The Study on the Application of Business Intelligence in Manufacturing: A Review

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Abstract

A manufacturing based organization operates in an environment where a fast and effective decision is needed. This is to ensure that the output is met with customer compliance. There exists manufacturing systems that collect the operational data and the data turns out to be in a high volume due to the state of the art of the abundant manufacturing operational data. Having a lot of data without the tool to analyze and extracting valuable information from it, increases the amount of time spent by employees focusing on the data itself. This eventually leads to a delay in a decision making process, resulting in a delay of products delivery to customer. To fill in this gap, a Business Intelligence (BI) implementation will be reviewed, with the aim to execute the right action at the right time or in other words, to improve the decision making process of an organization.

Keywords: *Business Intelligence, Manufacturing, Visual Representation.*

1. Introduction

The manufacturing industry may be the main resources for profit for a certain country. It is one of the major business activities. As the competition rises and customers become more demanding, the world has started to find a way to sustain and increase their profit. Because of the business states and environments which have now become globalized, there is a need to have a fast decision based on the updated information. The growth in the manufacturing sector has supported the world economy positively [25]. Growth in 2010 was revised from 4.3% to 4.5%, while in 2011 it was revised from 3.8% to 3.9%.

In Malaysia, sales in the manufacturing sector went up to 8.5% from the year 2009 to November 2010 [24]. The growth is seen rapidly high in the area of computer peripherals and electronics manufacturing industry. The computer peripherals and electronic product manufacturing company produces computers, computer peripherals, communications equipment and other electronic products. Examples of the products are printers, scanners, fax machines and so on. These products are used in homes and businesses, as well as in government and military sectors. The focus to synchronize business with the manufacturing unit of the manufacturing operations is needed as the segment has increased globally for more value-added chain [21]. Even though the computerized systems in the manufacturing companies for higher productivity, quality and lower production costs produce large volumes of data, the valuable knowledge might be hidden in it [14]. Having a lot of data does not guarantee that the most critical information is being attended. In a manufacturing based organization, a fast and quick decision is very much needed to ensure that the in house operation corresponds to the customer needs. The problem that arises in a shop floor control with this abundance of data is that, decisions are difficult to make in real-time by the status of the shop floor [16]. Two technologies are seen to improve the knowledge available to decision makers. They are the Business Intelligence (BI) and Knowledge Management [29]. The BI systems are chosen since they are becoming increasingly more critical to the daily operation of organizations [27].

2. Manufacturing Processes and Problems

A manufacturing organization consists of many processes initiating from customer orders until the delivery of products to customers [10]. The process flow in a manufacturing company is as shown in Figure 1. Being the general flow of the manufacturing organization, it might vary from one organization to another.

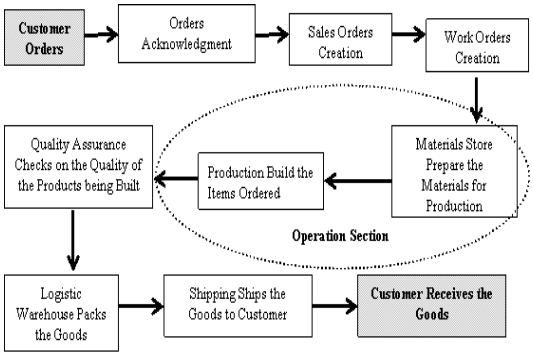

Fig. 1 Manufacturing Process Flow.

The problem seen in the operation section is that, whether the products have been completely built by the production folks or not, they are unknown [4]. The whole process stays invisible to others as there is no real-time information, unless we go down to the production floor itself and check the status ourselves. The problem seen in the Operation Section or also called the shop floor and production here is, the urgent customer orders are often overlooked. In other words, the priority of the orders in accordance to its delivery schedule is not being monitored and carried out. Employees tend to pick a simple order and item (that does not have so many materials to build for example) to fulfil. In addition, if ever exists an order which requires further attention, even though remarks are put in the list, this order is often neglected. Rarely will it be reviewed back by the production employees after the remarks have been updated. This results in the delay of delivery of that item, eventually affects the on time delivery performance of the organization. Moreover, in the program management side of the organization, a frequent follow up with the operational staffs has to be made to push them to fulfil the top priority orders.

