

# Implementation of lean manufacturing techniques in the bakery industry in Medellín

## Implementação de técnicas de fabricação lean na indústria de panificação em Medellín

Maria del Rocio Quesada Castro<sup>1</sup>   
Juan Gregorio Arrieta Posada<sup>2</sup>

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**Abstract:** The bakery industry has great economic and social importance in the city of Medellín; most of the companies are small with high levels of informality, low value added and productivity. Lean Manufacturing has become one of the most popular paradigms of waste disposal in the industrial sector and services, with great benefits of their practice on the improvement of the quality and organizational productivity. This work evaluates the level of implementation of the lean manufacturing techniques in the micro and small enterprises in Medellín, in the food sector. It was using diagnostic and follow-up tools with questionnaire to the production chief, which include 9 techniques or tools, and a variable of administration that allow organizations to a guide, to improve the current conditions of productivity. The main results show that the outstanding Lean practices are: PokaYoke, Kaizen and visual factory. However, for which the sector is considered to be of world class, the practices must be strengthened: VSM (generation of value), JIT (Production Flow) and ADMON (Administration). In addition, organizations must increase sales least 139, 20% to increase the level of efficiency of the sector, without changing the number of employees.

**Keywords:** Bakery; Lean Manufacturing; Improving; Productivity.

**Resumo:** A indústria de panificação tem grande importância econômica e social na cidade de Medellín. A maioria das empresas é pequena, com altos níveis de informalidade, baixo valor agregado e produtividade. O Lean Manufacturing tornou-se um dos mais populares paradigmas de disposição de resíduos no setor industrial e de serviços, com grandes benefícios de sua prática para a melhoria da qualidade e da produtividade organizacional. Este trabalho avalia o nível de implementação das técnicas de manufatura enxuta nas micro e pequenas empresas de Medellín, no setor de alimentos. Para tanto, são empregadas ferramentas de diagnóstico e acompanhamento com questionário para o chefe de produção, que incluem nove técnicas e uma variável de administração que permite às organizações um guia para melhorar as condições atuais de produtividade. Os principais resultados mostram que as excelentes práticas Lean são: Poka Yoke, Kaizen e fábrica visual. No entanto, para que o setor seja considerado de classe mundial, deve-se fortalecer as práticas VSM (geração de valor), JIT (fluxo de produção) e ADMON (administração). Além disso, para aumentar o nível de eficiência do setor, as organizações precisam aumentar as vendas em, pelo menos, 139, 20%, sem alterar o número de funcionários.

**Palavras-chave:** Padaria; Lean Manufacturing; Melhoria; Produtividade.

## 1 Introduction

Small and medium companies (smes) are a fundamental component in the Latin America industry, their importance is presented in different ways in different countries in the region, and this importance is related with the number of companies and the job creation and the product they manufacture

(Sosa, 2014). In Colombia the smes correspond to the 98.7% of the registered companies y the chamber of commerce.

In Latin America and Europe, the smes represent the 30% and 60% of the (GDP) respectively but still exists a great gap between the productivity in smes in

<sup>1</sup> Departamento de Ingeniería de Producción, Politécnico Colombiano Jaime Isaza Cadavid, Carera 48, número 7 – 141, Medellín, Colombia, e-mail: mrquesada@elpoli.edu.co

<sup>2</sup> Departamento de Ingeniería de Producción, Universidad EAFIT, Carrera 49, número 7, sur 50, Medellín, Colombia, e-mail: jarrieta@eafit.edu.co

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Europe and Latin America, the average participation in exportations is just 5% of the smes in Latin America. And if they cannot resolve this gap and improve their processes, managerial techniques, technology, the gap will persist in time.

Food and beverages industry represents in Colombia more than 20% of the total industry and the bakery industry in Antioquia which Medellín is the capital, place where the study was done, exists 806 bakery companies, and from this number 797 are smes (98%) (Medellín Chamber of Commerce, 2014a, b).

This type of companies, smes, have as a competitive advantage their close location to customers and a very wide products portfolio. The traditional products are. Sweet bread, pastry products, light bread, and many of them offer cafeteria services.

