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IMPLEMENTATION OF ENTERPRISE RESOURCE PLANNING IN A METAL INDUSTRY WITH DIFFERENTIATED PRODUCT LINES

Annibal Affonso Neto
annibal@terra.com.br
University of Brasilia - UnB,
Brasilia, Federal District, Brazil

Clovis Neumann
clovisneumann@unb.br
University of Brasilia - UnB,
Brasilia, Federal District, Brazil

ABSTRACT

Highlights:
The study contemplated the implementation of Enterprise Resource Planning (ERP) in production strategy and performance.
The behavior of the determining variables of the production strategy was analyzed.
The reflexes of the ERP adoption in the production strategy were studied.
The adoption of the ERP brought improvements to the company's operation, especially in the reliability and traceability of information.

Objective: analyze the impact of ERP implementation on the production strategy and performance of a mid-sized metallurgic company based in the Federal District and with a unit in Goiás.

Design/Methodology/Assessment: unique case study, aiming to understand in depth the various aspects associated with ERP deployment in a medium industry. The work considered the determining variables of the production strategy and was developed in the three metallurgic business units: doors and windows, profiles, poles, and arms, considering the employees' perception. From a methodological point of view, it was elaborated based on qualitative research in the modalities documentary research, observation and single instrumental case study, since the purpose was to understand a certain phenomenon in the context in which it occurred. The documentary research made it possible to survey information that supported the preparation of the interview script and the identification of the target audience.

Results: The reflexes of ERP adoption were identified in the production strategy. To assess the impact on production, operational performance objectives were considered. Based on the study, it was concluded that the adoption of the ERP brought improvements to the company's operation, especially in information reliability and traceability.

Limitations of research: As the implementation was recent, many of the employees heard still had no clear idea of the changes and the scope that the adoption of ERP would bring to plants and production.

Practical Implications: The study allowed the survey and registration of the challenges in the implementation of ERP in a metallurgical company with differentiated product lines, which is where its originality and relevance come from.

Originality/value: The originality consists in the fact that the study was carried out in a mid-sized metallurgic plant, located in the Midwest region, with three units and differentiated product lines, when the ERP implementation was being completed.

Descriptors: Planning; Information; Management; Strategy; Production.

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1. INTRODUCTION

The study *Avaliação do Desempenho do Brasil Mais Produtivo* (Performance Assessment of the Most Productive Brazil), prepared by the Economic Commission for Latin America and the Caribbean and the Institute for Applied Economic Research (ECLAC; IPEA, 2018), shows that the productivity trajectory in Brazilian industry has been characterized by stagnation in recent decades. According to the study, half of the differences in per capita income between nations can be explained by differences in productivity. In the same vein, the Inter-American Development Bank reveals that low rates of productivity growth are the main obstacle to economic growth in Latin America.

In recent years, much has been discussed regarding factors outside the plant, notably reforms, which improve the business environment, professional education, and infrastructure, and which simplify regulation and taxation.

Internally to the plant, due to the need to be competitive by increasing productivity in the face of global competition, Brazilian companies have been investing in the implementation of Enterprise Resources Planning (ERP). Many companies start the implementation process without having the exact notion of the challenges and their implications. This is because it is not just a matter of implanting one more system, but of carrying out an organizational transformation with consequences for the entire company.

In this context, this study aims to analyze the implementation of ERP in a mid-sized metallurgical company, with differentiated product lines, analyzing the repercussions of the adoption of the software in the production strategy from the operational performance objectives.

In the development of research, a research approach was adopted that differs from the line that has dominated the approaches adopted by researchers in articles published in renowned national and international journals, which is to study the theme 'production strategy' in order to relate the influence and alignment of competitive priorities to structural and infrastructural decisions. The conclusions portray the benefits obtained by the company – object of the study – with the implementation of ERP.

2. THEORETICAL FRAMEWORK

Enterprise Resource Planning

Enterprise Resource Planning (ERP), also called Integrated Management Systems, was developed in the late 1990s as a solution and evolution of Materials Requirement Planning (MRP) and MRP II (Ferreira *et al*., 2010; Oleskow *et al*., 2002; Rashid *et al*., 2002), and is now used by companies worldwide.

Its development and adoption by companies emerged from the need to integrate information that was scattered in a large number of other systems, which made access to this information difficult, not to mention the problem resulting from divergent data among the various systems available.

ERPs provide a unified data source for all company activity and therefore represent the backbone of the information management process. This management enables an improvement in the decision-making process and contributes to making it consistent, timely and reliable in organizational units and geographic locations (Chatzoglou *et al.*, 2016). ERPs integrate information from company sectors using the concept of a single database, enabling the continuous improvement of processes and meeting the need for reliable information in real time (Laudon; Laudon, 2007).

