

Ergonomics and Kaizen as strategies for competitiveness: a theoretical and practical in an automotive industry

Leandro Vieira^a, Giles Balbinotti^b, Adriano Varasquin^c and Leila Gontijo^d

^a*Universidade Federal de Santa Catarina. Rua Almirante Tamandare, 422, São Jose dos Pinhais, Paraná, Brasil.*

^b*Universidade Federal de Santa Catarina, Rua Butia, 77, Curitiba, Paraná, Brasil*

^c*Pontificia Universidade Católica do Paraná, Rua Maria Pasqualin, 388, São Jose dos Pinhais, Paraná, Brasil*

^d*Brasil. Universidade Federal de Santa Catarina, Florianópolis, Santa Catarina, Brasil*

Abstract. With increased international competitiveness in the automotive industry, came the concern of the companies save costs and lower production costs. For this purpose many ways are designed to reduce costs and waste of raw materials and reduce activities that do not aggregate value to manufacturing processes. In the early XVII appears the manufacturing system, which processes were hard with little concern for the health and safety of employees and conditions of the workplace. After the advent of the production system called lean manufacturing, a new paradigm in terms of production system capable of providing high levels of productivity and quality. It is based on waste elimination that occur during the production process. After began a new way of thinking, creating a culture of continuous improvement and lean process with no waste and reducing costs, without neglecting the welfare worker and improving the conditions of their work environment. This paper presents a reflection on the application of ergonomics in a lean production system of an automotive industry, using methodology based on the Kaizen (Continuous Improvement) to gain performance and improving the conditions of the workplace, also will be presented with positive and negative points in using this methodology in relation to ergonomics. The research will be conducted by collecting data 'in loco' and interviews with workers. Some studies show that in companies that are lean system and using the methodology of Kaizen, the results of product quality, levels of absenteeism and accidents are better than those obtained in companies that do not apply the same concept.

Keywords: working condition, lean manufacturing, performance, methodology, indicators

1. Introduction

Lean production is the third revolution of the automobile in order to produce vehicles. As said Womack, Jones and Roos (1990), lean production represents a new paradigm in terms of production system capable of providing high levels of productivity and quality. It is based on waste elimination that occur during the production process. After emergence of the system of Henry Ford, the volume per vehicle has risen sharply to 2 million units a year the Model T, but the departure of virtually all producers craft market did* drop the variety of products from thousands to tens of offers.

Lean production began in Japan, as he comments Womack et ALL (1990), it originated with the Japanese engineer Eiji Toyoda, he left for a three-month study by the Ford Rouge plant in Detroit, after studying carefully the system of factory production, the largest and most efficient manufacturing complex in the world, after much analysis and studies he came to a conclusion that mass production would never work in Japan "In this early experiment was born what Toyota came to call Toyota Production System, and finally lean production". Came with the system of analysis methodologies and improvement of works, among which we highlight the Kaizen, a tool for continuous

* Corresponding authors: email: l_vaz_vieira@hotmail.com.

giles.balbinotti@pop.com.br avarasquin@hotmail.com
avarasquin@hotmail.com

improvement system that covers all the needs of those involved in a production process.

2. Ergonomics and the Kaizen methodology

Ergonomics was a great evolution in the systems of mass production and lean because of the race for quality and productivity. According to IEA (2007), ergonomics is a scientific discipline that studies the interactions of men with other elements of the system, making application of theory, principles and design methods with the aim of improving human well-being and overall system performance.

Another important aspect is ergonomics as Balbinotti (2003) is that it seeks not only to prevent workers in jobs stressful and/or dangerous, but seeks to put them in the best possible working conditions to avoid accidental injury or fatigue excessive and improve performance.

The relationship of ergonomics in lean production can be observed in Figure 2 that the rate of absenteeism of Japanese companies is lower than the European and North American, it is arguable that there was action for this reduction. Within this line as Womack et al (1990) summarizes several indicators as well as yield and quality of the current performance, the assembly activity of the large producers. It's amazing the difference between the average performance of Japanese and Americans and Europeans, the size of areas needed repair, the percentage of workers in teams, suggestions, and the amount of training given to new workers in the assembly.