One of the improvement technique is Lean Manufacturing and this is based on continuous reduction of waste and increasing the quality of the products. Looking for more productivity, best quality, less time spent, less money invested, to obtain more revenues (Theuer et al., 2013; Holtskog, 2014).

The implementation of Lean Manufacturing in this industrial sector has many challenges and difficulties, this is due the low level of implementation of the continuous improvement culture in the smes and the lack of time to do this project (Jain & Lyons, 2009; Rasli et al., 2013).

In the food industry, the key factor to implement Lean techniques is the managerial commitment and leadership and economical support, the application of these techniques in the industry is beginning and due to the consumers and competitors pressure (Dora et al., 2013).

The objective of this work is to evaluate the implementation of continuous improvement actions related with Lean as. Poka Yoke systems, Smed, TPm, 5`s, kaizen, just in time systems, visual factory, six sigma; in the small and medium bakery enterprises in Medellín. Using a diagnosis tool such a questionnaire and the support of DEA analysis to evaluate improvement actions, looking for a rise in the productivity levels.

The DEA, (data envelopment analysis) is a non-parametric technique which has the following characteristics. Standardization, taken in account multiple inputs and outputs, and linear programming algorithms to evaluate two processes at the same time. (the efficient border and the inefficiency estimation). The first process, can be obtained from sources, according the orientation chosen, Input or Output. If the input is chosen, its level is maximized and the output level remains constant, in the contrary if the output is maximized, the level of input remains constant. The second process, inefficiency estimation, depends on the orientation used, and this is calculated

according with the distance to the border in each evaluated company.

## 2 Theoric background

Lean manufacturing, is a conceptual frame very well known in many industrial companies since the beginning of 90`s, lean could be better explained as the elimination of waste, or non value activities, those are one of the lean manufacturing field of work (Womack & Jones, 1994; Womack & Jones, 1996).

In Lean Manufacturing the change is supported in the culture, is more a managerial activity (Csokasy & Parent, 2007). Lean is a sociotechnical system (Raja, 2011). Lean production is seen as a philosophy who cares about technical and cultural aspects (Bhasin & Burcher, 2006). Bayou & Korvin (2014) recognize that Lean manufacturing is an strategy to invest less in the inputs and getting best production and product quality at the outputs including post sale services and customer relationships. For Toyota the use of Lean techniques has been and objective in their factories (Holweg, 2007; Martínez & Moyano, 2013).

### 2.1 Lean Manufacturing in small and medium enterprises (smes)

The research conducted by Zhou (2016), found that the factors affecting the implementation processes are the following.

- Philosophy concepts understanding;
- state of implementation;
- People`s perception of the process;
- advantages and benefits of the implementation processes;
- implementation difficulties.

This study presents a better way to understand Lean strategies and techniques and the way they could be used in the companies. An evaluation mechanism could be implemented to show the evolution of the improvements presented in the companies (Walter & Tubino, 2013).

### 2.2 Lean in the food industry

European food smes, according with Dora et al. (2013) present a good experience in the implementation of Lean Manufacturing techniques, with an incremental tendency due to the competition and customer demand. But studies have shown a low impact due the singularities of the sector. The raw materials, the demand so stationery, harvest variety, the complex and complicated supply chain, suppliers and buyers

net and the warehousing activities affect in a big way the motivation to implement Lean in smes companies.

In Colombia a research conducted by Arrieta et al. (2011) found that the industrial sectors with most implementation processes were 21% automation, 20% metalmechanical industry, 16% food industry. And the industrial sector with the lowest level of implementation was, textile industry and ceramic and glass.

### 3 Methodology

A questionnaire was developed and implemented with the operations manager or similar in 86 smes companies, from a total of 767 companies registered in the chamber of commerce in Medellin.

The questionnaire evaluated 10 variables with 55 questions. The variables were, Poka yoke systems, zero defects, TPM, kaizen, visual Factory, Smed, value stream mapping, 5s's, statistical processes control, Just in time. (De Diego et al., 2009).

