Influence of strategic positioning on ergonomic and productivity factors: establishment of a conceptual framework

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Activities and knowledge related to organizational engineering tend to be increasingly systemic, leading to a broader understanding of how organizations work. Specifically, in the sub-area of strategic and organizational management, decisions in the strategic scope are hierarchically distant from operational shop floor. This makes impossible to visualize the effects of strategic decisions on fundamental issues such as ergonomic issues and their impact on productivity. Faced with this problem, this qualitative research aimed to establish a conceptual framework selecting the main factors, and their influence in industrial dynamics from the strategic to the operational level. Also, considering the ergonomic and productivity factors. Therefore, a structured method for systematic review of the bibliography was applied. There were collected articles aligned with the interests and data. They were analyzed descriptively and synthesized introducing a conceptual framework, in which were identified relationship among the immediate levels and directly between strategic and operational level. Also, it identifies the formation of three information feedback cycles that are responsible for unpredictable behavior in socio-technical systems. Finally, it was possible to lay the foundation for modeling methods such as System Dynamics for future research.

Keywords: Strategic positioning, productivity, worker illness, dynamic behavior, Systems Dynamics.

1. Introduction

The systemic understanding of industrial events is a line of knowledge and research that has been expanded. This is because a systemic approach could converge to several organizational management issues usually addressed individually, leading to an associated understanding. Thus, one can predict how a decision in an industry or management level affects the organization, allowing seek measures that lead to favorable conditions for the organization operation (STERMAN, 2000).

Organization management issues can be divided according to the systemic level in which they are practiced. In operational terms, management seeks to set the objectives of the operation and take advantage of resources to meet tactical management (PORTER, 1980). Daily production planning and allocation of work teams are activities of the operational level and are performed while the phenomena that control it. However, a major challenge associated with these actions is to prevent illness and the consequent removal of the worker. This event does not affect only the productivity of the organization for causing disturbances to production processes, but also strongly affects the quality of life. It is pointed out that the correct understanding of this ergonomic issue precisely requires a systemic understanding of the factors involved in the phenomenon (BABER; GOLIGHTLY; WATERSON, 2019).

This is because at this level, the ergonomic management must deal with difficult behavior to predict the production lines. This was verified in the research conducted by Mattos et al. (2019) in an organization of automotive electrical components, where the actions of the manager for improving the production performance caused burden on workers and the consequent absenteeism due to illness. That is why the result obtained was lower than the expected productivity values.

In tactical terms, ergonomic management sets objectives over a longer horizon and encompasses activities such as monthly production planning (PORTER, 1980). In this case, many issues focus on the configuration of the processes. This adds other factors that somehow affect the health of the worker, making the context even broader and more complex, and then evidencing the need for a systemic approach. However, the proximity of the operational level to the tactical level still allows decisions to be related by the managers of each level working together.

But, in strategic terms, the decisions and definitions of the directors are hierarchically distant from the operational phenomena. This avoids seeing the effects of such strategic decisions on

key issues such as ergonomics and its reflection in productivity. In this sense, this research explored the factors at the strategic level and defined their cause-effect relationships with other systemic levels, offering specific guidance for strategic and organizational management. With a structure for such relationships, directors and managers can make decisions to obtain a desirable behavior, as discussed by Senge (2014).

At the strategic level were defined the factors that reflect the positioning of organizations, their influence on tactical factors, but also, the influence of these factors with the operational level. Among the operational level factors was focused on operational fatigue, illness, and worker absence. Consequently, there was also a focus on productivity, enhancing the practical relevance of the research. Finally, this research establishes a conceptual framework showing the main factors and their relations in industrial dynamics, from the strategic to the operational level, considering the ergonomic and productivity factors.

The information was obtained from the literature, being this research a secondary source research. A paper portfolio was built to represent a significant fragment of knowledge in the area. The structured process used to collect and select the papers portfolio was an adaptation from ProKnow-C (ENSSLIN et al., 2012). The main contribution of this investigation consists of a graphic descriptive synthesis.

2. Method and tools

This research had as main tool a structured process of Systematic Bibliographic Review (SBR) with the function of selecting scientific papers for the formation of a reference bibliographic portfolio for analysis. Initially, the research keywords were defined to represent the objects of study. These keywords were crossed to form the search terms. The terms were tested in some databases to check whether they collect papers aligned with the research. The databases that provided the gross portfolio were defined and the process was applied.