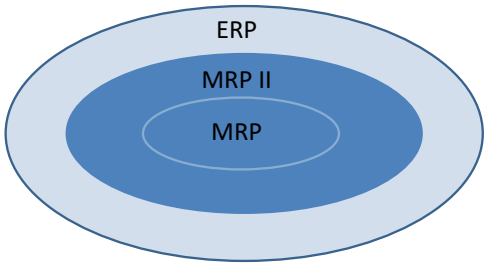

Figure 1. ERP as an evolution of MRP
Source: The authors themselves

An ERP is therefore software used for enterprise resource planning because it integrates business functions to enable more efficient operations. It represents an integration of accounting, financial, production and purchasing information among others. Due to the open architecture, its integration with other operating systems, databases and hardware platforms is feasible.

Figure 2 presents the structure of an ERP and its respective modules that enable the integration of diverse company data.

According to Barth and Koch (2019), in recent years the penetration of enterprise resource planning systems, ERP, in small, medium and large companies has increased. Organizations are required to adapt their systems and perform ERP upgrades to react to rapidly changing business environments, technological improvements and increasing competitive pressure.

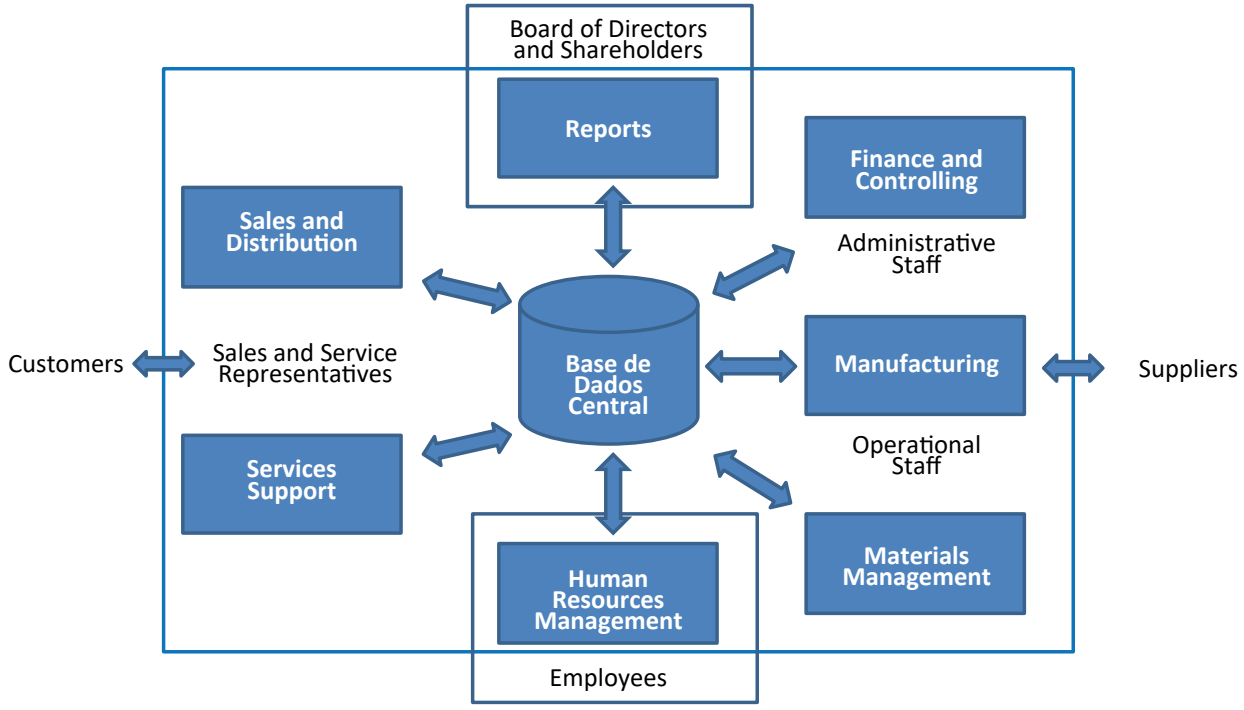

Figure 2. Enterprise Resource Planning
Source: Adapted from Davenport, 1998; Junior 2008

Traditional ERP in organizations is increasingly impacted by emerging information technologies such as cloud services and social media technologies. A recent survey conducted by the Gartner group in 2013 reveals that 47 percent of organizations plan to switch to cloud-based systems over the next five years (Rayner, 2014).

