

Strategic Management of Manufacturing – Proposal of a method that recommends Production Techniques to Leverage Different Competitive Dimensions

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ABSTRACT

The manufacturing strategy literature is very wide. The approach of some concepts, such as the Strategic Business Units (SBU) and Competitive Dimensions, evolves towards the concept of Focused Factory by Skinner (1974) and culminates in the definition of different techniques, systems and tools that leverage each Competitive Dimension. However, the literature is much more restricted when it comes to determining which particular manufacturing technique should be adopted among different possibilities. This study aims at filling this gap by proposing a method, which directs decision-making when one needs to define the most appropriate production technique(s) to be adopted within a specific industrial reality. The research method adopted is Design Research. The final method proposed assists its user to select the production techniques that are best aligned with a given application reality. It seeks to go one step further in unfolding Production Strategy by supporting industrial managers to adopt techniques and practices that meet their main demands and specific conditions experienced in their daily routines.

Keywords: Manufacturing Strategy; Strategic Business Units; Competitive Dimensions; Focused Factory; Production Techniques.

1. INTRODUCTION

The production systems built from Taylor's ideas, in the post war period, had as its main concern getting scale gains, because, during that time, the production capacity was smaller than the demand. It was the *product out* type of situation. When the demand becomes inferior to the supply, the *market in* approach is required. It raises, then, the companies' necessity to consider, simultaneously, different dimensions in the elaboration of their strategies and in the configuration of their production system: cost, quality, flexibility, delivery/service and lead time. The requirement of building robust production systems emerges, able of responding to the market in an effective and efficient way, according to the different dimensions of competition.

Antunes Júnior et al. (2013) reinforces that a company's competitiveness expresses itself differently for each business unit, in such a way that the production must be capable of meeting specific demands that are translated into different "value packs". The manufacture must be capable of fulfilling demands with advantage over its competitors, concerning its priority competitive dimensions, market to market: cost,

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deadline, lead-time, flexibility, quality and technology. It is necessary to organize the production systems in a way that they meet these several challenges properly.

According to the same author, organizing a production system consists of the following definitions:

- Methodology of strategic alignment of several business units;
- Best practices, tools and techniques to the pursuit of operational excellence, taking into consideration the specific business characteristics concerned.

In addition, according to Silva and Santos (2007), considering the content of best production practices, the literature researched in the study of these authors and in the previous studies of this researcher, there is a limited number of studies that investigate the integration of best practices with the company's specific context. Thus, some practices are relevant in the development of certain organizations, not being applied in others (Fitz-Enz, 1997; Davies and Kochhar, 2002; Urgan, 2004; Laugen, Boer and Frick, 2005). No studies, according to this author's research, correlate the best practices with the specific context and direction of this study.

1.1 PROBLEM AND RESEARCH OBJECT

The present study aims at answering the following question: how to select production techniques that would be better aligned to the context and reality that contribute to enhance the performance of the competitive dimensions?

Based on what and how each technique proposes to improve certain competitive dimension, an artifact was created that leads the user of this method to question what the main gap is to be worked on, which is target of certain production technique. Therefore, the present study contributes to industrial managers providing a method that will signal which technique to adopt facing the main problem(s) in the different competitive dimensions in their production realities.

The method is not something definitive. It cannot be considered complete and free from restrictions. We should emphasize that the proposal of the present study is to facilitate, recommend and support the user on the selection of techniques, who later will have to delve into the chosen techniques for subsequent adoption. In addition, the method that is simplified from the technique's vision into the organization, also presents limitations, but, it is a proposal with this bias: one option that supports the selection of production techniques, aligned with the individual necessities of the organization. Therefore, that is a method to support decision-making.

2. THEORETICAL REVIEW

In this section, we will conduct a literature review regarding production strategy, strategic business unit and dimension and characteristics of production.

2.1 PRODUCTION STRATEGY

The manufacture plays a relevant role on the company's competitiveness. According to Slack (1994), the manufacture should make sense in the operation to suit the strategic context, ensuring that its contribution to the competitiveness is clear and permanent. That means, the production must be aligned with how the business competes in the market. Still, according to the same author, the elaboration of the manufacturing strategy consists on the idealization of policies, plans and projects that define the direction of the manufacture until it becomes the source of competitive advantage. It clears the bonds between the global competitive strategy and the development of the company's manufacture resources. It brings the concept and the sense of "competitiveness" into the factory.

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According to Ghinato (2000), the summary definition of Production Strategy (and its deployment) undergo the following steps:

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1. Definition of the corporate strategy: the company's relationship with the environment in which it operates, its business, products and services;
 2. Definition of the Strategic Business Units (SBU's);
 3. Definition of the SBU's key Competitive Dimensions;
 4. Manufacturing characteristics: the manufacture must have the proper characteristics to leverage the key competitive dimensions;
 5. Focus: define the criteria being used to divide the space, machinery and people in manageable units, which will be focused in the essential abilities to leverage the competitiveness, being competent in those tasks that are demanded by the manufacture to deliver better response to its business unit. According to Lean Way Consulting (2015), a business rarely presents good performance in more than two or three key dimensions.
 6. Definition of concepts, methods, processes, techniques, practices, production tools that, when adopted, bring better response to different competitive dimensions.

The process brings direction and purpose, ensuring that the policies and individual decisions, throughout the organization all point in the same direction (Slack, 1994). This same author brings the idea that the manufacture goal would be answering the following question: what do we need of our manufacturing function that would make us capable of competing more effectively?

Corrêa and Corrêa (2011) claim that the operations strategy goal is to guaranty that the production processes and value delivery to the customers are aligned with the company's strategic concerning the financial results expected and the market intended to be served and adapted to the environment in which it is inserted. The operations strategy is concerned with the long-term development of processes and resources and with the creation of competences so the organization can have sustainable levels of competitive advantages.