The stages of the SBR process follows the following order: (a) the papers are collected constituting a gross paper bank; (b) redundancies are eliminated; (c) the papers are filtered for title alignment and (d) the papers are filtered for abstract alignment. Priority is given to papers with the highest number of citations (with the representative test); however, recent papers may naturally have a lower number of citations. The portfolio is filtered for full alignment, (e) papers with low representativeness citations but published in the last two years by authors selected in the previous stage are included. The abstract alignment is verified, (f) to cover the desired scope,

the paper database is expanded by analyzing the paper references (this last step helps the portfolio to include the most relevant papers for the research area that were not collected by using the search terms).

The structure of this process is complex; however, Figure 2 represents the selection process where the results are also presented in terms of paper quantity for each stage.

3. Literature review

The keywords focused on axes that reflect research interests related from the composition of the search terms. Thus, the identified factors are associated factors among themselves, which would make impossible to organize a systemic context. These terms using logical search operators define the search string. Figure 1 presents the search axes, the keywords used for each axis, and the search string.

Figure 1 - Keywords and search string

Axes	Description	Keywords
1	To approach the strategic level	competitive advantage, strategy(ies) position(s)
2	To approach the tactic level	operation management
3	To approach the operational level	production performance, manufacturing performance
4	To approach the main factors of interest.	ergonomics, human factors, overload factors
Search string (applied in the databases: Engineering Village, Web of Science, Scopus, Ebsco):		
("competitive advantage" AND "operation management") OR ("competitive advantage" AND "production performance") OR ("competitive advantage" AND "manufacturing performance") OR ("competitive advantage" AND ergonomics) OR ("competitive advantage" AND "human factors") OR ("competitive advantage" AND "overload factors") OR ("strateg* position" AND "operation management") OR ("strateg* position" AND "production performance") OR ("strateg* position" AND "manufacturing management") OR ("strateg* position" AND ergonomics) OR ("strateg* position" AND "human factors") OR ("strateg* position" AND "overload factors") OR ("operation management" AND "production performance") OR ("operation management" AND "manufacturing performance") OR ("operation management" AND ergonomics) OR ("operation management" AND "human factors") OR ("operation management" AND "overload factors") OR ("production performance" AND ergonomics) OR ("production performance" AND "human factors") OR ("production performance" AND "overload factors") OR ("production performance" AND "human factors") OR ("manufacturing performance" AND ergonomics) OR ("manufacturing performance" AND "human factors") OR ("manufacturing performance" AND "overload factors") OR ("manufacturing performance" AND "human factors")		

