VSM (Value Stream Mapping) Study in an Industry with Financial Analysis and Simulation Model Verification

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Abstract

This work is a case study of an industry of products for the automotive and white-goods sector, located in the state of São Paulo, Brazil, which is implementing lean manufacturing. The value stream mapping was used to identify all the actions that were in progress and what is the current state of the sector, based on one of its products. Due to the high complexity, the company decided to focus on actions that would bring financial and productive gains, therefore was selected the product family with the most representative sales. It was made a mapping of the current and future status and two significant improvements were identified. The study was supported by Lean Six Sigma tools, 3D simulation software and financial analysis to improve the results and reduce risks. Three scenarios with different improvements were created, the one with greater financial return in less time, productivity gain and alignment with the company's strategic planning has be chosen.

Keywords
Value Steam Mapping, Lean Six Sigma, Financial Analysis, 3D Simulation.

1. Introduction

Currently, there are many methodologies that industries adopt to improve their processes and products, including Lean Six Sigma. Lean methodology born from Toyota's lean production concepts, and Six Sigma, originally used by Motorola, came together and today it is practiced strongly in industries (QUINTANEIRO, 2014), highlighting the automotive.

Among all the tools known in the LSS, this research focuses on VSM (Value Stream Mapping), which according to Invernizzi (2006), aims to map the entire value chain of a product, allowing a macro view of all activities that are needed.

In this context, an industry in the implementation phase of the "Lean" culture that saw in its strategic planning the need to create a sector of continuous improvement to support the processes, will be the object of study in this work, which intends to answer the following question: How implement Lean Six Sigma, aiming to reduce costs, improve quality and eliminate everything that does not add value to customers.

Therefore, through the tools of the Lean Six Sigma methodology and the multidisciplinary knowledge of everyone involved in the manufacture of this product, this research explores the possibilities of investments and improvements, proposing the future state for the factory using the value stream mapping tool.

2. Literature Review

2.2 VSM (Value Stream Mapping)

The Value Stream Mapping can be explained as: “follow the production path of products’family inside the plant, from the consumer to the supplier, and carefully draw a map of the current state of their material and information flows” (QUEIROZ, RENTES E ARAUJO, 2004, p.2). Queiroz, Rentes and Araujo (2004) state that, after understanding the current state, the future state must be elaborated thinking about how the material should flow after the improvements.

2.3 7 wastes

According to Shingo (1996), waste is related and easily overlooked, so it must be analyzed for effective cost reduction. The seven categories of waste are:
1. Overproduction: Losses are associated with quantitative and anticipated factors, that is, making more products than will be consumed and making products before it is necessary.
2. Waiting: It’s related with the times of machines and / or devices stop due to inefficiencies in the process or breaks, generating waiting for factory resources.
3. Transport: Losses with transport are related to time and material movements that do not add value and generate costs.
4. Processing: It is related to the processes that are made and can be removed or minimized without affecting the quality of the products.
5. Movement: Can be generated by poorly planned layout and incorrect flow, resulting on unnecessary movements.
6. Defective Products: Relates to manufactured products that are out of the determined requirements regarding the quality of the products.
7. Inventories: Strongly linked to all other wastes, being a consequence of those mentioned.

2.4 Financial analysis

“Understanding the relevance of financial analysis depends, firstly, on realizing what it is, what it is for and what it focuses on” (FERNANDES CARLA, 2016, p. 25). The financial analysis according to Soares (2015, p. 25) is “the technique that supports decision making regarding the implementation of an investment, based on the determination of the magnitude relationship between the expected costs and benefits. That is the technique that allows to assess the economic and financial viability”. That’s why it can use different methods to optimize results. Its purpose is to evaluate the cash flow that will be generated by the selected investment, projecting the net cash value (disregarding depreciation and amortization) and adding the costs of fixed investments. In addition, other risk assessment methods can be used, such as calculating the discounted payback on the investment and calculating the internal rate of return to verify if it exceeds the minimum rate of return used for the investment.

