IMPROVEMENT OF CONTROLLING PROCESSES IN ORGANIZATION BY USING SELF-SERVICE BUSINESS INTELLIGENCE VISUALIZATION TOOLS

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Abstract

The manufacturing industry has undergone a digital transformation in recent years thanks to the rapid development of Internet of Things (IoT) technology, a stable and fast Internet connection, and software and application support for data management. The term Business Intelligence (BI) is well known, but in conjunction with manufacturing, which is currently perceived as a data-based process, it gives rise to the so-called Manufacturing Intelligence (MI). Manufacturing Intelligence needs tools to obtain data on manufacturing logistics, equipment productivity, and operations output quality, which are collected, analyzed, visualized, and made available for evaluation by responsible business people in real time through business intelligence systems. In order for manufacturing companies to remain competitive in a rapidly changing business environment, they must embrace these technologies and extract valuable information from them. The current trend in this area is the use of BI tools from the "self-service" category, which also allows "non-technical" managers to visualize data from various sources in the form of valuable information from the operational to the strategic level of business management.

Keywords: *business intelligence (BI), self-service BI (SSBI) visualization, manufacturing intelligence, manufacturing processes, data, real-time, big data, internet of things, planning, quality, maintenance, overeall equipment effectivness*

1 INTRODUCTION TO THE TOPIC

In the era called Industry 4.0, all processes, especially information processes, are accelerating and the demand for their timeliness, accuracy and delivery of the informative value understood by the sender and the recipient is increased in the same way. For this reason, innovative companies are moving from an archaic model of IT

department and data specialists to reporting needs. The paradigm shift towards self-service BI is advancing, which increases the overall agility of management processes.

1.1 Business Intelligence Development

The term Business Intelligence is a mainstream topic in the current interconnection of business processes and software infrastructure, but the term was first used in 1865 by Richard Millar Devens in response to the actions of banker Sir Henry Furnes, who based on internal and external information competition. [1] The first hardware components based on hardware and software retrieval date back to 1980, when the first database called the Decision Support System (DSS) was created, gradually creating large data warehouses and traditional BI systems such as Online analytical processing. (OLAP). [2] Over time, these complex systems have been used mainly by large companies, which have had the resources to deal with high infrastructure costs and IT specialists. SAP, Oracle and SAS were among the main players in the enterprise BI tools market. In recent years, however, thanks to self-service BI, small and medium-sized enterprises have also gained access to these opportunities. These tools are characterized by a user-friendly interface with drag & drop visualization functions. The goal is to give users working with enterprise data more freedom and responsibility at the same time, leading to decentralization of BI in the organization.

1.2 Self-service business intelligence specifications

Gartner defines “Self-service Business Intelligence” as end users who design and deploy their own analyzes and reports within an approved and supported architecture and portfolio of tools. [3] SSBI is thus a set of processes for converting data into information that is linked to the information infrastructure of the organization's hardware and software layer. SSBI is applicable to all domains of the company such as sales, purchasing, marketing, production, logistics, human resources or finance. The domain determines the key questions whose answers are to be visualized and at the same time defines what data is needed to answer these questions. In addition to end users, data model developers can also participate in SSBI, and their role is to provide a data model format that reflects key issues arising from a particular enterprise domain.

1.3 SSBI providers

There are currently a number of SSBI tool providers on the market. The most used tools are Microsoft Power BI, Table, SAP Analytics Cloud. Qlik Sense or Sisense. These tools differ in the possibilities of connecting different formats of source data and their initial modeling and interconnection, advanced functions such as predictive analysis based on the machine learning module. Most of these tools have both desktop and cloud look.