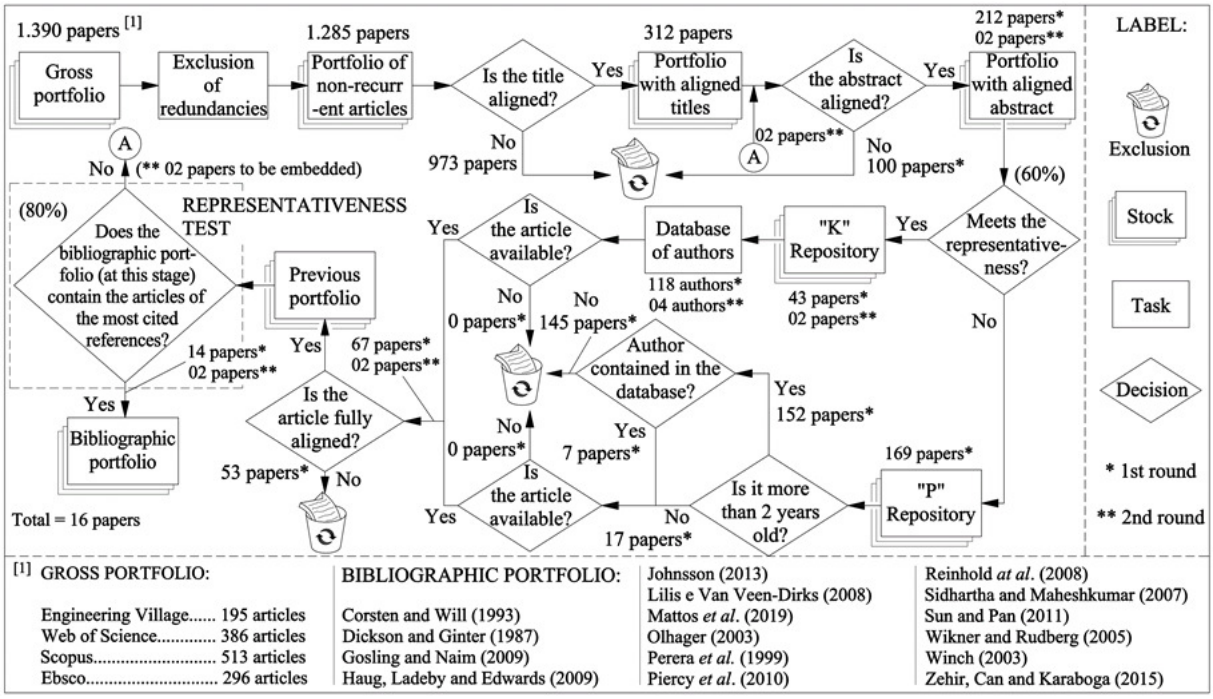
Source: Authors

From papers about operational level were addressed indicators such as physical fatigue, illness, and isolation. In the case of the tactical level, it focused on identifying the dimensions of production, since they generally characterize the organization processes in different segments.

At the strategic level, factors that characterized the strategic positioning of the organization were sought, since they reflect the organization values and how they will differentiate from the competitors.

The process was applied resulting in a portfolio containing 16 papers. The configuration following the ProKnow-C process is shown in Figure 2, as well as the results obtained in each step.

Figure 2 - The bibliographic review process results



Source: Authors

The explanations in the next section are based on information from the related papers in this bibliographic portfolio. However, citations from parallel bibliographies (specifically from books with recognized and consolidated content) were still inserted to complement and substantiate the information obtained in scientific papers.

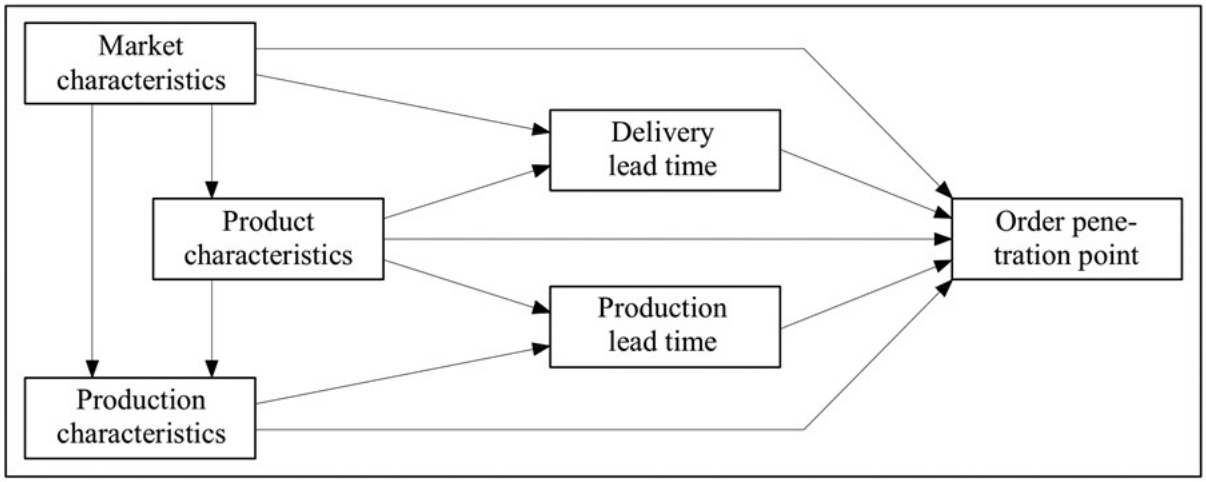
4. Exploration and description of the context

The analysis and description of the context began at the strategic level, following by the tactical level, and the operational level. The details of the factors increased in the same direction.

4.1. Relations at the strategic level

The conceptual model of Olhager (2003) illustrates cause effect relationships in an organization, Figure 3. In this figure, the organization favors the flow of relations, thus characteristic of the research does not target the systemic levels and decisions taken at the respective levels. However, this conceptual model highlights the influence of market characteristics on the system, these are external factors to the organization. In the research by Olhager (2003), the model also considers factors from other systemic levels, such as the "location of the order" (referring to the tactical level) and the "production characteristics" (emphasizing the importance of the operational level). These were addressed in the following sections.