	JAPONESAS NO JAPÃO	JAPONESAS NA A. NORTE	NORTE- AMERICANAS NA A. NORTE	TODA EUROPA
Desempenho:				
Produtividade (horas/veic.)	16,8	21,2	25,1	36,2
Qualidade (defeitos de montagem/100 v.)	60,0	65,0	82,3	97,0
Layout:				
Espaço (m ² /v./ano)	0,53	0,85	0,72	0,72
Área de Reparos (% do espaço de montagem)	4,1	4,9	12,9	14,4
Estoques (dias para amostragem de 8 peças)	0,2	1,6	2,9	2,0
Força de Trabalho:				
% da F.T. em Equipes	69,3	71,3	17,3	0,6
Rotação de Tarefas (0 = nenhuma, 4 = freq.)	3,0	2,7	0,9	1,9
Sugestões por Empregado	61,6	1,4	0,4	0,4
Nº de Classificações no Trabalho	11,9	8,7	67,1	14,6
Treinamento de Novos Trabalhadores (horas)	380,3	370,0	46,4	173,3
Absentismo	5,0	4,8	11,7	12,1
Automação:				
Soldagem (% passos diretos)	86,2	85,0	76,2	76,6
Pintura (% passos diretos)	54,6	40,7	33,6	38,2
Montagem (% passos diretos)	1,7	1,1	1,2	3,1

Fonte: Pesquisa Mundial das Montadoras do IMVP, 1989, e J. D. Power Pesquisa Inicial de Qualidade, 1989.

Figure 1. Characteristics of Japanese automakers, North American and Europe – 1989

From: The Machine That Changed the World

Two important comparisons between the systems and lean mass is what the authors said Womack, et al (1990), in the old mass-production factories, managers were hiding information about the condition of the factory, because they have such knowledge to the key its power. In a lean factory as Takaoka, all information - daily production targets, cars built to date, equipment breakdowns, personnel shortages, overtime requirements that are displayed in frames andon (electronic boards bright) visible in all seasons the factory.

No doubt it is important to analyze the lean system has resulted in a great company it is important to adopt an ergonomic program, they complement each other. According Balbinotti, (2003), the dissatisfaction of people at work, often neglected or unknown, arising from a mismatch between the content of an ergonomic work to men.

The methodology and the bases of a lean production systems, according to Martins et al (2006), the term kaizen is formed from KAI, which means changing, and ZEN, which stands for the better. Kaizen has expanded to an organizational philosophy and behavior, a culture focused on continuous improvement focusing on eliminating waste in all systems in an organization and involves application of two elements in the improvement, understood as a change for the better and continuity understood as acts as a permanent change. Thus, there should be a single day without some improvement in the company.

The Kaizen philosophy is the key to success of organizations to ensure competitiveness, as defined Masaki Imai (1994), "Kaizen, the Key to Success", ie continuous improvement in their personal, domestic, social and professional. When applied to work or say, the improvement that involves everyone. KAIZEN, business strategy involves everyone in an organization working to make improvements with low or no investment. with KAIZEN, an involved leadership guides people to improve the ability to meet expectations continuously high quality and delivery time.

Another important aspect that says Martins et al (2006), kaizen management philosophy can be applied in specific parts of the targeted organization, such as Kaizen project: to develop new concepts for new products, Kaizen planning: developing a planning system for both production to finance or marketing, manufacturing and Kaizen: developing actions that aim to eliminate waste in the factory-floor and improve the comfort and safety.

The organization should be to create a culture of continuous improvement, but without neglecting the welfare and quality of life of the employee, as defined MARTINS et al (2006), Kaizen is a management philosophy as it covers the continuing need for managers, workers in all aspects of life.

According to Matthew (2007) Kaizen aims to develop curiosity and creativity of people and direct them to the process of adding value to customers. Kaizen is not an attempt to light a fire under people, Kaizen turns the light on inside people. Know that the bottom Kaizen is about people. People who are not businesses innovate. You must change attitudes for Kaizen to work, which requires a great commitment and a long time, and much study.

Another important aspect that says Matthew (2007) when we improve a little each day, with time great things happen. When you improve conditioning a little each day, with time we will have great results in terms of conditioning. Not tomorrow or after tomorrow, but over time, we get a huge profit. Do not try to improve the lot overnight. Stick to the small daily development. It's the only way it works and when it happens, it's durable, it is necessary to Kaizen become imperative.

