Journal of
Information Technology & Software Engineering

Fazlollahtabar et al., J Inform Tech Softw Eng 2013, 3:1
DOI: 10.4172/2165-7866.1000116

Research Article Open Access

Proposing a Decision Support System for Service Oriented Manufacturing Based on Enterprise Resource Planning

Hamed Fazlollahtabar[1,2]*, Mahsa Asadinejad[3] and Babak Shirazi[4]

[1]*Faculty of Industrial Engineering, Iran University of Science and Technology, Tehran, Iran*
[2]*Niroogostar Energy Optimization Research Group, Tehran, Iran*
[3]*Department of Information Technology Engineering, Mazandaran University of Science and Technology, Babol, Iran*
[4]*Department of Industrial Engineering, Mazandaran University of Science and Technology, Babol, Iran*

Abstract

One way for enterprises to be successful in today's challenging market is to be agile and be flexible to handle market changes. Using a conceptual and operational framework for improving the enterprise and keeping their desired situation is always required. In this paper, a service oriented decision support system-based framework is proposed. The framework seeks for service oriented architecture (SOA) governance and suggests the initial architecture of the enterprise to support agility and optimality. Also, for the stability purpose a structure including service platforms, analyzers and decision support systems are employed to analyze the enterprise and make better decisions.

Keywords: Service oriented architecture (SOA); Decision support system (DSS); Enterprise resource planning (ERP); Business process reengineering (BPR)

Introduction

Costs and competitive pressures have caused today's organizations to create a convenient framework to move with high potential in a competitive market. In the context of the development rather than basic paperwork and basic decision making, integrated and comprehensive solutions containing modeling, simulation, monitoring, design and improvement, are used. The requisite for this solution is to use service context and integrated enterprise resource planning applications. In this article, initially the literature review of the basic components of the proposed methodology is discussed. Then, the proposed framework and its components are described. Finally, the implementation of the framework in an automotive manufacturing company is illustrated.

Literature Review

Nature of business process management and service-oriented architecture can be considered complementary with each other. In each organization in the first step, configurations of the organization is achieved through business processes. These processes need communication technology for their collaborations. The best and optimal form of this collaboration is presented in service oriented architecture. As a result, both components together can help to improve the organization.

Enterprise resource planning

One of the most important topics in today's organizations is enterprise resource planning. This planning starts from material supply and managing the suppliers and continues to customer delivery. This planning is called ERP [1].

Nowadays, enterprises have found that they need ERP systems but there are some weaknesses, namely:

1. Despite its achievements in the process of managing and planning resources, it is unable to respond to changes in dynamic real-time management and it is not suitable for reasonable decision-making in an agile enterprise.
2. Many companies still use the ERP as public information systems (designed to collect, transmit, compute information). In addition, decision support module in the ERP, just holds the data and information instead of its analysis.
3. Lack of flexibility in iterative ERP analysis methods, and inappropriate conclusions.
4. Today's ERPs are doing well in managing internal information, but the ERPs cannot perform desired action in the external interaction and decision-making.
5. Nowadays, with the development of service-oriented architecture and network organizations, there is the need to implement ERP in wide and collaborative format. But due to the lack of proper infrastructure and the lack of consistent framework to improve the ERP, good performance is not achieved.

According to the human need for information technology and knowledge management, many organizations have changed their goals and strategies through information technology. Therefore, significant research has been done in the field of service-oriented architecture. But there are not many experiences in the combination of this architecture with business process management to make integrated, intelligent and service-oriented enterprises. And often it is limited to simple examples of the partial implementations (according to the needs of specific organizations) and general framework in this area is among the world's research [2].The proposed framework in this paper is based on the ERP. ERP can be defined as integrated software which contains components or modules for planning, manufacturing, sales, marketing, accounting, human resources management, project management, inventory management, maintenance management and transportation management [3]. The definition, focuses more on the enterprise than other terms, including planning and resource, because the system acts more than planning and unless there is a focus on resources, it covers more elements than just internal resources [3]. ERP systems are based

***Corresponding author:** Hamed Fazlollahtabar, Faculty of Industrial Engineering, Iran University of Science and Technology and Niroogostar Energy Optimization Research Group, Tehran, Iran, E-mail: hfazl@iust.ac.ir

Received December 30, 2012; **Accepted** January 24, 2013; **Published** January 26, 2013

Citation: Fazlollahtabar H, Asadinejad M, Shirazi B (2013) Proposing a Decision Support System for Service Oriented Manufacturing Based on Enterprise Resource Planning. J Inform Tech Softw Eng 3: 116. doi:10.4172/2165-7866.1000116

Copyright: © 2013 Fazlollahtabar H, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

on the processes in different parts of an industry being designed upon best practices. It means that the process of ERP software packages to support the key procedures have been designed in accordance with standard procedures which have been proven that are the best way to do enterprise processes. Various approaches have been proposed for these systems and will be described further. Service-oriented architecture is used for these approaches.

