

Business Process Re-Engineering For Smart Manufacturing

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Abstract-Business process re-engineering is an essential part for smart manufacturing companies. It presents the important factors like time, resource utilization and cost before the practical implementation. In particular, time is a significant factor for business process simulation to acquire the customers' satisfaction. It's a challenging task to complete a business process promptly. In this paper, we proposed a process model named M1 by using the BPMN approach on Bizagi simulator to show the business process steps of a tool manufacturing company then we modified M1 and proposed a new process model M2 in order to reduce the working hours that we had by following the processing steps in model M1.

Keywords- Business Process Re-engineering, Manufacturing, BPMN, Business Process, Process Model.

I. INTRODUCTION

A. BUSINESS PROCESS MODEL [1]

Business Process Models are designed by using either UML activity diagrams or by using BPMN. In the field of business processes people prefer to use BPMN as it provides a notation which can be easily understandable by the users and as well as it can be used for simulations of Business Processes. There are various tools which can support the BPMN for simulation; we used Bizagi as a modeling tool.

BPMN is usually used for business process modeling and it has also the ability to represent an aspect of a work flow more efficiently.

The elements of BPMN modeling allow expressing the simple structures into business processes. The elements which are used in it are easily comprehended by the process designers and practitioners without any extensive training. BPMN is considered to be a framework than a concrete language, because sometimes expressions are not covered by the standard so they are left to the process designer.

B. BACKGROUND

BPMN is developed by BPMI and is currently maintained by OMG. It is a bridge communication between business process design and implementation. It is simple as well as easy to understand as it is similar to flowcharts and UML Activity diagrams. We can draw various types of diagrams at this platform named as process, collaboration and choreography.

Following are the Business Process Model and Notation (BPMN) elements [2].

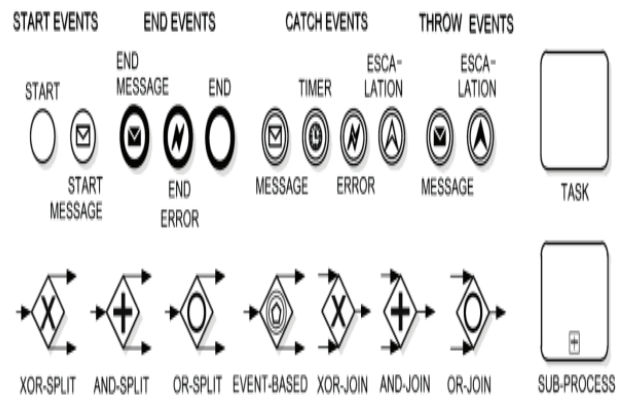


Figure 1

C. PROBLEM STATEMENT

This research addresses the following problem.

“To study what should the workflow for a manufacturing company to perform various tasks for their projects and how to reduce the working hours while performing different tasks by workers in a smart manufacturing company and How a Business Process Model can reduce the processing time by using automation at each step by using same number of resources”.

II. BUSINESS PROCESS MODELING METHODS

This section introduces various BPM methods in the literature, listed and discussed in the following subsections

1) By using PROCAS, researchers integrated CAD and CAM information into BPMN process model to calculate how inventories and production lines have to be extended for further product variants [3].

2) Production logistics system has been modeled by using a case study to examine the BPMN language. Modeling is carried out for three sub-systems. All the critical flows of objects and data have been addressed by using UML activity diagrams [4].

3) In [5] the BPMN is extended to uBPMN (**ubiquitous BPMN**). For this purpose the modeling requirements have been analyzed. The meta-object Facility meta-Model, XML schema of BPMN and notation has been extended.

4) An analysis on an existing IHC (Integrated Home Care) has been presented by using BPMN. An IHC model has been proposed that allows early detection and resolution of critical issues [6].

5) A concept and a design has been described by using CDME model and by defining manifold requirements for a domain specific extension of BPMN for the intraoperative surgical work flow modeling and for the execution in the integrated OR (operating rooms)[7].

6) Stroppi et al.(2011) present a procedure model based on model transformation, for the methodical development of valid BPMN extension model and another integrated procedure model for the BPMN extension design has been shown by Braun and Schulieter(2014) to extend the Stroppi et al. (2011) approach. The authors describe analysis step for domain requirements to identify the requirements of general modeling approach. A decision will be made based on these requirements for the suitability of BPMN [8].

7) A valid BPMN extension has been provided for CPs, which provides diagrams for documents and resources separately in order to enable stakeholder-specific perspectives for the reduction of complexity [9].

8) In [10] an analysis has been presented for the collaborative business processes in the service oriented architecture researchers proposed an evaluation method by using execution traces of business process combining it with a high-level assessment method using key performance indicators.