2.5 Simulation evaluation

The simulation is in continuous evolution because it follows the technology itself, which is something that changes continuously and daily. Its presentation is directly linked to the technology of the time, but there were specific moments of these changes that we classified until we reach the current one that is in type 4.
Type I is linked to the first simulation tools, where philosophers used mathematical models and models on an enlarged or reduced scale to observe the structure and characteristic of some studied physical event and possibly predict reactions once they understood how the system worked.
Type II comes with increased competitiveness and the need to polish continuous efficiency. With the creation of the first computers and programming languages (pascal, C, etc.), which were used as command macros for the creation of simulation models to test possible changes in the system and predict the result this would generate.
Type III is related to the speed evaluation of computer processors and memory and, as previously mentioned, simulation follows the technology, that means there was a very concrete evolution in the scope of simulation which began to create simulators of a specific character, an example of this was a simulator created for training train drivers.
Finally, the Type IV simulation, the tool that was used in this study, is a simulation loaded with visual resources, interactive and intelligent simulators, with a network of virtual reality resources and even expanded with artificial intelligence.

3. Method

This research is characterized as an action research that, according to Vergara (1990), is a tool that is based on studying and participating on some actions in the social sphere and interfering on them. In addition, this research also has an applied nature, which according to Vergara (1990), is a systematic study motivated by the mediated or not need for problem solving. It is also admitted that it may adopt an interventionist character, if the proposals for improvements are accepted and put into practice, because, according to Vergara (1990), the interventionist difference from the applied one, is that in the first one the improvements aren't just proposes, but also applied in practice.

Related to the data collection, this research is qualitative and quantitative type, because, according to Dalfovo, Lana and Silveira (2008, p. 6), quantitative research is "everything that can be measured in numbers, classified and analyzed. it uses statistical techniques" and qualitative research is that one which is not translated into numbers "in which it intends to verify the relationship between reality and the object of study, obtaining various interpretations of an inductive analysis by the researcher".

The research will be based on the value stream mapping carried out in the entire chain of the studied company, from the entry of raw material to external suppliers to the billing of the finished product. It was possible to collect detailed information on these processes and describe, through the lean six sigma tool, the mapping of the value flow, in order to see all existing waste and inefficiencies.

Due to the high complexity and extension evidenced, the company's management, together with the continuous improvement sector, will give guidance on which processes will be focused on the research, since it is not possible to attack the entire chain at once. This way, the actions that will bring the greatest gains to the company in financial terms, lead time, productivity, decrease in inventories and increase in quality will be the focus of the work.

4. Actual State

The study will focus on just one family of products, and to reach the process of assembling this product, production depends on other sectors of the factory and external suppliers, because the structure of the company in question is a verticalized manufacture with several different processes and expertise.

To be able to deliver the product to customers that produce stoves, it is necessary to have several internal and external suppliers that are responsible for delivering all components and raw materials. Among the company's main production processes, some are component suppliers.

One of the most important supplier sectors of the company is the electronic, since this sector assembles the electronic boards that are sent to the final assembly sector. In addition to the assembly of electronic boards, it is worth mentioning that the added value in this component is quite significant for the final cost of the product, in addition to its quality interfering strongly in the functionality of the product.

4.2 Study Process

The company has a vertical profile and among the main production processes of the factory, which can cause injection of thermoplastic parts, stamping of metal components, making molds for injection of thermoplastics and mold tools, in addition to various assembly processes. Serving several automotive customers, white goods and aftermarket.

The base product for the research, it is one of the company's flagships, having an average demand of 310,000 pieces per month, this product is supplied to stove manufacturers in Brazil and in several countries around the world. This family of products was chosen to be the target of this work, because it is very representative in terms of the company's revenue, with great projections in the market that are aligned with the company's strategic planning.