ERP Implementation

In spite of the challenges involved in implementing Enterprise Resource Planning, especially for smaller companies with fewer resources available, many companies are choosing to deploy them, mainly because of frustrations with incompatible systems, mainly to make business processes more agile. Some factors, according to Padilha and Marins (2005), are fundamental to the success of ERP implementation, whatever they may be:

- Obtain the Commitment from senior management;
- Implement change management to mitigate the "fear" of underinformed users;
- Identify key users, who are essential people in their respective sectors;
- To choose an experienced and respected professional for the position of Project Manager (Manager-User), in order to deprive the ERP from its characteristics as a system of the computer area, and to characterize it as a redesign of the management model;
- To plan and carry out trainings;
- To define the roles and responsibilities in the implementation of the system, through the union of knowledge and efforts;
- To customize the system to the company and vice versa, reflecting on the current reality of the company and the use of best practices;
- To choose and hire the appropriate consultancy (know-how);
- To ensure quality (quality assurance);
- To simplify in all aspects, from the definition of models, through the design of the solution, to the implementation of the system itself.

Although the adoption of some precautions can mitigate the risks inherent to the implementation of an ERP, the task is not trivial. According to the above-mentioned authors, the difficulties with ERP implementation stem fundamentally from two factors:

S&G Journal
Volume 15, Number 2, 2020, pp. 143-155
DOI: 10.20985/1980-5160.2020.v15n2.1652

- The company did not make the strategic choices needed to configure the systems and processes;

- The implementation process is naturally beyond the company's control.

Regarding the level of control of operations that the ERP should provide to the company, it depends on the design of the existing flow of products and services. A well elaborated value chain contemplates several controls and other functions in the company's processes in a much simpler way and with more accessible costs with ERP.

Studies suggest that 60% of ERP projects fail due to several factors, such as: the lower than expected return, the inability of the system to meet certain functional requirements, budget limitations, maintenance and high training costs, inadequate estimates of deadlines, incorrect system operation and failure to meet initial expectations (Ghosh, 2012).

When these failures occur, they can be attributed to:

- Lack of clarity about functional requirements. Functionalities are often not well specified;

- Lack of management commitment. The top management of the company decides to implement the ERP and, for not having the exact notion of the dimension and peculiarities of the project, ends up not committing itself;

- Inadequate training. Users are not properly trained;

- Inadequate selection of the software package. Packages are chosen based on employees' experience when deploying ERP in the companies where they previously worked;

- Poor scheduling and expectations. Time and effort required for implementation are underestimated;

- Incompatibility with business processes. Misalignment with support processes can affect ERP performance.

A good planning of the implementation process, since the choice of the supplier, is essential to obtain the expected results. Scheckenbach *et al*. (2014, p. 659) describe ERP updates as "mainly designed to take advantage of new technologies and business strategies to ensure the organization follows business development trends.

In one of the most recent models, Peng and Nunes (2017) propose the 9D ERP evaluation structure, which includes nine dimensions and 85 evaluation criteria, focusing on critical failure factors to be addressed in post-implementation.

Huang and Yokota (2019) published a survey whose results indicate that the use of the alignment assessment model between businesses and ERP is a more convenient method to help organizations identify the alignment status between organizations and ERP systems.

Production strategy

Manufacturing activities or strategic priorities were identified by Skinner (1969) as: productivity, service, quality and return on investment.

The production strategy can be studied from several points of view, according to Skinner (1969), regarding the importance of production for the company's strategy (Cohen; Lee, 1985; Swamidass; Newell, 1987; Anderson *et al*., 1989; Amoako-Gyampah; Boye, 2001). According to Garvin (1993), most publications address four main competitive priorities: cost, quality, delivery and flexibility. To these four competitive priorities, the author adds another one which is called services.

Slack *et al*. (2010) identify five operational performance objectives that are part of all types of operations, which are: quality, flexibility, speed, reliability and cost.

The objective of the production strategy is to provide a pattern of consistent decisions regarding the production process, and to provide the company with guidance regarding how to use resources in a way that sustains a competitive advantage in the long term. Once the competitive priorities are identified, it is possible to develop the design of the production system through a set of factors related to the decision areas. The production strategy, therefore, consists of establishing policies and plans to use a company's resources in order to better sustain the competitive strategy in the long term.

According to Slack (2005), for a long time it was considered that there was a contradiction in the concept of production/operations strategy, the former being an external and long-term approach focused on the aggregation of value and responsibility of the main executive, and the latter, operation strategy, refers to something complex, detailed, relating to the day-to-day of the company and responsibility of the lower hierarchical levels.