Service oriented architecture

Today, in addition to integration of resources, it is necessary to create an environment in which the separate parts of a single company or companies are able to manage themselves and their activities and interact with other parts of the business partners as well as customers and suppliers. So, the final aim is to create an environment that enterprises manage their business processes on business infrastructure regardless of the internal and external nature of the company environment. It cannot be satisfied unless providing the service context. In this context, the enterprise resource planning system requests are formatted to requested web services and the central server services the requested ones. The three main components of service oriented architecture are service provider, service broker and service requester and the three major concepts are publish, bind and find. Provider publishes the service to a service broker and requester finds the desired service using the broker and then requester binds the service to perform the desired action [4].

SOA (Service oriented architecture), regardless of programming language and the machine used to run services, provides a framework for serving distributed communication. In SOA[1], the key issues in the decision-making are real time behaviors of services. Real time services are data processing applications which connect to each other through a publish/sharing context as a web service and real-time data and messages are processed by those web services [5].

Decision support system

There is the need of monitoring and analyzing processes and systems to make critical decisions besides the service oriented context and this can be provided by DSS[2]. DSS includes software and data packages that can provide a variety of choices for developers to deal with various problems and providing the key decisions. These systems do, learning, providing the flexibility, responding quickly, covering changes and helping to make decisions in various areas. The reason of using these systems in a large scale is that many people use the same decisions in different systems or system parts. So they can use the standard algorithms or standard charts different charts [6]. Such contexts are required to establish a framework for enterprise resource planning. Several researches have been done on agile manufacturing enterprise architecture [7]. In most of them business process management and smart decision making are not seen together. In some of these frameworks, the main emphasis is on enterprise architecture and the enterprises are not considered as the process-driven enterprise [8]. To overcome the defects of not supporting intelligent decision making, some researchers have been done on decision support systems modules of the enterprise resource planning systems [9]. These modules cannot support interactions in large enterprises, but can be used as part of decision-support systems in each of the various systems [10]. According to the importance of business process and modeling of the enterprise processes in order to understand the system, various frameworks have been proposed for better understanding of various aspects of the organization.

And also some new approaches are presented in better combination of enterprise resource planning system parts and building a smart and integrated system in these approaches the optimal elicitation of the information and better combination of them in an appropriate level of the system is essential [11].

The Framework

The thing that is very important in implementation of the framework for any organization is the identification and also process improvement is one of the things that strongly help implementation of the framework so the process re-engineering can be performed as a prerequisite or concurrently with ERP framework implementation. Always at the beginning of entering to each organization, the basic recognitions come from mission of the organization and the reason of being organized. For this reason strategic project is needed to be done. These teams pay attention to various aspects of the organization: its operations, market, desired performance, budget and required infrastructure, and do strategic planning by using these organization topics. Reengineering or business process reengineering (BPR) projects start by beginning of strategic projects. Because strategic projects are key parts of the hole project of implementing ERP. The reason is obvious. The primary data and definitions make the infrastructure of projects and are incomplete or incorrect data will have destructive effects on whole parts of the project. Methodology and implementation approach of BPR is also very effective and also selecting an appropriate implementation approach could be a key decision. So the first step is to recognize the organization, its products, its mission, goals, and strategies [12,13].

After initial recognition and initial data elicitation, the second step is process and infrastructure recognition. In addition to this, the extraction of problems, difficulties, failures and drawbacks should be well done. After recognition system and process modeling are conducted. It also helps to document and better understand the organization. Many of the problems and drawbacks will be derived by modeling. The initial decision to improve and develop will be taken besides. After modeling, the analysis is needed. This analysis includes qualitative and quantitative analysis of the current state of the organization. To do this, the important parameters and indexes of the selected industry should be defined at first.

Analysis

For analyzing the present state, many ways can be used and also some softwares can be used to help analyze the enterprise. Primary data are inserted to the software or analyzing application, and then required graphs and analyzed data is obtained based on the original data. For example, to analyze the causes of problems, cause and effect diagram is drawn. In this diagram, the factors affecting the problems and shortcomings are showed, and then the sub factors of each factor will be defined. Using this analysis, the following factors will be considered, the origin of problems will be discovered and the way to solve them will be planned. It is critical to organizations to explore and extract the sick and inefficient processes. So, pareto analysis can be useful. With this chart, process needing to change will be extracted. In addition to these analyzing tools, quantitative analysis, such as six sigma can be very effective. Parameters and data extracted from the organization can be entered and then the six sigma chart and compatibility analysis can be extracted. Furthermore, the process capability index is extracted from the chart clearly shows the status of processes and important parameters.

