechman proposed enterprise modeling with two dimension form horizontal and vertical perspectives. Horizontal perspective has rooted in enterprise components and vertical perspective has rooted in enterprise requirements from different aspects (Lord et al., 2013; Pant & Ravichandran, 2001; Urbaczewski & Mrdalj, 2006).

This approach doesn't explain enterprise layers and their integration therefore; system analyzer needs deep experiences to suggest suitable architecture for modeling organization. Thus, this modeling approach is not effective for all organizations according its lack of understanding of organizational processes (Glenn, 2012; Lord et al., 2013; Pant & Ravichandran, 2001; Urbaczewski & Mrdalj, 2006).

3.2. SAP approach

SAP, one of leader company in information system marketplace, presented a product that called R/3 based on client / server architecture. R/3 is a set of operational processes that organizations use (Curran & Ladd, 2000; Dittrich, Mertens, Hau, & Hufgard, 2013; Gadatsch, 2013; Seethamraju, 2007; Valentim, Politano, Pereira, & Araújo Filho, 2014). The approach that is used in R/3 is called SAP approach. This approach explains all operations in enterprises based on four main instances, which are listed as follow: Data glossary, Commercial components, Data warehouse, and Operational possesses(Curran & Ladd, 2000; Dittrich et al., 2013; Gadatsch, 2013; Seethamraju, 2007; Valentim et al., 2014).

For developing ERP system, SAP approach focuses on two aspects: First aspect focuses on commercial components to create commercial action inside an isolated environment. Second aspect focuses on organization commercial activity to integrated commercial components by organization commercial activity (Curran & Ladd, 2000; Dittrich et al., 2013; Gadatsch, 2013; Seethamraju, 2007; Valentim et al., 2014).

Unfortunately, this approach doesn't figure out the place of each process in enterprise structure therefore after implementing ERP the system analyzer needs to replace processes in the organizational structure (Curran & Ladd, 2000;

Dittrich et al., 2013; Gadatsch, 2013; Glenn, 2012; Seethamraju, 2007; Valentim et al., 2014).

4. Research methodology

In first step, the research found out researches that worked on ERP implementation. Then researchers extracted development approaches that used in previous researches and examined them. After finding out challenges and weakness of previous models, the research proposed a nine-layer model for developing ERP system in organizations. Finally, the conclusion and suggestions for future research are proposed.

5. Proposed model

This research aims to overcome challenges that were addressed during explanation of both previous approaches in order to create a model, which uses structure-based and process-based approaches together. In other words, this research tries to propose a model that contains structure and process view. Thus, the research used prior approaches strongest points and proposed a model with nine layers.

Nine-layer model that proposed in this study makes structural relation between organizational processes. Each layer integrates special part of organization regarding to organization's general integration. Therefore, after ninth layer, all the organization will be integrated with ERP modules and components. Figure 1 shows all of nine layers of the proposed model. In this model, two layers of "Technology Integration" and "Application Integration" are same as umbrella that covers other layers.
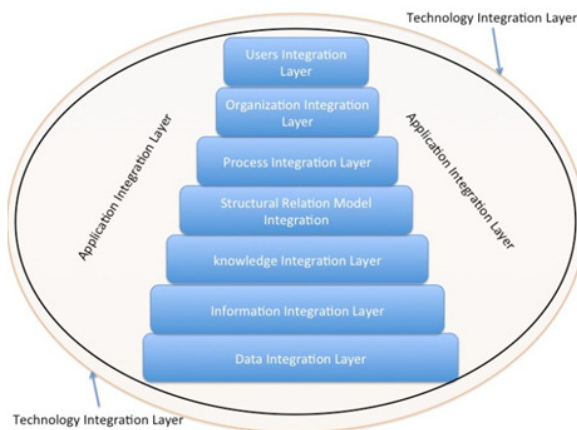

Fig. 1: Proposed Nine-Layer Model

According to the proposed model in the first, second and third layers, organizations should use special information systems. In first layer, which is called "Data Integration Layer", information system that is used is Transaction Process System (TPS) for integrating organizational data. Second layer of integration is "Information Integration Layer" this type of integration could be achieved by organization

automation system (OAS) and management information system (MIS). Layer 3 needs decision support system (DSS) and executive information system (EIS) in order to integrate knowledge.

In order to come out with "Structural Relation Model Integration" organization should use business process reengineering (BPR) in layer 4. In addition, BPR is main activity in order to provide integration in fifth and sixth layers. In the seventh layer learning requirement planning system (LRP) is used for integrate users.