According to Lean Way Consulting (2015), Manufacturing Strategy is a global pattern of decisions and actions that define the role, the goals and the production activities in a way that they support and contribute to the company's business strategy. The Manufacturing strategy affects and determines the individuals' behavior, the competitiveness and the success of an organization. It also addresses broad issues on how the resources should be configured, in order to reach the desired corporate goals.

2.2 STRATEGIC BUSINESS UNITS (SBU's)

This Focused Factory concept, proposed by Skinner (1974), evolved, according to Antunes Júnior et al. (2013), to the wide economic notion of Strategic Business Units (SBU's), that can be understood as different families of products that have direct relationship with the market.

Bond (2004) emphasizes that the main goal of a company managed by strategic business units (SBU's) is to offer products that best meet market needs. Focus allows a narrowing relationship between the SBU's with the market and, simultaneously, its specialization in skills to meet those needs.

According to Wheelwright (1984), in big and diverse companies, it is necessary to specify the strategy to the several sectors and groups. This author emphasizes the division of the company in SBU's, because each business unit concentrates efforts in a base in which, if it is suitable, improves the unit's competitive position to the customers' sub-segments being fulfilled, complementing the desired competitive advantage. The greater

the level of business diversification, the harder the conception of strategies becomes, due to the particularities of each “business inside business”.

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2.3 DEPLOYING THE PRODUCTION STRATEGY

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The competitiveness of a company is conditioned on its performance in dimensions such as cost, quality, flexibility, delivery and lead-time. As a company is not expected to deliver an excellent performance in all of these dimensions, Platts and Gregory (1991) observe the prioritization of these criteria that will determine how the manufacture will contribute to the business performance. By identifying the competitive dimensions that the manufacturing function can best contribute to the achievement of business objectives, a strategic role is then given to manufacturing. According to the aforementioned authors, a manufacturing strategy defines how the manufacture will contribute to achieving the business goals. There is a deployment of strategic decisions in the manufacturing areas in a way to align the company’s manufacturing resources (or business) with its competitive strategy, increasing the capacity to compete, in criteria already mentioned such as cost, quality, flexibility, delivery and lead-time. It is the prioritization of these criteria and the combination between manufacture and market strategy that will determine how the company will compete (PLATTS and GREGORY, 1991).

The production strategy aims at concentrating the production efforts to sustain the business competitive advantage. The Competitive Dimensions translate how a certain business competes in the market, that is, what are the competitive priorities of a particular business. To answer such competitive dimensions, the production makes decisions that can be grouped in categories, termed as categories of decision.

2.3.1 COMPETITIVE DIMENSION

The functional strategy, still according to Wheelwright (1984), should be developed and followed to sustain the commercial strategy. A functional strategy specifies how that function will sustain the competitive advantage desired. For the functional strategy to be effective, this one should sustain, through a consistent pattern of decisions about competitive priorities, the competitive advantage that the commercial strategy is seeking for.

With the production strategy being one of the functional strategies presented by Wheelwright (1984), an effective production operation is not necessarily one that provides maximum efficiency or engineering perfection, but one that adjusts to the company’s necessities for its competitive advantage.

The cross analysis between the market and the competition is necessary (ANTUNES JUNIOR et al., 2013). It is not simply aligning the customer’s demands, which are translated by the priorities of the competitive dimensions of the specific business unit. We also need to evaluate the real company position in relation to its main competitors.

Slack (1994) classifies the criteria that the consumers ponder when deciding to buy products:

- Order Winning criteria: are considered by consumers as key reasons for buying a product or service; therefore, should be offered a better performance than the competitor’s to enhance the company’s competitiveness and take over the market.
- Qualifying criteria: must be in a minimum level required by the market to compete, fulfilling the minimal performance pattern.
- Less important criteria: it does not influence directly the consumer.

This author proposes that the company must overcome the competitor’s performance to obtain competitive advantage, responding to the minimum performance in the qualifying criteria. Hill (1995) shares this vision, since he reinforces that reaching an exceptional

performance in one or two competitive dimensions will be of less value if the performance in another dimension is lower the minimum level that the market requires. This same author emphasizes the importance of an external vision (Characteristic of Marketing), because the competitiveness is not settled only by the competition, but also by the market aspirations, being the manufacturing competences carefully aligned with what the market wants.

This analysis between the importance of the competitive criteria and the performance towards competitors is introduced in the matrix Importance X Performance, figure 1.

This model shows the company or a specific business of the company how to direct the resources application, according to the position of the factors regarding the consumer's perception, also showing the comparison towards the competitors.

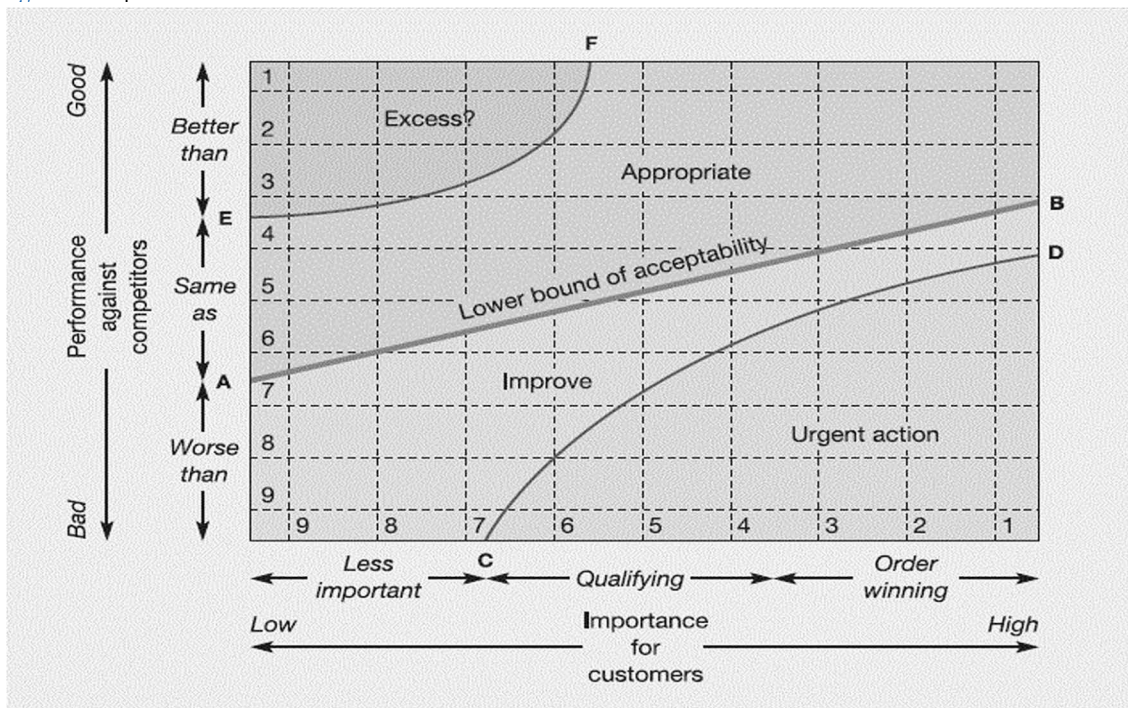
Paiva et al. (2009) claims that there are five competitive dimensions in the production area that relates to the business strategy:

- Cost: higher profit margin, lower profit margin with bigger scale;
- Quality: quality performance superior to competitors;
- Delivery: relationship between the suppliers and the customer (delivery meets the deadline, time to solve failures);
- Flexibility: capacity of absorbing chances in production batches not standardized, changes of product type to be produced;
- Innovativeness: company ability to introduce new products.

For the simple fact that this study aims at improving the performance of the production activity, which is composed by processes, and as the process improvements are what really matter, the "innovativeness" will not be considered as a competitive dimension.

According to Corrêa and Corrêa (2011) and Antunes Júnior et al. (2013), the consolidated dimension "delivery" gives rise to the dimension "lead time". According to Pacheco (2012), this division is coherent, since it gives to the dimension "lead time" the vision to improve the flow of whole value chain constantly, keeping the delivery dimension as the association of the deadline established with the client. According to Antunes Júnior et al. (2013), the lead time both in the product releasing and on production, allows the company to meet the availability of the market's increasingly fast expectations . As a result, of the

Figure 1 - Importance X Performance Matrix



Source: Slack (1994).

great importance given to the lead time dimension, by the authors aforementioned, this study considers the “lead time” as a specific competitive dimension. Thus, the competitive dimensions will be five: Cost, Quality, Delivery, Lead time and Flexibility.

2.3.2 MANUFACTURING CHARACTERISTICS

The Competitive Dimensions, also called competitive Factors, should be unfolded in Manufacturing Characteristics, when then the production characteristics are defined to answer the priority competitive factors, thus leveraging competitiveness. Table 1 presents an example of alignment between Competitive Factors and Manufacturing Characteristics.

2.3.3 FOCUS

The Focused Factory concept by Skinner (1974) is used in this part, because the project of a factory implies in the good deal of tradeoffs. The idea of this author, as already presented in this study, emphasizes that a business cannot present excellent performance in several dimensions simultaneously. Lean Way Consulting (2015), in turn, reports that a business will rarely have a good performance in more than two or three key-dimensions. According to this same author, a factory without focus has many products and it is too big to be managed efficiently.

Focus is defined by the criteria to be used to divide the space, the people and the machinery in manageable units. The answer usually passes through: products, processes, markets, customers, and geographical areas. The materialization of the production strategy is the layout, with the Flow Management being the essence of the Manufacturing Strategy (Make-to-Stock; Make-to-Order; Assemble-to-Order; Engineer-to-Order).

2.3.4 CONCEPTS, METHODS, PROCESSES, TECHNIQUES, PRACTICES AND TOOLS

A challenge of the production is to sustain the competitive advantage of the business over its competitors, answering the demands that are translated by the priority competitive dimensions of that business in the market. Antunes Júnior et al. (2013) proposes to organize production systems in a way that they respond properly to this challenge, optimizing the use of the company’s resources to maximize the results. This organization of this production system involves the definition of the strategic planning methodology and the management of several business units, and the definition of the best practices and/or tools and techniques in the production, to give a better response with excellence in operational level, according to the business specific characteristics.

Table 1 - Competitive Factors X Manufacturing Characteristics

Competitive Factors	Characteristics of Manufacture
Price	High efficiency (low cost)
Quality	Robust Processes
Agility	Short Lead time
Reliability	High process capability
Volume Flexibility	Modular arrangement of flexible capacity
Mix Flexibility	Lines and Cells of Manufacture and Mixed Arrangements
Innovation	
Service	Content in the manufacturing process
Brand	

Source: Adapted from Lean Way Consulting (2015).

Silva and Santos (2007) report that the best manufacturing practices are included more recently to the content of production strategy. Mills, Platts and Gregory (1995) emphasize that a broader vision related to production strategy is represented by the integration of best practices with the manufacturing decision areas. The authors quotes other recent studies that analyze the influence of manufacturing practices on the performance – just in time, lean production, manufacturing capacity, among others.

Still according to Antunes Júnior et al. (2013), the management of the production competitiveness is supported by continuous improvement circuits, each one of them aligned with a competitive dimension. In each of the improvement circuits (productivity, service/delivery, lead time, flexibility, quality, industrial innovation), the production techniques are presented, which are the pillars to better meet the improvement circuits that leverage the corresponding competitive dimensions.

In the next section, we describe the methodology, especially the way that the production techniques were selected.

3. METHODOLOGY

The research method chosen was the Design Science Research. Since the goal of the present study is to define a method of strategic production management, identifying and synchronizing the best existing methods design research is regarded as the most appropriate method.

When the objective of a study is the construction of a new method (artifact), or conducting research focused on problem solving, the traditional sciences can be limited. There remains the use of design science, a new epistemological paradigm to build the research. (DRESCH et al., 2015)

The most important, might be to articulate knowledge eventually dispersed to develop artifacts that perform a specific function and satisfy a necessity (DRESCH et al., 2015). Simon (1996) defends the necessity of a science that dedicates itself to propose ways to create (build and evaluate) artifacts that have certain properties. It is the science of the project – design science.