[1]Service oriented architecture

[2]Decision support system

Framework architecture

After understanding the present state, there is the need of a framework to use it for planning to make improvement. This framework provides intellectual and practical approach for planning to improve ERP architecture. Background and basis for this framework is a service-oriented architecture. In fact, this framework tries to provide the service-oriented architecture governance for the organization. So to achieve this, there must be a service-oriented infrastructure. And also, in the approach proposed in this framework, service-oriented computing is simply not enough and there is the need for Institutionalizing of these infrastructures and computations. Therefore, a radical change is needed in the organization to ultimately achieve the organization's service-oriented architecture governance. This framework has the following components and Essentials that will be expressed.

Integrating ERP and DSS

In ERP systems, resources and information available in the organization are so important and always having the right information about the resources and processes inside the organization, and outside the organization, including supply and SCM system's information and on the other side, product and the customer delivery Information, CRM, is a very important and efficient. Therefore, besides the presence of ERP in an organization there is the need to DSS as a partner and integrated by it, this helps organization efficiently use the organizational knowledge to make proper decisions and solve problems [14,15]. But the important point is the level of integration and the working mechanism. CoERP framework shown in figure 1 is a service-oriented framework for collaborative ERP where the service-oriented and distributed DSS is integrated to ERP to improve organizational knowledge and efficiency.

To accomplish this objective, there is the need for a separate ERP and a DSS inside each ERP. (The interaction between DSS and ERP is shown in figure 1 the reason is focusing on the information and data of each individual ERP. Because the operation and administrative decisions of each Section varies from others so decision making in each section should be more specialized. But on top level, we need to look from top to bottom to make coordination between sectors and provide the organization with general and more critical decisions. Resources and knowledge of the whole system can be contained from combining data from individual parts (sub-systems). Thus, in each sub-sector there should be unique ERP, DSS and in organization level there is the need of a general DSS, which is actually responsible combining and normalizing corporate decisions [16]. To provide such a context, it is required to make use of a specific mechanisms and modules that make it possible. This platform and infrastructure is supplied by tools, models and technologies which will be explained later.

The structure of ERP in supply chain

Here, we adapt the structure of the ERP in a supply chain. The structure is depicted in figure 2.

To integrate DSS and ERP, a framework DE (DSS-ERP) is assigned. As shown in figure 2 this framework provides appropriate context to integrate ERP and DSS in a distributed system. The framework is built on the supply chain, and the system context and technology is added to it. In the center there is a centralized system for integration and central point between all applications, ERPs, DSS s and the infrastructures. Each sector at any time can interact with by the Central part (the central core of the system, here is the "integration" part of the enterprise); and also can constantly cooperate and interact with suppliers and customers. In each sub-sector decision makers have access to a central system in order to manipulate decisions or take new decisions. Decision makers can access the organization or supply chain information by using central system data or communication and use of communication technologies to create IT infrastructure and enhance their own decisions.

The next step is to express the elements, requirements and inputs and outputs either within the frame of ERP and DSS in CoERP framework in a manufacturing organization. In a manufacturing organization, the initial requirement is to establish a channel for information exchange between resource planning systems and the whole manufacturing sectors, and prepare a system for real-time collaboration and eliminate the information gap which is a key point to achieve the goals and create an operating environment and agile manufacturing. So there is the need to simplify and remove several unnecessary layers of software and consider the business system standards. Three important elements in the strategy of this architecture are as follows.

1. Investment in technology of constructing applications
2. Making optimized integration and collaboration on applications
3. Preparing web services and Web applications for project implementation and production

Organizational sectors of ERP architecture

The architecture of manufacturing enterprises is shown in figure 3 to achieve those Strategies XML, OPC are very simple ways to create a data exchange standard. OPC is a simple extension of the process expression and focuses on process information exchange between

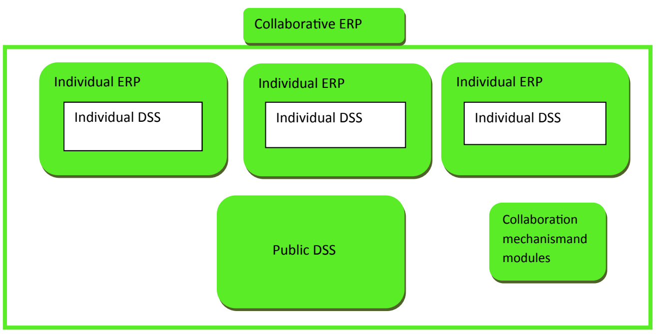

Figure 1: CoERP framework for collaborative ERP.