Figure 3 - Influencing factors in the organizational system



Source: Olhager (2003)

First, the most strategic decisions meet certain positions against the market. Therefore, the elucidation about the characteristics of the market is necessary for the correct justification of the strategic factors. In this sense, managers have specific tools to diagnose the environment in which they intend to operate, showing the strengths and weaknesses to define their position, as applied in the SWOT matrix. However, Porter (1980) highlights four key competitive market forces that can be taken as a general reference, as follows: competitors, new entrants, substitute products, suppliers, and consumers. The rivalry among competitors determines the degree of competitiveness of a sector. The threat of new entrants is due to the degree of ease or difficulty that competitors face to enter a sector. Substitute products refer to the degree of ease to replace a product or service for something similar that satisfies its need or causes to extinguish that

need. The supplier bargaining power increases when they are essential and unique to the organization, establishing a relationship of dependency. Additionally, the consumer bargaining power increases when they use means to force the price reduction. Given these forces, Porter (1980) also defines general strategies for dealing with those forces, establishing competitive advantage, which implies offensive or defensive actions to establish a favorable position in a sector. These general competitive strategies are leadership by cost, leadership by differentiation, and leadership by focus. The cost leadership strategy aims to obtain a significant price advantage over competitors in a market segment by concentrating all strategic activities on cost control and reduction (CORSTEN; WILL, 1993). The differentiation leadership aims to provide a unique perception of the product (DICKSON; GINTER, 1987). This can occur in one or more market segments and should not be confused with the "market segmentation" strategy (DICKSON; GINTER, 1987). The generic focus strategy corresponds to a very specific market segment. This is a more comprehensive case, once the segment is defined, the organization can establish its position at reduced cost or by differentiating its products or services.

The general strategies are taken as a reference since they are widespread and broadly reflect the general positioning of the organization to face market challenges. This breadth favors the establishment of a context that can be applied to different segments. Even so, specific cases can still be considered as intermediate points among the general strategies. As for this research, it is essential to highlight the effects of these strategies at the tactical levels, as explored in the next section.

4.2. Relations at the tactical level

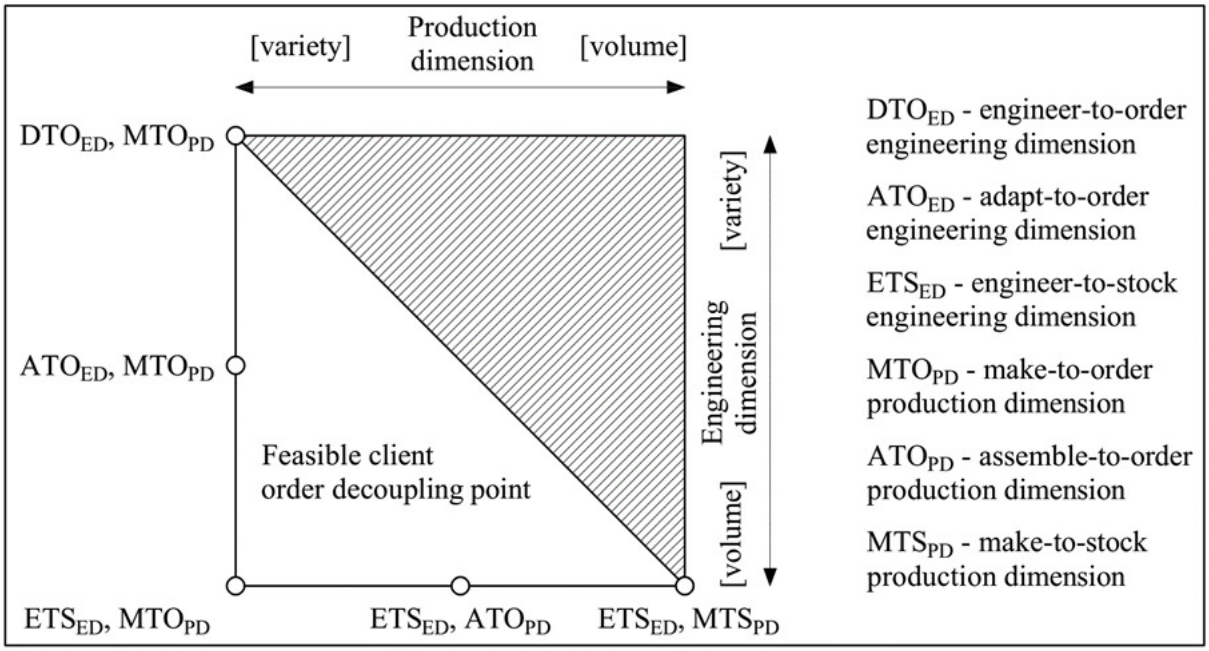
In tactical terms, the objective of management is to establish production planning over longer horizons, such as planning for one month or for several months. In general, this planning affects the volume and the variety of products in an inverse way, the larger the variety, the smaller the volume. This relationship is observed in the civil construction and manufacturing segments by Winch (2003), and in classic approaches, by Porter et al. (1999). In this sense, classic production strategies such as "make-to-stock", "assemble-to-order", "make-to-order", and "engineer-to-order" establish a balance between volume and variety, and in generally determine the tactical production planning.