It is proposed to work with paper published by Wahab et al. (2013) titled. "a conceptual model of lean manufacturing dimensions" and the Zhang & Niu article (Zhang & Niu, 2013) "Influence mechanism of Lean Production to manufacturing enterprises competitiveness".

The population was taken according with information from the chamber of commerce of Medellin, including the food industry, especially bakery ones. Showing a result of 797 companies registered. The sample was 86 companies, to get this number the Spiegel and Stephens formula (Spiegel & Stephens, 2001) was used. With an error of 5%, a  $p=0.5$ , assuming, 50% of the population use lean techniques. This questionnaire was validated in 5 cafeterias.

The data analysis was done using a Likert scale with an evaluation of 1, 3, 5 d a PF, (positioning factor) with a range of -100% and 100% using stat graphics.

The questionnaire scale is presented as follows.

5. Implementation of the Lean technique in the 80-100% of the processes or areas in the Company
3. Implementation of the Lean technique, in the 50-79% of the processes or areas in the Company
1. Implementation of the Lean technique, in the 0-49% of the processes or areas in the Company.

The positioning factor is evaluated according with the following Formula 1, defined by Marín (2000).

$$FP = \frac{1*(No.questions = 5) + 0,5* (No.questions = 3) - 1*(No.questions = 1)}{Total No.questions} \quad (1)$$

This classification permits locate the companies in 4 quadrants or sectors. Seibel (2004) and Arrieta et al

(2011). Sector I. Productive organizations, sector II. Basics organizations, sector III. Vulnerable including delays organizations, and sector IV. Promisories organizations. (The X axis, development of lean practice (calificación o desarrollo de la practica lean, the Y axis positioning factor)

**Quadrant I. Productives.** If a Company is located in this sector, has in the development of lean practices and positioning factor a grade of 3.0 and percentages above 60% (the minimal values expected) the companies located in world class companies (clase mundial) have a qualification above 80%, that means they have an operational excellence and have very good capabilities to compete in international markets.

**Quadrant II. Basics.** If a Company is located in this sector has a positioning factor between 60 and 100% and a development of lean practices between 1 and 3. In these cases, it is important to notice the low level of strength in the implementation of continuous improvement techniques.

**Quadrant III. Vulnerables.** If a Company is located in this sector present a percentage 60% or less and 3.0 in Lean practices development. This kind of companies has implemented some improvement techniques. in this quadrant are located too, the delay companies (rezagadas), those are the ones with values between -80% and 0. They have to invest strongly in improvements.

**Quadrant IV. Promissories.** If a Company is located in this sector, present a grade above 3.0 in the lean development techniques and has a positioning factor under 60%. The minimum desired level. This means the Company is working in improvement actions and their results are not good enough. In Figure 1. the different quadrants are shown.

In addition to the questionnaire, a group of question was applied to the managers, looking for this information, type of company, number of workers, education level, type of layout, quality procedures, technology associated to the production process, training level of the employees and their ability to find waste and mistakes in the process, and weekly sales.

With this information, each Company was analyzed, and located in their respective quadrant. Improvement actions are presented and the DEA analysis give more information about what are the road to follow.

According with the problems in the smes, the BCC model was chosen (Banker et al., 1984) this model has output orientation and permit comparisons between one Company and others similar. Using the qualitative information collected, was established an input. Workers, and an output, weekly sales, with this information the efficiency in weekly sales per worker was studied. Working with a BCC-O model implies increasing the weekly sales, maintaining the number of workers. This is due the social impact of firing worker is minimum.