In addition, many manufacturing organizations struggle with issues like the overall enterprise processes and information visualizations are limited, and also, manual forms and unstructured data not readily integrated or understood in relation to other data and systems [23]. Data are recorded from nearly all of the processes in the organization like the scheduling, assembly, material planning and control and many others. However, to make use of the collected data turns out to be an issue [12].

There exist several systems to serve the purpose of monitoring the shop floor activities like the Manufacturing Execution System (MES), Enterprise Resource Planning (ERP), Manufacturing Resource Planning (MRP) and Supply Chain Management (SCM) [15, 22]. However, those systems are lacking of analytical and historical data aggregation features that are needed for an organization to build up its value by executing intelligent business processes.

BI is said to overcome those problems as its implementations in the manufacturing industry, particularly the electronics and computer peripherals section will be reviewed here.

More and more manufacturing enterprises hope to take advantage of BI to transform the abundant data into information and knowledge to acquire competitive edge [7]. Without having to dig the valuable information from tedious reports and spreadsheets, BI application has the ability to foresee the future, like monthly delivery requirements, single and real-time operational data view and important information consolidation and presentation in high level [19]. A survey from Gartner and Forrester shows that majority of the firms are interested in investing the BI systems [5]. In the context of a widespread data analysis, BI is used to generate information that is decisive for appropriate actions to be taken [5].

3. Business Intelligence in Manufacturing

BI is defined as the method of converting data into information and subsequently to knowledge [18]. The types of knowledge obtained are about the customer requirements and decisions, organizational performance in the industry and the global trends. Another definition of BI, particularly the BI systems is, BI systems put together the gathering and storage of data and knowledge management with analytical tools to present a ready-for-action and complicated information to the planners and decision makers [28]. This is to assist them to obtain the right information at the right time, location and form.

Cindi Howson defines BI as a set of technologies and procedures that permit people at all levels of an organization to access and analyze data [6]. It permits people at all levels of an organization to access, interact with, and analyze data to manage the business, improve performance, discover opportunities and operate efficiently [6].

In this paper, Business Intelligence is defined as, information obtained to aid the decision making process of a business segment through the transformation of the existing data. The information is presented visually to give the intended users a clear guidance for a smooth decision making process and most importantly, an accurate and fairly fast decision.

The BI has been widely used nowadays in the manufacturing industry, to solve organizational issues from the business perspective, especially in decision making to maintain the company's competitiveness. As shown in Figure 2, a research by the Ventana Research on the BI applications has come out with the most of the respondents coming from the Services and Manufacturing industries.

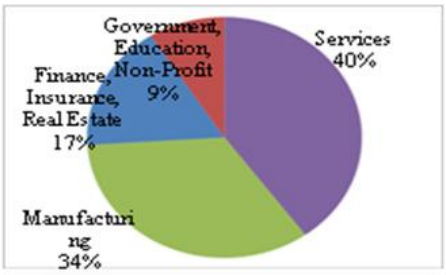

Fig. 2 Type of Industry with the most Participants of BI Demographic Survey. (Source: Ventana Research). 2006.

Since the production section of a manufacturing company plays a very important role where the operation runs, the BI is commonly applied in this area of an organization. Figure 3 shows that the Best-in-Class organization applies BI in the operation section.

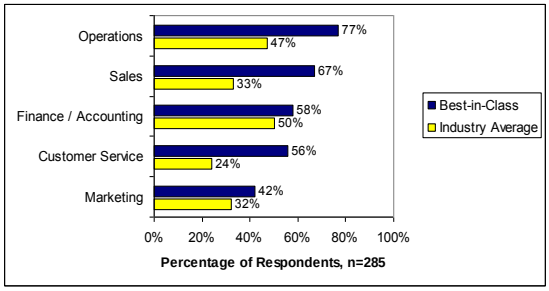

Fig 3. Statistics on the Usage of Business Intelligence Applications in Operations for Best-in-Class Organizations (Source: Abedeen Group). 2009.