The studied process focus on the assembly sector, which relies on pre-assemblies until reaching the final assembly line. The technical concept of assemblies and pre-assemblies will not be changed at first, since the work focuses on increasing productivity and quality, reducing waste and decreasing the Lead Time, being linked to the rearrangement of the layout and flow.
The study sector, treated by "Machining", currently begins its process in the winders, where after receiving the spool, the copper wire is wound and sent to the welding machine that welds the wire at the terminals and forms one of the coils. Then, two mirrored pre-assembly lines pre-assemble, sending the product for a preheating before receiving the resin that is on the coil.
After the semi-finished product stays in the oven for 5 hours to cure the resin, it is sent to the final assembly line, together with the electronic board, the board is assembled in the electronics sector fully prepared with anti-aesthetic environment, in this assembly line that is also mirrored, is where the product will be assembled, tested and packaged, ready to deliver to customers.

5. Improvements Identified

VSM requires a good survey of information to understand the entire flow of the factory and more than that to be able to identify processes and activities that do not add value to customers and make the product more expensive. Thus, already in the VSM of the current state, it is possible to identify opportunities for improvement, which will then be the direction of activities, improvements and projects.

5.1 Crimping Machine

In the current state of the factory, to make the spool, the stamping sector makes the terminals and sends them to the hydration sector, where drumming will be carried out to guarantee the quality of the terminals, eliminating burrs. When the terminals are drummed, they are sent to suppliers who are responsible for the termical treatment of the terminals.
Parallel to the process of making the terminals, the reels are injected in the plastic injection sector and as soon as the terminals that are already heat treated arrive again at the factory, the two components are sent to another supplier so that the terminals can be driven into the spool. Upon receiving the spool with the spiked terminals, they are directed to the machining sector to be wound and welded to form one of the intermediate products.
As a result of the high number of parts in the buffers that are made to guarantee the supply of processes carried out by external suppliers, such as the thermal treatment of the terminals and the crimping of the terminals on the reels, a long lead time is generated, which in turn impacts negatively in the company's results because it makes planning in production difficult and generates "holes" in the cash flow, since the raw material is purchased, manufactured and only after approximately 4 months are invoiced.
The proposed future state tries to solve the problems resulting from the excess of movements made for the manufacture of the product, for this purpose a crimping machine for the terminals on the reel will be integrated into the machining process, which will make the PI cheaper, will bring a significant gain in lead time and intermediate stocks.

5.2 Electronic Assembly

In the current state of the factory presents, among the internal and external suppliers is the electronics sector, every production made in the electronics sector represents the production planned for the next day of the plant, the electronics sector makes its schedule ahead of its client one day, in this case, the machining assembly sector.
The sector has a structure prepared for mounting the plates with anti-aesthetic floor, all employees or visitors who have access to the production line must wear anti-aesthetic jackets and boots, operators connected to the workbenches must use anti-static bracelets, all to ensure quality in assembly and do not burn the components.

5.2.1 Kaizen Electronic Assembly

In the current electronic assembly process, automatic assembly starts with a machine that insert components on electronic boards, being possible to insert only part of the components that make up the board. In the next step of the process, the workforce finishes inserting the components that the machine does not insert and sends them to the welding process, according to the layout.

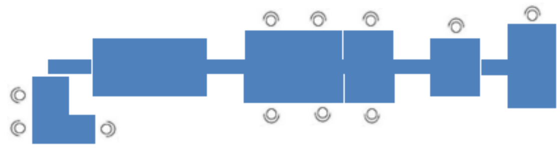

Figure 1: Layout Electronic Assembly

The first thing to do is to understand the current state of the line in question, and for that it is necessary to do a chronoanalysis, which means going to the factory floor and time all the processes. To guarantee a more reliable time, the times should be done several times.
After arriving at all cycle times, the ideal is to transpose the numbers in graphs to make easier to observe the times and the synchronization of the operators, since it is very important to determine the work rate, known as takt time.
In addition to the takt time, it is possible to know what is the number of labors that will be needed in the process by taking the sum of cycle times and dividing by the value of the takt time, we have the number that manpower that serves as a north to be followed. It is important to note that not all calculations are possible to meet exactly the amount of labor determined.