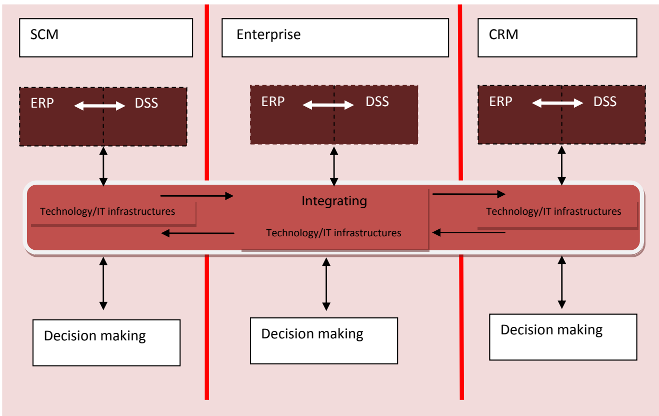

Figure 2: DE framework (communication through supply chain).

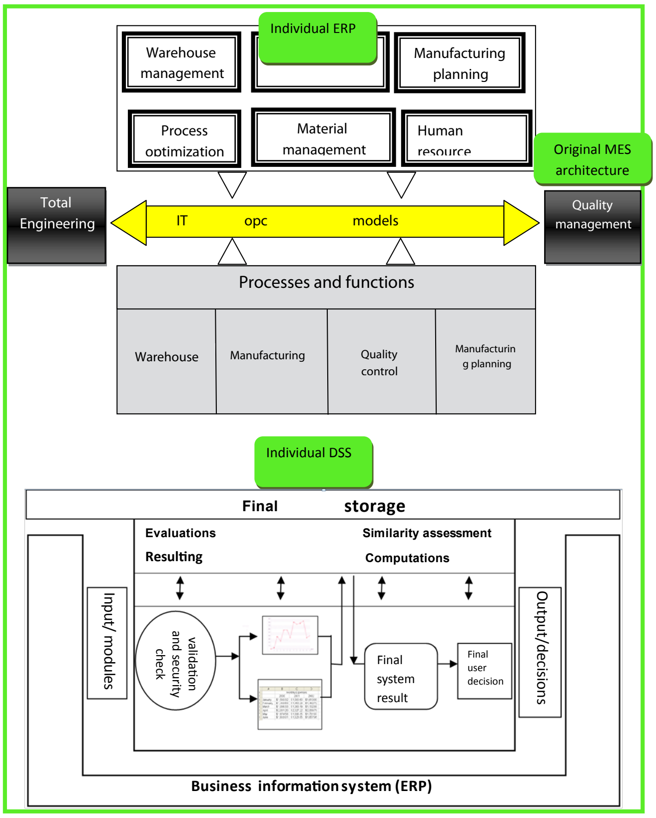

Figure 3: The architecture of individual ERP and the individual DSS inside it.

applications, hardware and processes. XML is a standard data exchange format and focuses on data exchange between applications. Thus, users can easily carry out various transactions. So there is a middle layer that contains XML, OPC and other mediators, models and infrastructures. This framework includes a part of the main process and a part of support and management. The main reason for the use of standard formats for information exchange is implementing the service infrastructure because we need real time conversions to better access to information and decisions. The main process part, including general manufacturing processes, which include storage of raw materials, production and manufacturing processes, quality control and logistics processes that are conducted principally in synchronized or associated with the manufacturing process, and final product storage.

The processes information is extracted from information management and is converted to a standard and normal format in the middle layer to be used in other sectors. Control and support parts which are at the top of this architecture, including warehouse management, manufacturing planning, process optimization, material management and human resource planning the control and support processes cooperate with each other and with the main processes. For example, warehouse management part considers the amount of raw material by using the manufacturing planning part and helps the warehouse management for repository space allocation. Then the information and decisions are transferred to material management. Warehouse management schedules and control the inventory. As it is clear, the information of this part is so important and can fully affect all manufacturing processes. Scheduling part, schedules all planning processes in the field of raw materials, manufacturing amount, quality controls, process planning and do other needed planning and is a synchronization base between other control parts. This architecture is looking for Process-orientation. As a result it uses human resource dynamically and in accordance with the process function. In this architecture, there are two other key parts which receive information from Manufacturing processes and the systems to evaluate and analyze them. These parts are shared between the whole organization's ERPs. The quality management part receives needed indexes and parameters in a standard format from middle layer to do analysis. Finally, extracted parameters are used for the planning and control decisions. Engineering management part manages and evaluates the quality and performance of systems, applications, and infrastructures. This is the architecture of the manufacturing organization that has been designed to do enterprise resource planning or in better words this is the individual ERP architecture. The next part which is in interaction with each individual ERP is individual DSS. The function of this part is done by using the case-based reasoning (CBR) method. The reason of using this method is that this method is implemented by the manufacturing organization and it is satisfies the manufacturing organization decisions.