In his book, Simon (1996) has written “To the project matters what and how the things should be, the conception of artifacts that accomplish goals”. Design science is a science that deals with the project. Therefore, it is not interested in finding natural or universal laws that explain a certain behavior of the objects that are being studied. In fact, the design science is the science that develops solutions to improve existing systems or creates new artifacts that contribute to improve the human activity. The nature of this research is usually pragmatic and solution oriented (DRESCH et al, 2015).

The goal of this study is to develop the knowledge to be used to solve problems (and not describe actions taken in the past) and as one of the researchers participates in the change process, the design research proves to be the suitable method.

3.1 METHODOLOGY AND STEPS OF DESIGN SCIENCE RESEARCH

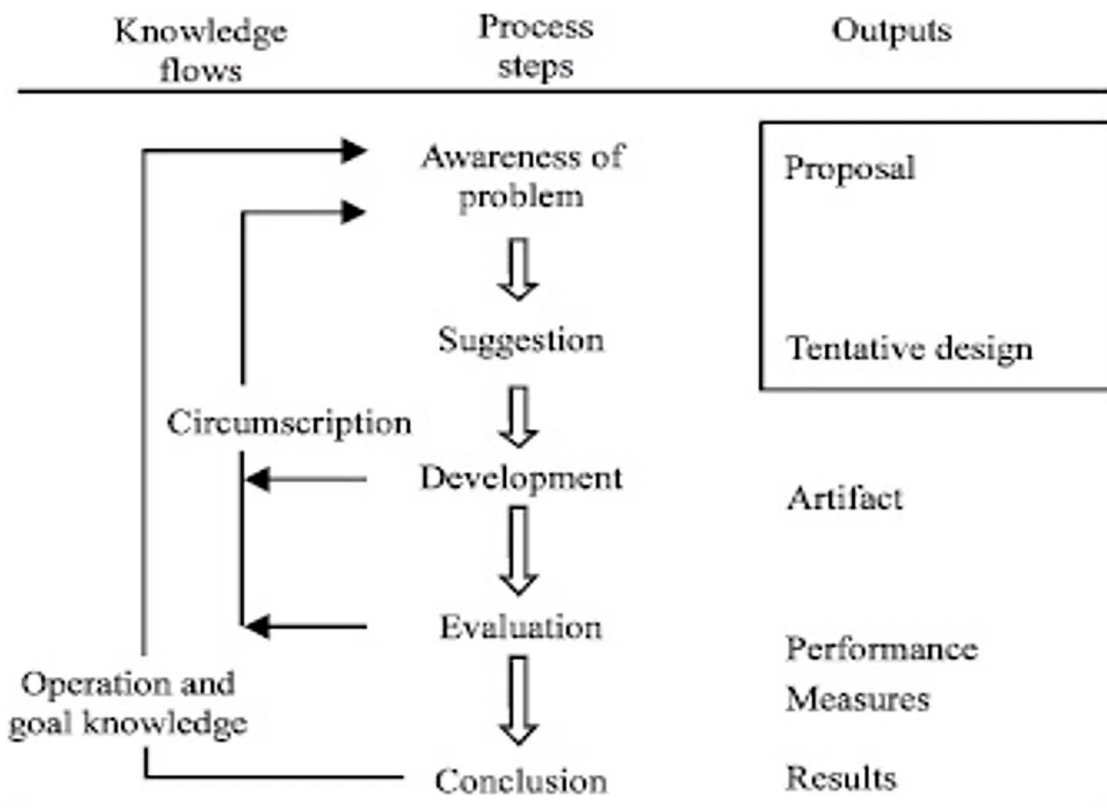
The design research method, figure 2, consists of two basic activities: build and evaluate. The construction is a creative process that has new artifacts as a result; the evaluation, in sequence, tests the utility of these artifacts, having as a result validated artifacts that can be models, methods or constructs (DRESCH et al. 2015).

Table 2 correlates the application of the Design Research to the research of this author, also detailing when the experts panel was used. The generic steps of the DR method are detailed to the specific research.

3.2 THE SELECTION OF PRODUCTION TECHNIQUES

Through the theoretical study regarding the production practices and techniques to leverage the different competitive dimensions, the present authors selected and studied deeply the techniques that are common between authors and scholars. When realizing that specific techniques repeat itself by at least two of the authors researched, it was defined that it would be a good criterion to study in greater depth these techniques, which would then

Figure 2 - The General Methodology of Design research



Source: Adapted from Dresch et al. (2015).

Table 2 - Use of DR (Design Research) and Expert Panel in the Research

Generic steps to DR	Detailed steps to DR
Problem identification	Difficulty in defining which production techniques (among the numerous existing) to adopt to the specific reality.
Awareness of the problem	Through the deep study of the theme, it was confirmed the perception of the author. Requirement: the artifact must be another option that recommends production techniques, supporting the industrial manager in his decision making.
Biographical review	Theoretical study of Production Strategy and its deployment, in addition to the techniques defined to belong to the method.
Artifact and classes of problems identification	There are existing artifacts (Pantaleão, 2003). The proposed artifact has its own characteristics: from the techniques' proposal to the reality.
Proposition of the artifact	After the biographical review and the experts' panel, who criticized the initial method and contributed to the construction of the method, the author proposes his method (artifact).
Artifact Project and Development	The author detailed the procedures of the construction of the method (artifact) with the DR being useful to create knowledge.
Artifact evaluation	The method (artifact) is evaluated under a set of criteria generated by DR, according to Hevner et al. (2004).
Explicitness of learning and conclusions	It is present in the conclusion and limitations' section.
Research communication	Step to be fulfilled after the defense of this thesis.