In the methodology of kaizen can not forget the concept value-added productivity, and informs Balbinotti (2003), in a company that seeks to produce more and better with less, always increase the effectiveness (purpose) and efficiency (means) should be concerned as quality planning (setting new standards) and the maintenance of quality (ensuring compliance with the standards) with the quality

improvement (continuous improvement). This means that increasing quality and reducing costs increases the value, through the concept of total quality, which means satisfaction for all.

The organizations work with people that influence productivity and can increase the value of the organization, according Balbinotti (2003), people influencing productivity, productivity change, productivity depends on the performance of people. The performance by changing the productivity of people, puts us in direct contact with the ergonomic issue is evident and the contribution of ergonomics in this context, since the ergonomics seeking better working conditions, so that work can be developed without the reduction of health of workers and therefore with lower rates of absenteeism and turnover, and this contributes to reduced productivity.

3. Methodology

The research presented was applied in an auto factory in Paraná, Brazil, the company works with the lean production system based on Toyota production system, the system is being used for almost 10 years. Ergonomics is part of this system to obtain results, and since the implementation of the company achieved many improvements in working conditions, as will be presented in the discussion of results. The foundations of this system are:

5'S: the application of the 5's of Japanese origin (Seiri, Seiton, Seiso, Seiketsu and Shitsuke) Apply the 5's will reduce waste, and jobs organized will reduce the offsets, improving safety, improving motivation of teams with a pleasant working environment, with the 5'S is possible to improve equipment performance.

Dexterity: is learning the operation of the workplace through training. The field of Dexterity allows the repeatability of gestures, which reduces the dispersion of implementation and the risks of non-quality, skill favors optimizing operations, improving the fluidity of movement. The relationship with the dexterity of ergonomics is the teaching of correct postures through training applied to employees.

Standardization: Standardization is the default operation being the best method of producing at the moment but there is no reason why there is no pattern change. Implementing the standard in the workplace there is the Standard Operating Sheet. The ergonomics is linked to standardization through the development of operational procedures that take into account the know-how and experience.

Ergonomics: the production system, ergonomics is the basis, along with standardization, dexterity and 5's. They are all interlinked so that you have a good working condition for the developer. The goal of ergonomics in this production system is to ensure the adequacy of the operator (human capabilities) and the jobs or job offers. Improve performance while preserving the Health Delete musculoskeletal disorders (TMS) related to work and improve the conditions under Labor.

Kaizen: This is the subsystem that has a greater connection with the ergonomics, as with continuous improvement or Kaizen ergonomics tends to evolve in the enterprise, making it an improvement in jobs and in most cases to improve the working conditions of developer, who on the increase employee satisfaction and company productivity, obtaining higher results. The subsystem Kaizen is a method based on the cycle SDCA (Standardize, Do, Check and Act) detailing for better understanding, S (Standard) means establishing the best standard for the operation time, D (Do) application form operations effective, C (Check) to observe the operations, find problems, improve posture, improve processes, A (Action) found after the improvements should act.

This is the subsystem that has a greater connection with the ergonomics, as with continuous improvement or Kaizen ergonomics tends to evolve the company, making it an improvement in jobs and in most cases to improve the working conditions of the employee, who forth to increase employee satisfaction and company productivity, achieving better results. The subsystem Kaizen is a method based on the cycle SDCA (Standardize, Do, Check and Act) detailing for the best understanding, the S (Standard) means establishing the best standard for the time of operation, D (Do) application form operations effective, C (Check) to observe the operations, find problems, improve posture, improve processes, A (Action) found the following improvements should act. There is an important relationship between the PDCA cycle (Plan, Do, Check and Act) and SDCA cycle, as will be shown in Figure 2, SDCA cycle, the method is applied in a stable process for small changes and is PDCA cycle is applied during a mellhoria and / or change. According Balbinotti (2003), Kaizen means of production, reduces the physical effort at the time, through the installation of mechanical assistance, for example, ensuring the proper gesture and poise, as well as the correct use of tools, through plans and also skills development for managers, aimed at leadership in the animation teams.