This is a perspective aimed at production systems of tangible goods. However, Wikner and Rudberg (2005) expands this perspective to include the engineering dimension. This

convergence generalizes the approach also in the services sector, as explored by Johnsson (2013) in the civil construction sector. Gosling and Naim (2009) still explore the "engineer-to-order" perspective in the supply chain, expanding this view for a systemic view.

The relationship between volume and variety in production planning is shown in Figure 4 for manufacturing and engineering activities. The "engineer-to-order" or "make-to-stock" are opposite strategies, the first establish more opportunities for a greater level of customization (greater variety of products and less volume). On the other hand, the "make-to-stock" strategy favors more standardized products and less volume.

Figure 4 - Volume / variety relationship



Source: Johnsson (2013)

Regarding the strategic level, the cost leadership strategy may require the standardization of products for reducing process cost, among other possibilities (PERERA et al., 1999). The cost leadership strategy points for high volume production, but also may involve additional costs in inventories.

In the case of differentiation leadership strategy, the costs are high because this strategy requires financial resources to ensure differentiation as to prevent excessive differentiation (LILLIS; VAN VEEN-DIRKS, 2008). Researches observe that organizations that adopt this strategy have a lesser focus on efficiency (LILLIS; VAN VEEN-DIRKS, 2008), which ends up raising costs.

However, financial performance gain support for not getting excessive differentiation, which ends up being unprofitable (LILLIS; VAN VEEN-DIRKS, 2008).

For that, organizations adopting the differentiation strategy need to be flexible enough to change the resources of production and services for changes in market and consumer needs, Sun and Pan (2011). Therefore, this study assumes that in a differentiating strategy, the position in the spectrum volume / variety declines for variety.

The above highlighted relations focus on two of the four dimensions of production described by Slack (2009). This author also shows, in addition to volume and variety, the variation in demand for the product and the degree of visibility that customers have of production.

4.3. Relations at the operational level

The factor "cost" and therefore the "price" are operative consequences, but directly influenced by the cost leadership strategy. This relationship occurs directly from the strategic level to the operational level. Similarly occur from the top managers to the workers. This establishes an organizational culture of cost reduction, which is reflected on the daily activities.

On the other hand, a leadership by differentiation requires processes flexibility to follow changes in market perception; this strategy is also related to innovation (SIDHARTHA; MAHESHKUMAR, 2007; ZEHIR; CAN; KARABOGA, 2015). This demands adequate and constant recognition of consumer needs and the added value of interest, Sun and Pan (2011). The requirements for research and development can affect the operational capacity. But, at the same time, the flexibility of operations requires a broader knowledge in terms of activities for production, i.e. the know-how. Knowledge is a factor addressed by Mattos, et al. (2019) that models the context by System Dynamics. For this reason, the research by Mattos, et al. (2019) also describes the relationships conceptually, where knowledge and capacity are influencing productivity. The search for productivity can lead to fatigue due to working conditions such as repetitive tasks, time of cycles, time for physiological recovery (MATTOS, et al., 2019), binding or monotonous position, unilateral tension of muscles, vibration, noise, factors that cause skin diseases (REINHOLD, et al., 2008), among others. These factors cause overload, illness, and consequent worker absenteeism. This absenteeism, in turn, ends up requiring substitute workers without the proper operational knowledge, again affecting productivity. Thus, a cycle is formed at the operational level, the characteristic responsible for behaviors difficult to predict. Productivity defines the cost of production and the differentiation obtained,