Thus, this study will focus on the application of BI in the operation section of a manufacturing company. The next section will analyze the previous research pertaining to the application of BI in the operation or production department of different segments of manufacturing organizations.

4. Previous Studies

An elaboration of the previous studies related to the application of BI in manufacturing organizations in the operation or production site will be discussed in this sub topic as Table 1 shows.

From Table 1, nine paper works from different manufacturing sectors will be analyzed. The classification is done according to the manufacturing sector, problems, BI solution for the problems and the results obtained from the BI tools applied.

All the nine researchers who studied on the BI application in the manufacturing company applied it in the Production or Operation section of the organizations. There are different areas of manufacturing where the studies had been done, which are semiconductor, cement, chemical, faucet, electronics, general manufacturing enterprise, plastics and chemistry and automotive.

The studies show problems related to business data and execution of the organization. The most common problem is the reports inconsistencies and difficulties. This eventually imposed a delay in decision making process. Other than that, the lack of visibility of certain business activities are also the major concerns for the manufacturing firms. The need to increase the production output is also among the common challenge for the manufacturing organizations to implement the BI.

With the major problems faced by the manufacturing organizations, researchers have come out with different types of BI framework. Majority of the studies focused on developing frameworks that are doing the integration of the existing systems with the BI services. The second popular BI framework for solving the problems of business execution for manufacturing organizations is the dashboard. There is also the web based tool implemented.

Above all, it is the benefit of the BI applications that all of the manufacturing companies are looking for. The most obvious results of BI applications that benefit them is the ability to see the performance of certain business process in real-time or the visual representation of data in an informative manner. A number of manufacturing organizations also experienced higher productivity while reducing the manufacturing cost. The benefit of improving the customer related activities is also gained.

Thus, it can be concluded from the previous studies that the manufacturing industry indeed did implement the BI applications in order to boost up its growth. In its highly competitive market, where the manufacturing organizations are facing with a large volume of data, BI is seen to be the best solution for all. In order to establish a BI framework, researcher must focus on the visual representation of data that shows the performance of

organization's operation. The integration of existing manufacturing systems with BI tools also should be taken into consideration, as well as having the web and portal for the business process.

5. Conclusions

This paper reviews the various applications of BI for the improvement of an organization performance in the manufacturing industry. In all the case studies, BI applications helped the organizations to overcome most of the problems they had, particularly in relation to the information overload while there is a need to extract a valuable information from the data. Without having enough visualization and information, it is time consuming for the management and employees in general to plan future steps and path forwards to run the operation smoothly, subsequently lead to the remarkable poor on time delivery performance, higher production cost, poor production planning, etc. This paper proves that BI should not be neglected nowadays, if we have a lot of data but could not answer the question of what is important in the data.

With the reviews being discussed, this paper opens up extensive research for the implementation of BI in the manufacturing industry. Further study will be done, in which it is expected to help the decision makers make full use of their business information, in the sense that data is turned into a useful information and knowledge. In the next case study, it is hoping that the BI framework to be designed is able to benefit the frontline and operational employees of the manufacturing company, by helping the organization improves its on time delivery performance consistently.