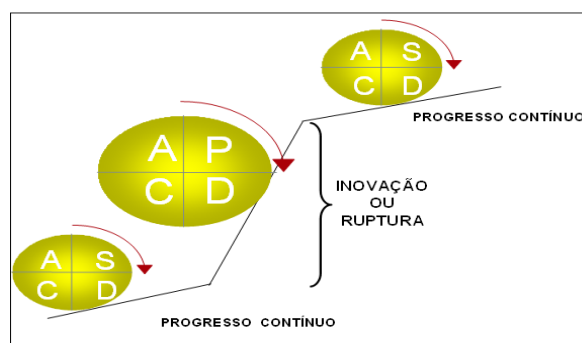


Figure 2. Characteristics of Japanese Car Manufacturers, North American and Europe – 1989

From: Automotive industry documentation

Measure of Time: Everything is time-based manufacturing, the time of the job you should take the cycle time of the production line, and all synchronized so that the customer receives the product on time. Ergonomics is also concerned with time, for improved ergonomics reduces losses of income and therefore of time.

Quality Control: For quality control, or better, quality management, relies on some tools to deal with quality or ergonomic problems, a method is the Qc-story (method of problem solving), the 7 quality tools (Pareto Diagram, Cause and effect diagrams, histograms, check sheets, scatter charts and control charts). Ergonomics has a relationship that through these tools is necessary to address problems with ergonomics.

Performance Management of Resources: serves to avoid problems with equipment, being necessary to perform preventive maintenance. The TPM is aimed at reducing and avoiding any loss of production-related equipment that could break. Ergonomics can follow this performance with the means to identify critical points for a man to avoid accidents.

Just in Time: Is the customer to manufacture the required products in the required time as required. The importance of JIT in a lean production system is to regularly identify and eliminate waste, low inventory.

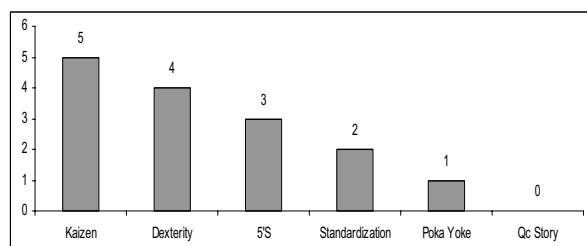
Guidelines for the Management: is a management system that allows you to Target all efforts and resources on one goal to success for the company. Based on strategic planning, identifying the organization's targets, according to Falconi (1997), is a subsystem of TQM (Total Quality Management) and facing competition not only includes the improvement of existing products and processes, but mainly the innovation represented by new technologies.

The lean production system is based on Japanese tools to reach excellence in everyday life, aims to ensure the quality demanded by customers, reduce costs, produce the required products and be responsible and respect the man.

4. Results

This survey was conducted in an automobile, which has about 4.000 employees and 3.000 employees of outside firms. To analyze the company's results, we applied a form to identify the knowledge level of the lean production system and what the relationship with the ergonomics program implemented in the company. The form with 12 questions, 3 of 9 closed and opened to identify the views of officials in the relationship between ergonomic factors and work conditions and production system of the organization. This form was administered to 10 employees, that is Manufacture 4, Human Resources 2, Quality Control 1, Logistics 1, Performance 1 and 1 Communications Department.

Most of the survey was answered by the area of production, and even be the largest public company and where the lean system is more powerful. It was observed that there is a difference between the concept of lean production system and system of mass production among company employees, of the 10 employees of eight research think the company is using lean production and two mass production. The Graphic 1 the results in graphic form (closed questions) and feedback sequence divided by area.



Graphic 1. Question about the degree of importance of the tools that support ergonomics.

We can see through the Graphic 1 that the kaizen, the Knack, and 5's are really the most striking evidence for the relationship with the ergonomics. The following are the main comments from employees.

Viewpoint of the Logistics area: The participation of the supervisor, ergonomist and workplace safety is to identify which points / stations with ergonomic problems and act on improvements to eliminate them (or at least reduce). This, and make technical

improvements to the station will also bring the benefit of "trust and credibility" among all parties, also reflecting on productivity and work quality.