1.4 SSBI architecture

The individual components of SSBI have the same basis as traditional BI. The main element of the architecture is data sources containing structured and unstructured

data from the company or its external environment. In data warehouses, this data is stored within ETL components, which integrate this data into a standardized form without errors and duplications, thus creating basic data (business) models. From the basic data models, data flows into the SSBI tool, which consists of three main parts, which are a semantic data model containing data needed for a particular business domain, machine learning data model to create predictive analytics and the visualization environment for creating individual reports and subsequent dashboards. [4]

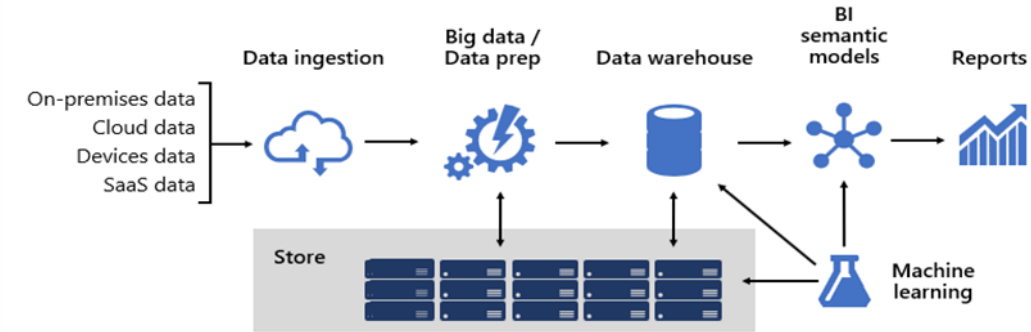

Figure 1 SSBI solution architecture Source: [4]

Analytical functions

SSBI tools, like traditional BI tools, allow for descriptive analysis to understand the current situation, predictive analysis to predict possible events based on machine learning, and prescriptive analysis to provide an explanation of the current situation and advice to achieve set business goals. [5]

1.5 Dashboard

The dashboard is one way to obtain raw data about production processes and present it in a way that becomes useful information for various stakeholders, such as stakeholders, business management or maintenance. Using the dashboard, managers can monitor key performance indicators (KPIs) by several ways. They can customize their dashboard in any way you want to get an overview of KPIs related to their domain area. Thanks to the interactive dashboard, they also have the ability to automatically analyze visualizations at a more detailed level through the drill-down function.

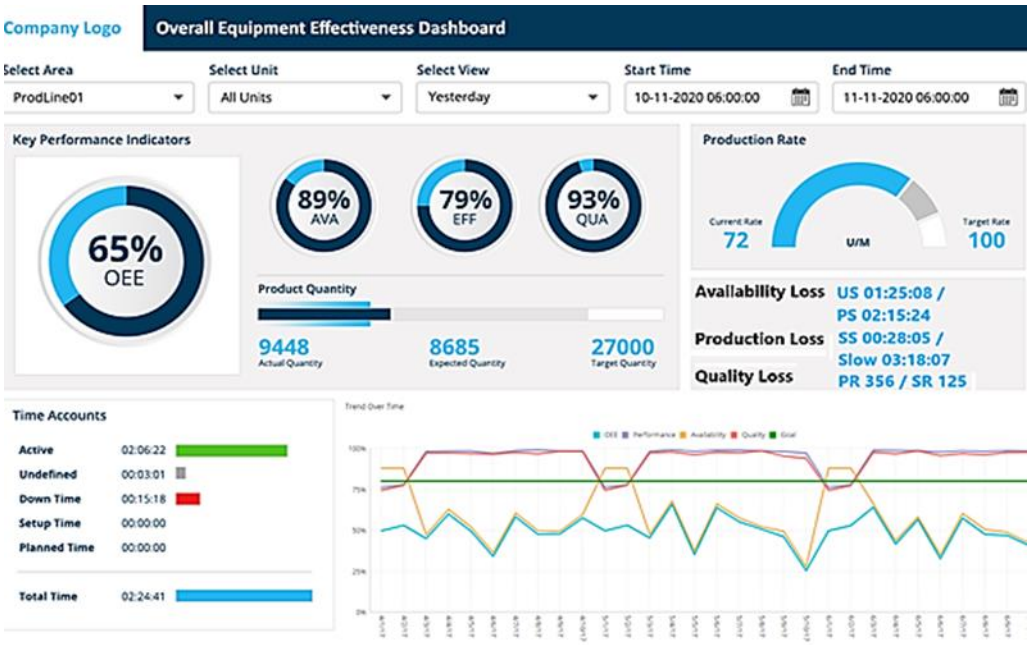

Figure 2 OEE dashboard [9]

SSBI tools from some providers support the creation of mobile dashboards for mobile devices and tablets, which further confirms the level of increased flexibility in the use of automated reports. Managers thus always have up-to-date information on key KPIs with them.