The internal architecture of it is shown in figure 3. Each decision support system is for one specific ERP. Information of that ERP system or subsystem is used for Feedstock.

As said before, in each system or subsystem, the data should be converted to a standard and normal format to easily be able to be transferred between different systems and web servers.

So the information is entered into the decision support system. This system contains a database (including data andbasic rules), and an inference engine. The data from the ERP system enter in an appropriate format to it and then the data will be evaluated not to be false or access the system in the appropriate format and are evaluated to be false or destructive. Entered data is combined with previous data previous rules (which were stored in data base previously) and needed tables and graphs are extracted. This part is responsible for the inspection and evaluation. Then information is moved to decision making and optimization part and again the results will be shown graphically to specific user, and the user can review it. The reason of this review is making final decision. Because this system is actually a decision aid system and not a decision making system and actually helps decision-making team. But the final decision makers of the system are managers and senior officials of the organization. Then again, the results decisions return to the system and apply to the control and process parts of the system. At last decisions are stored in database for later use.

Public DSS architecture

What said before was about each part of the organization architecture. In collaborative organizations as mentioned, there should be also a service-based communications which integrate and coordinate all systems. To create such collaborations, it requires a central decision making system. The central base is located on the Web server (Figure 4).

Its operation is as the information and decisions come from each individual DSS (if it is needed)or from other places such as main database or other bases, at the beginning and enter into regulation base where it does initial assessment or normalization .this part is called regulation base where is the entry point of public DSS. This part is also designed to avoid unwanted penetrations, manipulations and destructions. Also this part is as a cache memory which can make previous decisions available for faster access and speeds up servicing and decision searching. If there is the need of information from other DSS they should be requested and entered to the regulation base. This

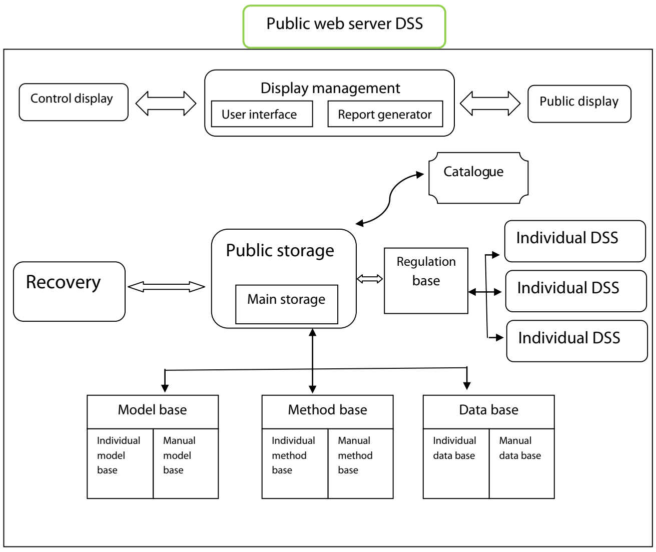

Figure 4: Public DSS architecture.

public DSS has a big storage of methods, models, data and basic rules. In this DSS there is a backup of individual DSSs to avoid the risk of data loss. This backup is stored in a place which is called public storage. The next part is the central part of public DSS. It contains two parts, a public storage and a main storage. Information from individual DSSs, the methods , models, data, needed rules, all the parts are imported to this part, because public storage part works as a RAM memory and after the decision making process is finished, decisions should be stored in main storage. It even stores individual DSS decisions and data so it can be the data and decision source of the overall system. System models, modules, data bases and decisions are constantly updated by other system parts. After combining required data, they should enter recovery part.

After extraction of the data requirements from the public storage and entrance into the recovery, the combination of previous data and analysis is performed. Methods of analysis and decision making are similar to the individual DSS. But there are some specific models, methods and modules that are just for public DSS. There is one monitoring and observing part which helps managers and users see decisions and make final decision (just managers and specific users can make final decisions). Analyzed information and initial decisions come to this part after being stored in public storage part. After final decision making, then again decisions go back to recovery part to change to standard format and then are stored in main storage part for later use. They will be sent to individual DSSs if they were needed. In addition, a public display is available to show final decisions that are stored in main storage to authorized users. Users can access to required information by searching in the catalog.

Communication context

To make a suitable communication context, there is the need of some mechanisms and modules. These mechanisms and modules with the use of network platform can help implementing a distributed ERP. These mechanisms and modules are expressed in figure 5.