Source: Elaborated by the authors

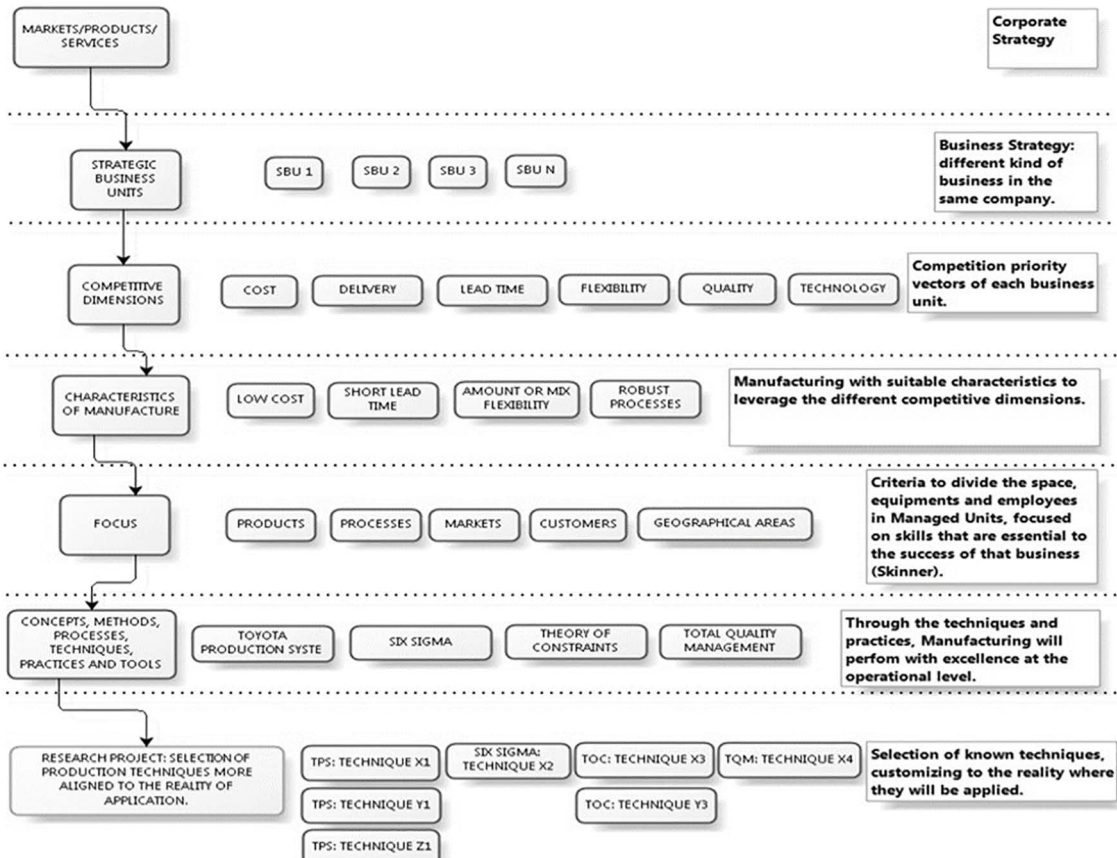
take part in the method of production techniques selection. Due to the fact that the bibliographical research verified that national authors / scholars had already conducted research on a global scale, and due to the fact that the present study is not focused on researching the techniques themselves, but in the choice of the techniques according to the reality where they may be adopted, it made the present authors limit their research by national authors / scholars of production practices.

The focus of this study is to develop the six steps, described before, with the intention to create a method that prioritizes the adoption of certain production technique over another, among the known production techniques, which are adopted to better respond to the manufacturing characteristics and their correspondent priority competitive dimensions. For instance, suppose that there are three main production techniques being adopted to improve the competitive dimension cost. How to define which of these techniques should be adopted primarily? Figure 3 summarizes the focus that the present study wants to explore.

The main author/scholars of production practices and techniques researched were: 1) Antunes Júnior, Klippel, Seidel and Klippel (2013); 2) Antunes Júnior and Produttore Consulting (2008, 2015); 3) Pacheco (2012), whose study researched authors as Inman, Sale and Green Jr. (2008), Pettersen (2009) and Mehrjerdi (2011); 4) Machado and Heineck (2001); Martins (2009); 5) Veiga, Lima and Costa (2008); 7) Ghinato and Lean Way Consulting (1996, 2000, 2015).

The initial practice list, which was composed of 25 techniques, was completed in a final list of 29 techniques (12 techniques were inserted in the method, by the specialists' suggestion; likewise, 8 techniques of the original list were removed). The final list of techniques was evaluated by 5 (five) specialists, who rated the impact of each technique in each competitive dimension.

Figure 3 - Research Focus



Source: Elaborated by the authors

The majority of the 25 production techniques and practices of the method's final list belong to a specific approach/theory/system: the Toyota Product System (TPS) Theory of Constraints (TOC), Six Sigma and Total Quality Management (TQM). Table 3 correlates the techniques with their respective approaches.

It is important to emphasize that specific production techniques have an impact in more than one competitive dimension simultaneously, that means one practice contributes more decisively for one competitive dimensions, but it also has a positive influence on another dimension. This was taken into consideration in the creation of the method, if a certain production technique has a relevant impact in different competitive dimensions, the technique appears in the method in these different competitive dimensions where it contributes to leverage the improvement. The research with specialists defined, which techniques impact the most in which competitive dimensions.

A theoretical individual research was done of the 29 concepts, methods, processes, techniques, practices and/or tools to develop the method. For each one of these 29 techniques, a summary table was created, having the fields "Main goals" and the "How to" of each technique.

After the proper appropriation of these techniques and specially knowing what differs one from another, a proposed method was created, which is basically the main goal of this study. This method was presented to and valued by an expert panel that critically evaluated the first version of the method (M0), evaluating and suggesting modifications. A survey was conducted with the experts. Those experts were chosen by two criteria: a) Minimal Academic and/or professional experience of 10 years; b) Major experience in Lean Manufacturing, because it is the major part of techniques the method to be proposed (see table 14 – Attachment).

