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EVALUATION OF CONCEPTUAL AND SOFTWARE MODEL IN IMPLEMENTING ENTERPRISE RESOURCE PLANNING (ERP) WITH PROCEDURAL APPROACH OF BPMN2 AND MICRO SERVICE ARCHITECTURE

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Abstract: Nowadays, correct resource management of every organization depends on the integrity and relationship between suppliers, customers, stakeholders, staffs and other parties so that it is one of the main significant criteria for success of the organization. Increase in agility and flexibility within access to information is one of profits obtained from correct implementation of human resource management system managing business processes. For this purpose, this study aimed at using previous experiences to evaluate and design a new model of enterprise resource planning (ERP) using processes modeling and micro service architecture (MSA) to obtain the most effectiveness of mentioned system. This study was conducted to provide the suitable mechanism for management decision-making simplifying business processes and managing the modern knowledge relying on modern technology and applying software knowledge through automating tasks of each process in order to make relationship between intra-organizational, extra-organizational units and other informational resources based on service-oriented architecture or micro service architecture (SOA and MSA). This research can be used by organizations and manufacturing companies tending to implement ERP.

Keywords: Enterprise Resource Planning (ERP), (Business Process Model and Notation) BPMN2 Standard, Micro Service Architecture (MSA), Process Modeling

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1. INTRODUCTION

Competitive pressures and costs in current world make organizations to create a proper framework to move through competitive market; undoubtedly, agility and compatibility with market changes are factors for organization's success. In the field of development, paperwork and primitive decisions are replaced with integrated and comprehensive solutions to modeling, simulation, monitoring, design, and improvement operations and prerequisite for this solution is use of service concept and applications of integrated human resource planning and serving concept. In other words, nature of business process management and service-oriented architecture can complete each other. ERP is the significant factor in organizations and consists of all planning and supplying processes including initial supply, suppliers' program, service delivery to customer and exclusion from organization; such planning is called ERP (Sheri, S. 2006). There are some weaknesses in ERP. Although ERP is doing its task well in managing internal information of organization, ERP is not capable of doing any effective action within external interaction and group decision making. Hence, ERP cannot achieve an immediate dynamic comprehensive management that is an underlying response to practical changes and reasonable decision-making despite its achievements in resource planning and management process. Moreover, many companies still use ERP at a common level such as general information systems that collect, transfer, and calculate data. Moreover, decision support module in ERP maintains the data collection phase instead of holistic analysis. Finally, limited flexibility of ERP in repetitive analysis in various companies and illogical conclusions of it can be mentioned as its weaknesses.

Considering the service-orientation development and presence of network organizations, ERP implementation is an essential action within an extensive context; however, the suitable efficiency is not achieved due to lack of proper infrastructures and use of a macro framework to improve ERP performance. Efficiency of ERP systems can be considerably increased predicting time and quantities, making holistic integration, reducing errors, and improving performance. The certain point here is that achieving the Best Practice in knowledge management of each process and standardization are the most prominent points of ERP implementation (Abbaszadeh Minagh, Sh., Khtaei, M. R. 2013). Since MSAs have been invented to reduce costs, create usability, increase efficiency, and prevent from repetitive tasks instead of human resources and automation of them, ERP plays a vital role in such holistic plan (Tafaghodi Jami, S. 2016).

Organization planning system is an adjustable software package based on global standards to create integrated information between all organizations units such as financial, accounting, human resource, supply chain, and customer management units with customer-oriented approach to respond to market. All applied programs of organization perform as an integrated software program on dataset in ERP so that all units can share their information and make relationship with each other. Such integration leads to a return of capital at a wide range in organization.

2. THEORETICAL LITERATURE

Nowadays, all of large manufacturing, service, and governmental organization need an ERP system or are negotiating to select an ERP system compatible with their requirements. ERP systems are changeable, adjustable information systems that make information-based processes and information integrated inside, and between organizational units (Ehsan, S. 2011); in addition, it can be stated that ERP is a method to plan and control all required resources to receive, produce, deliver, and meet customers' needs in manufacturing, distributive, and service companies (Naeimi, Sh. 2013).