According to Okoshi *et.al.* (2019), manufacturing strategy plays an important role in the competitive strategy of businesses, because it connects performance indicators to company objectives. The operations strategy is organized

into performance objectives and decision areas that define its content.

Production strategies are developed, considering competitive criteria or operational performance objectives, which allow a more adequate analysis in terms of the positioning of products and goods in relation to market and customer requirements.

Four basic operational performance objectives are commonly used: cost, quality, delivery and flexibility. Paiva *et al*. (2009) identify five competitive criteria in the area of production management, which are related to the business strategy of the organization, namely: costs, quality, delivery performance, flexibility, and innovation. The last criterion, innovation, "is traditionally defined as the ability of the company to launch new products and/or services in a short period of time" (Paiva *et al.*, 2009, p. 56).

Companies are developing new management models for their manufacturing functions. The complexity of competitive standards and the paradigm shift based on connected manufacturing requires a closer understanding of the relationships between companies' performance results and manufacturing capabilities (Nudurupati *et al.*, 2016; Lauras *et al.*, 2010).

According to Hill (2005), the formulation of the production strategy includes five stages:

- Definition of business objectives;
- Determining the marketing strategies to achieve these objectives;
- Evaluating how different products conquer markets to the detriment of competitors;
- Establishing the most appropriate way to make these products available;
- Promoting the infrastructure required to support operations.

Studies that link production strategy to performance results generally explore the causality effects between policies and outcomes. Esmaeel *et al*. (2018) show how production strategy aligns and connects results to strategic manufacturing decisions.

ERP implementation, operations strategy and operational performance objectives

The relationship between business strategy, production strategy and information systems strategy has been analyzed in the literature. Several studies have been published addressing ERP and the impact of their implementation on organizations (Valipour *et al*, 2012; Chen *et al*., 2009; Dantes; Hasibuan, 2011).

Cao and Dowlatshahi (2005), for example, identified links between production strategy and the strategic orientation of information systems. They analyzed the correlation between company performance and information systems when aligning production strategy and information system strategy (Byrd *et al.* 2006; Chan; Reich, 2007).

Sabherwal and Chan (2001) and Chan (2002) studied the correlation between the strategic orientation of information systems and decisions in terms of operations strategy, as well as between business strategy and information strategy in business performance.

Another survey addressed ERP implementation at Rolls-Royce, using the case study methodology focusing mainly on the implementation project, the cultural aspects involved, and the technical problems of implementation (Yusuf *et al*., 2004).

The relationship of ERP deployment with the strategy and cultural aspects involved in aligning ERP implementation with products and processes was also addressed by Bowersox *et al*. (1998), Davenport (1998), Hammer and Stanton (1999), Jacobs and Whybark (2000) and Soh *et al.* (2000).

Other authors have contemplated ERP implementation in manufacturing (Yen; Sheu, 2004; Yusuf *et al*., 2004) and in competitive priorities or operational performance objectives (Yen; Sheu, 2004). This study concluded that the ERP implementation impacts several aspects of business operation and performance.

3. METHOD

This study is of an exploratory nature. The research in metal industry has been developed through qualitative research in the modalities documentary research, observation and single instrumental case study.

Qualitative research was chosen because it developed in the natural environment, and because the researcher's concern is the meaning people give to events and the deductive approach. The documentary research was developed in particular on the company website and in manuals and procedures used by employees.

The objective of the first stage of the investigation was to know the history of the metallurgic industry, since its

S&G Journal
Volume 15, Number 2, 2020, pp. 143-155
DOI: 10.20985/1980-5160.2020.v15n2.1652

foundation in the 1960's, and the main transformations that have occurred. Then, the case study was developed in the units where the techniques applied were observation and interview.

The object of the study was the implementation of ERP. The single instrumental case study was used since the purpose of the research was to understand, in depth and from several points of view, a certain phenomenon in the context in which they occurred.

In the instrumental case study:

> "The interest in the case is due to the belief that it may facilitate the understanding of something broader, since it may serve to provide insight into an issue or to contest a widely accepted generalization by presenting a case that does not fit into it (Mazzoti, 2006, p. 641).

According to Yin (2005, p. 33), the case study "is the method chosen when analyzing contemporary events when relevant behaviors cannot be manipulated". The author adds:

> "It is a form of empirical research that investigates contemporary phenomena within their real life context, in situations where the boundaries between the phenomenon and the context are not clearly established where multiple forms of evidence are used".

