Preliminary results of a labor productivity problem in the quotation department of a small growing co-packing company

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Abstract

Colombia, like other Latin American countries, is a country of small and medium-sized enterprises (SMEs), where the use of operational (unskilled) labor is intensive, under a configuration of cells and/or process lines for manufacturing or providing services of different kinds. This article is based on a review of the case of a company that stands out in the market as a provider of contract packing services and support for logistics processes in the city of Medellín (Colombia); it presents difficulties in its growth and capacity to respond to customers. The process of quotations appears as a bottleneck of all its commercial and operative work, product of a formal design, based on rigorous calculations of normal times and complex standards that require qualified human resources and a time of elaboration that affects costs and time of response. This is the first review and conclusions of the analysis made to the process under study.

Keywords: Line balancing methods, production line balancing, small and medium enterprises, time optimization, worker optimization, precedence diagram.

Resumen

Colombia, al igual que otros países latinoamericanos, es un país de pequeñas y medianas empresas (Pymes), donde el uso de mano de obra operativa (no calificada) es intensivo, bajo una configuración de células y/o líneas de proceso para la manufactura o la prestación de servicios de diversa índole. Este artículo se basa en una revisión del caso de una empresa que se destaca en el mercado como proveedora de servicios de empaque por contrato y apoyo a procesos logísticos en la ciudad de Medellín (Colombia); presenta dificultades en su crecimiento y capacidad de respuesta a los clientes. El proceso de cotizaciones aparece como un cuello de botella de toda su labor comercial y operativa, producto de un diseño formal, basado en cálculos rigurosos de tiempos normales y estándares complejos que requieren recursos humanos calificados y un tiempo de elaboración que afecta los costos y el tiempo de respuesta. Esta es la primera revisión y conclusiones del análisis realizado al proceso en estudio.

Palabras clave: métodos de balanceo de línea, balance de línea de producción, pequeñas y medianas empresas, optimización del tiempo, optimización de trabajadores, diagrama de precedencia.

1. Introduction

The Industry sector is one of the most numerous sectors in Colombia and the small and medium enterprises, ones of the sectors with the greatest presence by units formed. From the total amount of companies, 96% are SMEs and contribute 80% of the employment in the country that results in engines of economic growth (Dinero, 2017). In the case of Colombia, for 2019, for a sample of 1640 SMEs taken in "La gran encuesta PYME", made by ANIF, in Colombia, Industry represents 31%, Commerce 37% and Services 32% (ANIF, 2019). The subsectors that presented the greatest contribution to the dynamics of business creation were labor-intensive sectors: garment making, printing activities, furniture manufacturing and processing and conservation of fruits, vegetables, and tubers (ANIF, 2019). Additional, the Colombian industry is diverse; from the 30% of industry sector sample, 17% of the companies surveyed were engaged in the production of food and beverages, 12% in furniture and other manufacturing activities, 11% in the production of rubber and plastic products, 10% to clothing, 9% in publishing and printing, 9% in the manufacture of metal parts, 8 in leather, footwear and leather goods, 8% in machinery and equipment, 7% in substances and chemical products, 3% in textile product and others industries with 6%. This diversity completes a Pareto that represents a large part of Colombia's industrial activities (ANIF, 2019).

The production lines of these companies, by their level of production in relation to costs, assume the intensive use of labor. Although there are mechanized processes, the national industry prefers manual labor for the processes of assembly, handling of raw materials, product in process and finished product, in the process of preparation, marking, packaging, and packing, to name some tasks, well adapted to the demand presented during the year. In all these processes, times and movements optimization of the involved worker's Labors is a common task, no matter the size of the company. This situation validates the improvement of productivity conditions in the production lines, theme included by the main recommendations to policies in the country (Consejo Privado de Competitividad,

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2019). If this represents simplifying general methods for ease of practical adoption of tools, develop a good method including these conditions, is a task with added value for companies. For these reasons, a practical procedure is proposed, allowing an entrepreneur or production manager (with medium knowledge of arithmetic and mathematical logic) to take advantage of the operations research discipline and its optimization factors in labour-intensive processes.

According to (Lepori, Damand & Barth, 2013), the supply chain (SC) is a network of production and distribution sites which provide raw materials that they process. The generated products are delivered to consumers via distribution networks. Logistic services providers, like 3PL, offer their customers the possibility of outsourcing various activities within their warehouses, such as storage and co-packing. The company that supports this article, works in the market of co-packing and promotional services, offering services of bundling, shrink packaging, inkjet lots and DIN codes printing, over labelling, support for reprocessing in manufacturing and picking operations, packaging, dispatch and loading of trucks in distribution centres, among other Labours. It serves companies in various sectors such as food and beverage, toiletries, personal care, appliances and in general, any company that within its marketing work to promote their products through assembly of offers and promotions, has production lines that need manual reprocessing or operational support to order preparation in warehouses. Its customers are characterized by a strict demand, that requires a fast response, a characteristic of an Agile type company, a distinctive feature that Gattorna considers in their Dynamic Supply Chain classification (Gattorna, 2010): “a customer who is completely chaotic, and who is still waiting for lightning service with a discount”, or a company whose customer is simply disorganized”.