$$Takt\ Time = \frac{Avaiable\ Time}{Demand} = \frac{(7{,}98hrx20daysx3600) - (0{,}17hrx20daysx3600)}{302.000\ p/month} = 1{,}86\ \frac{sec}{p}$$

$$N°\ MOD = \frac{\Sigma\ operations\ times}{Takt\ Time} = \frac{23{,}33}{1{,}86} = 12{,}54\ \cong 13\ labors$$

Line balancing enters on this stage of the Kaizen to balance all the times of the operators and ensure that everyone does the operations within a maximum time interval, always worrying about getting the takt time. When any of the processes are not below the takt time, the operations must be merged in order to try to divide a little of each operation to each of the stations or operators.
When the division of an operation is not possible, the solution is to add operators to perform the same processes, because this way, the time is divided by the number of operators that perform the same function up to a value that is below the takt time.

Table 1: Value addition

45	
0,001319%	AV
99,78869%	NAV
0,209993%	NVN
99	Lead Time Dias

After understanding the entire process flow and calculating the takt time and the number of operators, considering the basic calculations for directing the work, the analysis of the values begins to propose future states considered ideas by the research team.
For the future state of the assembly of electronic boards, in addition to reduce the time of operations by eliminating some activities that do not add value, it is necessary to propose a new layout to meet the desired configuration, since the previous configuration of the assembly does not meet the needs estimated by the team. Figure 2 illustrates in an illustrative way the proper layout configuration to meet the requirements estimated by the team.

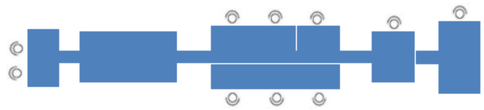

Figure 2: Layout proposal

6. Financial Analysis

The first change is the purchase of the crimping machine, it will not impact the final production line, but it is an investment that can reduce the costs of both the product and the company's logistics, in addition to reducing inventories in the area of reel injection.
The current cost of the part until the crimping process is R$1.63, making the proposed change that includes the purchase of the crimping machine for the factory and thus eliminating the logistical processes from the external supplier, this cost would drop to R$1.51. The investment in the crimping machine, taking into account its purchase, installation and training is R $ 2,000,000.00.
In addition to the internalization of the crimping machine, the proposal is also to change the layout of the electronic sector (MOE) and take it to where the Assembly and Machining (MUS) is today. The following figure shows how the integrated layout of MOE with MUS would look.

Figure 3: Final layout proposal

The following investments are required to apply the change in the MOE sector: Hiring a company to change internal machines; Hiring a company to analyze the electrical network for the new installations; Buy antistatic floors; Installation of antistatic floors; Purchase and install protective walls in the area of the new MOE.
These investments have the following costs: R$ 7,100.00 for internal movement of the machines, R$ 244,972.161 for the installation of the electrical network, R$ 19,350.00 for the purchase and installation of antistatic floors and R$ 19,600.00 for the purchase and assembly of the partitions. Totaling an investment of R $ 291,022,161 for the change as a whole.
In addition it was possible to reduce 8 manpower in the process of this change (information from the VSM Proposed)
The reductions made after the changes and the total investment are shown in the table below:

Table 2: Costs and investments from final changes proposal

	Unitary	Total
Fixed cost		
Building rent		R$110.000,00
Factory security		R$50.000,00
Electrical energy		R$300.000,00
Maintenance		R$50.000,00
Supplier payment		R$1.050.000,00
		R$1.560.000,00
Variable cost		
Raw Material	R$5,28	
Packaging	R$0,50	

Labor (35)		R$119.999,00
Logistic cost		R$35.868,36
	R$6,28	R$154.868,36
Expenses		
Administrative payment		R$200.000,00
Investments		R$2.291.022,16
Depreciation		R$ 30.000,00
Selling price	R$14,50	
Factory demand		310.000 (month)