These mechanisms can be used by ERPs and DSSs. The mechanisms and models, including communication base, coordination and control mechanism, interface and display, regulation base, reasoning machine and Mutual base. As we know, a collaborative ERP initially requires a strong infrastructure of communication network or network hardware and software. Because otherwise implementing a collaborative ERP is impossible. When there are such communications, existence of controlling mechanisms to control and monitor these communication will be Undeniable. Also existence of communication needs standard and mutual language. Nowadays most use standard formats such as XML. Also, other transformations may be needed that takes place in regulation base. There are mutual data, softwares, hardwares in ERP collaborations that should be used for various reasons such as cost reductions and savings in time and energy. For public review,

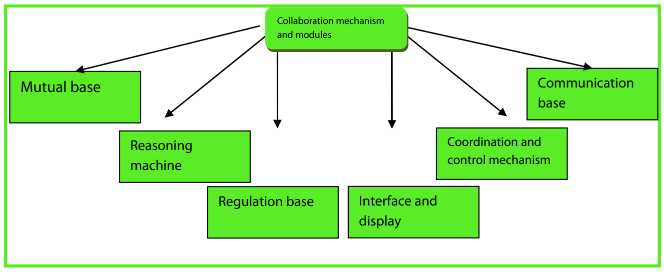

Figure 5: Communication and collaboration mechanisms and modules.

Formula	field	index
Total machine stop time / total productionhours	Effectiveness	Stopping rate
Total repairs and maintenance costs / totalproduction costs	Profitability	Repair cost rate
The total waste costs/ total production costs	Profitability	Waste rate
Rework numbers in a month / total number of products in a month	Effectiveness	Rework rate
Defective automobiles / total automotive production	Effectiveness	Defective production rate
Production capacity / expected production rates	Effectiveness	Product rate

Table1: Important indexes extracted from automotive manufacturing enterprises.

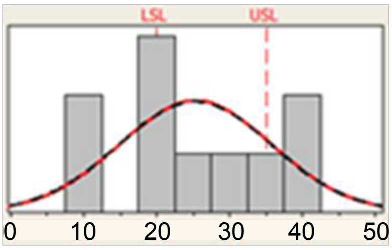

Figure 6: Six sigma diagram.

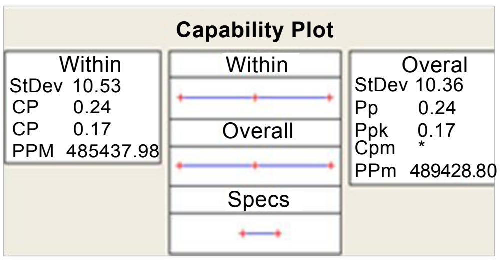

Figure 7: Process capability index.

Citation: Fazlollahtabar H, Asadinejad M, Shirazi B (2013) Proposing a Decision Support System for Service Oriented Manufacturing Based on Enterprise Resource Planning. J Inform Tech Softw Eng 3: 116. doi:10.4172/2165-7866.1000116

monitoring and supervising bye managers and users of these systems, monitors and display parts are offered. There is another smart part as a reasoning machine to assist all system parts by using artificial intelligence, monitoring, control, coordination and improvement.

Implementation

To implement this framework, the data is extracted from an automotive manufacturing factory in Iran. Due to the weaknesses in the organization and its malfunctions, the proposed framework was applied to improve the organization. As it was said before in implementation steps, at first strategic management team was formed to identify and deal with the present situation. This identification contains the general understanding and basic knowledge of the resources, inputs, outputs, suppliers, customers, mission, vision, goals and strategies, as well as detailed knowledge including, weaknesses, threats, strengths and opportunities. After this identification analysis begins. In this step process modeling is done for better documentation. Since in proposed framework BPR project begins within the ERP project, the present situation analysis which contains of extracting appropriate indexes, extracting the needed data and analyzing them all will be handed over to BPR team, some of the extracted indexes are shown in the table 1.

Many qualitative and quantitative methods can be used to analyze these indexes, 6 sigma is one of that methods (Figure 6). An example of 6sigma for stopping rate index is explained below.