2 USAGE OF BI TOOLS IN MANUFACTURING CONTROLLING

The main production and support processes produce a large amount of data, on the basis of which the information and material flow in the company and with its suppliers or customers is managed. As part of the operational controlling of individual processes, certain key performance and quality indicators are set in companies, which are part of quality, productivity, efficiency or maintenance reports.

2.1 Overall Equipment Effectiveness

OEE is one of the main aggregate indicators of the evaluation of production processes in companies. The indicator descriptively shows the current state of the overall quality of production, the overall performance of production facilities and their overall availability. This indicator by itself does not provide information to managers on how its values can be increased. However, analysis and visualization of device data via SSBI tools offer this capability. [8]

2.2 Overall equipment performance

Achieving a higher and more stable level of production cycles often requires redefining production process operations and equipment configuration. Constraints that prevent a higher cycle time frequency from being part of the entire production system. By monitoring system bottlenecks in real time, SSBI tools help more accurately quantify constraints while defining plans for processes that need to be reconfigured to increase cycle frequency.

2.3 Overall outcomes quality (fully productive time)

Knowing which production processes and operations aggregated into work centers operate at a high level of production quality and which do not is essential for the efficient running of production operations in terms of downtime and poor-quality costs. The key is to have visualized data on individual production operations in real time in the form of key quality parameters and their tolerances. Plant configuration data and operating parameters, along with sensor data, provide valuable information. Combining this configuration data with operation output quality data allows SSBI tools to search for information on cause-and-effect patterns between device configuration and operation output quality. Thus, managers can prevent the emergence of poor-quality outputs by proactively configuring equipment based on visualized results. Another use is to identify the factors that affect the quality of process outputs to reduce the likelihood of a mismatch in subsequent operations. These factors are then analyzed by statistical methods, which result in, for example, a cluster map that visualizes the individual outputs of the operation by separating the outputs of the operations by the degree of probability of deviation from the tolerance limits of quality indicators. This type of visualization allows for efficient benchmarking configuration of test equipment. [6,7]

Figure 3 Quality dashboar [10]

For executives, an overall real-time scrap dashboard (Picture 2.) with access to historical data is important in reporting. Dashboards contain results for individual departments over time, on the basis of which proactive steps are further taken to achieve the best possible results.

2.4 Overall equipment availability (maintenance and logistics)

Production facilities and their technical condition critically affect the efficiency of production processes. Static maintenance intervals often do not correspond to changing factors affecting the technical condition, resulting in failure and increased final maintenance costs and downtime. The data entering the SSBI software from the device sensors can be used for predictive maintenance planning based on an assessment of the current state of the art, which is visualized through various key indicators in the user interface. The ML module determines the real-time failure rate based on historical data. The number of remaining device cycles can be evaluated from the probability indicator, after which the probability of a fault will increase significantly (Picture 2.). These indicators integrated into the report or dashboard help to proactively plan maintenance tasks and thus reduce equipment failure rates. [6, 7]

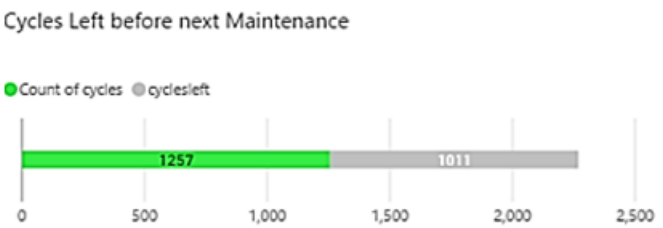

Figure 4 Visualized predicted maintenance by machine cycles [6]

