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# A Business Intelligence and Analytics for Service Oriented Manufacturing Resource Planning

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# A Business Intelligence and Analytics for Service Oriented Manufacturing Resource Planning

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**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), Business intelligence and analytics (BI&A), Enterprise resource planning (ERP).

## 1 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.

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.

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].

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

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based 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.

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[1], regardless of programming language and the machine used to run services, provides a framework for serving distributed communication. In SOA, 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].

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] [17-19]. 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 [12]. To overcome the defects of not supporting intelligent decision making, some researches have been done on decision support systems modules of the enterprise resource planning systems [8]. These modules cannot support interactions in large enterprises, but can be used as part of decision-support systems in each of the various systems [13]. 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 [9].

## 2 Proposed 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 [10,11].

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

[1] Service oriented architecture
[2] Decision support system

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.
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.

## 3 Configuration of Business 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.

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.

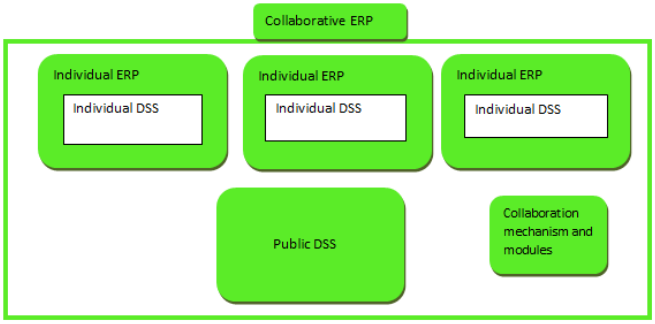


**Fig. 1:** CoERP framework for collaborative ERP.

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.

### *3.1 Organizational Sectors of ERP Architecture*

The architecture of manufacturing enterprises is shown in Figure 2. 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 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 are extracted from information management and are 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 are 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 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 and basic 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.

## 4 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, 6sigma is one of that methods. An example of 6sigma for stopping rate index is explained here.

According to Figure 3, 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 good 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 *pp* is equal to $C_p$;

because this diagram is plotted using 10 sample data (see Figure 4. 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).