In ERP, all systems can be divided to three levels including:

Level 1: operational systems

Level 2: tactical systems

Level 3: strategic systems

Operational level consists of a set of real data. Tactical level is applied by middle management for data analysis. Strategic level provides senior management with collective data to support decisions. The relation between business process management and MSA is clear since activities at the lowest level are services. A system or function with top-down approach breaks down to the smaller parts to reach basic services level. In bottom-up approach, services are combined creating processes or systems. There is not any priority in top-down or bottom-up approaches. However, business is first understood in top-down approach the details are addressed while details are more examined in bottom-up approach with probability of stripping process. It is suggested to use a combination of two approaches (Rezaei Khatir, M. 2015). Business process modeling (BPMN) is a method that formulates steps of a business process, individuals, organizations or responsibilities of a system for those steps and data related to each step. BPMN is an interesting point in MSA. A language makes it possible to reuse business services; this language is called BPEL4WS or BPEL and is a BPM

characterization with a strong infrastructure (IBM, Microsoft, Oracle, BEA) (Golian, H. 2009). In current world, an integrated resource management system is required to make technology and business compatible in organizations, but the important point is lack of compatibility of suggested systems to organizations and real performance and nature of them. There is always a wide gap between expected efficiency of resource management system and what is seen in organization. Hence, strategies and objectives, processes, approach, and culture of organization should be in line with organization's coordinating system (Hanafizadeh, P., Ahad Zare, R. 2006). High production time is one of problems in manufacturing organizations and companies and factors affecting this problem consist of human factors, errors in production planning, weakness of IT infrastructure, weak performance of institutes and problems in supplying pieces and requirements. Weakness of human force is a problem that is seen in various parts. Considering the current problems in organization, we searched for factors affecting it and implemented them through Minitab Software and a part of these analyses in pieces and equipment production industry in similar organizations have been expressed herein. The main weakness of organization consists of problems in production planning that may harm a part of organization. Supply of pieces and requirements can considerably effect on performance of other parts that is divided to two sub-branches of "non-adjustment with production" and "improper estimation of requirements". In fact, the correct planning align with production can play a vital role in saving time and money. A phase of analyzing current situation was theoretical expression of problems and nominal analysis of them. In addition to this method, Pareto method is also effective within analysis. According to the principle about economics expressing by Vilfredo Pareto, 80% of organization's problems are related to 20% of factors and processes, this method was used to find defected processes in order to correct them and improve total performance of organization.

In this project, some problems considering in Pareto Diagram were implemented through Minitab Software. Some options are shown in the following consisting of process delay, extra impose cots and functioning time, surplus rate of work and rework, and quality of production sector. Effective processes are illustrated in these diagrams and finally their effects as well as collective diagram of their effects have been illustrated. These diagrams are shown in figure 1.

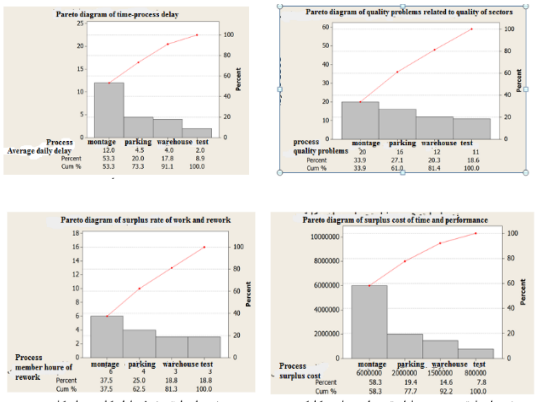

Figure 1. Pareto diagrams

Figure 1 indicates Pareto diagrams in which, montage processes such as inefficient processes that should be changed have been illustrated. The process that should be changed is warehouse that has a considerable effect on cost, time, and quality of processes. The most effective and correct quantitative analysis of organization is use of sigma 6. In the following, some parameters of process capability, mean, standard deviation, and dispersion from normal rate are explained.

The first index is stop rate that is related to time to stop production line or intermediate stage. First, the trend of mean and deviation was examined considering xbar chart and R chart. Mean was calculated using following formula:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \tag{1}$$

Then distribution of mean deviation was calculated as follows:

$$MD_{\bar{x}} = \frac{1}{n}\sum_{i=1}^{k} f_i |m_i - \bar{x}| \tag{2}$$

Non-optimal situation can be seen in this figure, because descending trend is indicated instead of constant trend in mean.