In addition to the critic, experts also filled out a table that would measure the impact of each production technique in the different competitive dimensions.

The modified method, according to the experts' critics (M1), was applied in an industrial reality for validation. The industrial manager of the respective company had an adequate level of knowledge of the production techniques presented, because, if not, he could not contribute, in an effective way, to the evaluation of the method created for the selection of techniques. The present study has a strong professional side, but the academic experts' critics attribute robustness to the method.

4. DEVELOPMENT

The critics of experts can be summarized in the following topics:

- a. It is necessary to define precisely the competitive dimensions, because each one of them has many sub-goals. As an example, the competitive dimension "flexibility". What flexibility are we talking about? Volume flexibility (capacity of changing the volume of production)? Or mix flexibility that is the ability of changing the production *mix* in an economic way? Table 4 details the sub-goals adopted in this study for each competitive dimension.
- b. The proposal of these authors was, based on the bibliographic review, just after that, to establish a list of most referenced techniques for each competitive dimension, criticizing afterwards the method with experts. However, it was unanimous between them that due to the fact that many techniques have an impact on different competitive dimensions, the new proposal established was to make a research with these five experts in order that they could then attribute index and define what techniques are more appropriate for each competitive dimension. In sequence is the techniques list for each competitive dimension, what is the result of the filling by the experts

Table 3 - 29 Techniques X Approaches

Techniques	Approaches			
	Lean	TOC	Seis Sigma	TQM
1	Job Management			
2	Total Productive Maintenance (TPM)			
3	Standardized Work	X		
4	Levelized Production -Heijunka	X		
5	Pull Production System – Kanban	X		
6	Drum-buffer-rope scheduling - DBR		X	
7	Fine Production Scheduling			
8	Study and (Re)configuration of Layout			
9	Single Minute Exchange of Die – SMED	X		
10	Jidoka	X		
11	Housekeeping - 5S	X		
12	Poka-Yoke	X		
13	Line Stop – Andon	X		
14	Statistical Quality Control			
15	DMAIC cycle		X	
16	Quality Control Circle - QCC			X
17	KAIZEN	X		
18	One-Piece Flow / Ikko Nagashi)	X		
19	Takt Time	X		
20	Periodic (hour-by-hour) Monitoring of Rhythm	X		
21	Gemba Walk	X		
22	Staggered Audit - Kamishibai	X		
23	Visual Control Management	X		
24	Help Chain	X		
25	Handling Routines & Supply Materials – Mizusumashi	X		
26	Method of Analysis and Problem Solving (MASP)			X
27	Real-Time Production Monitoring (OEE – Overall Equipment Effectiveness)	X		
28	Multifunctional Operator	X		
29	Shojinka (varying the numbers of operators in accordance with demand)	X		

Source: Elaborated by the authors, based on Antunes Júnior, Klippel, Seidel and Klippel (2013); Antunes Júnior and Produt-tare Consulting (2008, 2015); Pacheco (2012), whose study researched authors as Inman, Sale and Green Jr. (2008), Petter-sen (2009) and Mehrjerdi (2011); Machado and Heineck (2001); Martins (2009); Veiga, Lima and Costa (2008); Ghinato and Lean Way Consulting (1996, 2000, 2015).

Table 4 - Detailing of the Competitive Dimensions

Competitive Dimension	Sub goals	Description
Cost	Cost to produce	The cost to produce the product.
Quality	Conformity	Product according to the specifications.
Delivery	Punctuality	Meet agreed deadlines.
Lead time	Delivery	Time to deliver the product.
Flexibility	Mix	Ability to change the mix of production economically.

Source: Elaborated by the authors.

of a table that analyzes the impact of each technique/practice in each competitive dimension, according to the 5 point Likert scale (tables 5 to 9):

Table 5 - Techniques for the Dimension Cost

<i>KAIZEN</i>	4.4
Real-Time Production Monitoring (OEE – Overall Equipment Effectiveness)	4.4
Total Productive Maintenance (TPM)	4.2
Method of Analysis and Problem Solving (MASP)	4.2
<i>Shojinka</i> (varying the numbers of operators in accordance with demand)	4.2
Quality Control Circle - QCC	3.8
Multifunctional Operator	3.8

Source: Elaborated by the authors.

Table 6 - Techniques for the Dimension Delivery

Pull Production System – <i>Kanban</i>	4.8
Levelized Production - <i>Heijunka</i>	4.4
One-Piece Flow / <i>Ikko Nagashi</i>)	4.4
Fine Production Scheduling	4.2
<i>KAIZEN</i>	4.2
Drum-buffer-rope scheduling - DBR	4
Takt Time	4
Method of Analysis and Problem Solving (MASP)	4

Source: Elaborated by the authors.

Table 7 - Techniques for the Dimension Lead Time

One-Piece Flow / <i>Ikko Nagashi</i>)	4,6
Takt Time	4,4
Levelized Production - <i>Heijunka</i>	4,2
Study and (Re)configuration of <i>Layout</i>	4,2
<i>KAIZEN</i>	4,2
Pull Production System – <i>Kanban</i>	4
Handling Routines & Supply Materials - <i>Mizusumashi</i> (<i>Mizusumashi</i>)	4

Source: Elaborated by the authors.

Table 8 - Techniques for the Dimension Flexibility

Single Minute Exchange of Die – SMED	5
<i>Shojinka</i> (varying the numbers of operators in accordance with demand)	4,8
Multifunctional Operator	4,6
<i>KAIZEN</i>	4,4
Levelized Production – <i>Heijunka</i>	4,2
Pull Production System – <i>Kanban</i>	4
Study and (Re)configuration of <i>Layout</i>	4
One-Piece Flow / <i>Ikko Nagashi</i>)	4

Source: Elaborated by the authors.