According to the above graph, six sigma diagram is more beveled than normal distribution. Process capability index, 0.24, which represents that the process is undesirable (As we know, the index in god situation should be 1 or more than 1) and also the C_{pk} is 0.17, which indicates that process still needs to be improved. In this case, the p_p is equal to $C_{p,}$, because this diagram is plotted using 10 sample data (Figure 7). Due to the extent of the contents, we do not explain other diagrams. (Other investigated indexes are: repair cost, waste rate, rework rate, defective production rate, manufacturing rate and product rate which are checked in these organizations). Waste rate is in better situation compared with others and rests of indexes have "need to review" or "undesirable" situations. According to what was stated, qualitative and quantitative analysis on the current situation of the organization and has been done. In addition, strengths and weaknesses and areas requiring improvement were identified in processes analysis. After that, there is the need to identify and create the best state using the proposed framework. Proposed "Best state" for the organization would not perform the best situation for it. Because many factors can affect the best state and turn it into the worst. Tease factors can be: organizational culture, existing technology, knowledge and education of the staff, the resistance of the staff against the changes, available budget, state of market, political, social and economic issues and the matching of the current systems with new IT technology, etc. So without considering such factors, simply because the process is not ideal, they should not be changed or improved. There for after considering such factors,

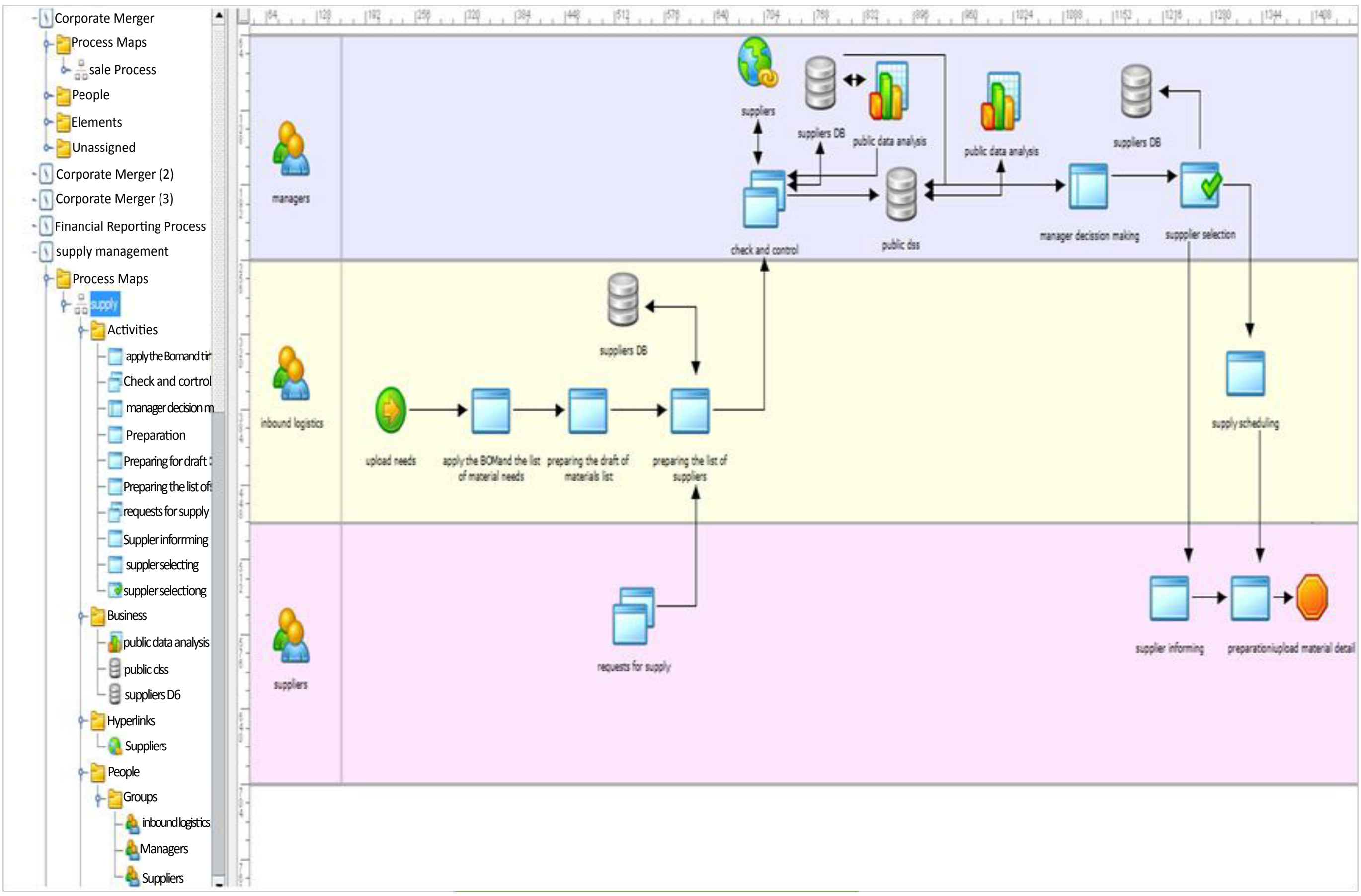

Figure 8: A simulation.

a prioritization can be done to improve the current situation. After considering the factors and the results of the analysis of the current state of the organization, the planning for improvement starts. This planning takes place across the framework and its components. For this purpose, the process must be improved at first and BPR should be done with considering new technology infrastructure and the framework. An example of system simulation is presented in figure 8.

