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A CASE OF BUSINESS PROCESS REENGINEERING VIA SIMULATION

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ABSTRACT

Business Process Reengineering (BPR) is one of the important change management approaches which have applied strategically. In this paper, BPR is aimed by achieving dramatic improvements on the available business pro-cesses of a company in private sector by using simulation technique. Several performance measures have been defined in order to be able to monitor the system performance. Major ones of those are the percent of responding demands, and the lead time, which is the time between the placement and receiving of the order. The demand change is known as the fundamental problem of the system by the company. After the assessments made, it has been seen that the demand change, contrary to the assumptions made, does not have significant effect on the system performance. It has been determined that the main problem arises from the operational process/es in the system and solution toward this direction has been.

Keywords*: Business process reengineering, Simulation, Production planning*

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1. INTRODUCTION

In today's competitive world, the industry throughout the world is also going through a necessary and innovative change. In this ever changing world by customer requirements, change and competition, companies searching new ways to make their businesses more efficient and competitive. They analyse their current systems, processes and try to find new solutions to their business problems. Recently, we witness that some of the most successful companies in the world, seem to have come up with an amazing solution to their business problems which is called Business Process Reengineering (BPR). "Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed", [1].

Nowadays, globalization and increased competition make organizations more innovative and adopt approaches based on change management [2]. The objective of this paper is to redesign business processes of a company in private sector by achieving dramatic improvements on the available business processes by using simulation technique. To measure the performance and predict the effect of change on the system would be useful with simulation of system.

In this context, supply chain process of the related company will be analysed and an application of reengineering will be achieved by commenting revealed results from the data which was obtained as a result of this analysis. Supply chains have been faced with numerous changes that are contributing to increasing their complexity, such as the global business operations and the adoption of new business philosophies as agile, lean, and efficient customer relationship management, and quick response programs [3, 4].

This paper is expected to aid companies that strive to redesign their business processes in order to accomplish critical improvements in performance. Thus, in ever-changing and develop-ing world as companies gain a competitive advantage; quality, productivity, profitability and customer satisfaction will increase. In following chapters literature study is conducted then cur-rent system simulation BPR simulation presented. Finally in last chapters, results and conclusion is provided.

2. ROLE OF BPR

In recent years, we have been witnessing a management concept called "Business Process Reengineering" which has become commonplace among companies which seek for adapting rapid external changes and changes in the marketplace. BPR has been practiced as a formal discipline since the early 1920's. Then it was known as "Methods and Procedures Analysis" always searching for new ways of restructuring work flows or improving business organization [5]. BPR has been studied extensively since its initial widespread application in the late 1980s. For almost a decade now there has been considerable discussion in the literature on BPR and today there still remains considerable confusion, particularly amongst managers.

As it has been mentioned, BPR focuses on redesigning work processes to enhance productivity and competitiveness. The demand for a new approach to company restructuring has been fuelled by the awareness, that many of the existing business logic is built on premises of considerable age [6]. These existing processes were first designed as a set of sequential manual procedures, and then automated parallel with the accelerating development of technology [7]. However, this automation did not change the strong efficiency orientation pushing for optimizing procedures or functions and a maximum level of control; neither did it address the organizational externalities, such as customer demands. Corporations today must break through existing paradigms and use them as a frame of reference for establishing new ones. This can be expressed through new rules, policies, procedures, structures, values and beliefs [8]. The first step towards success is recognizing the need for change. Companies that wish to use BPR must determine the best strategy and follow through with the objectives. BPR will not be successful if the company flagellates. It will also not be successful if the company uses BPR over and over again. The reengineering process must come from the top down – the executives must be committed and ready to promote the changes as an example for the rest of the company [9]. Reengineering in the classical sense can also be differentiated from other programs such as TQM, rightsizing, restructuring and automation. The hyperbole surrounding reengineering often makes it difficult to differentiate between these changes programs [10]. Table 1 summarizes key dimensions of these programs. Rightsizing and restructuring are typically used to refer to adjustments in staffing requirements and changes in formal structural relationships, respectively. Neither approach focuses on the business process. Automation refers to typical application of technologies (including IT), where the application focuses mainly on automating existing procedures without questioning their appropriateness or legitimacy. Both TQM and reengineering improvements focus on processes [11]. However, TQM involves bottom-up participation, usually within function, continuous evaluation of current practices resulting in incremental changes in work design.