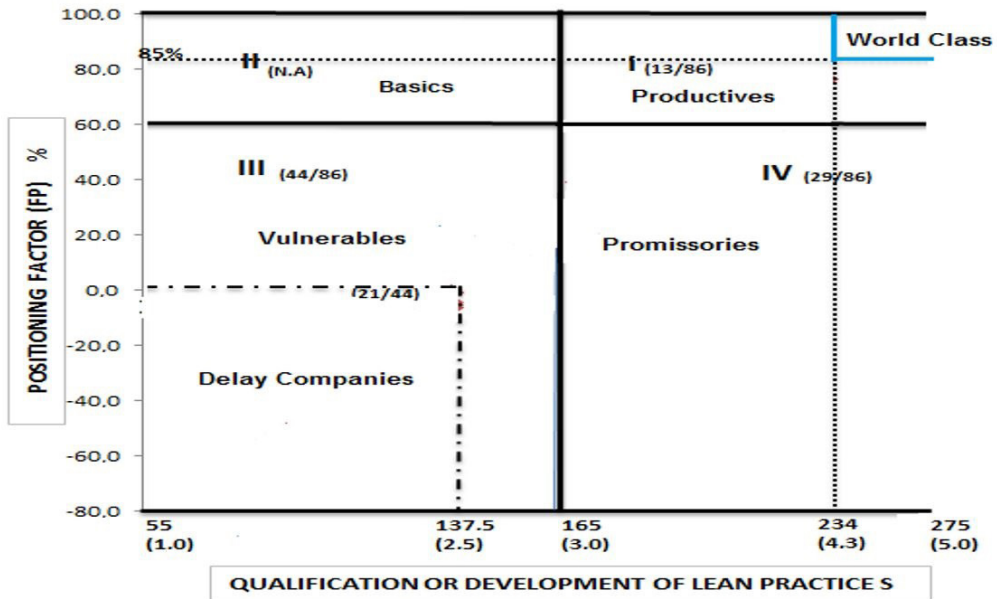


Figure 1. Organizational quadrants. Source: Authors. Explanatory note: N.A. means “Does not apply”.

## 4 Results and discussion

### 4.1 Lean Manufacturing tools actually implemented in smes bakery companies.

According with the study the implementation level of lean techniques is low, getting a grade of 2.98 in a 1 to 5 scale. This means, the companies has some advances in the implementation but it is not enough to create value to this industry.

With the qualification by quadrants, most of the companies were located in quadrant III, or vulnerable, 44 of 86 companies, (51.56%) 21 of them in the area of companies delayed (retrazadas) this is due the lack of implementation of lean techniques. But it is important to show that hte 15.12% of the total of the smes companies, are located in the quadrant I or productive ones. This is they have a great level of implementation of lean techniques, but no one was located in the area empresa de clase mundial, world class. In Figure 2 is presented the information before explained.

In Figure 3, is presented the average grade of the companies interviewed, is show the grade of each lean manufacturing tool. The poka yoke systems and the 5's are the tools best implemented. This results has concordance with studies of Dora et al. (2013).

Bakery companies has low level of implementation of lean techniques due to they direct most of their efforts to have excellent quality and fulfill the legal and technical requirements of the food and drugs administration of Colombia (Invima).

### 4.2 Characterization of the bakery smes companies related with the lean techniques in the study

The most relevant lean techniques implemented are Poka yokes systems, kaizen, and visual Factory, this is because each company knows their defects, number of suggestion given by their employees, exists programs of recognition and awards for suggestions and the person is well trained in visual Factory and 75% of the administration has undergraduate studies, and 43% of the workers has high school studies and the majority of the companies has regional distribution (69%), the age of the technology is between 2 and 8 years old, and the 46% of the companies has regular training programs to their people in order to find waste and defects, and 62% of the people in the factories is trained to work in any position or work station.

### 4.3 Continuous improvement proposals to increase organizational effectiveness

In this part are presented ideas and recommendations to the companies can move from one quadrant to another, in Figure 4 is shown the improvement route, the companies has to follow.

According with the weakness identify in the delayed area (rezagados), some actions were presented to let the companies the opportunity to improve and grow (Juárez et al., 2014). The improvement actions that permit pass from vulnerable to promissories are presented in Table 1.