4.1 METHOD OPERATION

The user interface with the method is through the Excel panel. The first step, when using the method, is to define what is the priority sequence of the competitive dimensions of a certain Strategic Business Unit. The user of the method will question: what is the most important competitive dimension and where the performance is worse to the competitor? Again, the 5 point Likert scale was used so that the user could then assess the importance of each competitive dimension to a certain Strategic Business Unit.

After the definition of the importance rank of the Competitive Dimensions for a certain SBU, the method will lead the user to question themselves about the real demands towards each competitive dimension, following the sequence of the most important to the

least important dimension. Each technique battles certain demands/problems. Therefore, when reading the general problem(s) and the specific ones to the competitive dimension mentioned, the user verifies how much they identify their reality in such problems, general and specific, attributing an index, according to table 11. The 9 point Likert scale was used as a reference, besides the zero index, which determines that a certain gap does not exist.

Generic problems can be the target of many production techniques. The specific problems, in turn, detail general problems better, which facilitates the technique direction, because normally the techniques improve or solve general or more specific problems.

To reach the general problems, which the user of the method will question, the field “main goals” is used, from the theoretical summary table of each studied technique. To reach the specific problems, the field “how to” of the same summary table of each technique is used. Table 12 shows this relation between the problems and the techniques’ proposal.

Once the user attributes an index to the problems that are the target of certain production techniques, according to the representativeness of these problems in their reality, the method will recommend to the user the techniques to be adopted. Exemplifying: for the situation where the user chose the index nine, the technique that targets general and specific problems is the first technique to be recommended by the method. Therefore, successively, following the index in descendent order, the other techniques will be recommended. For situations that the user chose index zero, this linked technique will not appear as recommended. The user must attribute a different index for each evaluation performed, thus establishing a ranking between the evaluated situations and the most representative of their

Table 9 - Techniques for the Dimension Quality

Standardized Work	4.8
<i>Jidoka</i>	4.8
Poka-Yoke	4.8
Statistical Quality Control	4.8
Quality Control Circle - QCC	4.8
KAIZEN	4.8
Line Stop – <i>Andon</i>	4.6

Source: Elaborated by the authors.

Table 10 - Important Indexes of Competitive Dimensions

5	Most Important Dimension
4	
3	
2	
1	Less important Dimension

Source: Elaborated by the authors.

Table 11 - Relevance of the problems in the user’s view of the method

9	Portraits perfectly an existing gap
8	Portraits very well an existing gap
7	Portraits well an existing gap
6	
5	
4	
3	
2	Portraits a relevant problem a little
1	Portraits a relevant problem very little
0	It is not a real gap

Source: Elaborated by the authors.

Table 12 - From the Theoretical Study to the Method

Theoretical study of the practice	Practice on the method
Main goals	General problems
How to	Specific problems

Source: Elaborated by the authors.

reality should obtain higher indexes. The method allows only one index repetition for each competitive dimension evaluated.

After the method recommends the sequence of production techniques for the most important competitive dimension, the method will follow the next competitive dimension (less important), passing through all the dimensions, if the user wishes to do so. The user can decide how many competitive dimensions, according to their respective importance in order to obtain the production techniques recommended. The method can be used for only one dimension, for some, as well as for all of them.

The fact that the method was applied to only one reality does not allow us to consider this method as totally approved. It is clear for the authors that it is important to conduct applications in different industries. At the same time, it is important to mention that this application in a company was the first and a difficult experience to conduct inside a company with its own method and culture.

4.2 METHOD APPLICATION AND RESULT ANALYSIS

The method was applied in an industrial reality through the evaluation of a manufacturing manager, joined along with one of the authors. The company in which the method was applied is a beverage company that has continuous manufacturing processes and a knowledge level of production strategy and production techniques aligned with the method's proposal.

Some conclusions and evolutions that were reached in the method application, took place during the discussion about it, along with the industrial manager who used the method:

- a. It is recommended to analyze more than one competitive dimension, as some techniques impact in more than one dimension, simultaneously. It is important to verify if the techniques recommended are not convergent in different dimensions. This more complete analysis, generating a final result of production techniques recommended, can show that certain techniques are repeatedly recommended in different dimensions. This, in a certain way, validates the method and the techniques to be adopted;
- b. After the final result of the recommended techniques, it was observed that an additional analysis could be incorporated to the method: the gap of technique adoption. The method could also evaluate what is the adoption level of a certain technique in the reality where its application is recommended. The adoption level is the application and utilization level that a certain technique already has in that reality. There is no sense recommending a technique to a certain reality if its adoption is already mature (adoption level = 9). As a suggestion of the evolution of the method, the final recommendation of technique could then be defined as a multiplication between the current method and the adoption gap of the recommended technique, being this the inverse value of the adoption level (9 minus the adoption level). The example on table 13 clears out this proposal of evolution on the method to which it was reached during the application.

In the example of table 13, although the *Kaizen* technique had been the second recommended technique (TPM was the first recommended technique) by the original method,

due to the fact that its adoption gap is higher than the TPM technique, the *Kaizen* technique became the first recommended technique;

- c. The fact that the user knows minimally the concepts in the questioning proposed by the method in the user’s own reality, makes the method to contribute to the user manager. The method would contribute very little if the user could not comprehend relatively well the content of the questioning that the method proposes the user to do. Once again, the fact that the method proposes to include only simple and well-known techniques definitely facilitates its application;
- d. The method by Excel panel is of a simple and quick application, it was inviting for the user to use it. In this practical application of the method, it was noticed that the manager wants practical solutions for their reality. Repeatedly, the manager emphasizes that if the method would be complex, certainly it would not receive the same treatment;
- e. The proposed method that causes the manager to question their reality, recommending in the end production techniques aligned to the main problems evaluated by the manager themselves, may be an option to replace an external consultancy in the area. Again, the method is not complete and absolute, with the consultants’ experience being of importance when considering to orientate on what and how to improve the production competitiveness in the given enterprise’s reality. However, the use of the method can enable the user to make the first evaluation of their reality, since they have the greater knowledge of this reality, allowing the consultancy to be a complementary work. In addition to this, the recommendation of production techniques should be complemented afterwards by a deeper study of the recommended techniques by the method. The user will have a minimum level of knowledge to perhaps, hire a consulting service. Having a conceptual basis and a better understanding of things, a consulting work would be then better used, adding much more results.