	Rightsizing	Restructuring	Automation	TQM	Reengineering
Assumptions questioned	Staffing	Reporting relationships	Technology applications	Customer needs	Fundamental
Focus of change	Staffing, job responsibilities	Organization	Systems	Bottom-up improvements	Radical changes
Orientation	Functional	Functional	Processes	Processes	Processes
Role of IT	Often blamed	Occasionally emphasized	To speed up existing system	Incidental	Key
Improvement goals	Usually incremental	Usually incremental	Incremental	Incremental	Dramatic and significant

Table-1: Reengineering and Other Change Programs [12]

3. METHODOLOGY

A consolidated methodology has been developed from the four methodologies previously presented and an Integrated Definition Method (IDEF0) model was developed to provide a structured approach and to facilitate understanding. But for the sake of brevity, we have shown only the major activities in the IDEF0 model. In the ensuing section, we deal with the details of our methodology. Planning and preparation are paramount factors for any reengineering project to be successful. The first step of "planning and preparation" is identifying whether a need for reengineering is crucial or not.

Map and analyse as-is process: In order to successfully redesign the process, reengineering team should first understand and delve into the existing process. Although some organizations attempt a new process design while totally ignoring the existing processes most need to map the existing processes first, analyse and improve on it

to design new processes [13]. Design to-be process: After identifying the processes to be reengineered design alternatives to the existing process/es which aim at accomplishing company's strategic goals are generated. One of the ways that facilitate setting alternatives is "Benchmarking". Implement reengineered process: When so much time and effort is spent on analysing the current processes, redesigning them and planning the migration, it would be prudent to run a culture change program simultaneously with all the planning and preparation. Improve process continuously: Implementing the reengineered pro-cess does not assure the success of the reengineered process alone. A key to success for every reengineering effort is to improve the reengineered process permanently by both monitoring the progress of the process and the results.

Success of BPR projects is crucially dependent on BPR techniques and tools identified 72 techniques which are commonly associated with BPR. These techniques are related to Quality Function Deployment (QFD), process modelling, simulation, rule specification, database techniques, and process measurement. They relate these to five areas of BPR: technology, management, business processes, structure, and people. In BPR projects a battery of tools and techniques is to be deployed based on the conditions and circumstances [14].

Simulation is a tool that can be used to support BPR when physical system models or logical mathematics models are too difficult or costly [15, 16]. Simulation refers to methods for studying a wide variety of models of real world systems by numerical evaluation using software de-signed to imitate the systems' operations [17, 18]. Basically, it is the process of conducting numerical experiments to get a better understanding of the behaviour of that system for a given set of conditions.

The enablers required need to identified and evaluated. Identify enabling constraints and additional requirements, i.e. new skills training, etc. A judicious mixture of these enablers is required for process reengineering [19, 20].

4. APPLICATION OF THE BPR MODEL

Supply chain process of an industrial company will be analysed; a simulation model will be set and developed for BPR. This BPR case study will be applied for a particular product. Firstly, general information about the company will be given and then the studies will be detailed. The in-formation given here has been obtained from the interviews conducted with the company personnel and from the company's website. The name of the company will not be denounced and it will be called "the Company" from here onwards.

This study has been performed in the Company's Building Products Division. The Building Products Division operates globally and owns a total of 15 manufacturing facilities: 9 spread out over Germany, England and France and 6 in Turkey. Combined, these factories produce an average of 5 million ceramics sanitary ware, 36 million square meters of ceramic and wall tiles, 370 thou-sand modules of bathroom furniture, 3 million faucets, 350 thousand bathtubs, 2,5 million bath-room accessories, 150 thousand concealed cisterns and 550 thousand WC pan seats and covers every year.