Viewpoint of Human Resources: In the better ergonomic design of the workplace (ergonomics in design), or better, are suited to the employee (ergonomics series, correction of problems), the likelihood of having products with best quality is higher, in order to decrease the physical and psychological operator allowing better perform the activity of the job. With regard to what has been predictable as, for example, occupational diseases, more specifically on musculoskeletal disorders, guidelines and actions to ergonomics are essential for improving QWL (quality of work life) and also for reducing the impact on cost for companies facing legal problems.

Viewpoint of the area of Manufacture: The system currently used in all car companies to achieve a high degree of competitiveness and performance, seeking a greater return of profits to the detriment of work in production jobs, to reduce losses and increase productivity with lower labor and possible mainly targeting the most important factor is that the proper treatment of people. Absenteeism has a direct impact with ergonomics, if the operator begins to miss work that can be put in where it performs the operations are no conditions that compromise their posture, causing muscle fatigue and subsequent absence from work.

Viewpoint of the area of Performance: I understand that the lean production system recommends a suitable job for execution of its activity, in addition to 5'S must be ergonomically aligned. When deploying the ergonomics the company will be providing a better quality of life to the contributor (fatigue) will avoid people to depart / problems related to lack of ergonomics at work, avoid future labor actions, with a more favorable job may occur improvement or even elimination of a quality problem, among others.

Viewpoint of the Communications Department: All the work to improve the ergonomics of a workstation must occur in conjunction with all the operators who work in that post. You must create a culture in the companies to conduct regular reviews on all jobs, with the goal of establishing a "preventive" of future problems.

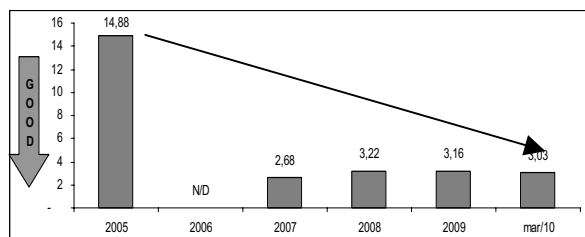
It can be seen from the viewpoints of the employees that the company's ergonomic program, has affected several areas of the company, raising awareness about the health of employees. Another important point that all areas have a preventive target to work on, avoiding the risk of accidents in the workplace. A negative point

is the research division of knowledge production system that the company currently works.

5. Discussion and conclusion

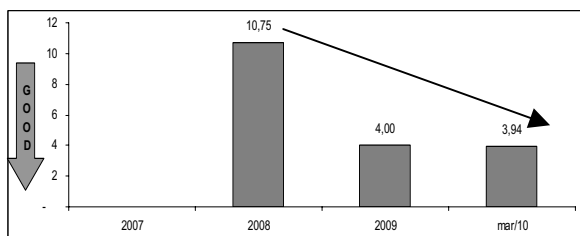
Approach of the case it was found that the company is concerned about the continuous improvement of working conditions for operators, as presented indicators of Human Resources and Quality, listed below:

The company's ergonomic program, the jobs are divided into two types of critical posts and the posts are less critical than with the low level of risk for accidents and muscle problems. The most critical positions where there are medium and/or high likelihood of the employee having trouble muscle. According Balbinotti (2003), ergonomics seeks not only to prevent workers in jobs stressful and/or dangerous, but seeks to put them in the best possible working conditions to avoid accidental injury or excessive fatigue and improve income.



Graphic 2. Absenteeism Index

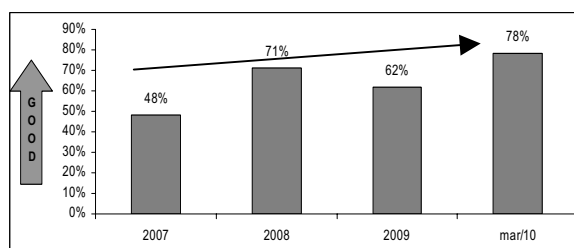
Absenteeism is the absence of employees in the workplace. It is noticeable that from 2008 the level dropped drastically, many activities were organized to reach this number low. It is important to note in Graphic 2 that the level of absenteeism of Japanese firms that had a lean production system is related to this indicator of the company studied.