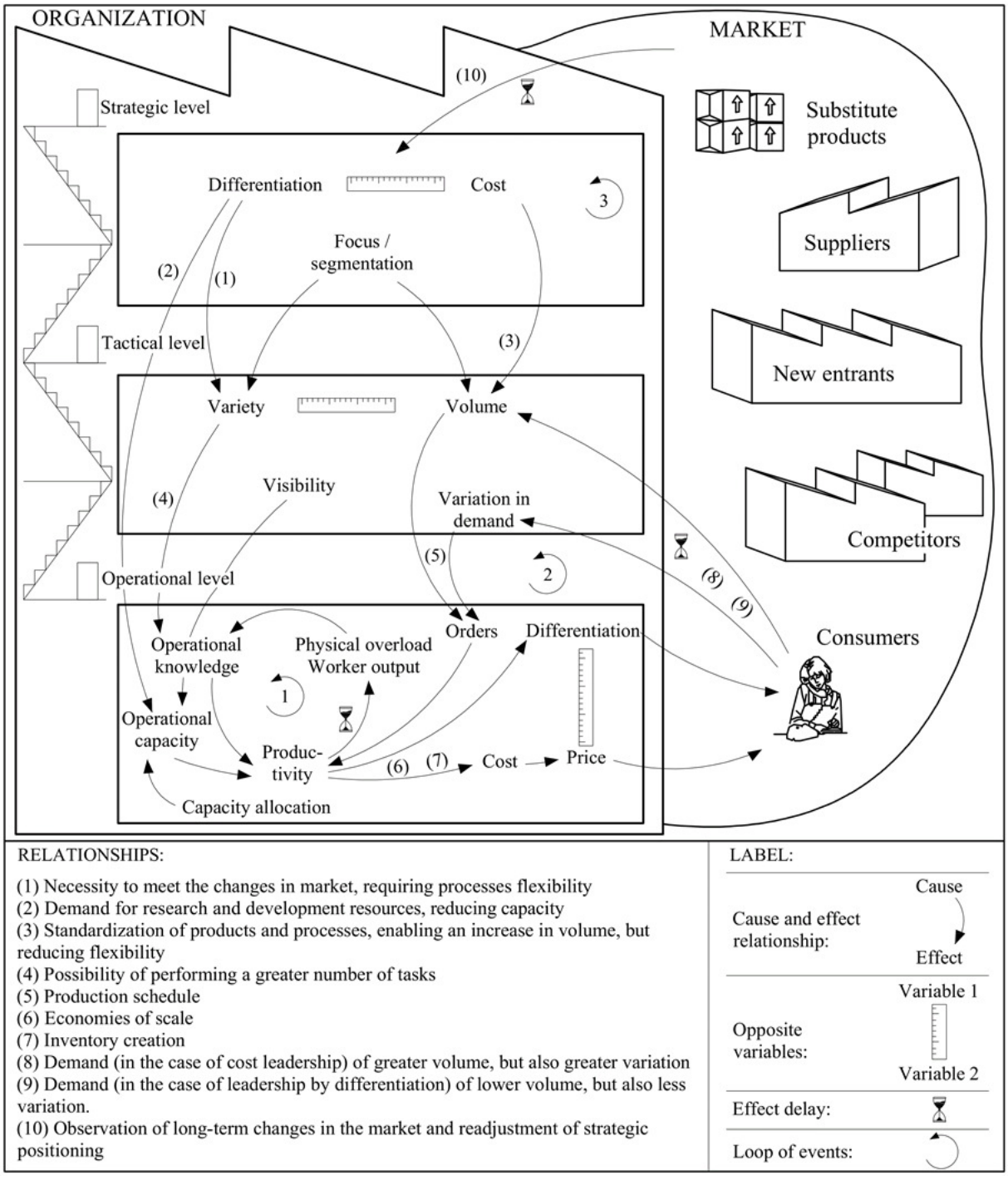
which depend on the general strategy chosen. Both, the differentiation, and cost reduction obtained at the operational level represent factors that impact the environment outside the system, in this case the consumer directly. The consumer perception about the conditions of these factors causes a response to the system, determining the demand from the system. This demand can occur in two ways. In case of cost reduction strategy, if well implemented, the demand will be a higher production volume, but subject to sudden variations. In the case of a successful implementation of the differentiation strategy, the demand will be more stable due to brand loyalty, however in a lower volume. This shows an information feedback cycle configured between the operational level and the tactical level, and suffering exogenous influence from the market.

4.4. Conceptual representation

The information listed above may be incorporated in a conceptual diagram. This diagram was constructed in order to graphically represent the context for a better understanding.