ERP modules and components provide application integration layer. The most important layer, which should be more focused, is technology integration; this layer is a big umbrella and it refers to use of same and compatible technologies in all of the layers. Figure 2 presents all layers and activities in order to provide integration in each layer.
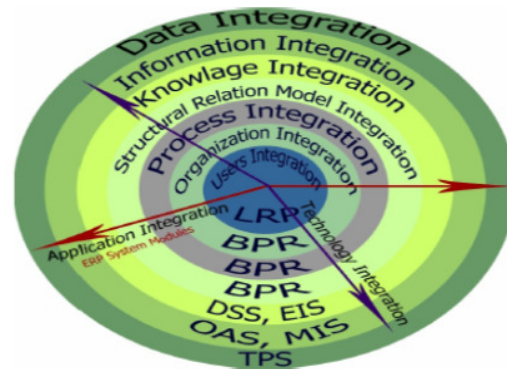

Fig. 2: Proposed model and activities in each layer

5.1. Data integration layer

This layer is fundamental layer for integration in the proposed model, using shared databases and preventing from data redundancy are important for data integration.

Data is everywhere among organizational transactions. Data gathering based on traditional methods is a highly cost activity and needs plenty of time. Therefore, organizations use TPS for this purpose. TPS is a system that performs data gathering and imports them into databases. Thus, proper TPS selection helps organization in data integration, information production and ERP development.

5.2. Information integration

During using ERP in the organization, after data gathering, organizational data become information across different processes. Mismatch between information causes problems in knowledge production. Therefore, it is important to integrate and synchronize information. To reduce mismatches and increase information complementariness and integration, organizations should use proper OAS, KWS and MIS in this layer. This is to help

organization in information integration, knowledge production and ERP development.

5.3. Knowledge integration

This layer is same as information integration layer; however, the difference between these two layers is where the input of this layer is information, not data. To reduce mismatches and increase knowledge complementariness and integration, organizations should use proper DSS and EIS. This is to help organization in knowledge integration and ERP development.

5.4. Process integration

Integrating organizational processes and integrating them with ERP's components are important activities that model tries to overcome in this layer. BPR is important activity that organization performs in order to gain process integration.

5.5. Structural relation model integration and organization integration

In these layers, model tries to draw relations between organizational components within the company and their relations with components from out of the company. For optimizing relations in order to integrate organizational structure, BPR will be applied. In fact, these layers are a base to integrate organizational components and ERP components.

5.6. Users integration layer

This layer aims to integrate personals within the organization with ERP system. The layer more focuses on organizational culture and uses LRP for integrate users and organization processes with ERP components.

5.7. Technology integration Layer

Eighth layer of model shows importance of integrated and matched technologies in ERP development. This integration and synchronization includes: operation system (OS), programming framework, programming platform, software analyzing, hardware, software, system engineering methods, diagrams etc. ERP developer team should carefully use and integrate technologies because it's important for future updates and optimizations.

5.8. Application integration layer

Applications are ERP system's components and modules that are used by users. These components and modules should be integrated and use integrated databases, information and knowledge in the organization.

These components and modules are extracted and designed according to organizational processes.

Users should be trained to use ERP components and modules.

6. Evaluation of model

To evaluate the proposed model, this research used expert check method. 10 experts were asked during expert check process. People who were participated in this check had been experienced in IT, Computer Engineering, IT project implementation, implementing ERP system, and system and industrial engineering.

Firstly they were asked about layers and researchers of this research got experts opinions about 9 layers. To answer this question, experts should fill to things first a table with degrees of Strongly Disagree, DissAgree, N/A, Agree, and Strongly Agree Second, a comment box for writing open opinions. Results showed 6 of experts were strongly agreed and other 4 were agreed with layers. However, some of them were not agreed with the sequences of layers.

Therefore, second question was set to ask them their opinion about layers sequence. To answer this question, experts should fill to things first a table with degrees of Strongly Disagree, DissAgree, N/A, Agree, and Strongly Agree about each sequence, Secondly, a comment box for writing open opinions. Results of answers showed 6 experts were strongly agreed, 2 were agreed and one was N/A and the last one was disagreed. Throught reading experts opinions about sequences in the comment box, researchers of this research found out the N/A and disagreed expert were not clear about the sequences. Therefore, researchers explained more about these layers and finally both agreed with sequences however, with 2 suggestions. First suggestion was about materials of each layer, experts suggested that for applying proposed model, each organization should define layers materials and components at first then start to utilize it. Second suggestion, suggests researcher to test this model in a real organization as a case study, in order to get real results.

7. Conclusion and future works

Aim of this research is to propose a model for developing ERP in the organizations based on solving previous approaches problems. Therefore, the research proposes a Nine-Layers model which each layer of the model integrates some parts of organization. This model starts with integrating data, and finally, integrates users with ERP system. In this model application integration layer includes ERP components and modules and covers data integration to user integration layers. In addition, general integration layer focuses on technology and covers all other eight layers.

Proposed model was tested with experts check method. In the testing process 10 experts were participated and the research took their opinions

and suggestions in order to improve quality of model.

For the future studies the research suggests other researchers to extract ERP components and modules, in addition the way of integration of components and instances of each layer in different organizations. This model could be applied for implementing ERP system in organizations as case study for future studies.

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