Process Re-design and Automation Using Enterprise Resource Planning System for Manufacturing Industry

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Abstract. In the era of Industry 4.0, automation is the backbone for any industry to grow and sustain. Many studies suggest that ERP system helps industries to integrate and automate most of the business processes, enhance production efficiency and financial performance. However, the manufacturing industries with make-to-order business model are struggling with production planning and control systems. The aim of this research is to provide solution for overcoming the problems of late order deliveries, cost overruns and limitation of communications and information flow associated with production planning and control in manufacturing industries. A qualitative case study in a steel parts manufacturing industry is conducted to understand and analyze the prevailing problems and processes. Based on observations, a business model is proposed by re-designing according to standard practices of ERP system, then ERP System is selected and designed according to the case industry requirements. This paper mainly focuses on implementation of the Manufacturing module. To verify and analyze the impact of automation, data is collected from case industry for implementation and execution in ERP System. After implementation, significant reduction of production wastages in terms of paperwork, time and error is observed, saving the costs and time related to these wastages. Hence, it is found that ERP System contribute in improving production planning and control system for case industry by ensuring timely delivery and cost control due to better production planning and monitoring and provide real-time visibility of data and information, enhancing business performance.

Keywords: Production Planning and Control, Cost Control, Order Delivery, Process Automation, ERP, Business Processes, Communications.

1 Introduction

Use In today’s world of technology, digital transformation is greatly being embraced across various manufacturing industries. With fourth Industrial Revolution, known as “Industry 4.0”, the world of manufacturing is also changing. ERP System is among one such tool that provide the industry owners a complete view of all aspect of their operations based on real
time with accuracy and speed, which ultimately enhance functional collaboration, productivity, business processes and better decision making [1-6]. The operational efficiency is enhanced by automating the processes using ERP Systems [7-8] while helping them in transforming and improving business processes [9-10]. This ultimately paves the way for using ERP system in manufacturing industries. Manufacturing industries are facing issues related to production planning and control, resulting in late order deliveries, cost overruns, inefficient resource utilizations, inappropriate production scheduling, uncertainty in supply chain and poor cross-functional collaborations and communications. One common reason is that most of these industries use spreadsheets, manual or disparate systems to manage production planning which is time consuming, error-prone, lack integration and real-time visibility. The production planning is more challenging for industries with make-to-order business model (process start only after customer order), as it requires complete integration of core business functions i.e. sales, production, procurement, finance etc. to ensure timely delivery of order while also controlling other inefficiencies of processes. To overcome such challenges, many studies recommend to adopt ERP Systems. ERP system helps to simplify and streamline largely technical business processes of manufacturing industries [11-13].

From Studies, it is also found that Odoo ERP System can also be implemented in manufacturing industries to improve the operational performances [14-15]. Hence, in this research, an industrial case study is conducted to provide the basis for improving the production planning activities through analyzing the feasibility of adopting and implementing of Odoo ERP Systems by first re-designing and developing the proposed framework of business process and then their automation using Odoo ERP System in manufacturing industry with make-to-order business model. The purpose is to investigate the impact of automating the processes using Odoo ERP System on production planning activities and to determine whether ERP system could contribute in in-time and within budget delivery of orders, cost control, streamlining and integrating the business processes and reducing the production wastes.

2 Research Methodology

The methodology of this research is comprised of three phases, namely; i) Problem Review and Case Study Analysis, ii) Business Process Re-Designing, iii) ERP System Design and Implementation, as shown in Fig. 1. In first phase, the problems related to production planning and control function is analyzed through qualitative case study approach in a steel parts manufacturing industry and as result, major issues in information flow, late deliveries, cost overruns and poor communications are observed. It is found from many studies that such problems can be reduced by automating the process and adopting ERP Systems, therefore, the same is investigated in this research. In second phase, an improved framework for business process (To-Be) is proposed. In last phase, based on the requirements of case industry, ERP System is selected and designed by defining the implemented modules and features. The collected data from case study is used for implementation in ERP System for verifying and analyzing the impact of processes automation on case industry business performance.
3 Industrial Case Study and Analysis

A qualitative case study is done for selected case industry to analyze its processes through direct observations, interviews and focus groups. In this research, a steel parts manufacturing industry is selected as the case industry. This case industry is facing most problems related to production planning and communication which result in:

1. Late order deliveries
2. Cost fluctuations and escalations
3. Inefficient inventory management
4. Poor information flow and cross-functional communications

The case industry is currently using an in-house financial management software as its legacy MIS system for its day-to-day financial cash flows, vouchers generation etc. which is insufficient to support and cater for streamlining the other business functions of the industry. Most of the data and documentation is through MS Excel/Word and no integration among different business functions is existed.