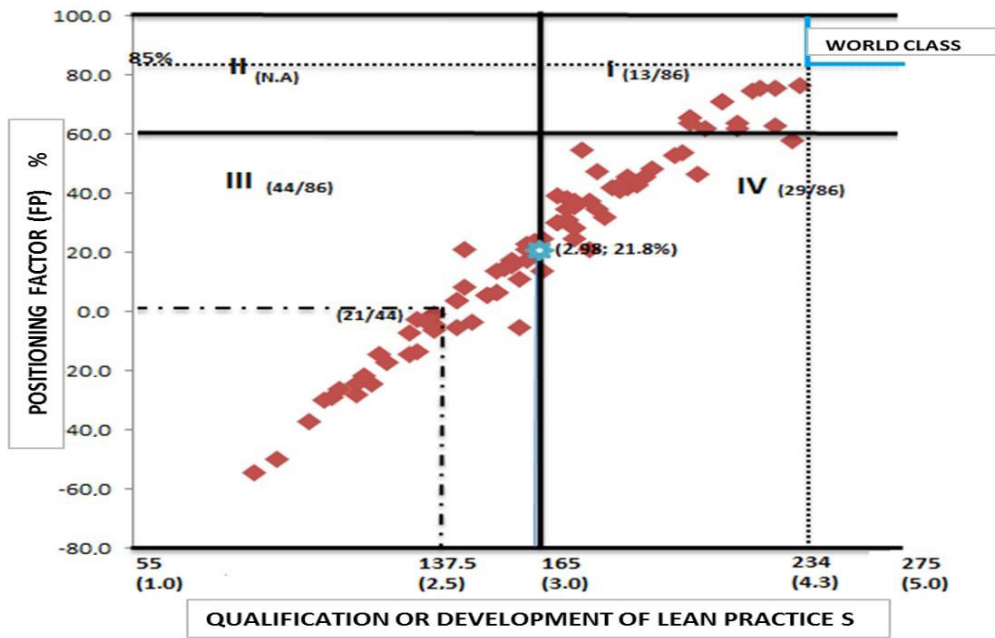


Figure 2. Clasification of the companies evaluated. Source: Authors. Explanatory note: N.A. means “Does not apply”.

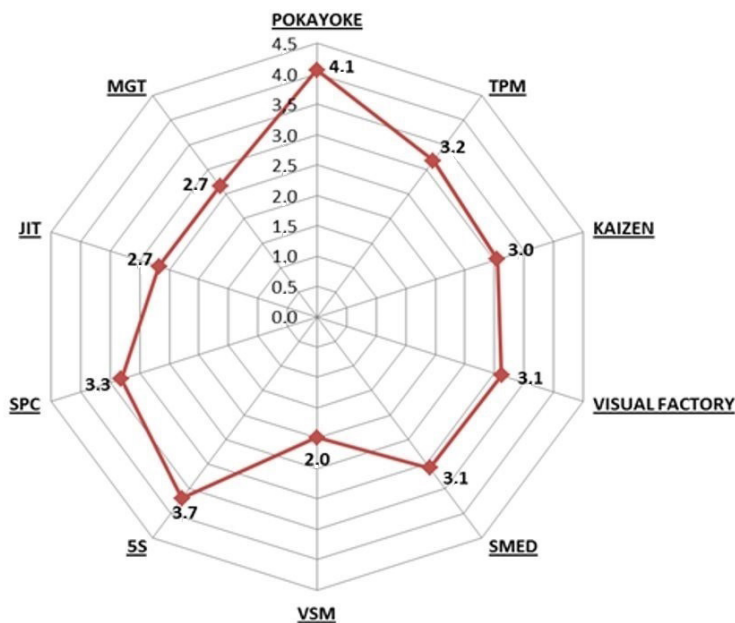


Figure 3. Radar of the implementation level of each lean techniques. Source: Authors.

To move in the route of improvement for one promisorie company to a productive one, Table 2 shows some actions in order to attach this goal.

Productive companies are good by themselves but it is important to continue with the lean manufacturing phylosophy and techniques, in Table 3 is presented some actions to achive this goal.

With the objective of complement the information obtained by the questionnaire and the positioning factor,

a DEA analysis was done, with the model BCC-O. This model of sales by employee seems contrary to the research done, due lean manufacturing aims to get less cost through the chain but presents results to be used by the smes bakery industry to increase their efficiency. Just 3 companies were efficient, (0.03%) the rest have to improve their cuantitavie relation of weekly sales per worker. Results are shown in Figure 5.