9) A multiagent-based is proposed for pedestrian simulation in subway stations which integrates all elements of subway station simulation together and provides an application of Meta model proposed by *Behe* [11].

10) Researchers proposed a formal token-based BPMN semantics by taking BPMN2.0 then the proposed simulation technique is implemented on top of existing plug-ins for Process Mining Framework and it has been verified on various models [12].

11) A relyBPMN extension has been proposed to involve resource reliability information on business processes modeled with BPMN languages. Researchers provide use case with examples including human resources

and sensors and also considering their reliability information on resource assignments [13].

12) An approach of BPs verification has been proposed based on a provided model and as well as on the events logs from process execution in BPMN2.0. This BPs verification concerns on control flow and data flow perspectives of processes[14].

13) In [15] BPMN has been used to propose an agent-based simulation (ABS) conceptual model by developing a web-based visual modeling tool called ABMN Designer.

III. RESEARCH DESIGN AND METHODOLOGY

Since the tool manufacturing companies require a complete work flow to be followed before to start any project in order to deliver the products to the customer on time.

In this chapter we elaborate the steps that are being followed to achieve the main target.

- **Stage 1**

The research methodology is aligned with the objective to design a business process model named as M1 for a tool manufacturing company. That model M1 provides a complete work flow for the company in which the workers of each department and their tasks are explained in detail.

- **Stage 2**

Once the model M1 is completed then we simulate that model M1 and if it shows a large amount time to complete a single project then we try to find out those factors due to which it takes a lots of time to complete that project.

- **Stage 3**

After finding out those points on which the time can be reduced i.e. if a worker is performing the task manually in any department of the organization then we provide any other option for him/her to complete the tasks. We modify the model where the changes are required to achieve good results.

- **Stage 4**

Once we made the required changes a new modified model M2 we have that model will be simulated and then compare the results of M2 with the previous model M1. The result of M2 must be better than M1. So the model M2 is then considered the final model to be followed by the manufacturing industry.

IV. IMPLEMENTATION AND SIMULATION

In this section we show the business process models M1 and M2. First we show the model M1 and those areas in it which can be modified in order to produce a better result. Then in the next section we elaborate the results of each model and then compare them.

A) Model 1

1. M1 Structure

First we design a model to give a work flow to a manufacturing company. In the model below we designed three departments and then hire workers to perform the tasks in each department. We assign the total number of workers in each department in the Fig no.3 and also assign them one by one at each point to perform the tasks in the table no.1.

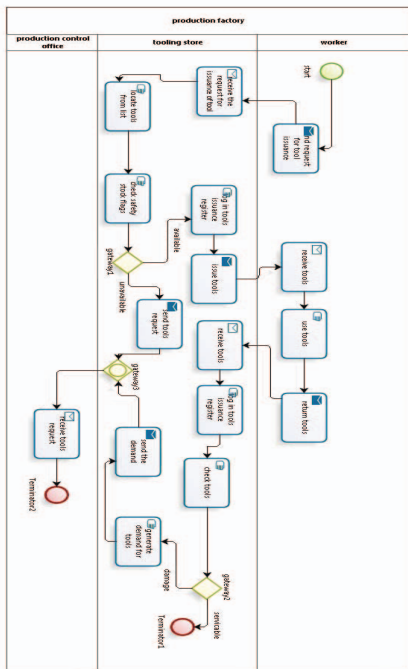


Figure 2

2. M1 Resources

Once we complete the model then assign the total number of workers to each department separately. The total period of project completion in any company really depends on the assigned resources also.

TOTAL NUMBER OF RESOURCES

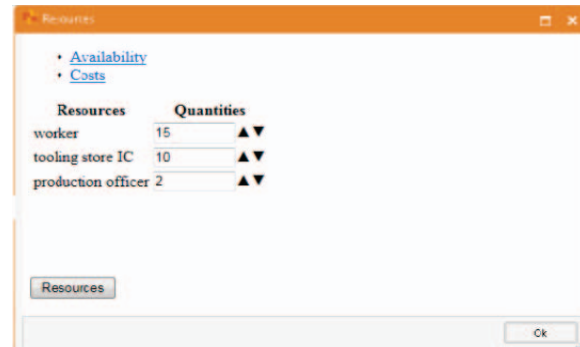


Figure 3

RESOURCE AT EACH TASK

Task Name	Input (Number Of Resources)
Send request for tool issuance	Worker=1
Receive request for issuance of tool	Tooling store IC=1
Locate tools from list	Worker =1
Check safety stock flags	Tooling store IC=1
Log in tools issuance register	Tooling store IC=1
Issue tools	Tooling store IC=1
Receive tools	Worker =1
Use tools	Worker =1
Return tools	Worker =1
Receive tools	Tooling store IC=1
Log in tools issuance register	Tooling store IC=1
Check tools	Tooling store IC=1
Generate demand for tools	Tooling store IC=1
Send the demand	Tooling store IC=1
Send the tools request	Tooling store IC=1
Receive tools request	Production officer=1

Table 1

3. *MI Time*

At this level we assign the processing time and wait time as inputs to each Event Task and to each Gateway also.