3.1 Existing Business Process (As-Is Analysis)

To get better understanding of the processes of case industry, the existing business process are studied and As-Is analysis is shown in Fig. 2 below, along the processes phases, i.e. order initiation to production planning and then production activities.

![Fig. 2. Existing Business Process Design (As-Is Analysis).](image-url)
3.2 Observations

After studying and observing the existing working processes in case industry, all main processes are further investigated through direct observations, individuals interviews and focus group discussions to get better understanding and insight of prevailing problems in the case industry. The summary of the observations is shown in Table 2 below:

Table 1. Summary of Case Study Observations.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Initiation</td>
<td>Direct Observation &amp; Interviews</td>
<td>100% Manual</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>(Sale Enquiry &amp; Sale Order)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production Planning</td>
<td>Direct Observation, Interviews &amp; Focus Group</td>
<td>85% Manual &amp; 15% MIS Legacy System</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>(BOM, Job Card/ MO, Stock Check, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>Direct Observation &amp; Interviews</td>
<td>100% Manual</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>(Routing, Loading, Scheduling, etc.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3 Data Collection for Sample Product

For verification and implementation in ERP System, the sample product, namely, Flange Coupling Assembly is selected from case industry. The slip-on flanges design specifications are according to the ASME/ANSI B16.5 Standard as shown in Table 2 with bolts, nuts and washers as vendor items and presumed to be available in stock while the operations employed for manufacturing of flanges in case industry are shown in Table 3, with sequence and work centers where these operations are performed.

Table 2. Design Specifications & Structure for Sample Product.

<table>
<thead>
<tr>
<th>Parts Description</th>
<th>Quantity (for 01 Set)</th>
<th>Total Quantity (for 100 Set)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip-on Flanges (16”, Class: 300)</td>
<td>02</td>
<td>200</td>
</tr>
<tr>
<td>Hex Head Bolts (M33, L190)</td>
<td>20</td>
<td>2,000</td>
</tr>
<tr>
<td>Hex Head Nuts (M33)</td>
<td>20</td>
<td>2,000</td>
</tr>
<tr>
<td>Plain Washers (OD 33)</td>
<td>40</td>
<td>4,000</td>
</tr>
</tbody>
</table>

Table 3. Manufacturing Process Design for Sample Product

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Operation/Process</th>
<th>Work Center Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Casting of Ingots</td>
<td>Casting Station #12</td>
</tr>
<tr>
<td>2nd</td>
<td>Forging of Ingots</td>
<td>Forging Station #12</td>
</tr>
<tr>
<td>3rd</td>
<td>Turning of Forged Rings</td>
<td>Lathe Station #12</td>
</tr>
<tr>
<td>4th</td>
<td>Drilling of Holes for Bolts</td>
<td>Drilling Station #12</td>
</tr>
<tr>
<td>5th</td>
<td>Inspection</td>
<td>Assembly Line #12</td>
</tr>
<tr>
<td>6th</td>
<td>Assembling of Coupling</td>
<td>Assembly Line #12</td>
</tr>
</tbody>
</table>
4 Results and Discussions

4.1 Proposed Business Process (To-Be Analysis)

Based on the observations and issues highlighted in case study, the gap analysis between the existing processes and in-built standardized processes of Odoo’s ERP system is performed and as result the proposed business model is obtained as shown in Fig. 3 below. Based upon the obtained gap and case industry mandatory requirements, the existing business process (As-Is) is re-designed by incorporating few improvements and adjustments to provide the improved proposed business process (To-Be). The To-Be analysis based on selected ERP modules, i.e., Sales, Manufacturing, Inventory and Purchase, along the main phases of case industry business process.

![PROPOSED BUSINESS PROCESS DESIGN (TO-BE ANALYSIS)](image)

**Fig. 3.** Proposed Business Process Design (To-Be Analysis).

4.2 ERP System Design

For this research, Odoo ERP System is selected because it is open-source, and both budget and user friendly. With emphasis on manufacturing, the main module used for implementation and analysis in this research is Odoo’s Manufacturing Module, along with Sales and Inventory Modules. Features that will be implemented are:

### 4.2.1 Sales Module

Feature that will be implemented in Odoo’s Sales Module is the “Creation of Sale Order”.
4.2.2 Manufacturing Module

Features that will be implemented in Odoo’s Manufacturing Module are:
1. Definition of Work Center
2. Creation of Bill of Materials
3. Definition of Routing & Operations
4. Creation of Manufacturing Order

4.2.3 Inventory Module

Features that will be implemented in Odoo’s Inventory Module is “Creation of Delivery Order”.