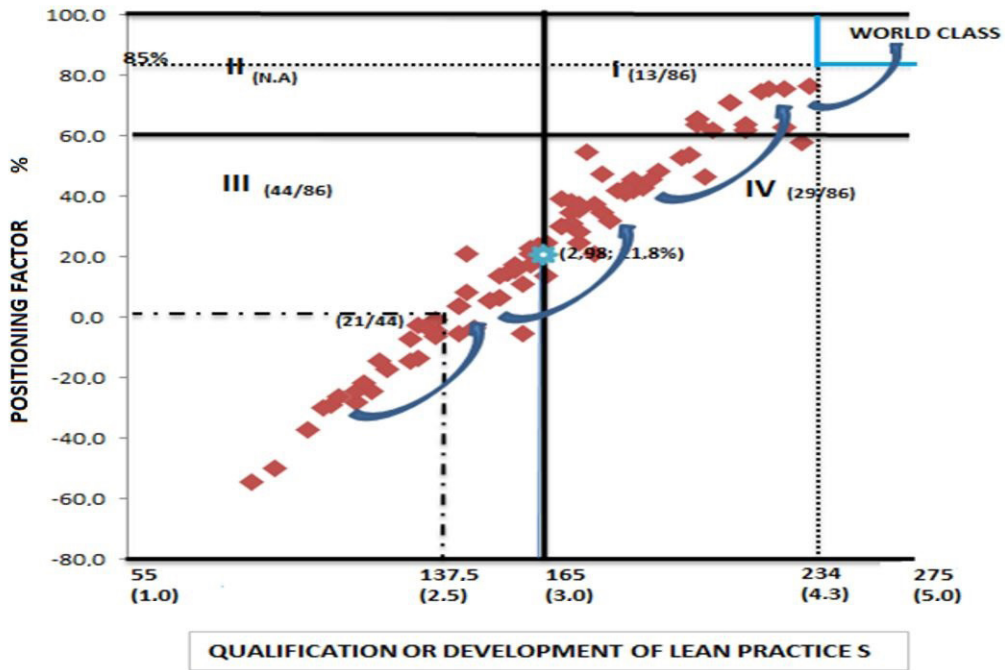


Figure 4. Improvement route. Source: Authors. Explanatory note: N.A. means “Does not apply”.

Table 1. Improvement actions for delayed organizations.

LEAN PRACTICE	IMPROVEMENT ACTIONS
VSM	Standardize and document processes, from supplier to customer. Use EDI systems, to integrate the supply chain
JIT - ADMON	Use Kanban cards to connect work stations Implement EDI and radio frequency with customers and suppliers. Improve layouts, develop u systems Training people in lean systems Motivate the self-control and the workers can decide by their selves

Source: Authors.

Table 2. Improvement actions for promissory companies.

LEAN PRACTICE	IMPROVEMENT ACTIONS
VSM	Standardization and documentation of all processes through the supply chain.
ADMON	Develop a hierarquical communication structure. Train the worker in find and eliminate the seven wastes: (overproduction, inventory, waiting time, movements, transportation, reworks)

Source: Authors.

Table 3. Improvement actions for productive companies.

PRÁCTICA LEAN	ACCIONES DE MEJORA
ADMON	Evaluate cost of wastes. Implement a suggestions and Ideas program, letting the workers participate with their own ideas.
TPM	Develop a TPM Program and train the worker in basics aspects of maintenance.
SMED	Constantly evaluate the manchinery set ups and implement 5s structures in the work place
5ESES	Implement the five pillars, specially pillars 2,3 and 4. To get better work conditions and the workplace turns into a easy and safe place to work.
JIT	Use Kanban cards to control production and transportation Administrar la producción (planear, programar, ejecutar y controlar) partiendo del pedido del cliente. Créate manufacturing cells in u shape to reduce distances, and produce short batches.

Source: Authors.