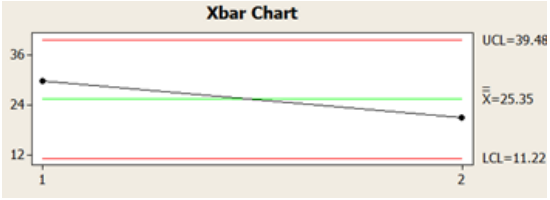

Figure 2. Xbar chart of stop rate

To calculate standard deviation, following equation was used:

$$s=\sqrt{s^2}, s^2 = \frac{\sum_{i=1}^{N}(X_i-\mu)^2}{N} \quad (3)$$

Since distribution of standard deviation is considered in this figure, following formula is used:

$$s=\sqrt{s^2}, s^2 = \frac{1}{n-1}\sum_{i=1}^{k}(m_i - \bar{x})^2 \quad (4)$$

Moreover, figure of deviation depicts ascending trend that indicates non-optimal situation.

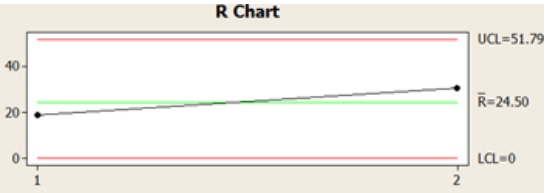

Figure 3. R-chart of stop rate

Hybrid figure of these two dispersions can be seen above and lower than normal line.

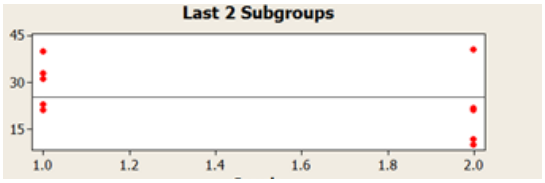

Figure 4. Hybrid chart of R-chart and xbar-chart of stop rate

In addition, it is seen in figure related to distribution and dispersion that data are scattered separately at area 4, but are at range of normal distribution.

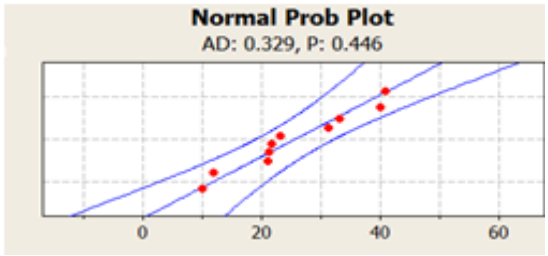

Figure 5. Dispersion distribution

Hence, figure 6sigma is plumper than normal distribution chart. This specification is calculated by following formula:

Fourth central torque

$$m_4=(k = \frac{m_4}{s^4} - 3) \quad (5)$$

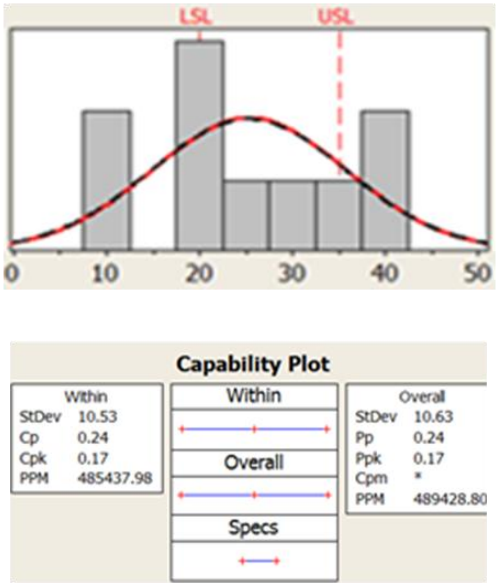

Figure 6. Capability Plot

According to figure 6sigma, process efficiency index[1] obtained to 0.24 that indicates non-optimal situation of process- as we know, this index should be equal to 1 or above in case of suitable situation; on the other hand, process capability index obtained to 0.17 indicating problematic process. In this sample, p_p and c_p are equal since there are just 10 fixed data. Extra charts and diagrams are not explained because of summarization. According to recognition of ERP scope and procedural approach as well as MSA, the recommended technical and architectural suggestion is based on following options:

- Distinguishing structure of work
- Work process in each part of distinguishing structure of work
- Provided documents and products at each part of work structure

To produce software with high quality that is compatible with needs of users in organizations and companies, RUP methodology was selected. RUP that is the product of IMB Company is indeed a methodology to control and implement software projects. This methodology is a framework to conduct software projects successfully in which, all steps of project are started from organization analysis and architecture and ends with software testing and Gold Release providing.

This method of software production and development divide project times to some repetitions in which, 9 defined disciplines are

[1] Cpk

passed through RUP and activities related to repetition and repetition outputs are determined in each discipline within project schedule.

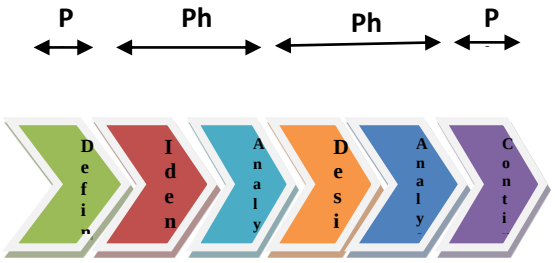

Figure 8. Modeling and process improvement phases

Phase 1: identifying current situation (As-is-Process)
This step consists of identifying current situation of commercial process within following frames and this recognition is obtained using various data collection methods such as interview, study of existing documents, revisit of current activities of organization, etc.
Phase 2: design of improved model
Design of new processes using some technics including brain storming, creativity, comparative modeling, and Best Practice regarding flow of value added of organization based on Scor, Porter, and APQC models and Deming's Ring Attitude (PDCA).
Phase 3: supervision over continuous improvement of processes
Fixed processes cannot be beneficial forever considering the current changes in business environment even if these processes have been designed so professionally.
Some mechanisms are designed at this step regarding continuous improvement of processes and presented to organization. These mechanisms would reduce future process re-engineering.

3. FINDINGS

There are various methods recommended to evaluate performance of ERP system, but financial indexes have been mentioned as important factors traditionally since these indexes reflect the results of previous performance. At first step of research with explanatory aspect, a limited part of population and some experts and professors were interviewed to find their viewpoints about the research subject. Hence, qualitative method was applied at this step. In fact, this part of study was conducted to percept nature of issue that there have been few studies about phenomena related to it. At next step, the model and hypothesis were provided based on findings; therefore, this was an inductive research in terms of methodology. Then, some questions were designed to accept or reject questions. At this step of study- that is a survey study in terms of objective, nature of individual properties and perceptions of people were examined analyzing their responses to questions; hence, quantitative method was applied at this step. Ultimately, results of evaluation and research findings were interpreted. As it was mentioned, it is hybrid research combining qualitative and quantitative methods.