For the collection of information in the interviews, the Interview Consultation methodology was used, from which a group of specialists to be interviewed was selected to discuss a certain subject. The Interview Consultation procedure consists of, for the first interviewee, elaborating a script of questions adequate to the characteristics of the individual. This set of questions will be the script for the interview with the other interviewees. After the first interview, a summary of the discussion that serves as a guideline for the preparation of the questionnaire for the second interviewee is made. In the second interview, the aim is to corroborate the information obtained in the first interview and complement the knowledge on the subject. This process is repeated for the other interviewees until the information obtained in subsequent interviews does not present new knowledge. The methodology made it possible to achieve a broad knowledge of the subject, based on the partial, dispersed and generally biased knowledge of the employees.

4. RESULTS

Profile of the business group and respondents

The company studied is a metallurgic industry, leader in the segment in the Midwest region, which operates in the manufacture and marketing of, among others, profiles, industrial tubes, plates, and laminates. It has a factory with business units in the Federal District and in the state of Goiás, and several stores that sell products manufactured by the industry, agro-industrial products, tooling, locksmith accessories, and personal protection equipment.

The company has three business units: doors and windows; profiles; poles and arms. The profiled products unit has two plants: one in Brasília and another in the satellite city of Taguatinga. The doors and windows unit is located in the city of Anápolis, in the state of Goiás. The unit of poles and arms is located in a satellite city of Brasilia. The units of doors, windows and profiles develop and manufacture the products. The electro-hardware unit (poles and arms) only carries out assemblies.

The products manufactured by the company serve several sectors and constructive applications, such as civil construction, distribution, transformers, public and residential lighting, auto parts, commercial and industrial facilities, agricultural machinery and implements, furniture industry, storage systems, sugar and alcohol industry, and naval industry.

The competition in each segment is differentiated: the competition is segmented from small locksmiths to larger companies.

A differential of the company is the flexibility to meet different demands through a wide range of products, which implies a low production scale.

Product Lines

The line manufactured encompasses different types of products. The doors and windows business unit manufactures, besides windows, shutters, side-hung doors, sliding doors, fire doors, Maxim-Ar and swing doors. The profiled business unit manufactures industrial tubes, metal roofing tiles, calendered and curved structural profiles, roofing tiles and ridges, cut, folded and calendered sheets, profiled rails and ruffs, as well as other products requested by civil construction. The unit of poles and arms, on the other hand, serves mainly concessionaires responsible for electric power distribution and public lighting, manufacturing arms for lighting, telephonic poles and supports for luminaries.

Analysis and discussion of results

The research work in the company was conducted by means of qualitative research in the modalities documentary research, observation and case study. The objective of this first phase of research was to learn about the history of the company since its foundation in the 1960s and the main transformations that have occurred since then. At this stage, it was possible to know how the company was structured in business areas and the main product lines manufactured by each unit and the use of each product to meet the most diverse constructive applications.

Then, the case study was developed in the units applying the fundamental techniques of observation and interview. To collect data in the plants, as described in the methodology, qualitative research in the natural environment was used. The aim was to identify the significance that the company's employees gave to the ERP implementation process and its impacts on day-to-day activities. The approach used was inductive since the researchers did not start from hypotheses established *a priori*; therefore, they did not worry about collecting data that would corroborate or deny such hypotheses. A semi-structured data collection tool was used and interviews with managers and other professionals involved in production and manufacturing planning were conducted. At the end of the interview, recorded and transcribed, narrative reports were generated, illustrated with quotations, examples and descriptions of the phenomenon provided by the interviewees.

Eleven leaders belonging to the three units of the company were interviewed. The definition of the number of interviewees considered that more interviews would not necessarily improve the quality of information or lead to a more detailed understanding of the phenomenon, since there is a limited number of interpretations or versions of reality.

The interviews began with the Executive Director of the company and included employees from different hierarchical levels and functions such as managers, supervisors, coordinators, and foremen.

The interviews lasted an average of 40 minutes and the scripts were customized for each respondent according to the activities performed by each one and the information collected from the previous interviewee. Therefore, some questions deemed not pertinent, according to the position or area of activity, were suppressed in the interviews with employees. Likewise, the interview with each leader made it possible to refine the approach that would be developed with the next interviewee.

The proposed issues addressed the implementation of ERP in the business group, its repercussions on business units, production, operational performance objectives and the value network of operations.

Impact of ERP deployment on the company

The first part of the script sought to know, in general, the perception of the respondents in terms of the impact of ERP implementation in the company. Questions about what led the company to implement the ERP, main challenges, main problems of the post-implementation period, main benefits generated, the level of knowledge of employees on the company at the time of implementation and whether the implementation time was compatible with the estimated.