First is necessary to calculate de Cash Flow:

$$Cash\ Flow = Entrances - Exists$$
$$Cash\ Flow = (14{,}50 * 310.000) - (6{,}26 * 310.000 + 230.000 + 1.560.000)$$
$$Cash\ Flow = \ 758.331{,}64$$

To calculate the Payback of these investments, taking into account the gains that were shown previously, it is possible to make an accumulated cash flow, to discount the investments. For this we will also use the NAV calculation to bring the cash flow to the values corresponding to real time, a TMA = 5% will be used. The Discounted Payback accounts are shown in the table below:

Table 3: Discounted payback calculation

Years	Cash Flow	Discounted Cash Flow	Accumulated Cash Flow
0	-R$ 2.291.022,16	-R$ 2.291.022,16	-R$ 2.291.022,16
1	R$ 758.331,64	R$ 722.220,61	-R$ 1.568.801,55
2	R$ 758.331,64	R$ 687.829,15	-R$ 880.972,40
3	R$ 758.331,64	R$ 655.075,38	-R$ 225.897,02
4	R$ 758.331,64	R$ 623.881,32	R$ 397.984,30

To take better conclusions, it's possible to calculate the internal rate of return (IRR) as seen bellow, where CF is the discounted cash flow in the correspondent year:

$$0 = CF_0 + \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \cdots + \frac{CF_n}{(1+IRR)^n}$$
$$0 = -2.291.022{,}16 + \frac{722.220{,}61}{(1+IRR)^1} + \frac{687.829{,}15}{(1+IRR)^2} + \frac{655.075{,}38}{(1+IRR)^3} + \frac{623.881{,}32}{(1+IRR)^4}$$

This equation was solved by putting the values in an excel table, and the value of IRR was 6,909%

It is expected that the result of the actions will reduce approximately 25 days of production lead time, in addition to reducing resources and improving the quality of the products, since electronic products must be stored, transported or handled with suitable equipment.

Table 4: Value addition after changes

38	
0,001634%	AV
99,71763%	NAV
0,280737%	NVN
74	Lead Time Dias

7. Conclusion

VSM (Value Stream Mapping) is a tool that allows you to have a macro view of all operations that are carried out to produce a certain product. Often, top management does not have the same vision and when a mapping is done, it is possible to transmit and demonstrate in practice all activities that do not add value.

There are several challenges when implementing and disseminating a culture in a company, as management support which has the biggest importance. Everyone must have the knowledge and believe that Kaizen works, and Six Sigma projects bring results for the company. Using VSM is an excellent tool to convince when the culture change initiative isn't top down.

Just as the Value Stream Mapping is a tool to have a vision of the whole process and with it is possible to propose reductions and improvements, in this action research, it was possible to see the tool from a different angle, because, in addition to all the potentials improvements and, consequently, financial gains identified to the company, it was used to manage activities and make strategic decisions together with a s financial analysis study and finally a simulation in 3D software of the chosen final scenario.

Analyzing the results obtained, it is possible to see the changes as viable or not for the company to implement. Payback criteria and internal rate of return were taken into account, where for the project to be viable needs to have a payback lower than 5 years and the IRR must be greater than the TMA (in this study used as 5%), or at least both must equal in value. If only one of the statements above is true, the investment cannot be considered 100% safe for the company.

The scenario proposed was taking the two changes and both needed to prove to be a safe and viable investments. The results obtained were a payback of 3 years and 5 months, acceptable in the established standards, and an internal rate of return of 6.909%, higher than the TMA of 5%.

With the studies done, it is possible to analyze that, among the impact scenarios analyzed to implement the changes proposed in the value flow map presented by the company, what will bring the greatest financial advantage for the company is just making the Kaizen change.

However, not only should the financial advantage be analyzed, as the first change proposed has already been emphasized, it is important for operations and billing since it has a great impact on inventories and production lead time, becoming a critical process.