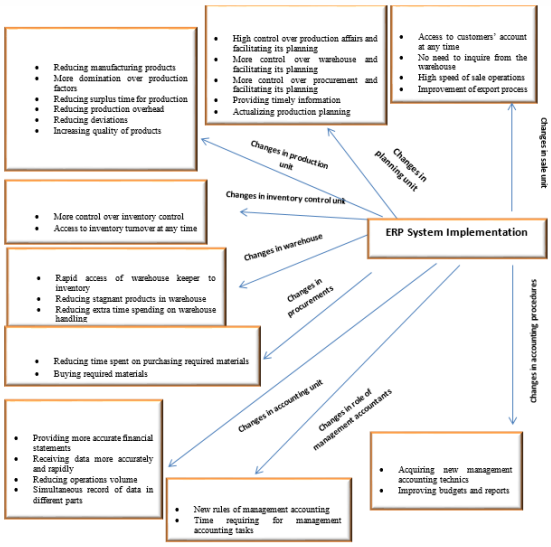

Figure 9. Research Model

Regarding research objective that was evaluation of agreement of respondents to questions, hypotheses, and questionnaire were tested at 5-point Likert scale in order to ease interpreting results of Likert scale compared to other scales. T-test was used through SPSS Software to analyze questions. Statistical population consisted of all persons affiliated to companies in which, ERP had been implemented. These companies were as follows: Iran Khodro, Saipa, Behpakhsh, Tractor Construction, Steel Melting, SGS, DNV, Communication Development Research (TETA), Reno Pars, and industrial company of Iran Henkel. In addition, statistical sample consisted of experts in scope of ERP who had practical work experience. It was supposed to examine effect of ERP system on sale unit. The effect rate was evaluated considering the various cases mentioned in questions. Summary of results are presented in following figure:

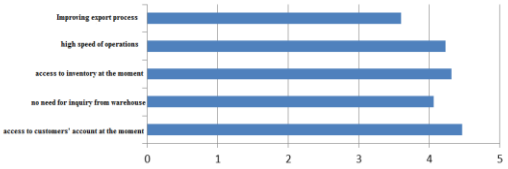

Figure 10. Effect of ERP systems on sale unit

Mean results indicate that companies that have adopted ERP system can access to customers' account at the moment (mean=4.46), do not need to inquire from warehouse (mean=4.06), can access to inventory at the moment (mean=4.31), have high-speed sale operations (mean=4.23), and have improved export process (mean=3.6); hence, this hypothesis is accepted since total mean obtained to 4.12.
The next hypothesis was related to effect of ERP system and planning unit and following results obtained:

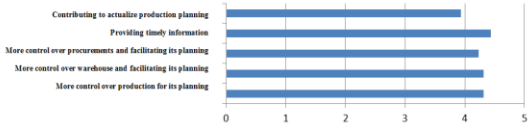

Figure 11. Effect of ERP systems on planning unit

Mean results indicate that companies that have adopted ERP system have more control over production affairs by planning unit so that it is simple for them to plan production (mean=4.31), planning unit has more control over warehouse (mean=4.31), procurements are more controlled by planning unit and it is simple to plan procurements (mean=4.23), provide timely information for planning (mean=4.43), and can actualize production planning (mean=3.93); hence, this hypothesis is accepted since total mean obtained to 4.23.
The next hypothesis was related to effect of ERP system on production unit and following results obtained:

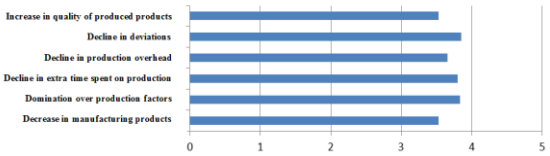

Figure 12. Effect of ERP systems on production unit

According to the obtained data from ERP system implementation in production unit, number of manufacturing products is reduced (mean=3.53), there is more domination over production factors (mean=3.83), the time spent on production is reduced (mean=3.8), production overhead is declined (mean=3.66), deviations are reduced (mean=3.86), and quality of products is increased (mean=3.53). This hypothesis is accepted since total mean obtained to 3.7.
The next hypothesis was related to effect of ERP system on inventory control unit:

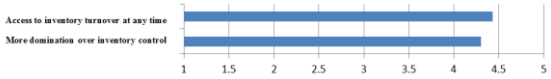

Figure 13. Effect of ERP systems on inventory control unit

Results showed that ERP system implementation in inventory control unit creates more domination over inventory control (mean=4.3) and makes it possible to access to inventory turnover (mean=4.43); in this regard, the mentioned hypothesis is accepted (mean=4.36).

The next hypothesis examined effect of ERP system on warehouse unit:

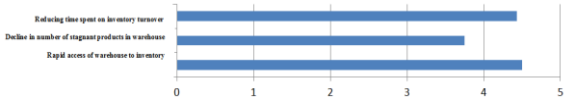

Figure 14. Effect of ERP systems on warehouse unit

According to the data obtained from ERP system implementation in warehouse unit, it is more rapid to access to stock inventory (mean=4.5), the number of stagnant products will be reduced (mean=3.75), and the time spent on warehouse handling will be reduced (mean=4.43). The total mean obtained to 4.24; hence, this hypothesis is accepted.
The next hypothesis examined effect of ERP system on procurement unit:

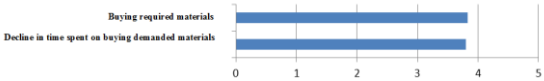

Figure 15. Effect of ERP systems on procurement unit

According to the results obtained from ERP system implementation in procurement unit, the time requiring for buying demanded materials is reduced (mean=3.8) and the required materials are purchased (mean=3.83). This hypothesis is accepted since total mean obtained to 3.81.