Name	Type	Input
start	Start Event	Arrival interval=10mins Maximum arrival count=1000
Send request for tool issuance	Send Task	Wait time = 5min Processing time=5min
Receive request for issuance of tool	Receive Task	Wait time = 5min Processing time=5min
Locate tools from list	Manual Task	Wait time = 5min Processing time=10min
Check safety stock flags	Manual Task	Wait time = 5min Processing time=10min
Gateway1	gateway	Available =70% Unavailable =30%
Log in tools issuance register	Manual Task	Wait time = 5min Processing time=10min
Issue tools	Send Task	Wait time = 5min Processing time=5min
Receive tools	Receive Task	Wait time = 5min Processing time=5min
Use tools	Manual Task	Wait time = 5min Processing time=2hours
Return tools	Send Task	Wait time = 5min Processing time=5min
Receive tools	Receive Task	Wait time =5min Processing time=5min
Log in tools issuance register	Manual Task	Wait time = 5min Processing time=10min
Check tools	Manual Task	Wait time = 5min Processing time=12min

Gateway2	gateway	Available=75% Unavailable =25%
Generate demand for tools	Manual Task	Wait time = 5min Processing time=7min
Send the demand	Send Task	Wait time = 5min Processing time=1min
Send the tools request	Send Task	Wait time = 5min Processing time=1min
Receive tools request	Receive Task	Wait time = 20min Processing time=5min

Table 2

4. *Identified Points to Modify*

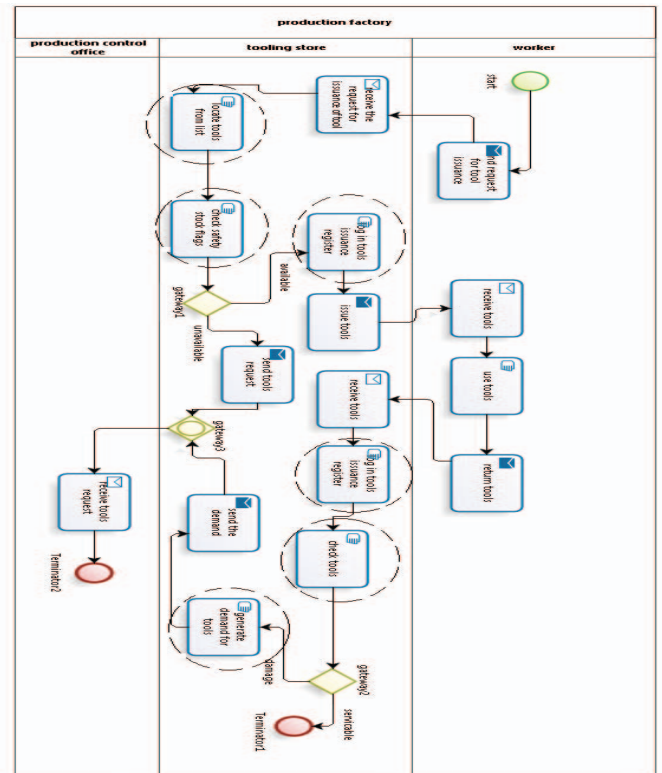


Figure 4

B) Model 2

1. M2 Structure

We have to reduce the time shown by the model M1 to complete the tasks. So, we made some changes in M1 to reduce the working hours. The modified model is M2 which is shown in Fig 5. We almost replaced all the manual tasks which are pointed to modify in the Fig no.4 with the user tasks.

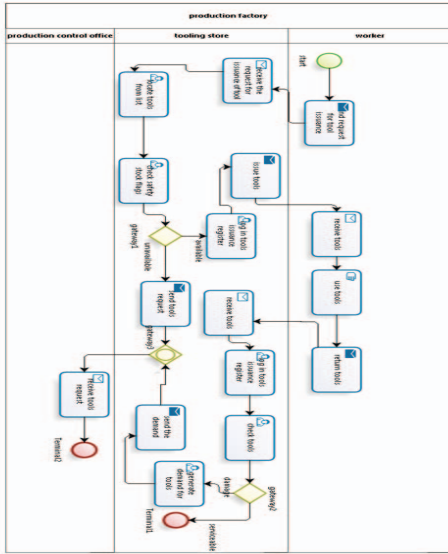


Figure 5

2. M2 time

In the M2 we assign values of processing and wait time for each user task but the values for other tasks as same as in the M1.