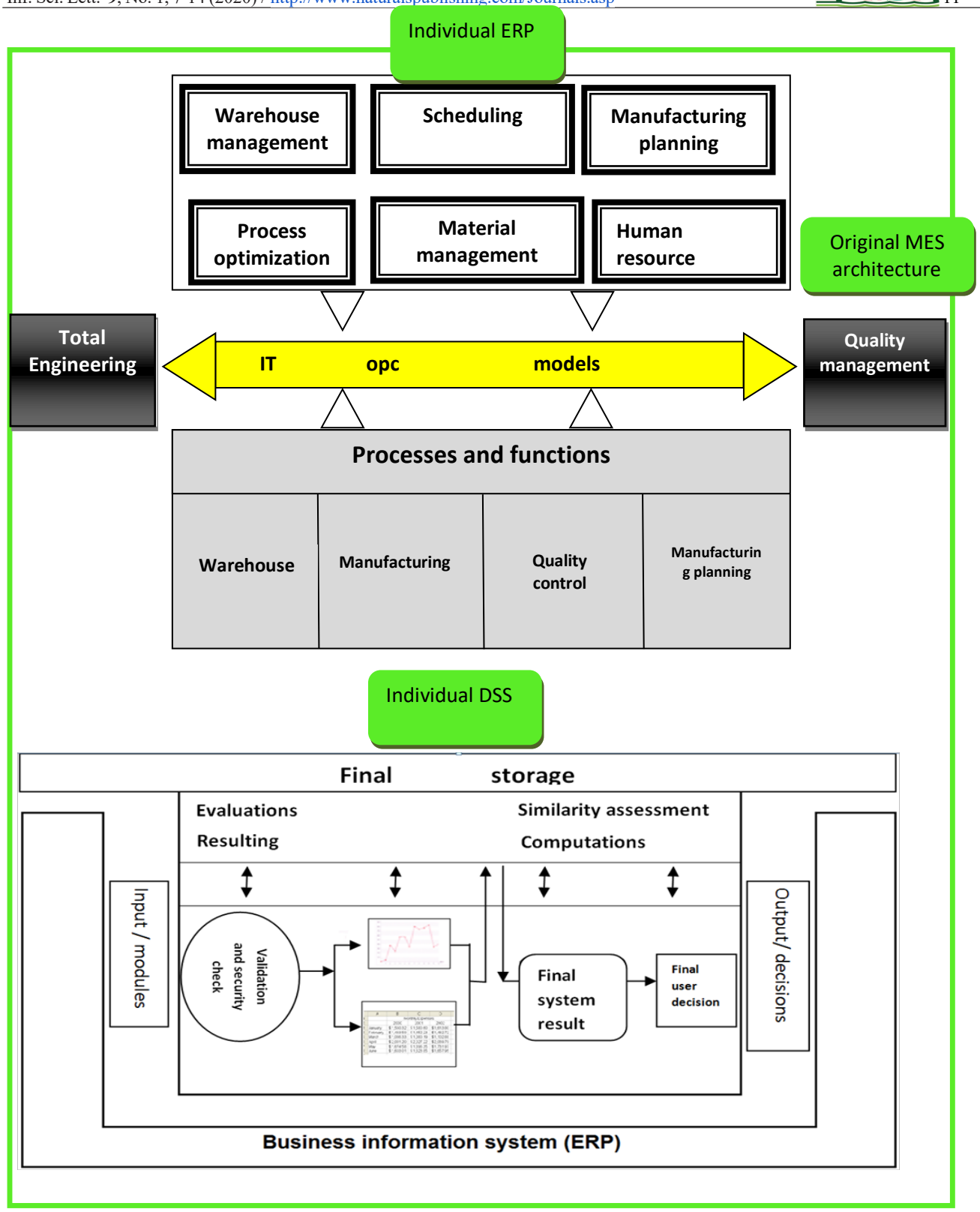


**Fig. 2:** The architecture of individual ERP and the embedded DSS.

**Table 1:** Important indexes extracted from automotive manufacturing enterprises.

| Formula | field | index |
|---|---|---|
| Total machine stop time / total production hours | Effectiveness | Stopping rate |
| Total repairs and maintenance costs / total production 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 |

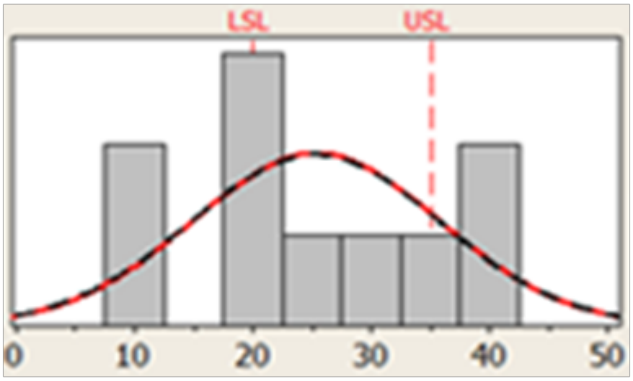


**Fig. 3:** Six sigma diagram.

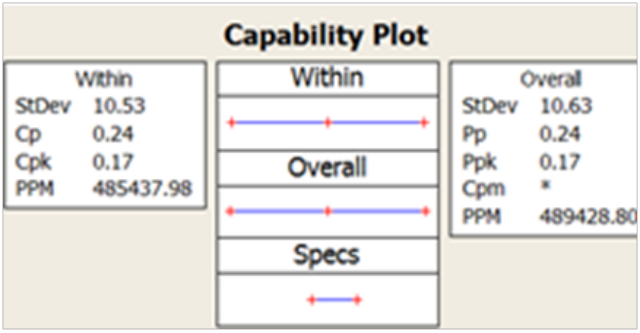


**Fig. 4:** Process capability index.

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, 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, 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 5. 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.

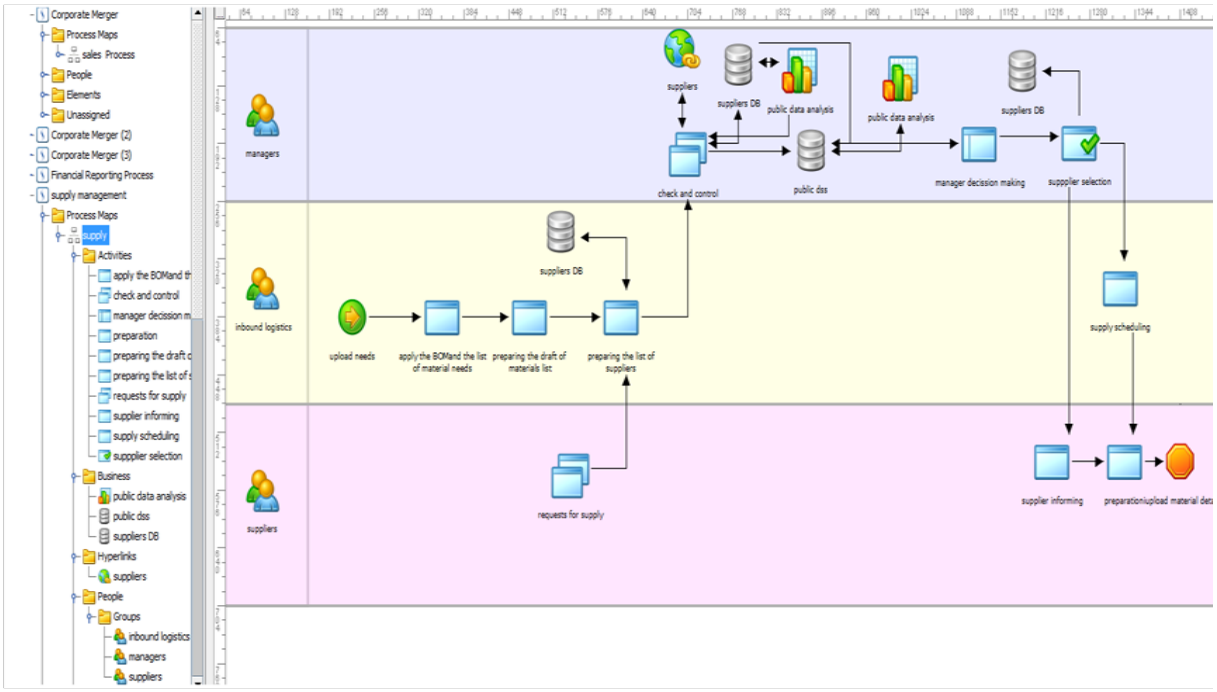


**Fig. 5:** A Simulation.

## 5 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.

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