Finally, the last hypothesis examined effect of ERP system on accounting unit:

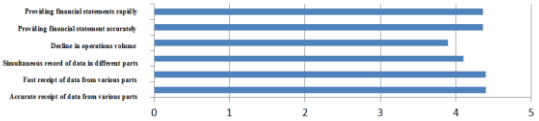

Figure 16. Effect of ERP systems on accounting unit

According to the information obtained from ERP system implementation in accounting unit, data can be received from all parts of company more accurately (mean=4.4), data can be received from

all parts of company more rapidly (mean=4.4), data can be recorded in various parts simultaneously (mean=4.1), volume of operations will be reduced (mean=3.9), financial statements will be provided more accurately (4.36) and financial statements will be provided more rapidly (mean=4.6). This hypothesis was also accepted since total mean obtained to 4.25.

4. DISCUSSION AND CONCLUSION

T-test was conducted to determine significant difference between mean values and results showed significant difference. According to the mentioned points, hypothesis 1 was accepted and ERP system could provide timely information for planning unit. Therefore, this unit could simply perform control and planning tasks. In this regard, information flow between production, warehouse, and procurement units simplified. This system had the positive effect on production unit. Providing timely information, domination of supervisors on production factors increased, decisions were made based on planning and deviations were reduced. In addition, ERP system could create possible access to inventory turnover at any time in inventory control unit making more domination over it. In warehouse unit, the extra time spent on warehouse handling was reduced because of timely and accurate information.

ERP system made it possible for procurement unit to buy required materials since staffs could be aware of such materials. Ultimately, ERP system could positively effect on accounting unit providing more accurate and fast financial statements. Since accounting records are done systematically in different parts of organization, accounting operations can be reduced within ERP system; hence, members can use their time to analyze data and solve problems.

The most prominent properties and advantages of such architectural method are as follows:

- Non-integrated information and island systems are problems of current systems in organizations, while these problems can be solved creating service-oriented architecture and integrated systems in this context.
- It is essential to create some changes in processes and reengineer them due to lack of process orientation, stripping processes and structure orientation in organizations.
- Communicational weaknesses and their consequences make organizations to create holistic communicational contexts implementing MSA and creating communicational networks.
- Lack of technological infrastructure is the problem in current organizations and their failure in achieving goals and this may effect on efficiency and yield of organizations directly or indirectly. The suggested framework in this research can provide a proper infrastructure.
- Lack of decision support system- that can contribute to important decisions in various managerial layers as cooperator system- can be mentioned as the weakness of current dynamic organizations, because minor changes in modern organizations are considered as a part of business. Hence, it is vital to have an analyst and decision supporter to solve such problems.
- Improper business processes can be mentioned as the problem in organizations without HRP frameworks, because implementation of such frameworks is based on strategic examinations and implementation of strategic management. According to resource planning frameworks, organization's processes are analyzed and improved within various periods ad such improvement is in line with organizational goals.
- Organizations that do not analyze situations may face unachieved goals and strategies; hence, analyst and decision supporter systems inside the organizations can make it possible to achieve organizational goals reengineering processes.
- The current large manufacturing organizations should make relationships with customers and suppliers within production chain and business process. Beside such need, they need to transfer information rapidly in order to perform rapid organization resource planning based on demands and such issue depends on an extensive and service-oriented organizational resource planning system.
- Incorrect and improper communications and lack of provided timely data within supply chain may prevent organization from achieving its goals, because accurate and timely data in current competitive markets can be used as a competitive advantage. It will be beneficial for organizations to create MSA and apply collective organization resource planning systems besides decision-supporter systems.
- High production costs are originated from non-efficiency in systems and the suggested model in this research aimed at increasing efficiency in organizations within various periods.

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