Regarding what motivated the company to implement the ERP, the following were mentioned by the interviewees:

- Improvements to both finalist and support processes in order to enable their traceability;
- Cost reduction throughout the company and processes;
- Need for greater control and security of information so that it is more reliable and obtained in real time, ease of exporting this information, and reduction of its dispersion propitiated by integration.

The main challenges for deployment were mentioned as:

- Lack of prior knowledge of the tool by the company's employees, which made its application difficult;
- The contractor's lack of knowledge of the contractor's processes to give adequate support to the implementation as well as the limited knowledge of the consultants about the tool. The contractor's expectation was that all the contractor's consultants would know all the modules, which did not occur;
- In the door and window unit, the main challenge was to migrate from a manual process to a computerized one. In the profile, pole and arm units, where the migration between ERP tools took place, the need to migrate from one system to another and the employees' resistance to change was mentioned. This resistance was due, in part, to the lack of an awareness effort and the mastery and sa-

S&G Journal
Volume 15, Number 2, 2020, pp. 143-155
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fety with which they dealt with the tool previously used. It was also mentioned the difficulty of having to get involved with a new tool while conducting the normal and daily activities of each employee. That is, the team involved in the implementation did not give up its routine tasks to dedicate itself exclusively to the implementation of the new tool.

Regarding the problems faced in post-implantation, the lack of parameterization of some factors and the great inter-relationship and interdependence between the areas were reported. This has often slowed down implementation, since progress in one sector is dependent on what is done in another. It was also mentioned a certain misalignment between production and commercial in the first moments of using the tool. Some reports that were generated in the tool previously used are no longer generated in the new tool.

The immediate consequence of this was that the factory was producing and the commercial did not "see" this production, which shows a gap in integration. Another factor mentioned is that the tool is very limited, that is, not very flexible, which caused a culture shock in relation to the new tool, since the employees, especially the Brazilians, were used to a system with greater flexibility. Complaints were also reported regarding the lack of support and consulting support in the first moments, when the contractor's employees did not yet have full command of the tool.

As for the benefits provided by the adoption of the ERP, they were perceived by the employees of the metallurgic industry:

- global view of the company;
- greater traceability and reliability of information and in particular for the closing/conciliation of accounting accounts provided by a better interconnection between fiscal and financial routines;
- improvement in the management of the finalistic and support processes;
- greater commitment of employees to their activities, since any failure in one activity has repercussions on others;
- Improvement in the production costing method, providing greater knowledge of the costs incurred in manufacturing.

With regard to the previous knowledge that the employees had about the company, there was consensus that it was satisfactory. Another point where the perceptions were similar was regarding the estimated time for implementation. All interviewees were unanimous in stating that the implementation lasted longer than initially planned.

Impact on production strategy

After understanding the effect of ERP implementation on the company and seeking to focus on production, which is the main objective of the study, the interview, in a second moment, was conducted to raise the perception of respondents on the impact of ERP in factories and production.

The way in which the processes preceding the deployment were surveyed was investigated. Then, the impact of the ERP on the production processes was understood; and the effects on production controls, on the production strategy in a comprehensive way and particularly on production planning, on the production process, on productivity, on the level of losses, waste, scrap and rework, and on decision making in production and on integration with the supply chain were evaluated.

Regarding the survey of production processes, this step was facilitated by the fact that the company is certified by ISO 9000. In addition to the information provided by the ISO documents, the hired company conducted surveys with some employees for a better knowledge of production processes and metallurgical routines. The implementation of the tool printed the need for small adjustments in some processes; however, the changes were punctual.

Production controls were the area where respondents pointed out the greatest improvements, assuming the accuracy of the information imposed on the ERP. Information regarding what is being produced is now more accurate and reliable than before the ERP was implemented or in the previous version from another supplier. The integration of inventories with the production process and the inventories carried out during the year were also mentioned as important gains in production controls. Some respondents expressed the expectation that the maturation of the system would lead to further improvements in controls.

In the strategy of production planning in particular, it has been observed that reliable information provided by the ERP makes planning more robust by providing accurate information that enables the development of a planning process appropriate to the reality of the plant, orderings, raw material stocks and, consequently, a better production strategy. In addition, they assist in planning the

need for materials in the plants. With the adoption of ERP, production orders are planned and then scheduled in the system.