4.1 Examination of the System

The system in hand involves supply chain process of the company. The main problem of the sys-tem is the large amounts of demands arriving at unforeseen times. These demands cannot be meet within the desired speed and quality of service. So, the percent of responding demands is low. With performed this BPR study, to increase the percent of responding demands and to shorten lead time is aimed. This study was applied for a particular product. The product in hand is the bathroom furniture. It will be called product "A" from here onwards. Product "A" is one of the most demanded products. Demands regarding product "A" are made from two different channels as retail and project sales.

Monthly demand amounts provided by the company for both types of the demands between the years of 2010 and 2012 are shown in Table 2.

	Retail Sales Demand (unit)			Project Sales Demand (unit)		
Month	**2010**	**2011**	**2012**	**2010**	**2011**	**2012**
01	**255**	**589**	**921**	**142**	**309**	**322**
02	**203**	**527**	**1466**	**180**	**547**	**144**
03	**246**	**911**	**1439**	**268**	**131**	**557**
04	**207**	**986**	**1421**	**130**	**1178**	**1365**
05	**655**	**938**	**1359**	**393**	**729**	**270**

06	**270**	**1245**	**828**	**221**	**338**	**678**
07	**297**	**867**	**1230**	**368**	**391**	**775**
08	**265**	**1149**	**724**	**129**	**452**	**429**
09	**137**	**794**	**1135**	**56**	**175**	**246**
10	**391**	**698**	**737**	**251**	**694**	**199**
11	**379**	**597**	**1195**	**183**	**241**	**733**
12	**290**	**980**	**1005**	**110**	**2371**	**616**

Table-2: Monthly Demand Amounts

The data given above has been evaluated using the Best Fit program and it has been found that both types of the demands conform to Normal Distribution. The fiction in the simulation study to be made is to create a time-based demand. Therefore, what counts as the basis for us is the inter arrival times of the demands. Thus; while the mean (μ) and standard deviation (σ) of the inter arrival times of the demands made through retail sales channel are 0.95 and 0.33 hour (hr) re-spectively, the mean and standard deviation of the inter arrival times of the demands made through project sales channel are 1.59 and 0.78 (hr.) respectively. The current process flow can be summarized in Figure 2 and definition of the each operation is given as:

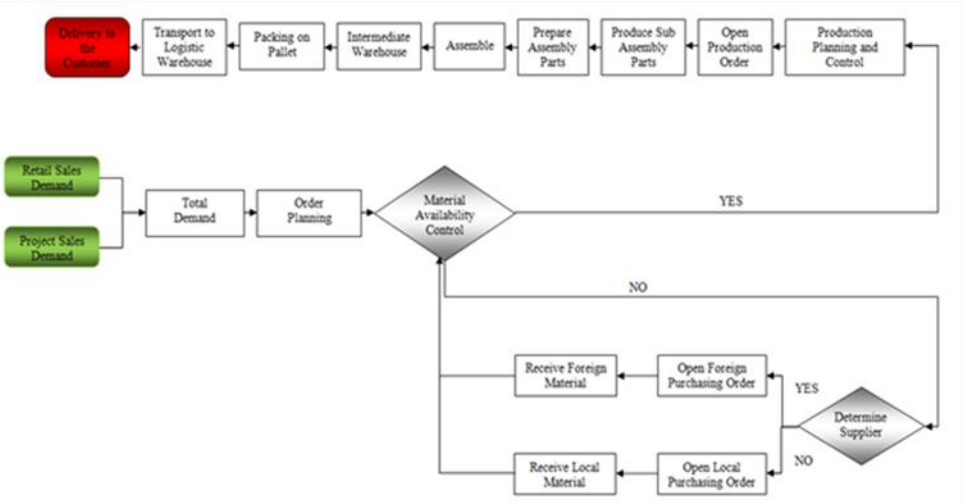

Fig.-2: The current process flow

Retail sales demand: These types of demands are end user demands. So, these demands have a great importance. They must be responded primarily and their service level must be the highest. Project sales demand: Project sales demand which are project basis, received in large quantities. These demands are not end user demands. So, their priority is lower than retail sales demand. Delivery time depends on the project's completion time. Total demand: These demands are the total of retail sales demand and project sales demand. Demands are instantaneous and can be taken at any time. Order planning: At this stage, time of delivery to the customer is determined considering criteria such as forecasts, reorder point (ROP), capacities. This operation is done three times a week on Monday, Wednesday and Thursday. This is a very crucial stage. Because if this stage is not completed, procurement and production processes cannot start. In other words, the step of order planning triggers all other processes. Material availability control: Material requirements planning (MRP) over the Systems, Applications and Products in Data Processing (SAP) system runs to control material availability. Due to this control, the material requirements are determined. So, it is decided to material availability based on quantity on hand. If material is available, it is preceded to the stage of production planning and control. If material is not available, order is placed. In case of material requirement: Firstly, supplier is determined. Then ac-cording to this information, purchasing orders are opened. Open foreign purchasing order: This operation is done once a week on Friday. Friday is waited to do this operation collectively be-cause of the variety of the products. Open local purchasing order: This operation is done twice a week on Tuesday and Friday. Tuesday and Friday are waited to do this operation collectively because of the variety of the products. Receive foreign material: The lead time of the import ma-terials are between fifty and seventy days. Most probable value is fifty-five. In the meantime, ordered import materials are received. After receiving operation had been done, received quan-tity is checked. Receive local material: The lead time of the local materials are between seven and eighteen days. Most probable value is fifteen. In the meantime, ordered import materials are

received. After receiving operation had been done, received quantity is checked. Production planning and control: If material is available, it is preceded to production phase. So then first planned orders are transformed into production orders. The production plan required is pre-pared. Open production order: At this stage, production order is opened according to the pro-duction plan prepared. Thus, materials are reserved for relevant order. Produce sub assembly parts: After production order had been opened, sub assembly parts are produced. This production stage is for the production of the semi-finished goods. Prepare assembly parts: Produced sub assembly parts and raw materials are prepared quantities and dimensions used in assembly. Following these materials is transmitted on the assembly line. Assemble: The assembly process is the final stage of production. At this stage, prepared assembly parts are combined with each other and finished. Thus, production process is completed. Intermediate warehouse: Finished products are stored in the intermediate warehouse order-based temporarily. Packing on pallet: The products of the same order are packed based on optimum pallet structure. Transport to logistic warehouse: After the products had been packed, they are transported to logistic ware-house. Delivery to the customer: This is the final stage of the process. At this stage, it is made delivery to the customer by logistic warehouse. Delivery time is about two days.

4.2 Simulation Model of the System

Micro Saint Sharp is a discrete-event network simulation software package for building models that simulate real-life processes. With Micro Saint Sharp models, useful information can be gained about processes that might be too expensive or time-consuming to test in the real world.

Micro Saint Sharp does not use the terminology or graphic representations of a specific industry. If the system can be drawn as a flow chart, then a model of the process can be built in Micro Saint Sharp. The degree of model complexity is flexible. A simple, functional model can be built just by drawing a network diagram and filling in the task timing information. Micro Saint Sharp includes a fully functional programming language. This sophisticated programming language will make it more efficient to write code especially for large, complex models.

The assumptions related to the model are explained below:

- A month contains 30 days.
- A month contains 24 work days.
- Inter task switching time is ignored.
- Unit of time used in simulation is second.
- Each model run takes one year.
- Demand characteristics are assumed to be normal distribution.
- One unit raw material is used to obtain one unit finished product.
- First-in first-out (FIFO) method is taken as a basis.
- The main outputs of the model are responding demand percentage and lead time.

Based on the information obtained by the company, the data that does not significantly affect the real system are ignored.

When the simulation study conducted, the service time allocated for the progress of the demands created in the system is shown in terms of time (hr)/unit in Table 3. These times and the data regarding the distribution of these tasks have been determined based on the data provided by the company and the experiences.

