

## BI: Lean Manufacturing Indicators Applied to HR Applications - An Implementation Study

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**Abstract**—In the past years the world has witnessed a large number of changes motivated by the financial crisis concerning how the process of management occurs on production on factories. A way to control this situation is through indicators. This article describes not only usual indicators in lean manufacturing that can be used in human resource management but also the best way to design the data warehouse considering the level of granularity and the level of data detail. To begin with, we will analyze the lean manufacturing indicators addressed in the academic literature. Furthermore, we will analyze these indicators with the indicators used by leading research companies in Brazil. Lastly, we will design the data warehouse to comport these indicators considering the level of granularity and the level of details to analyze these data. By the end of this project, we intend to get the list of indicators capable of managing and analyzing the production and performance of the employees in factories. With these indicators, the factory will be able to manage the team correctly, whatever the situation of global finance is. This approach allows us to determine the indicators that will help the company identify problems on the team management for increasing the production and it will also contribute for real growth of the company. The indicators identified in this article will determinate the way to implement successfully BI solutions associated with human resource systems and manufacturing systems.

*Keywords*-BI; Lean Manufacturing; Indicators; HR Systems.

### I. INTRODUCTION

Everything we do has a goal. The goals of generating indicators are many, and the focus of this article is studying the lean production indicators that can be applied to people management. Carreira [1] comments that maybe one of the essential principles of the lean production is the continuous elimination of waste. In order to reduce or eliminate the waste of any activity / process, as lean production preaches, we need first to measure this activity / process. Without the follow-up of the executed processes, it is not possible to indicate if anything needs enhancement. Based on this assumption, this article studies the indicators for monitoring and reducing the waste associated to people management systems. The first question is: why applying the principle of lean production to monitor indicators in people management systems? The answer is simple: waste reduction can be

achieved through employee performance or allocation. Waste is not only associated to raw material, but also to the processes that occur inside the company. When we think about waste, the first thing that comes to mind is physical material, but we cannot forget that even employees can be a part of waste (or even wasted).

As Hibbs and Sullivan [2] say, the purpose of lean manufacturing is to deliver the final product to the client as fast as possible, and one way to do that is finding and eliminating waste. However, identifying what is and what isn't waste is not always an obvious task. Shigeo Shingo [3], co-developer of Toyotas production system, identified seven types of waste (and one additional type) that can be easily remembered by the acronym DOTWIMP:

- 1) Defects: This is probably the most obvious type of waste, lean production focus on preventing defects differently from the usual finding and repairing them.
- 2) Overproduction: producing more than necessary or producing before it is necessary is regularly seen as stocking.
- 3) Transportation: Unnecessary movement between processes. When moving material or items between factories, work cells, offices or machines, no value is generated.
- 4) Waiting: People or items waiting for the next production process.
- 5) Inventory: All material, work in progress and final product that is not initially processed. Inventory over the minimum will take on space and generate delays on identifying flaws.
- 6) Motion: People or equipment in motion or moving more than necessary to execute the necessary.
- 7) Processing: Processing the final product to the client beyond necessary, which only add costs and no value to it.
- 8) Additional eighth waste: This is regularly noted as an additional waste to the seven original ones, and it refers to under using the creativity and abilities of the employees.

Having identified the waste possibilities related to the employees, it will be necessary to determine a data warehouse that might uphold this data, and that will allow us to focus on the problem.

According to Vercellis [4], a data warehouse depends on the objective that is aimed to achieve. Before designing a data warehouse, we need to bear in mind which questions we would like to answer. For example, which cost center is spending more, or from the most costly center, which is the employee generating more costs? The answer to this question is directly related to the granularity of the data warehouse, and it is extremely important for the success of the project. With all these premises, by the end of the project we will have indicators connected to the lean manufacture that will be able to be applied to the human resources management. Besides that, we will have a data warehouse implementation proposal correspondent to the level of data granularity necessity.

## II. METHODS

According to McClellan [5], for approximately 20 years the Manufacturing Execution Systems (MES) were the focus for manufacture management. Initially, it was developed for providing the first management line, with visibility to manage the job requests and the attributions of the work units. The MES systems were involved on the indispensable connection between the stakeholders and the logistics production processes events. For the fact that the MES system can manage and execute the log of events of the logistics and production processes, they are an important and accurate real-time data source, becoming integrated to the corporation intelligence. In another way, the MES systems are a collection of business processes that provide a real time vision of events that are happening in the factory execution plan, or calculates how much and what must be produced, according to data received from the Enterprise Resource Planning (ERP) system.

Wang [6] comments that the maximum priority of the lean manufacture is to measure the performance of the processes. The measurement of the process performance provides the desirable level of results, which is the objective for taking a decision on production and it helps identifying the desired production level for the programmed activities. Now, be careful with the objective that you are willing to find through the indicators; you might achieve them is what said Levinson and Rerick [7]. Meaning, many times the indicators will reveal information that we are not willing to listen to or recognize.

Levinson and Rerick [7] highlights 3 rules for identifying process performance indicators:

- 1) Indicators need to be objective. The indicators must be precisely defined and quantifiable (needs to be possible to measure in numbers).

- 2) The process measured through the indicator needs to be under the control of the team or person that will execute the measurement (the indicator needs self control).
- 3) The indicator needs to encourage the work environment and needs to help the company to obtain corporate results. Besides the indicators being related to the objectives of the company, it needs to be understood by all as such.

The items above highlighted the indicators characteristics, in order for it to have an expected goal that can be understood by everybody in the company as constructive indicators. This will help the teams to manage these indicators and work positively on obtaining such, or else the indicator might be seen as criticism directly connected to a team or process. The highlighted items showed the objective of the indicators related to the manufacture process to the processes inside a factory. The responsible body of execution of processes inside factories is human resources, or, besides worrying about how the processes are being managed, there is a need to stay alert to the individual performance of the human resources (people).