No significant change has been observed in the production process, since this is mainly a function of the technology employed and of machines and equipment. ERP does not command any equipment, although it does provide more precise information to the operator who must adjust the machine. Only the greater traceability of information in the production sector and not in the manufacture of the products themselves was mentioned by several interviewees.

As for productivity, there was a slight drop in the beginning of the implementation due to the need to adapt some procedures. Subsequently, it returned to normal levels since it depends, in large part, on the demand generated by the orders that arrive at the plant, since the production is pulled by the commercialization of the products.

With regard to losses, waste, scrap and rework, there has been no reduction insofar as the loss depends on the technology employed and what is being produced; however, there is more precise information on the scrap that will be generated in the production process in terms of quantity/weight and characteristics of the scrap. Another important aspect is that the anticipation of information on the volume of scrap that will be generated in the process allows a more accurate pricing of the order. When the customer requests, for example, a certain volume of a specific type of material, the volume of scrap that will be produced is evaluated in advance and this cost component is inserted when the sales price is formed.

The availability of more accurate and reliable information has provided improved decision-making in the plants, with a view to greater integration between production itself and PPSC (production planning, scheduling and control).

Finally, as for integration with suppliers, a certain difficulty was observed at the beginning due to the changes the company went through. Once the initial difficulty was overcome, today there is a slight improvement due to the fact that the information generated by the supplier enters directly into the system, even though this integration is limited to the receipt of the invoice and not the order. It is expected that this integration will be improved in the future, with the adoption of new and more sophisticated versions of ERP, through the integration between the company's ERP and the suppliers' ERP.

Impact on operational performance objectives

The analysis of the impact of ERP adoption on operational performance objectives was performed considering the variables: process and product quality, production speed/rhythm, reliability of produced items, production flexibility to meet orders, and reflexes on production costs, as illustrated in Figure 3.

As for the impact on process and product quality and production speed, no gains have been reported, mainly because these variables are determined by the qualification of the workforce, technology and equipment employed.

In the factory of poles and arms, the main process is the assembly and is directly related to the qualification of the workers involved. In the Profiles business unit, a system other than ERP is used to guarantee the quality of products and processes. This other system is configured from the requirements of ISO 9000.

A benefit of ERP in terms of process and product quality and production speed was that the need for paper circulating in the mills was considerably reduced, facilitating the production process and the production rhythm, because the system's consultation is generally more agile than the handling and search for information in printed reports.

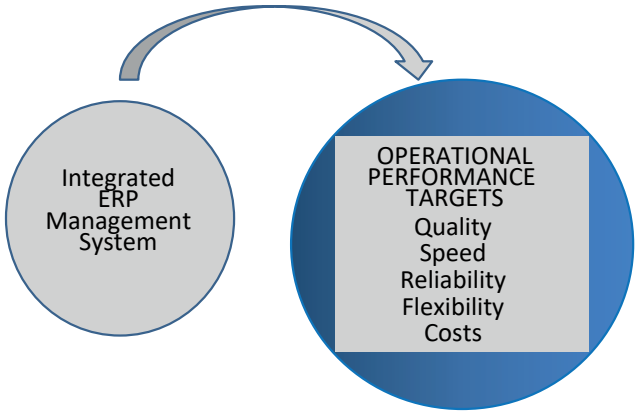

Figure 3. Impact of ERP on operational performance objectives
Source: The authors themselves

There has been an improvement in the marketing process, as the finished product appears faster in the system, and this information is important for the sales area to inform the customer and schedule delivery.

As far as the reliability of the produced items is concerned, ERP enables greater traceability and better handling and analysis of the order item by item instead of globally, as was previously done. With the ERP, the order

S&G Journal
Volume 15, Number 2, 2020, pp. 143-155
DOI: 10.20985/1980-5160.2020.v15n2.1652

is identified item by item with the information of its respective prices and weights.

The adoption of the system has improved the flexibility of production to meet orders, since currently the capacity of each registered machine of equipment has been mapped through the ERP and, thus, it is possible to better allocate orders in order to improve the capacity of the machines. Another aspect in relation to flexibility is that the ERP prioritizes orders independently of the order of arrival.

One difficulty the company faces is that ERP has led to changes in product, raw material and component codes. Previously, the codes took into account families of materials and now they are just sequential numbers.

With regard to production costs, no gains have yet been identified. However, there have been statements to the effect that they are better calculated today. When you install a production order, you already have an estimated cost, and when you finish it, you can compare the actual cost with the planned cost. In the case of scrap generation, when you fulfill an order, the information needs to make it possible for the pricing to be refined by incorporating this cost item. In other words, before the sale takes place, the salesperson already has the dimensions of the product and information about the losses that will be generated in the production process, which allows this value to be passed on to the customer who requested the order.