Task Name	Distributio	Parameter Values (hr)
Receive Foreign Material	Triangular	(1; 1,09; 1,39)
Receive Local Material	Triangular	(0,14; 0,3; 0,36)
Produce Sub Assembly Parts	Normal	(0,1; 0,05)
Prepare Assembly Parts	Normal	(0,01; 0,002)
Assemble	Normal	(0,1; 0,07)
Intermediate Warehouse	Triangular	(0,01; 0,02; 0,04)
Packing on Pallet	Normal	(0,002; 0,0004)
Transport to Logistic Warehouse	Normal	(0,0004; 0,0002)
Delivery to the Customer	Normal	(0,04; 0,02)

Table-3: Service Time for Tasks

4.3 Verification and validation of the model

One of the most effective methods used to verify the model is to get "Trace" report of the pro-gram. Micro Saint Sharp provides this opportunity to users. By this way flow of the system during simulation was followed and running of the model properly is observed. The clock times for beginning effects, ending effects, and scenario events are listed. Any syntax errors are indicated the major outputs of the simulation model created is 0.44. That this ratio is low means that there are significant bottlenecks in the current system and these must be resolved in order to increase the system performance. For the system examined by us, since the data are limited and similar models do not exist, conducting a complete validity test has not been possible. However, based on the data at our hands and the outputs obtained after the simulation study, it is said that the system reflects the reality in general.

4.4 Analysis of current process outputs

The data obtained as a result of running of the simulation model created for a period of a year under the assumption that each month is thirty days long are shown in Table 4.

Output	Value
Total Number	14409
Retail Number	9106
Project Number	5303
Finished Number	6302
Finished Retail	3993
Finished Project	2309
Produced Number	6302
Ordered Piece	0
Responding Demand Percentage	0,44
Lead Time (hr)	1,07

Table-4: Current Process Outputs

The following results have been obtained as a result of the simulation study conducted:

•It is seen that 9106 and 5303 demands from retail sales channel and project sales channel respectively and a total of 14409 demands have arrived to the system. 44% of these demands have taken finished product form and have been delivered to the customer. That is to say, the responding demand percentage, which is one of the major outputs of the simulation model created, is 0.44. That this ratio is low means that there are significant bottlenecks in the current system and these must be resolved in order to increase the system performance.

•While 63% of 6302 number of finished products corresponding to the percent of responding demands constitutes the demands made through the retail sales channel that have taken the product form and delivered to the customer, 37% constitutes the part that made through the project sales channel and has taken product form that is delivered to the customer.

•When the variable of Produced Number is examined, it is seen that the value which this variable has taken after the end of a year is the same as the variable of Finished Number. This shows the result that all of the products produced in the system have been delivered to the customer.

•When the variable of Ordered Piece is examined, it is seen that no state in which the raw material necessary for the production of product "A" is not available in stock has been experienced. All of the demands have been met the available of raw material inventory.

•When the lead time which is one of the major outputs of the simulation model created is examined, it is seen that the time between the placement and receiving of the order is 1,07 hr/unit. It is among our major goals to shorten the lead time. After the bottlenecks existing in the system are determined and resolved, it is expected that this period will become shorter.

4.5 The effect of the demand change on the current system

As stated also in the beginning (see: Examination of the System), it is thought that the main problem experienced by the company in the current system, is the large amounts of the demands arriving at unforeseen times. In other words, the state that the demand is very change is not managed by the company. For this reason, the effect of the demand change on the current system has been asked to be investigated. Based on this, in order to be able to measure the behaviour of the current system against the demand change, time-based standard deviation values of the

demands made through retail and project sales channels are shown in Table 5. Under the assumption of the 20% of the standard deviation values under normal state, low and high change values have been calculated.

	Standard Deviation for Retail Sales Demand in hours (R_i)	Standard Deviation for Project Sales Demand in hours (P_i)
Low Change	0,26	0,63
Normal State	0,33	0,78
High Change	0,40	0,94

Table 5. Standard Deviation Values against the Demand Change

The combinations that will occur between the change states for the demands made through retail and project sales channels are as given below in Table 6:

(R_1, P_1)	(R_1, P_2)	(R_1, P_3)
(R_2, P_1)	(R_2, P_2)	(R_2, P_3)
(R_3, P_1)	(R_3, P_2)	(R_3, P_3)

Table-6: Combinations between Change States

For each of the combination occurred above, the variables of Responding Demand Percentage and Lead Time values have been reached as shown in Table 4.6 as a result of running of the simulation model for a period of one year. Accordingly, it is seen that the values of these performance criteria taken as a result of different combinations, are very close to each other. In other words, the demand change, contrary to what is assumed has not affected the percent of responding demands and lead time significantly. In this case, it is observed that the major problem in the system is in fact not the demand change, but there exists a critical problem in the operational process/es of system working.