Table 1: The Application of Business Intelligence in Manufacturing

Researcher	Manufacturing Sector	Area in Organization	Problems	BI Solution	Results
A.L. Azevedo and J.P. Sousa, 2000	Semiconductor	Production and Operation	• Order prioritization is only by date • Unlimited capacity assumption • Time-consuming plan regeneration	• Decision Support System – Business Systems and Manufacturing Execution Systems integration	• Customer orders management in real-time in a distributed environment. • Delivery dates are determined based on capacity check, thus improve the due date calculation efficiency, precision and reliability.
Russell Barr, Fayyaz Hussain and James Sommers, 2005	Cement	Operation & Finance	• Information is shared by e-mail with excel spreadsheet attached leads to data inconsistency • E-mail sent is from different time frames	• Real-time Performance Dashboard	• 3% reduction in operation costs. • 5% increase in production
Gang Xiong, Timo R. Nyberg and Feiyue Wang, 2010	Chemical	Production & Global	• No common visibility among departments – inconsistent decision making • Low production output due to no real-time response ability to manufacturing disruptions and demand changes • High maintenance cause due to no real-time between production plan and execution	• XMII (Manufacturing Integration and Intelligence)	• 3% - 5% reduction in manufacturing costs • 8% - 10% increase in production yield • Increase customer responsiveness

Juhani Heilala, Matti Maantila, Jari Montonen, Jarkko Sillanpaa, Paula Jarvinen, Tero Jokinen and Sauli Kivikunnas, 2010	Faucet	Production	• Manufacturing simulation data is updated only once or very rare • Simulation analysis produces many tables, lists and reports – difficult and time consuming for decision makers to locate the information	• Simulation-based Decision Support System focusing on visualization.	• Capable to see the potential bottlenecks or other production problems to take corrective actions • Pro active planning and problem solving for production • Benefit for production operators: Early information for upcoming work • Benefit for production engineers: Planning changes or new systems
Anil B. Jambekar and Karol I. Pelc, 2006	Electronics Measuring Instruments	Production, Finance, Competitors and Customers	• No monitoring systems to adapt to industrial operational condition. • No preparation for managers for potential increased production sale. • Serious needs to increase sales and expand business.	• Managerial Dashboard	• Ability to monitor the firm's operation performance • Managers benefit it by able to identify technical and managerial knowledge to prepare for a large scale manufacturing
G R Gangadharan and Sundaravalli N Swami, 2004	Electrical and Electronics Components	Production, Store and Sales	• Difficulty to forecast sales, production and distribution • Poor service and high inventory level • Reporting systems are hard to use, inflexible and outdated	• Data Mart, Data Tracker, Reporting and Web Integration	• Boosted up the company's revenue by 36% • Information that used to take hours or days to report is available instantaneously – in sales, forecasting, production, planning, order tracking, profit analysis and ad-hoc reporting

Cheng Yuan and Li Zhigang, 2010	General Manufacturing Enterprise	Production involving Technology, Planning, Dispatcher, Manufacturing, Store and Logistics.	• The application of traditional BI is separated with business process execution • There is a need to convert business-relevant data into analytic information systematically	• Process-oriented Business Intelligence – Integrating BI services with business processes like production, planning, procurement, store etc.	• Close monitoring on key performance indicators by engineers – Improve overall technical process control • Planners can establish reasonable production plan where orders are available analytically • Supervisors can monitor production schedule, improve resources management – minimize cost and maximize production output • Operators able to use production equipment effectively and arrange tasks reasonably
Leo Sennott and Jorge Willemsen, 2009	Semiconductor	Production	• There is a need for the company to improve product and process yield with thin profit margin • Different data sources come from different facilities – A need for data integration	• Dashboard (Desktop Status) • Web-based analysis tool (Parameter Viewer) • Portal (Skyworks Data Portal and Rapid Prototype Line Portal)	• Yield monitoring capability • Improve product performance activities • Real-time production build status • Real-time visibility into various plant manufacturing operations • Provide real-time knowledge to improve the company's competitiveness
Margarete T. Koch, Henning Baars, Heiner Lasi and Hans-Georg Kemper, 2010	• Plastics and Chemistry • Automotive	Production / Manufacturing Operation	Plastic and Chemistry: • No Overall Equipment Effectiveness-indicator • No daily reports • No features for process analysis • No business oriented analysis in MES Automotive: • No package cycle analysis • Insufficient integration with non-production related systems	• Operational BI - Integrating Manufacturing Execution Systems with BI	• Increase business performance by integrating complete processes and enriching technical indicators with economic data • Machine and production data can be used to do combined analysis. e.g. To analyze the production related choices on customer and financial side

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