The remained article is organized as follows: in the Literature Review Section, a summary of the most representative contributions within the field of line balancing is presented. Next, the methodology proposed to review the process of the company and results expected. In the Results Expected Section, a brief about potential results expected. Finally, the conclusions of the literature review and the possibilities that are expected as final results.

2. Statement of the Problem

The company in consideration for the problem analysis, technically supports its operations in labour-intensive configurations distributed along the process line, tasks that are calculated through sampling considerations, using as a base the General Electric table (Caso Neira, 2006) that provides, against practice, an estimate of normal operation time adjusted to needs and then serves to quantify the unit value that is the basis of calculation to make the quote that is sent to the customer.

The company is going through a good time thanks to the recognition of the quality and good service provided to its customers. However, this situation is causing many requests for quotations that is exceeding the current capacity to deliver on time, a situation that also begins to show withdrawals that affect the sale of service and generate concern among managers, who do not identify the reasons for the delay or how to solve it, without having to think about increasing the specialized and expensive human resources that currently makes the calculations to quote, if the process maintain the same calculation protocol.

3. Literature Review

The literature review is divided into 5 main topics, which configure the understanding of the topic and the contributions of this article. The topics to be discussed are: Packaging, Importance of Packaging, Use of Labour, Work measurement and balancing method.

Packaging is the container that holds, protects, preserves, identifies the product, facilitated handling and commercialization (Quian, *et al.,* 2002; European Parliament and Council, 1994; Vidales Giovanenetti, 1995). According with Quian, *et al.* (2002) there are three types of packaging. Primary packaging is in direct contact with the product, secondary packaging contains one or more primary packages and serves to protect and identify them and to communicate the qualities of the product, finally, tertiary packaging which contains the two previous ones and its function is to distribute, unify and protect products throughout the commercial chain (Dixon-Hardy, Darron & Curran, 2009) Additional, secondary packaging is outside the primary packaging, and may be used to prevent pilferage or to group primary packages together. Tertiary packaging is used for bulk handling, warehouse storage and transport shipping (Ampuero & Vila, 2006). Some applications of paperboard packaging are medical packaging, hard and soft drink, fruit and marine products, cosmetics and personal care, office stationary and accessories, fabrics and garments, white goods and other durables, electrical equipment, entertainment and other electronics, shoes and leather ware, gems, toys and sports goods, chemicals and fertilizers, frozen food packaging, pharmaceutical packaging, dry food packaging etc.

According to the European Organization for Packaging and the Environment, the main functions of packaging are protection, promotion, information, convenience, unitization, and handling. In order to serve different purposes of handling a product in different stages of its lifecycle, various types of packaging may be involved (Kumar, *et al.,* 2017). The primary packaging is also known as sales packaging, which constitutes of the sales unit to be received by the end consumers. The secondary packaging is often called a grouped packaging. It consists of the group of sales units packed together and provides convenience for replenishment or sales with an aggregated unit, such as a dozen. The tertiary packaging is known as transport packaging. It is designed to ensure damage-free handling and transport of a number of secondary packages contained in an outer case, on a pallet or in a crate.

In Gutta & Kuriger (2013) different packaging system levels were of interest at different levels of the value chain. Of the packaging suppliers, one manufactured only primary packaging and the other both primary and secondary packaging. That led to discussion of both primary and secondary packaging. The brand owners' main focus was on primary packaging. The attributes of secondary and tertiary packaging affecting value were mentioned in the context of

picking and shipping processes. The wholesaler interviewed was not often affected by the primary packaging attributes but secondary and tertiary packaging attributes were extremely critical in affecting value. In the value creation processes of the retailers, secondary packaging attributes had the greatest influence on value. One of the biggest challenges of a packaging value chain could actually be the fact that consumers' value perceptions concern the primary packaging whereas the perceived value at other levels of the value chain mainly stems from secondary and tertiary packaging. This further reinforces that packaging should be considered as a packaging system with three levels."

Peters Gerard Schubert a company that produces packaging equipment states that there are many territorial-specific factors in the emerging markets. In particular, however, there is a big difference between primary packaging requirements and secondary packaging requirements. As a general rule, the demand regarding fraud-resistant packaging is first seen in the primary packaging sector (e.g., filling of syringes or vials). In the secondary packaging sector (e.g., cardboard packaging, blister etc.) these demands are implemented with a time delay, partly because secondary packaging is often still processed manually. However, the investments for this implementation are also lower.