5. PROPOSED SIMULATION MODEL

Within the scope of the reengineering work conducted after the examination of the current supply chain process of the company, the proposed simulation model has been created in the Micro Saint Sharp simulation program. The visual form of this created model in Figure 3 and the details regarding the model are given below.

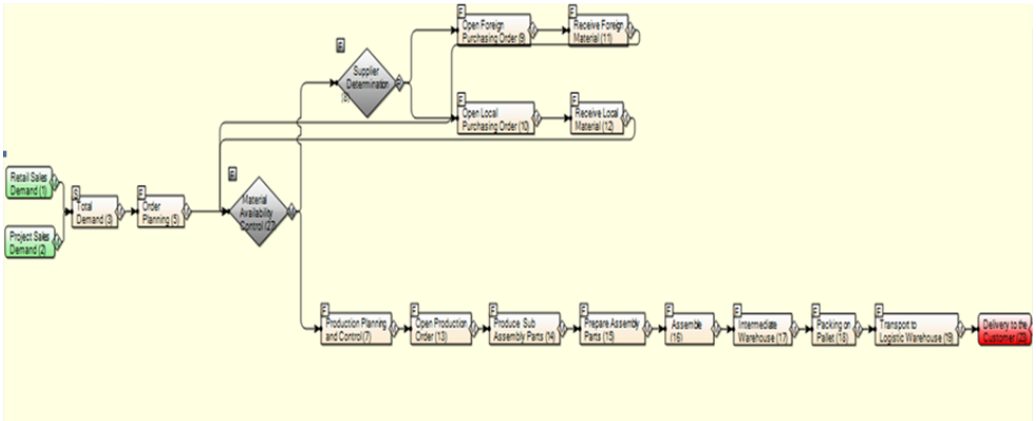

Fig.-3: Proposed Simulation Model

Order planning process which has a critical role on the current system, have been manually made only three times a week on Mondays, Wednesdays and Thursdays. While this causes time loss for labour and also holding of the orders received on other days, it has lowered the system performance. With the redesign of the process, it is proposed that this process be automated on SAP via concurrent program that can be done by the software team of the company or outsources. In other words, before reengineering this process that only three days a week that will be able to be done automatically by the system on every day of the week after reengineering. Thus with saving of time, the system performance will be significantly increased.

In the case that the demand change is at extreme points, as a result of running of the proposed simulation model for a period of one year, the variable of Responding Demand Percentage and Lead Time values have been obtained as shown in Table 7. Based on this, similar to the current system, it is seen that the values that these performance criteria taken as a result of different combinations are very close to each other. Thus, the demand change has not significantly affected the responding demand percentage and the lead time in the proposed system. It has been once more observed that the fundamental problem in the system is not related with the demand change, it arises from the operational process/es.

Demand Change	Responding Demand Percentage	Lead Time (hr)
(R1, P1)	0,839	0,460
(R2, P2)	0,839	0,473
(R3, P3)	0,849	0,440

Table 7. Performance Measurements

In the case that the demand change is at extreme points, as a result of running the proposed simulation model for a period of one year on a monthly basis, the amounts of raw material inventory at the end of each month, and holding costs are shown in Table 5.15. Based on this, for both of the demand types; in the case that low change is experienced, the total annual holding cost is at the minimum level; in the case that high change is experienced, the total annual holding cost is at the maximum level.

6.1. Results and discussion

After the reengineering work conducted via simulation, several results have been obtained. In order to be able to evaluate these results, the findings before and after reengineering have been summarized in Table 8.