Therefore, the final scenario contains financial advantage change and the change that solves one of the major billing problems in one of the company's main products. In addition to the results of payback and internal rate of return analysis being positive, this scenario proves that the investment is safe to the company and the most strategically advantageous. The treated information was also proven in the simulation performed in the Flexsim software.

References

AEAC. *Tabela de honorários mínimos para elaboração de projetos de instalação elétricas e telefone, tubulação de alarme/CFTV/lógica/som/TV e SPDA (sistema proteção contra descarga atmosférica)*, http://www.aeac.org.br/downloads/543e8753a5aba.pdf, Acessed day: November 12, 2019.

Dalfovo, M. S., Lana, R. A., Silveira, A., Métodos quantitativos e qualitativos: Um resgate teórico, *Revista Interdisciplinar Científica Aplicada*, Blumenau, v.2, n.4, p.01 – 13, Sem II. 2008, http://www.aedmoodle.ufpa.br/pluginfile.php/168069/mod_forum/attachment/271244/MONOGRAFIAS%20M%C3%89TODOS%20QUANTITATIVOS%20E%20QUALITATIVOS.pdf, Acessed day: January 24, 2019.

Domingos, J, *O que é fluxo de caixa? Aprenda a calcular e mude a realizada da sua empresa*, https://www.voitto.com.br/blog/artigo/o-que-e-fluxo-de-caixa, Acessed day: October 7, 2019.

ESD ANTIESTÁTICOS. *Piso Vinilico ESD*, https://antiestaticos.com.br/produto/piso-vinilico-esd#dimensoes, Acessed day: November 8, 2019.

Fernandes, Carla et al, *Análise Financeira – Teoria e Prática*. Lisboa, 2016, https://static.fnac-static.com/multimedia/PT/pdf/9789726188421.pdf , Acessed day: February 11, 2020.

Invernizzi, G., *O Sistema Lean de Manufatura aplicado em uma indústria de autopeças produtora de filtros automotivos*, Dissertação de Mestrado, Universidade Estadual de Campinas, Campinas, 2006.

Quintaneiro, S. I. N., *Uma perspectiva Lean Seis Sigma na Melhoria Contínua de um Sistema Logístico de Produção*, Dissertação de Mestrado, Universidade Nova de Lisboa, Lisboa, 2014, https://run.unl.pt/bitstream/10362/14242/1/Quintaneiro_2014.pdf, Acessed day: January 27, 2019.

Queiroz, J. A., Rentes, A. F., Araujo, C. A. C., *Transformação enxuta: aplicação do mapeamento do fluxo de valor em uma situação real*, Universidade de São Paulo, 2004, http://www.hominiss.com.br/es/img/usr/teses-artigos/Transformacao_enxuta_aplicacao_do_mapeamento.pdf, Acessed day: August 17, 2019.

Bona, A., *Descubra o que é VPL e qual a sua importância nos investimentos*, 2019, https://andrebona.com.br/descubra-o-que-e-vpl-e-qual-sua-importancia-nos-investimentos/, Acessed day: October 16, 2019.

PORTAL DORI. *Sinduscon divulga tabelas de Custo Unitário Básico no Estado de São Paulo*, 2019, https://www.portaldori.com.br/2019/02/05/sinduscon-divulga-tabelas-de-custo-unitario-basico-no-estado-de-sao-paulo-referencia-janeiro-de-2019/, Acessed day: November 19, 2019.

Prates, R. W., *O que é TIR (Taxa Interna de Retorno)?*, 2019, https://www.wrprates.com/o-que-e-tir-taxa-interna-de-retorno/, Acessed day: October 14, 2019.

Reis, T., *Aprenda a analisar investimentos utilizando a taxa Interna de retorno*, 2018, https://www.sunoresearch.com.br/artigos/taxa-interna-de-retorno/, Acessed day: November 13, 2019.

Shingo, S., *O Sistema Toyota de Produção: do ponto de vista da engenharia de produção*, Porto Alegre, Editora Bookman, 1996.