5. CONCLUDING REMARKS

The proposal of the research was to create a method that would help industrial managers on the definition of which production techniques to adopt in order to improve the response of the specific reality lived by these managers. The authors noticed that the theme production strategy and its deployment to the level of techniques/practices is not sufficient to support the manager who wants or needs to leverage results in the different competitive factors. It is necessary to customize a generic package of techniques and practices to the specific reality, because it is possible to transform, in an efficient way, the industrial production.

Giving better response in an operational level does not mean that there is a detachment from the corporate strategy. On the contrary, the authors wanted to present a connection between the corporate/business strategy with the production that is translated by

Table 13 - Method with the addition of technique adoption gap

Techniques current method	Recommendation	–	Technique Adoption level	Adoption gap	Final result: (index of the current method multiplied by adoption gap)
9	TPM		4	5	45
7	KAIZEN		2	7	49
4	MASP		7	2	8
3	Shojinka		6	3	9
2	Multifunctional Operator		5	4	8
1	OEE		8	1	1

Source: Elaborated by the authors.

the manufacturing strategy, and its deployment to the production practices/techniques that would leverage the manufacturing operational performance, which in the end, would give better competitive advantage to that business and corporation.

The authors concluded, after the bibliographic research, that there are several techniques and practices that when applied improve production performance. Applying many of them without clear criteria would generate a lot of confusion, not bringing an effective result. The criteria to consider techniques known and disseminated, together with the criteria for adopting techniques in line with the reality in which they are intended to be applied, it was shown to the public of the industries that the research aimed at, a right decision, what was evaluated by the user manager of the method.

There are several studies published to select production techniques to the corresponding reality. This created method, which recommends techniques, started from the individual proposal of each technique, verifying if the problem fought by the techniques are lived in the specific reality. Therefore, the internal diagnosis is made through the bias of the techniques. This proposed method proved to be simple and objective to support the decision-making of the manager; although, it is clear that the decision for one or another production technique is far more complex than to make a correlation of the proposal of the technique (problems that the technique struggles with) and if such problems are presented on the day-to-day. The characteristics and specificities of each reality cannot be despised in the final decision of each technique being adopted. Therefore, it is worth emphasizing that the method is simple and easy that it can direct a manager in the search for more appropriate techniques according to their reality. However, the manager needs to have in mind that the method is not definitive and other analyses must be made to corroborate with the method's proposal of recommended techniques.

It is worth highlighting that the experts' panel used in the research review allowed the method improvement. The experts could signal weaknesses and indicate other options to be considered in the final method proposal, which added more robustness, not limiting the final method based on the simple bibliographic research. The analysis of the specialists, thus obtaining a "new" method, added more reliability and credibility to the final method.

The application of the method allowed some remarks, before only based in perceptions, which could be proven, even with only one specific reality application. As an example, we can quote the importance attributed by the user manager of the method for the techniques to be well known. It permitted the conclusion of viability of putting the method into practice, because techniques distant from the manager's reality would turn the method impracticable. Another positive aspect identified by the user was the simple and quick way to use the method that would be the reason for the managers to put it into practice.

Still on the method's application, the interaction between the user and one of the authors could bring new remarks to the method and to the manager. There is a participatory construction process of knowledge between them. To the user manager, in addition to the contributions resulting from the use of the method, there is an organizational learning process, to the practical part as well as to the theoretical one. As a suggestion, this method can be improved by other studies as for example, to apply it in another industry.

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Table 14 - Panel of Experts – CV and experience

Paulo Ghinato	Ghinato holds a BSc Degree in Metallurgical Engineering from the Federal University of Rio Grande do Sul (1987), a Master's in Production Engineering from the Federal University of Rio Grande do Sul (1994) and a Ph.D. Degree in Manufacturing Systems Engineering from Kobe University (1998) - Japan. Ghinato has over 25 years of experience in the field of Industrial Engineering, being very active in subjects such as JIT, KANBAN, HEIJUNKA, SMED, TPM, POKA-YOKE and JIDOKA
Tarcisio Abreu Saurin	Postdoctoral studies at the University of Salford (2012), PhD in Production Engineering at the Federal University of Rio Grande do Sul (2002), Master's Degree in Civil Engineering at the Federal University of Rio Grande do Sul (1997) Federal of Santa Maria (1994). Current Associate Professor II of the Federal University of Rio Grande do Sul in the Department of Production and Transportation Engineering. He currently has a coordinator and / or researcher in applied research projects with companies in the distribution, electric power generation, healthcare, manufacturing and civil construction sectors.
Guilherme Luz Tortorella	Adjunct Professor in Production Engineering at the Federal University of Santa Catarina, concluded his Post-Doctoral research in Production Systems, Doctor in Industrial Engineering (2012), Master of Science in Production Systems (2005). Experienced in Production Systems and Quality Systems area. Moreover, Guilherme has worked for 12 years in the automotive industry with experience abroad in Mexico, England, USA and Uruguay. He is a member of the Production Systems Simulation Lab and Productivity and Continuous Improvement Lab
André Antônio Luzzi	André Luzzi holds a Master of Science in Production Engineering from the Federal University of Rio Grande do Sul and a Production Engineer from the University of Vale dos Sinos - Unisinos, accumulating 21 years of industry experience in technical, managerial and consulting positions. André has 10 years of experience in implementing Lean System concepts and mechanisms, developing and coordinating improvement activities in productive and administrative environments in large companies in Brazil, Argentina, Colombia, Mexico and Peru.
André Siedel	Master Degree in Administration at Universidade do Vale do Rio dos Sinos (2003). Currently is Professor at La Salle University in Canoas – RS, and invited Professor at Unisinos University. Owner and Director of Master skills Training and Consulting. Has experience in Management.

Source: Elaborated by authors.