In continue, the simulation of the proposed system will be expressed using the framework, Where service-oriented architecture, structure of collaborative ERP, communication of supply chain, decision-making in individual DSS and public DSS and also other components of the framework are shown.

As can be seen, the figure shows a part of the simulation of a process. This section provides requirements of assembly process. At the start of this part, the request for supply will be sent to the relevant department. The system will record the request and then decision making should take place. Information of previous suppliers is available in specific database. Also new suppliers can send their request to the system. All information will be sent to the manager site to make decision. Ultimately after decision making process it is sent to the selected department and the system will inform the specific supplier to supply. The thing that is important is communication between system layers and departments, suppliers and customers which is obtained by providing service infrastructure. The individual and public decision support systems are shown. These take place as the request comes from special department and then needed data is extracted from individual DSS then these data join to other extracted information and go to manager layer, and store in public storage on web server to go to the recovery part and the decision making takes place. After decision making by the system takes place, it goes it display part to be informed to the managers and after verification and confirmation final decisions store on main storage of the public DSS. Then the finalized decisions go to desired department. As is obvious the whole communications are done through the services. The layered structure of ERP is presented and the communications through supply chain for resource planning is implemented. And also process improvement and reengineering is done on processes such as assembly process.

Conclusions

In this paper, we presented a service oriented framework for ERP and DSS of manufacturing enterprises that the present state analysis, process and functional analysis and other planning and scheduling have been presented. We have presented process reengineering and implementing the service oriented architecture for manufacturing enterprises to improve the organization's performance (with respect to the manufacturing industry) by using the framework and its components such as DSS, ERP architecture and other mechanisms. At last, a simulation study in automotive manufacturing enterprise in Iran has been presented. This framework helped manufacturing enterprises to improve their enterprises by improving their processes, resource planning, communication, present state analysis and decision making by giving them a functional structural method to move across and get better performance and efficiency.

References

1. Molnár B, Szabó G (2011) Information architecture of ERP systems at globalised enterprises in a small EU member state. IEEE 157-162.
2. Vescoukis V, Doulamis N, Karagiorgou S (2012) A service oriented architecture for decision support systems in environmental crisis management. Future Generation Computer Systems 28: 593–604.
3. Finkelstein C (2006) Enterprise architecture for integration: Rapid Delivery Methods and Technologies. British Library Cataloguing in Publication Data.
4. Shafiei F, Sundaram D, Piramuthu S (2009) Implementing a Multi-Enterprise Collaborative DSS. IEEE 220-229.
5. Vescoukis V et al. (2012) Computer Systems of future generation.
6. Shimizu T, De Carvalho MM, Laurindo FJB (2006) Strategic Alignment Process and Decision Support Systems: Theory and Case Studies. Idea Group Inc.
7. (2007) Emerson Process Management Manufacturing Execution Systems Capabilities.
8. Moghaddam SM, Shabgahi GL, Moghaddam MM, Nasiri R (2009) A Proposal for Using Parallel Flows with the Aid of DSS in ERP Projects. Second International Conference on Computer and Electrical Engineering, Iran.
9. Nieuwenhuyse V, De Boeck L, Lambrecht M, Vandaele N (2011) Advanced resource planning as a decision support module for ERP. Computers in Industry.
10. Power DJ (2003) Categorizing Decision Support Systems: A Multidimensional Approach. Idea Group Inc.
11. Shafiei F, Sundaram D (2004) Multi-Enterprise Collaborative Enterprise Resource Planning and Decision Support Systems. Proceedings of the 37th Hawaii International Conference on System Sciences.
12. James L (2002) Collaborative ERP - The Second-Generation of Realistic E-Business. White Paper by the Lian-James Consultancy.
13. YAO S (2008) Research on the Model of Collaborative ERP based on GDSS. International Conference on Information Management, Innovation Management and Industrial Engineering.
14. Rippen M (2005) Decision Support Systems. Tesella Scientific software solutions.
15. Chen Z (2000) Computational Intelligence for Decision Support. CRC Press LLC.
16. Bresfelean VP, Ghisoiu N, Lacurezeanu R, Sitar-Taut DA (2009) Towards the Development of Decision Support in Academic Environments. 31st Int Conf on Information Technology Interfaces, Cavtat, Croatia.