Output	Before Reengineering	After Reengineering
Responding Demand Percentage	0,44	0,84
Lead Time (hr)	1,07	0,47
Total Holding Cost (m.u.)	8407	2882
Total Production Cost (m.u.)	18906	36303
Total Cost (m.u.)	27313	39185

Table 8. Comparison of Before and After Reengineering

The following results have been obtained in consequence of comparison of before and after reengineering: The main outputs of the study conducted are “responding demand percentage” and “lead time”. When the values that these outputs taken are examined, while 44% of the demands were being responded before reengineering, it is seen that 84% of them have been responded after reengineering. Thus after the reengineering work, it has been observed that an improvement at a ratio of 91% has been achieved in responding demands. On the other side, when the lead time is examined, as this period was 1,07 hr before reengineering, it has decreased to 0,47 hr after reengineering. Here, an improvement at a ratio of 56% has been achieved. All of these values clearly show us that with its being conducted every day and automation of the order planning process that was earlier done manually three days a week, the process innovation have been experienced in the current system.

Finally, when the previous and after reengineering cost values are examined, a decrease of approximately 66% in the total holding cost after reengineering and an increase of 92% in the total production cost have been observed. The reason why the total production cost has increased this much is the increase of the production amount depending on the improvements in the system performance after reengineering. When the total cost after reengineering is examined, it is seen that an increase at a ratio of 43% is experienced due to the significant increase of the total production cost. Despite the high ratio improvements achieved in BPR projects, increases in the costs are inevitable.

7. CONCLUSION

In this paper, supply chain process of a company operating in the private sector has been examined and the simulation model of the related process has been created in the Micro Saint Sharp simulation program. After running the created model for a period of one year, several performance outputs have been obtained. Major ones of those are “responding demand percentage” and “lead time”. With the assessment of the outputs obtained, the bottlenecks on

the system have been tried to be determined and besides, the effect of the demand change on the current system have been investigated. As a result of the evaluations made, it has been observed that the demand change does not significantly affect the system performance and the main problem is related with the operational processes in the current system. Based on this, the order planning process that has a triggering role for other processes on the system has been focused.

The order planning process conducted manually only three days a week in the current process is proposed to be atomized and be conducted on every day of the week as a solution with process reengineering. In parallel with this, a new model has been designed in the Micro Saint Sharp simulation program. After running this model for a period of a year, several outputs have been obtained. Besides, the effect of the demand change on the proposed system have been investigated and as a result of the evaluations made, it has been concluded that the demand change does not have any significant effect on the system performance. Thus, it has been once more observed that the fundamental problem in the system is not the demand change; it arises from the operational processes.

When the results obtained before and after reengineering are commented, while 44% of demands are being responded before reengineering, it has been seen that 84% of them are being responded after reengineering. Thus after reengineering, it has been observed that an improvement at a ratio of 91% has been achieved in responding demands. When the lead time is examined, while this period was 1,07 hr before reengineering, it has decreased to 0,47 hr after reengineering. Here, an improvement at a ratio of 56% has been achieved. All of these values clearly show us that with being conducted every day and automation of the order planning process that was earlier done manually three days a week, the process innovation has been experienced in the current system. On the other side, with the increase of the system performance after reengineering, it has been observed that the costs increase as well. This state is inevitable in BPR projects. Here, the production amounts have increased and based on this, there has been increase in the production costs and total costs. Besides, based on the solution proposal presented in the IT area; in the case that the company gets outsources to make the necessary software, this will also cause an additional cost. However, in order to succeed in the BPR projects, IT infrastructure must be very strong. As it is emphasized one of the critical success factors is the IT infrastructure in BPR projects. Therefore, the companies should introduce innovations into the IT area during their business processes as far as possible by considering the changing and developing technology.

The solution proposed in this paper is basic and easy to apply practically. Therefore, it can be easily applied in the company where it is handled during the study and in the case that it is applied, it will provide significant benefits. Also, the solution proposal propounded is expected to help similar companies trying to redesign their business processes in order to achieve dramatic improvements in the performance. It is possible to develop the in question study from several aspects. For example, the created model can be run for a different product type on the basis of more performance measures. Thus, different bottlenecks on the system can be determined and based on this; different solution proposals can be presented.

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