According to Gawron [8], there are two ways to evaluate the performance of a person:

- 1) Subjective method: through opinion obtained in interviews and questioning or through the work environment follow-up.
- 2) Experimental method: through data collection for measuring performance.

The main way of measuring production is through gathering of data for performance measurement. This analysis form is easier, as it can be executed in an automatic way through an information gathering system and can be seen in a synthesized way (making people groups, processes and sector analysis easier) or in an analytical way. For the generation of lean manufacture indicators related to people management, the work must use long-standing references on people management processes, i.e. Before entering on detailing of a few selected indicators, some concepts must be understood:[9]

- 1) Effort: Level of energy and human creativity put in a task.
- 2) Performance: Way of using the effort to achieve a final goal.
- 3) Goal: What is wanted to obtain joining effort and performance on a task.
- 4) Results: the consequence of using this energy.
- 5) Productivity: the proportion between the obtained result and the amount of energy necessary to obtain the result.

As some examples of indicators that will be dealt with on the ongoing task, we quote a few indicators below:

- 1) Indicator to show the quantity of items produced by hour by an employee.

$$Productivity = \frac{TotalofProducedUnits}{TotalofProductionHours}$$

- 2) Indicator to show the wage cost of each unit produced, that is, the percentage of an employees wage that the product retains by its manufacture process.

$$WageCostUnit = \frac{AmountofRemuneration}{TotalofProducedUnits}$$

The generation of the indicators shown above and other indicators that will be worked on, will depend on obtaining data. The methods for obtaining the necessary data for generating the indicators for its turn will depend on the area of execution of the indicators. The indicators generated in this task can be applied to several types of manufacturing companies, considering that in some cases the possibility of investment of the client for producing data will be limited. The gathering of information for the indicator generation may vary from manual data input, the manufacture item read through QR Code or through the manufacturing items through the RFID readers. All these processes can be grouped according to the request related to the process of obtaining data.

### III. EXPECTED RESULTS

Because this article is a work in progress, the expected final result is establishing a list of indicators connected to the manufacturing and applicable to human resources management.

As highlighted on Section II, the process of measurement of the current situation is necessary to execute the production planning of a factory. Using, as focus, sectors that depend on human power to develop its part, there is a need to measure the performance of not only the processes, but also of human resources. Nowadays, there is extensive literature related to measuring the development of processes of manufacture, but our objective is to execute the performance measurement of the human resources connected to the manufacturing processes, being the human resources, in some processes of manufacturing, essential. The proposal of data warehouse that we will have by the end of the project must gather all clients needs, that is, the level of granularity must be from a managing level to an operational level. Considering that the main goal in defining these indicators is waste reduction (employee) and faster delivery of the final product to the client, we must consider these characteristics on the data warehouse definition (taking into account the dimensions). Initially, the following pattern can be used for the definition of the data warehouse (this will suffer alterations as the work evolves):

- 1) Dimensions: It will be used to define the granularity of data in the moment of the indicators exhibition.

- 2) Measurements: It will be used to define the granularity of data in the moment of the exhibition of the indicators.

For proving the work efficiency executed, the indicators and the model of data warehouse will be applied to the process of manufacturing of a software house (where the data is collected through a managing system of software development management). Other clients will be used for validation of the projects efficiency. The company responsible for the project development counts with about 20 thousand clients from many different areas. The article finds itself at this moment on the conclusion step of the definition of which indicators will be developed. The technical definitions concerning the data warehouse developed until now are described in this article.

### IV. STATE OF THE ART

In order to write this article, a research was made to find other existent articles that talked about the same topics of this work in progress. The more important ones are listed below:

- 1) Lupu, Bloga, Sabau and Muntean [10]: An article that details the development of real projects of business intelligence in an ERP system. The article defines some success factors for BI projects integrated to ERP systems.
- 2) Petterson [11]: An article that defines the concepts, methods and results of lean manufacture and also verifies the differences between other processes popularly known as factory management.
- 3) George [12]: It presents concepts related to lean manufacture and shows how companies can use them to reduce waste and increase competitive advantage considering the current global economical situation.

The written works used in this article will help to develop this project in a way that each of the mentioned references is able to connect in a specific way to the work to be produced.

In [12], George details the Six Sigmas of lean manufacture and how to implement them in order to prevent the company from having a financial crisis (as the one that happened in 2008), the work in progress detailed in the article possesses a work line very similar to the one developed in [12], the difference is that this work in progress focus on definition and complementation, where lean manufacture indicators are related to people management. Choosing the topic of this work in progress was inspired by the needs of the market to implement indicators for people management as a solution for the ones already existent in people management. Another motivating factor is the lack of written works in this area. By the end of this article, we will have the definition of a data warehouse ambiance to contemplate lean manufacture indicators related to people management. The main difference between this article and the ones mentioned

above are the definition of lean manufacture and how to apply them in a software of people management in the Brazilian market.

#### V. CONCLUSION

This article briefs objectives and activities that are intended to be achieved with this project. This way, partially, we conclude that this paper will help defining the indicators to be used by people management systems. Using manufacture indicators as background, this article identifies manufacturing indicators applicable to people management, with the goal of eliminating waste, remembering that this objective is continuous on implementing lean manufacturing. With the absence of literature with this level of focus on the subject, this article has the objective of gathering academic material to this area of great importance on industries.

#### ACKNOWLEDGMENT

We would like to thank all the people who helped directly and indirectly the development of this work so far.

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