Siqueira, F., *Descubra como calcular o fluxo de caixa e qual a sua importância*, 2018, https://blog.ideiaembalagens.com.br/descubra-como-calcular-o-fluxo-de-caixa-e-qual-a-sua-importancia/, Acessed day: October 22, 2019.

Soares, Isabela et al., *Decisões de Investimento – Análise Financeira de Projetos*, Lisboa, 2015, https://repositorio-aberto.up.pt/bitstream/10216/82888/2/116731.pdf, Acessed day: February 11, 2020.

Vergara, S. C., Tipos de Pesquisa em Administração, *Caderno EBAP*, n. 52, junho 1990, https://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/12861/000055299_52.pdf, Acessed day: January 24, 2018.

Biographies

Isabela Marcon is a student in the last year of production engineering at Sorocaba's engineering university named FACENS university. She has already participated in two simulation competitions made by FlexSim and in the last year won the third place with her group with an industry simulation with stock improvements. She is part of FACENS simulation group since 2017 and thanks to this started the scientific research that came to this publication.

Monique Yngrid da Silva is in the last semester to get a bachelor's degree in production engineering. She has basic experience on simulation software courses, and she was academic monitor for two years until the invitation to participate in the university's simulation group. She has already participated in some university and national simulation competitions and won some awards. She published banners in congresses such as the Brazilian Symposium on Operations Research and National Congress of Scientific Initiation.

Thiago Henrique Brisoti is in the last year of production engineering at FACENS. He has already participated in three simulation competitions, two with Flexsim software and one with Promodel. He has been member of FACENS's simulation group since 2017 and he has initiated his scientific researcher, that came to this publication, one year ago.
Adilson Rocha graduation at Ciências Econômicas from Universidade de Sorocaba (1994), master's at Business Administration from Universidade Presbiteriana Mackenzie (2000) and doctorate at Production Engineering from Universidade Paulista (2014). Has experience in Economics, acting on the following subjects: comércio exterior, estratégia, logística, competitividade and vantagem competitiva.

Henrique Ewbank de M. Vieira is Professor in Industrial Engineering at Facens University, Brazil. He has a Post-Doc in Environmental Sciences from Paulista State University, Sorocaba, Brazil. He earned PhD in Management from Federal University of Rio de Janeiro, Brazil, Graduate Certificates in Logistics & Supply Chain Analysis and in Systems & Supportability Engineering from Stevens Institute of Technology, New Jersey, USA, and B.S. in Industrial Engineering from Estácio de Sá University, Brazil. He has taught courses about operations research, management and data science for graduate and undergraduate students. His research interests include demand planning, inventory management, supply chain, and multi-criteria decision making.

Marco Antonio dos Santos Junior is Graduated in Production Engineering from the Grande ABC University, holds an MBA in Business Management from FGV and is a Lean Six Sigma Master Black Belt. He has 24 years of experience in large industries, working in the areas of business excellence, value analysis engineering, project management, production and quality management, process engineering and maintenance, exercising leadership and working on projects of great impact for the company. He worked on 10 LSS projects directly as a member and project leader focused on optimizing operational costs and supporting strategic projects in the purchasing, legal, human resources, manufacturing and quality processes. He currently is the Regional Master Black Belt Regional of the company ZF do Brasil Ltda, coordinating since 2016, 150 teams of Black and Green Belts and maintaining good relationships at all levels of all eight ZF Brazilian plants. He has been teaching since 2015 at the Facens in the areas of production engineering, mechanics and mechatronics, as well as in post-graduate courses.

Rodrigo Luiz Gigante is master in Production Engineering from the University of São Paulo (2010); Bachelor of Applied Mathematics and Scientific Computing from the University of São Paulo (2007). He is a professor at Facens University. His areas of expertise are Operational Research, Discrete Event Simulation, Scheduling, Queue Theory, Production Planning and Control and Logistics.