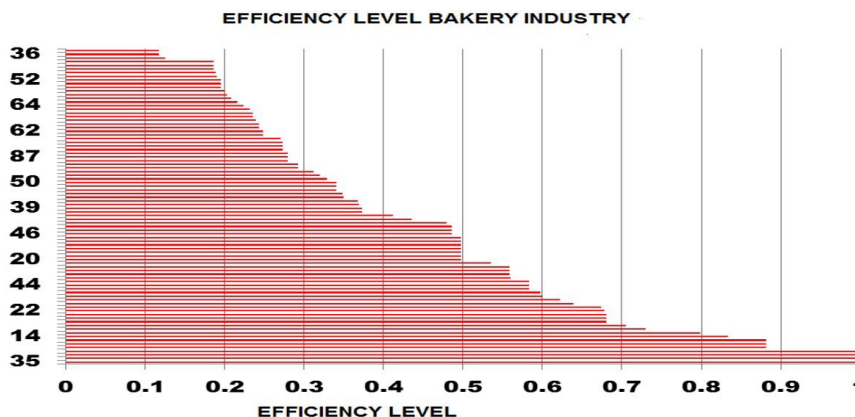


Figure 5. Smes bakery sector efficient level. Source: Authors.

Table 4. Weekly sales requirement to increase efficiency.

	ACTUAL SALES (\$) /WORKER	RECOMENDATION (INCREASE SALES IN)
QUADRANT III	967.46	236.85%
QUADRANT IV	1182.71	174.85%
QUADRANT I	1235.00	139.20%

Source. Authors.

Table 5. Weekly sales requirements to increase efficiency

RECOMENDATED RANKS %	NUMBER OF COMPANIES
0-50	3
51-100	6
More than 100	35
	Total: 44

Source. Authors.

Table 6. Weekly sales requirements to increase efficiency.

RECOMENDATED RANKS %	NUMBER OF COMPANIES
0-50	7
51-100	3
More than 100	19
	Total: 29

Source. Authors.

Table 7. Weekly sales requirements to increase efficiency.

RECOMENDATED RANKS %	NUMBER OF COMPANIES
0-50	6
51-100	3
More than 100	4
	Total: 13

Source: Authors.

The level of weekly sales recommended, keeping constant the number of workers is presented for quadrant in Table 4. The quadrant I, productives companies is the most efficient.

The inefficiencies detail analysis for quadrant shows, in quadrant III, the companies named as delayed (rezagadas), the 93.18% of the companies on this quadrant, (44 companies) needs to increase their sales more than 51%. Those requirements are shown in Table 5.

In quadrant IV, the companies classified as promisorios, the 75.68% of then, 22/29 companies, needs to increase more than 51% their weekly sales. Information is presented in Table 6.

In quadrant I, the productive companies, the behaviour is similar, the 53.84% of the companies in this area 7/13, needs to increase their weekly sales in more than 51% to increase their efficiency. Those requirements are shown in Table 7.

To increase the sales with the same quantity of workers it is necessary to lean the production processes, by reducing wastes, not just diminishing production costs and increasing service level, but promoting a Company culture, since the basement to the top who is always looking for improvements. And to optimize the DEA analysis models of profit and cost model were considered, and the quantitative variables used were, utility margin/time or costs/time.

### 5 Conclusions and final remarks

The bakery industry is located in the early stages of the implementation of lean manufacturing techniques, but, taking in account they don't have formal knowledge about lean, in an empirical way, they have implemented some of the topics of the improvement tools, specially related with product quality and productivity.

This research shows that a few organizations are located in quadrant I, productive companies, they have high standards of implementation of lean manufacturing techniques, like Poka Yoke systems, kaizen, visual factory and specially TPM. To this bakery sector be considered world class companies they have to reinforce practices like VSM, JIT, and administration.

Some key success factors in smes bakery companies are: Leadership and management, presented in high level of managerial commitment, economical support and constant supervision of the implementation processes, and the limitations to the implementation of lean manufacturing techniques are, process nature, automatization levels, quality requirements and short life cycle of many of the products, people's training and the informality in the labor.

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