The conceptual diagram is shown in Figure 5, in which are symbolized the market, the forces operating in this environment, and the organization in its internal context. In the internal context, the segmentation on the systemic levels is emphasized. Also, the factors result in the system dynamics as identified by the analysis conducted.

Figure 5 – Conceptual framework of dynamic context



Source: Authors

The next section establishes a discussion facing the papers selected in the SBR, comparing the results, and showing how the results of this research contribute to the evolution of knowledge.

5. Discussion

The research was directed to a specific line to represent the context. The general strategies derive from a well-known study; however, similar studies could differ from this respect. For example, some organizations adopting the engineer-to-order strategy, in certain circumstances, would obtain products or services characteristic of mass production (HAUG; LADEBY; EDWARDS, 2009). Even the general competitive strategies taken as a reference have their variations and specificities, as shown by Piercy et al. (2010) in relation to the cost strategy. And, organizations can adopt a strategy in which the leadership by cost or by differentiation are not antagonistic, as considered by Corsten and Will (1993), and evidenced by Lillis and Van Veen - Dirks (2008).

However, the conceptual framework resulting from this research, when compared to the model by Olhager (2003) and other models such as Corsten and Will (1993), allows to visualize the flow of information among the levels systemically. in addition to establishing a distinctive scope and a trend towards viewing the flow of causes and effects throughout the organization, the theoretical framework also indicates important discoveries applied to management. Through the sequence of causal relationships, it is possible to see, for example, how the adoption of the cost leadership strategy increases the volume, generates more orders, uses operational capacity, and delivers a lower price to the consumer, who resumes purchasing products, strengthening a cycle of actions and consequences.

However, another cycle working in parallel (identified as cycle 1) can act to restrict or decrease the available operational capacity, generating fluctuations that need to be addressed by internal interventions. In the adoption of the differentiation strategy, causal relationships and factors involved indicate issues related to knowledge management even more complex. Even such complexity to be correctly understood may require the construction of computational simulation models. In this sense, the conceptual framework resulting from this research establishes the basis for a modeling process applying System Dynamics. This modeling method directly takes results' advantage of this research in the first modeling stage. The causal relations can be re-exposed in a diagram, possibly broader, but the whole concept maintained. With System Dynamics, the modeling process leads to a mathematical model used in computer simulations. Simulations generate future scenarios that are especially useful in a context with many relationships among the factors, such as what this research has shown. With such scenarios, there would be a theoretical contribution to the area of production engineering ergonomics as

they lead to an understanding of the phenomenon that is difficult to obtain only by subjective interpretation. But also, the availability of a simulation model could help managers to test actions in a virtual environment in order to obtain higher levels of productivity. This method was applied by Mattos et al. (2019) exploring only the operational level.

6. Conclusions

The strategic and organizational management decisions at the strategic level are hierarchically far from operational issues, which difficult to see the effects on key issues such as ergonomics and its reflection on productivity. However, the conceptual framework presented in this research, associates strategic factors, tactical, and operational (the latter related to ergonomic issues and productivity), reinforcing the cause effect relationships among these factors.

The conceptual framework highlighted three cycles of feedback information. The knowledge of these cycles is fundamental for the management activity, since they are responsible for the behavior of the systems, which is difficult to predict and control. Only the analysis of the cause effect patterns can indicate how fluctuations in productivity can occur in any of the general strategies adopted by the organization.

Such a conceptual framework also establishes the basis for a modeling process. Thus, the behavior of the system can be analyzed for different external conditions and internal policies. This is the main indication for future research since it would lead to an advanced level of understanding of operational effects on a specific strategy.

The use of SBR as the main tool in the research method was able to provide data for supporting the analysis. However, the research also has limitations, such as constraints addressed by the references. As a result, an external environment characterized by five main forces was considered, not including factors in the supply chain. Also, in the internal context, the ergonomic factors addressed only physical issues.

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REFERENCES

BABER, Chris; GOLIGHTLY, David; WATERSON, Patrick. Editorial: The cybernetic return in Human Factors and Ergonomics. **Applied ergonomics**, v. 79, p. 86-90, 2019.

CORSTEN, Hans; WILL, Thomas. Reflections on competitive strategy and its impact on modern production concepts. **MIR: Management International Review**, v. 33, n. 4, p. 315-334, 1993.