Name	Time (minutes)
Locate tools from list	Wait time =5 Processing time=2
Check safety stock flags	Wait time =5 Processing time=2
Log in tools issuance register	Wait time =5 Processing time=2
Log in tool issuance register	Wait time =5 Processing time=2
Log in tools issuance register	Wait time =5 Processing time=2
Check tools	Wait time =5 Processing time=2
Generate demand for tools	Wait time =5 Processing time=2

Table 3

v. RESULTS and DISCUSSION

A) Result

1. M1 Result

By following the work flow of the model M1 in the fig no.2 we get the result that has been shown in the table no.4. In which the total number of time to complete the whole task is 153300 minutes which is equal to 106 days and 11 hour.

Name	Type	Instances completed	Instances started	Min. time (m)	Max. time (m)	Avg. time (m)	Total time (m)
production factory	Process	1000	1000	36	215	153.3	153300
start	Start event	1000					
Terminator2	End event	481					
receive the request for issuance of tool	Task	1000	1000	5	5	5	5000
send request for tool issuance	Task	1000	1000	5	5	5	5000
gateway1	Gateway	1000	1000				
receive tools request	Task	481	481	5	5	5	2405
send tools request	Task	307	307	1	1	1	307
issue tools	Task	693	693	5	5	5	3465
receive tools	Task	693	693	5	5	5	3465
return tools	Task	693	693	5	5	5	3465
use tools	Task	693	693	120	120	120	83160
receive tools	Task	693	693	5	5	5	3465
gateway2	Gateway	693	693				
Terminator1	End event	519					
send the demand	Task	174	174	1	1	1	174
gateway3	Gateway	481	481				
locate tools from list	Task	1000	1000	10	10	10	10000
log in tools issuance register	Task	693	693	10	10	10	6930
check safety stock flags	Task	1000	1000	10	10	10	10000
log in tools issuance register	Task	693	693	10	10	10	6930
check tools	Task	693	693	12	12	12	8316
generate demand for tools	Task	174	174	7	7	7	1218

Table 4

2. M2 Result

By following the steps of the model M2 in the fig no.3 we get the total time to complete the whole project is 118388 minutes which is equal to 82days 5 hours and 8 minutes.

Name	Type	Instances completed	Instances started	Min. time (m)	Max. time (m)	Avg. time (m)	Total time (m)
production factory	Process	1000	1000	20	168	118.388	118388
start	Start event	1000					
Terminal2	End event	478					
receive the request for issuance of tool	Task	1000	1000	5	5	5	5000
send request for tool issuance	Task	1000	1000	5	5	5	5000
gateway1	Gateway	1000	1000				
receive tools request	Task	478	478	5	5	5	2390
send tools request	Task	307	307	1	1	1	307
issue tools	Task	693	693	5	5	5	3465
receive tools	Task	693	693	5	5	5	3465
return tools	Task	693	693	5	5	5	3465
use tools	Task	693	693	120	120	120	83160
receive tools	Task	693	693	5	5	5	3465
gateway2	Gateway	693	693				
Terminal1	End event	522					
send the demand	Task	171	171	1	1	1	171
gateway3	Gateway	478	478				
locate tools from list	Task	1000	1000	2	2	2	2000
check safety stock flags	Task	1000	1000	2	2	2	2000
log in tools issuance register	Task	693	693	2	2	2	1386
log in tools issuance register	Task	693	693	2	2	2	1386
check tools	Task	693	693	2	2	2	1386
generate demand for tools	Task	171	171	2	2	2	342

Table 5

B) Discussion

We save 24 days and 16 hours by reducing the total required time to perform the whole business process from 106 days and 11 hours to 82 days 5 hours, by using the same number of resources that were assigned as whole and were also assigned individually to perform the each different task. Model M1 shows a number of “manual tasks” that take more time to complete a business process step. In the modified model M2 we replaced most of the *manual tasks* with the *user tasks* from the swim lane named as “tool IC”. Now each “user task” completes its individual tasks more quickly as compare to the each “manual task” consequently we get better results from M2.

C) Future Scope

- i. This study is applicable for all goods and services industries in general and manufacturing industry in particular.
- ii. It helps to improve the business process strategy.
- iii. It also helps the engineering and management graduates to have practical knowledge of Road map to complete tasks in a more short timing via a suitable model, its designing, implementation and simulation.
- iv. Last but not the least it will also enable students of Masters and Bachelors degree's to understand the structure of applied research and its execution.

VII CONCLUSION

A business process model has been implemented and simulated for a tool manufacturing company and then that model has been modified to reduce the manual tasks through automation. From the first model we picked out those points which can be improved to acquire a better result. In this paper we explicated both of the models in detail. The implementation of these process models and their simulation reduce the delay while performing various tasks throughout the whole process. It increases the customers' satisfaction as the companies precede their requests quickly.

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