In accordance with Niemelä-Nyrhinen & Uusitalo (2013) on many occasions, a producer considers must be given to outside manufacturing facilities that may be able to produce the product at a lower cost. In this context a viable alternative is co-packing. Contract packaging, also known as Co-Packing, is the overall process of assembling a product or good into its final finished packaging (Weinstein, 2002). As the packaging is customized according to the characteristics that are determined for the product this can be a simple or very complex process. Packaging can be as simple as just putting an identification of the product or as complex as completely design the packaging for the product (Weinstein, 2002). Therefore, determining the price of a packaging can become a determining factor for the company that is dedicated to this work, this means involving techniques for measuring the work that must be done and thus being able to determine its cost.

Work measurement is an important contributor to the planning and control of operations, and offers a useful basis on which to evaluate alternative ways of delivering work. A definition of work measurement is given for the British Standard number 11003, BS 3138 (1992) the definition of work measurement is "The application of techniques designed to establish the time for a qualified worker to carry out a task at a defined rate of working". Work measurement is the application of techniques which is designed to establish the time for an average worker to carry out a specified manufacturing task at a defined level of performance (FCP, 2020; Gaynard, 1997). According to International Labour Organization (ILO), work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions, and for analysing the data so as to obtain the time necessary for carrying out the job. These techniques are related to time study, sampling technique, pre-determine time standards and standard data (Groover, 2007). Kanawaty (1996) explains that the basic procedure consists of three stages analysis, data collection and synthesis.

In ILO are described five scientific techniques for work measurement such as time study, pre-determined motion time systems, activity sampling, analytical estimating and synthesis. Time study is the most important technique of work measurement. It is concerned with the direct observation of work while it is being performed (Yusoff, 2012). Also, ILO defined time study as a work measurement technique for recording the times and rates of working for the elements of specified job carried out under specified conditions, and for analysing the data so as to obtain the time necessary for carrying out the job at a defined level of performance. To Meyers there are three conditions to do time study: (1) a qualified, well-trained operator, (2) working at a normal pace, and (3) doing a specific task.

One of the applications of the time study is to determine the balance in the use of the resources that a process has. For example, in the case of a process consisting of a line of activities that is carried out sequentially, the measurement of times allows to identify bottlenecks. To balance a process that is performed sequentially, the concept of line balancing is used. The definition of line balancing proposed in Baines (1995) indicates that it is a procedure for assigning work to assembly workers in a way that balances work assignments among workers and minimizes the number of workers required.

The most relevant problems in the context of line balancing refer to the assembly lines, where a wide variety of applications can be found. In Arora (2004) a traditional line balancing problem is analysed for the case of the manufacture of diesel engines. The analysed aspects include the allocation of the resources, the quality in the balanced line, the probabilities of failure and the states of inventory, where each of the showed aspects, evidence improvements in relation to the current situation. Another case of application is described by Thomopoulos (1967) where the problem of line balancing for the textile industry is analysed. It is a relevant problem because textile factories, particularly those based on small batches and orders, must respond quickly to seasonal changes. However, the problems of line balancing can be very completion as it is evidenced in Basu, Shinde & More (2015). An example of this complexity are the general models for different configuration of the assembly line are done to minimize the costs or the cycle time like the case presented by Güner & Ünal (2008) and Álvarez-Miranda & Pereira (2019). These models allow decision makers to select assembly operations based on a better understanding of their decision impacts in both the short term and long term under conditions of uncertainty. In this context it is essential to know the current situation of a system to process orders on time. Similarly, to increase productivity, it is necessary to understand and describe the behaviour of the system to predict the situation of the company in the short term and increase productivity. A useful tool in this line balancing analysis is the precedents diagram to show the order of the process, the elements processed and the relationship between the activities of the process.

According to Samouei & Ashayeri (2019), the relevance of the realization of an intuitive line balance for SMEs, is based mainly on two reasons: The first is the consideration that processes, in smallest and medium enterprises, are oriented to manual operations. This consideration makes it more difficult to apply widely disseminated methods in the literature to obtain results through metaheuristics, heuristics and algorithms in general such as those proposed in Chen *et al.* 2019; Askin & Zhou, 1997; Baybars, 1986; Scholl & Becker, 2006; Pierreval *et al.,* 2003. Furthermore, it makes difficult to predict the next events when the production system is modified through the simulation of discrete events such as those exposed in McMullen & Tarasewich, 2003 y Wang *et al.,* 2009. And the second one, has in account industries where the demand for products is personalized and the proliferation of optimum characteristics increases the need for flexible systems that can produce different versions of similar products. This consideration has been widely studied in line models as they have been Sculli (1984). In these circumstances, Zupan & Herakovic (2015) presents solutions for different types of SME using the line balancing method and it demonstrates that these can grow and be strong to face the world economic turmoil.