2.5 Supply chain and intralogistics

With the help of SSBI, management staff can evaluate the supply chain and regularly analyze data to ensure timely deliveries of the required quality. This will help the company track transportation costs, poor quality costs and other KPIs. An advanced use of SSBI is the so-called "End-to-end supply chain visibility", which consists of a shared dashboard between the various actors in the supply chain. Sharing the status of ordered material in real time allows you to make a prompt response in production planning or to provide input material to backup suppliers in hazardous situations. An example of using SSBI is warehouse inventory data visualization, which provides a visual reference for current inventory levels and pending orders. This makes it easier to forecast inventory needs and set reordering points. [11]

Operational material transfers within the in-house material flow, material handling in individual company departments and information flows are production logistics processes that need to be organized, controlled and optimized. Data flowing from warehouse information systems and MRP in combination with data from sensors

of individual devices in production centers represent an input into the analytical algorithms of SSBI tools. Thanks to this real-time data, material flows can be more accurately coordinated over time, eliminating downtime and increasing production center productivity and resource utilization. [6]

3 BENEFITS OF SELF-SERVICE BI

SSBI brings a number of benefits to controlling processes, which significantly relieve the management of employees in various activities.

The key advantage is the elimination of manual data collection and their adjustment for reporting purposes. Once the dashboard is designed and deployed, KPIs and other information are available at all times with up-to-date data for all users across different departments. Problems with manually extracting raw data from the system, manipulating them in an Excel spreadsheet, and creating graphs for that data are a thing of the past. A well-designed dashboard allows filtering for different time periods, eliminating the need to search past reports. At present, executives are forced to spend a disproportionate amount of time creating their own reports. Consolidating reporting into dashboards or page reports saves time. At the same time, the dashboard sharing option allows managers to make informed decisions independently, supporting democratization of decision-making at the operational management level. Dashboards provide so-called bird´s eye perspective on individual department statements with easily visible contexts, thus creating more scope for finding opportunities for improvement. In this way, manufacturing companies are able to increase the agility of management processes and respond ad-hoc to disagreements. With the availability of dashboards for multiple users, it is important to set read, edit, and share permissions. Within the SSBI tools, the powers are easily adjustable, thus eliminating security risks when working with corporate data. A great benefit for companies is the fact that the implementation of SSBI tools is relatively fast and requires relatively low costs of HW and SW depending on the functional requirements of the tool.

4 CHALLENGES OF SSBI

When implementing SSBI in an enterprise, a detailed data security policy must be prepared. because sensitive data can be leaked through a direct connection to the company's data sources. At the same time, it is important to prepare basic data models by experienced data analysts to avoid erroneous relationships between tables, which would cause incorrect analysis results. Therefore, it is necessary to subsequently divide the users into so-called "power users" and "casual users". Power users have the technical knowledge needed to create reports and dashboards. Casual users are regular users of ready-made reports and dashboards, which they use to make specific decisions.

An obstacle in the implementation of SSBI can be the overall low interest in working with the new software tool on the part of users. This phenomenon can occur

when users have doubts about the importance of SSBI for their daily data work. For this reason, it is important to provide users with full-featured training with hands-on demonstrations in their domain so that they can compare their traditional reporting practices with those using the SSBI.

5 CONCLUSION

Nowadays in manufacturing world are data and analytics becoming increasingly important in decision making processes and reporting. Since the main goal of every manufacturing plant is to produce planned amount of production efficiently as possible with required quality, manufacturers need to constantly look for ways to continually improve. In field of decision making based on data there are new ways of how to track and control manufacturing KPI with self-service business intelligence tools. These tools are able to provide up to date, shared, clear and accurate information for various system stakeholders, such as quality and production management, maintenance or even logistics management. SSBI is an upcoming trend allowing non-technical casual users to use Business Intelligence in a self-reliant manner with the least support of technical power users. Dashboards are the key element of a user's SSBI because they offer a comprehensive view of each production area. On the other hand, individual production managers can filter the content according to their needs and focus within the reporting, thus gaining an overview and the opportunity to look for room to improve individual indicators.

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