4.3 Implementations in ERP

At this stage, the final implementation of collected data is done for verification. The ERP system is configured with the requirements of case subject industry’s business processes. With reference to the proposed business process design (To-Be), as shown in Fig. 3, the Sale Order – SO is generated through Odoo’s Sale Module and afterwards a Manufacturing Order – MO is generated through Odoo’s Manufacturing Module, by defining Work Centers, Bill of Materials and Product Routings and Operations. The Manufacturing Order – MO is released to perform the manufacturing of non-available item of the sample product (Slip-on Flanges), according to routings and operations at defined work centers. After completion to finished product, the Delivery Order is generated through Odoo’s Inventory Module while finished product is transferred to the warehouse for shipment. The main input data required is the Bill of Materials with details of components, operations and work centers and the updated stock level. Based on the collected data, the implementation in Odoo’s ERP system is executed as following steps shown in Table. 4 below.

Table. 4. Steps for Implementation in Odoo ERP System

<table>
<thead>
<tr>
<th>Module’s Features</th>
<th>Features Display</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sale Order:</strong></td>
<td></td>
</tr>
<tr>
<td>Using Odoo Sales</td>
<td></td>
</tr>
<tr>
<td>module, the new</td>
<td></td>
</tr>
<tr>
<td>Sale Order is</td>
<td></td>
</tr>
<tr>
<td>generated for sample</td>
<td></td>
</tr>
<tr>
<td>product of “Flange</td>
<td></td>
</tr>
<tr>
<td>Coupling Assembly”</td>
<td></td>
</tr>
<tr>
<td>with order quantity as 100 Sets.</td>
<td></td>
</tr>
</tbody>
</table>
### Work Center:

Using Odoo Manufacturing module, all the involved six work centers for manufacturing the sample product is defined. The display of details of all parameters of work center named Casting Station #12 is shown while all others can be defined in the same manner.

### BOM:

To add the details in Bills of Materials (BOM), Odoo Manufacturing module is used with reference data from Table. 2. The display of Bill of Materials is shown:
Routing/Operations:

The data for operations description and sequence and work centers from Table 3 is used in Odoo’s Manufacturing module for defining the routings and operations and display is shown:

Manufacturing Order:

After all the data configured and defined, the next step is to create the Manufacturing Order – MO in Odoo Manufacturing Module, as shown:

Delivery Order:

After the completion of all manufacturing processes, the delivery order is generated in Odoo’s Inventory module for shipment of the product to the customer as shown:
5 Conclusions

This research investigates the impact of advance concepts of industry 4.0 and automation on production planning and control activities in manufacturing industries through Odoo ERP system by focusing on the problems of late order deliveries and cost overruns associated with production planning and control. For this purpose, an industrial study is done on a steel parts manufacturing industry to understand the problems in real environment and a framework of “To-Be Business Process” is proposed based on best practices of Odoo ERP system to automate and improve the case industry business processes. The data is collected from case industry and used for implementation in selected Odoo modules. The implementing features of Odoo Sales module includes the Sale Order, Manufacturing module includes the Bill of Materials, Operations, Routings and Manufacturing Order and Inventory module includes the Delivery Order. After the implementation of case study data in Odoo ERP System, it is observed that the automation of processes results in significant reductions of production wastages in terms of paperwork, time and error. Thus, it is concluded that Odoo ERP System contribute in improving the production planning and control system for the case industry by facilitating in actual time tracking of production for accurate costing, saving the time of manual working, limiting the errors, saving the costs related to wastages and ensuring the timely delivery by better production planning and monitoring. Implementation of Odoo ERP System also helps in integrating and streamlining the business functions, ensuring transparent and real-time visibility of data and information, thus better management reporting, communication and decision making. The findings of this research would be the roadmap for concerned professionals of manufacturing sector to adopt and implement the ERP systems in their domains. Further research can be done by incorporating the implementation of other Odoo modules like Accounting, Purchase and Quality along with selected modules of this research, to analyze the impact of their implementation in respective business functions and on overall business performance and by using other ERP Systems/Suits available in market.

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