4. Methodological Procedure

Under these conditions, a descriptive exploratory research of mixed type is developed to find the reasons that generate the difficulties of development of the company, in commercial and operational terms. To do this, it is necessary to describe the commercial and operational processes that take place in the company and to find the bottlenecks that do not allow, from a functional point of view, the growth of the company. Then it is necessary to analyse the reasons that determine this characteristic and, finally, with the information collected, to formulate a solution that offers an answer to the need for improvement. The data are provided through internal information analysis, unstructured interviews and open-ended questions with employees and managers of the company, together with the examination of secondary information sources. This information must be used to describe the actual quotation process, its tasks and characteristics, using a flow chart description and calculations of time job variables per processes and tasks to recognize the bottleneck in the process.

After the exploratory stage, a solution must be proposed to improve the actual quotation process in search of an optimal solution that increases the speed of the quotation and gives the possibility to deliver more quotations on time, with less complexity of calculation. A standard method.

5. Preliminar Results

After the description of the process using flow charts and time calculation per job involved, quotations calculation is identified as a bottleneck in the commercial operation. It is using a formal method of line balancing calculation; the longest quote calculation time is given in the measurement of the tasks, which bases the repetition sampling of the task to be performed, for the calculation of the normal time per task, on the General Electric sampling table. Each task ranges from 6 to 15 seconds, a situation that due to the requirements of the table in use, leads to make between 100 and 200 repetitions for each task.

On the other hand, a process, equivalent a one-customer reference, consists of 5 to 10 tasks, with an average of 6 tasks, which means that the person who prepares the cost estimate must make between 500 and 2000 measurements per process, with an average of 1000 samples. A customer can request more than one reference in a single quote.

144 quotations made by an Industrial Engineer, during six months with the particularity of having time of work per quote that began to be carried as a result of the delay in delivery to customers of these requests were analysed. It was found an average of 3 references per request, which crossed with the quote calculations offered an average of work equivalent to 1,080 man-hours, Passing the total time to work days of 8 hours, this work is equivalent to 135 work days, which allows less than 0.93 days for each quote.

In addition, the engineer in charge of the quotations has the task of sending and following up on the quotations, generating reports and presenting them to the immediate boss. When interviewing the engineer, he comments that his job is very stressful and that his indicators of on-time delivery of quotations are 62%, which allows him to understand that there is a 38% chance of successful delivery.

He acknowledges that the issue of process simplification would support that indicator and most likely there would be more accepted quotations. He also comments that he has tried to get someone assigned to help him but acknowledges that the process is complex and he would need someone who has a similar rating in order to maintain the level of accuracy requested; since these are unit quotations, management prefers accuracy over on-time delivery.

The work that is most often quoted is the bundling and over labelling, occupies 70% of the units that are quoted in the company. It is also the manager that does not allow to increase the amount of qualified personnel because the value of the engineer is a high cost in the process, because their salary weighs in the final quotations, due to the quantities by reference that the clients request, (between 1000 and 10.000 units) and that obey to Labours of marketing that wants to generate impulse to a product and not to stay as product of line in the market.

Other characteristics that stand out in the process are that some approved quotations are made only once because most of these processes are made for marketing and product launching or promotion.

It is important to say that under operational conditions, the final configuration of the work is different, most of the time, to the structure used to calculate the quote. This is because the workplace is assumed and could change due to the needs of the process. Sometimes the original work location is used for storage and it is necessary to change the number of people in the given final work area to do their job.

6. Discussion

From these results it can be understood that the quotation process needs a simple and easy way to minimize the complexity of the calculation and optimize the use of time in this work. Firstly, to give a new method of calculating iterations that reduces the simulation time for the tasks and secondly, to revise the line balance method to translate the calculation of the time of contribution in operational terms adjusted to the total number of people, available for the final work conditions.

7. Conclusions

The situation found confirms the concern of the directives. There are delays in the quotation process that are harming the growth of the company. The process is subject to complexities of calculation that together with the needs of precision imposed by the director of the company, do not allow, apparently, find a different way out to maintain the current method used, a topic that intersects with the need to hire qualified personnel of similar cost to those who develop the work at present.

In the literature found, some general methods of balancing for small batches are established, applicable to the process under review. A reliable method, easy to understand that optimizes the quotation process while being reliable for the director will be the ideal answer to the problem.

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