Graphic 3. Index Accident

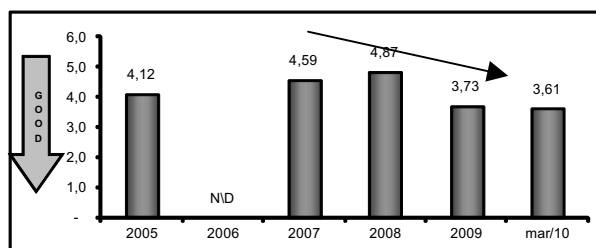
The company's accident rate is calculated as the proportion of accidents for the hours worked by

employees. This indicator includes all types of accidents with and without leave the company. All efforts to improve the ergonomics and conditions of employment are to prevent and avoid the level of accidents, and the company's goal is equal to zero.



Graphic 4. Vehicle without rework (%)

Through field research have identified the days of inventory, as well as others you can see a constant search for "lean" and the graphics have shown again the comparison of Figure 1 that the author relates the level of stocks of companies lean, is a quest for lower production cost.



Graphic 5. Performance Production

The Graphic 5 shows the level of performance of the company to produce more at lower cost and less resource as possible. This indicator is important for productivity in relation to competitiveness, productivity is mainly defined as the ratio between output and factors of production used, competitiveness involves obtaining greater competitive advantage, or be the best at what it produces. When working on Ergonomics and working conditions of employees to search for productivity is achieved, it is noticeable that in recent years the company aims to improve working conditions and consequently increase the productivity of employees.

It is the indicator that measures the percentage of cars that can carry all the way from the assembly line without the need to be taken off line to perform rework. As said Womack, et all (1990). Lean producers, in turn, openly aspire to perfection, always declining costs, absence of defective items, no stock

and a myriad of new products. Another aspect seen in Figure 1 of the authors' analysis is the quality level of the industries that lean production system has, always striving for perfection and when comparing with the result is visible to the search company in terms of perfection in product quality.

According to research presented, it is possible to observe that today there is a high level of concern about the quality of working life in business, because people are not worried about their own health, only when problems arise and this will be bad for both company and the employee because the employee will have to move away due to health problem, and the company will lose one of its employees, which in turn will have to hire another employee and training him, thereby generating cost more to the company.

You can see that working in the lean system, the company may have better results are reconciled with the ergonomics. The company's employees have a need to use and the ability to solve problems in the system "lean". The subsystem used for improvement of working conditions and also for process improvement is Kaizen, workers use this tool to improve their own job and their colleagues.

Based on research in the field was possible to identify that there are developers with different ideas about the system of the company, which were targeted by this research on the main characteristics of a lean production system. And most of the employees interviewed agree with the reconciliation of the lean system ergonomics, relating mainly to complement each other.

Employee productivity is directly related to the company's ergonomic program, you can see in the results discussion and point of view of employees, which officials acknowledge that the company does for them.

Through this research is to identify possible that by creating a culture of continuous improvement (Kaizen) employees, effective improvements with simple and to the process of organization, are use for their own benefit that is improving ergonomics and working conditions of the job.

Just as some studies have already proposed the same argument in this article, other issues could be improved and enhanced with the topics discussed, aiming at the real situations of the working environment.

References

- (1) Balbinotti G. (2003), *A Ergonomia como Princípio e Prática nas Empresas*, 1º Edição. Curitiba: Editor Gêneseis.
- (2) Campos, V. Falconi(1997), *Gerenciamento pelas Diretrizes*, Belo Horizonte: Fundação Christiano Ottoni.
- (3) Automotive industry documentation, (2010).
- (4) IEA – International Ergonomics Association, Retrieved May 02, 2007, from <http://www.iea.cc>.
- (5) Womack, J. P. & Jones, D. T. A (1990), *A Máquina que Mudou o Mundo*, Rio de Janeiro: Editora Campus.
- (6) Womack, J. P. & Jones, D. T. A (2004), *Mentalidade Enxuta nas Empresas*. Rio de Janeiro: Campus.
- (7) Martins, Petrônio G. E Laugeni, Fernando Piero (2006), *Administração da Produção*. São Paulo: Editora Saraiva.
- (8) Matthew E. May (2007), *Toyota A formula da Inovação*. Rio de Janeiro: Editora Campus.