ENSSLIN, Leonardo; ENSSLIN, Sandra Rolim; PACHECO, Giovanni Cardoso. Um estudo sobre segurança em estádios de futebol baseado na análise bibliométrica da literatura internacional. **Perspectivas em Ciência da Informação**, v. 17, n. 2, p. 71-91, 2012.

DICKSON, Peter R.; GINTER, James L. Market segmentation, product differentiation, and marketing strategy. **Journal of marketing**, v. 51, n. 2, p. 1-10, 1987.

GOSLING, Jonathan; NAIM, Mohamed M. Engineer-to-order supply chain management: A literature review and research agenda. **International journal of production economics**, v. 122, n. 2, p. 741-754, 2009.

HAUG, Anders; LADEBY, Klaes; EDWARDS, Kasper. From engineer-to-order to mass customization. **Management Research News**, v. 32, n. 7, p. 633-644, 2009.

JOHNSSON, Helena. Production strategies for pre-engineering in house-building: exploring product development platforms. **Construction management and economics**, v. 31, n. 9, p. 941-958, 2013.

LILLIS, Anne M.; VAN VEEN-DIRKS, Paula M. G. Performance measurement system design in joint strategy settings. **Journal of Management Accounting Research**, v. 20, n. 1, p. 25-57, 2008.

MATTOS, Diego Luiz; ARIENTE NETO, Rafael; MERINO, Eugenio Andrés Díaz; FORCELLINI, Fernando Antônio. Simulating the influence of physical overload on assembly line performance: A case study in an automotive electrical component plant. **Applied ergonomics,** v. 79, p. 107-121, 2019.

OLHAGER, Jan. Strategic positioning of the order penetration point. **International journal of production economics**, v. 85, n. 3, p. 319-329, 2003.

PERERA, H. S. C.; NAGARUR, Nagen; TABUCANON, Mario T. Component part standardization: A way to reduce the life-cycle costs of products. **International journal of production economics**, v. 60, p. 109-116, 1999.

PIERCY, Nigel. F; CRAVENS, David W; LANE, Nikala. Thinking strategically about pricing decisions. **Journal of Business Strategy,** v. 31, n. 5, p. 38-48, 2010.

PORTER, Michael E. **Competitive strategy: techniques for analyzing industries and competitors.** New York: Free Press, 1980.

_____ **Competição: estratégias competitivas essenciais.** Gulf Professional Publishing, 1999. 515 p.

REINHOLD, Karin; TINT, Piia; TUULIK, Viiu; SAARIK, Silver. Innovations at workplace: improvement of ergonomics. **Engineering economics**, v. 60, n. 5, 2008.

SALMON, Paul M; WALKER, Guy H; READ, Gemma J. M.; GOODE, Natassia; STANTON, Neville A. Fitting methods to paradigms: are ergonomics methods fit for systems thinking? **Ergonomics**, v. 60, n. 2, p. 194-205, 2017.

SENGE, Peter M. **The Fifth Discipline Fieldbook**: Strategies and Tools for Building a Learning Organization. Crown. 2014. 608 p.

SIDHARTHA R. Das; MAHESHKUMAR P. Joshi. Process innovativeness in technology services organizations: Roles of differentiation strategy, operational autonomy and risk-taking propensity. **Journal of Operations Management**, v. 25, n. 3, p. 643-660, 2007.

SLACK, Nigel; CHAMBERS, Stuart; JOHNSTON, Robert. **Administração da produção**. Atlas. 2009. 703 p.

STERMAN, John. **Business Dynamics**: Systems Thinking and Modeling for a Complex World. McGraw-Hill School Education Group. 2000. 768 p.

SUN, Li-Yun; PAN, Wen. Differentiation strategy, high-performance human resource practices, and firm performance: Moderation by employee commitment. **The International Journal of Human Resource Management**, v. 22, n. 15, p. 3068-3079, 2011.

ZEHIR, Cemal; CAN, Esin; KARABOGA, Tugba. Linking entrepreneurial orientation to firm performance: the role of differentiation strategy and innovation performance. **Procedia-Social and Behavioral Sciences**, v. 210, p. 358-367, 2015.

WIKNER, Joakim; RUDBERG, Martin. Integrating production and engineering perspectives on the customer order decoupling point. **International Journal of Operations & Production Management**, v. 25, n. 7, p. 623-641, 2005.

WINCH, Graham. Models of manufacturing and the construction process: the genesis of re-engineering construction. **Building research & information**, v. 31, n. 2, p. 107-118, 2003.