One of the interviewees drew attention to the fact that labor time is better used today. In the previous ERP only the moment of the beginning of production and the moment when the table was closed were informed. Currently, the production order already has an estimated time for the manufacture of the product, which allows better control of the supervision of the operation and the work of the production employee from this reference. In case manufacturing takes longer than previously foreseen, the production supervisor can check what may be happening.

Still regarding production costs, it cannot be ignored that they are determined, to a large extent, by the costs of electric power, labor and raw material, in this case, steel.

5. CONCLUSION

Based on the study, it was possible to verify that for the ERP implementation, which counted on the commitment of the top management, key users were identified, a manager was defined for the project, the trainings were planned and carried out, the roles in the implementation were defined and the system was customized according to the reality of the company, as recommended by Padilha *et al*. (2005).

The adoption of ERP brought improvements to the metallurgical operation, as recommended by Chatzoglou *et al*. (2016) and Laudon and Laudon (2007), especially in information reliability and traceability. The implementation was determined by the need to integrate many pieces of information that were scattered in the various systems, making it difficult to rescue this information in an agile way, as well as considering the problems arising from divergent information among the various systems and databases. The ERP made it possible to integrate information from the various sectors of the company into a single database, which improved the process of production planning and consequently the development of production strategies by meeting needs for reliable information in real time. In other words, the adoption of ERP has improved the company's operations, reducing losses and mitigating the risk of the operation, since it has made it possible to integrate information from the various business units, ensuring their reliability and availability and real-time access for decision making.

As mentioned by Cao and Dowlatshahi (2005), the study identified important links between the production strategy and the strategic orientation of information systems and the correlation between the performance of the metal industry and the information systems (Byrd *et al.*, 2006; Chan; Reich, 2007).

As addressed by Sabherwal and Chan (2001) and Chan (2002), this study identified the integration between the strategic orientation of information systems and decisions in terms of operations, as well as between business strategy and information strategy in business performance.

The cultural issues involved in the implementation of the ERP could also be identified, as anticipated by Yusuf *et al*. (2004), when they studied the implementation of the ERP in Rolls-Royce, using the case study methodology, focusing mainly on the implementation project, the cultural aspects involved and the technical problems of implementation. The relationship of ERP implementation with strategy and cultural aspects involved in aligning ERP implementation with products and processes was also addressed.

A gap that could be observed was due to the sizing of deadlines and expectations, which were underestimated as mentioned by Ghosh (2012).

With regard to production controls, interviewees pointed out the greatest improvements conditioned to the accuracy of the information imposed on the system. Infor-

mation about what is being produced has become more accurate and reliable when compared to the time before the ERP implementation or another vendor version.

Specifically regarding the operational performance objectives, Yen and Sheu (2004) and Yusuf et al. (2004) observed the following:

An ERP benefit in terms of process and product quality and production speed was that the need for paper circulating in the mills was considerably reduced, facilitating the production process and increasing the production pace, since the system consultation is more agile than the handling and search for information in printed reports;

With regard to the reliability of the items produced, the ERP enables greater traceability and better handling and analysis of the order item by item rather than the global way it was previously done. With the ERP, the order is identified with the information of its respective prices and weights;

The adoption of ERP has improved the flexibility of production to meet orders, since the capacity of each registered equipment is currently mapped and, thus, orders can be better allocated to enhance the capacity of the machines;

With regard to production costs, information which allows concluding that there was a gain has not yet been identified; however, it was found that they are currently calculated with greater accuracy. For example, when you install a production order, you already have the estimated cost, and when you finish the production order, you can compare the actual cost with the planned cost. In the case of scrap generation, when you fulfill an order, reliable information enables you to price the product by incorporating that cost item into the final price.

In addition, it was noted that the availability of labor became better used. In the previous system, in the case of units that already had ERP from another supplier, only the time of the beginning of production and the time when the table was closed were informed. Currently, the production order already shows the estimated time for the manufacture of the product, allowing a better control of the supervision of the operation and the work of the production employee from this reference. In case manufacturing takes longer than initially foreseen, the production supervisor can check what may be happening.

Finally, with regard to the supply of the plants, it was noted, after the interviewees were heard, important gains that can be intensified with greater integration between the ERP of the metallurgic company and its suppliers. Incremental improvements were noted, as mentioned above, in the note entry that is made directly into the system with the recording of more details and information.

Based on the analyses carried out, the objective of the study was achieved by assessing the impact of ERP implementation on the company's production strategy.

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