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Productivity improvement in a polishing sector of a metallurgical industry with MASP application

Ederson Benetti Faiz*, José de Souza**, Alexandre Beluco***, Jorge Luis Braz Medeiros****, Frederico Sporket*
**(Faculdades Integradas de Taquara - Faccat, Taquara - RS - Brazil.*
*** (Fundação Liberato - FETLSVC/DPPI, Novo Hamburgo - RS - Brazil.*
**** (Universidade Federal do Rio Grande do Sul - UFRGS/IPH, Porto Alegre - RS - Brazil.*
***** (Universidade Federal do Rio Grande - FURG/PPMEC, Rio Grande - RS - Brazil.*
Corresponding Author: José de Souza

ABSTRACT
This paper presents the application of the Analysis and Problem Solving Method (MASP) in the reduction of losses and the search for higher productivity of the forged part polishing sector. The decline of the demand for hand tools such as the forged hammer causes a reduction in the utilization of productive capacity and a decrease in the labor employed. The objective of this paper is to identify opportunities for improvements in sanding and polishing line productivity. The purpose also contemplates the organization of the sector to improve performance in the development and maintenance of the company's competitiveness. The methodology used was a case study. From the analysis of losses and the use of quality tools, it was possible to propose inexpensive and straightforward actions, improving the organization of the sector, reducing production times, as well as reducing ergonomic risks.
Keywords – MASP, Productivity, Process Improvement, Polishing.

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I. INTRODUCTION

The company's production of forged hammers in this study was around 312,000 pieces in 2009 and plummeted to 91,000 pieces in 2015. This fall in demand led to a reduction in the installed structure and, consequently, a decrease in hired labor. In pursuit of the resumption of growth, the company plans to introduce new products as well as manufacture products currently purchased from third parties. Thus, it would also start to use the installed structure, keeping the hired labor. The workforce employed in both the forging and sanding and polishing sectors is challenging to hire due to the working environment, subject to noise and high temperatures about the supply of jobs offered by the region's tourism sector.

The objectives of this were the application of the MASP (Method of Analysis and Problem Solving) steps aiming to identify the losses in the polishing process, as well as the use of the 5S program, focusing on the first three [1]. Senses of use, organization, and cleanliness.

The application of the Problem Analysis and Solution Methods (MASP) tool is an essential differential in the search for better results in the metalworking industry [2].

In general, quality tools are of the utmost importance for industries to achieve rapid competitiveness [3-4].

II. REVIEW

In recent decades there have been several changes in the management and organization of production systems [5]. Industries have invested in the continuous improvement of the quality of their products and services [6-7].

The method seeks the root of the failures through the application of several quality tools, identifying the most effective and appropriate solution to the problems [8].

The method increases the likelihood of satisfactory answers [9]. The MASP methodology can be applied to detect a problem or to better the process, seeking the optimization of new forms or production techniques [10].

In the forging hammer fabrication process, the material used is SAE 1045 steel cut in billets. The cut material is taken to combustion furnaces, where it is subjected to high temperatures that can reach 1200 ° C, being later formed by open dies inserted in fall hammers [11].

In the free matrix, the material is compressed between the upper matrix and the lower matrix [12].

The heating in combustion furnaces causes the formation of scale on the surface of the part, due to prolonged exposure under high temperature [13]. Due to this, the part undergoes the blasting process. Shot peening, scientific name given to the blasting process, is defined as the mechanical cold surface treatment of metal parts, resulting from the impact of spherical particles driven by compressed air or rotation, allowing the surface finish [14].

In the next step to this process, the parts are sent to the sanding and polishing industry. The forged part is submitted to the machining process, aiming at the removal of additional material, obtaining the piece in its desired final shape [13]. The sanding process prepares the surface for applying finishes, such as paints and varnishes [15].

Polishing may consist of the first step in a coarser process, removing grooves and scratches from cutting or roughing, using sandpaper with variable particle size [16].

In the second stage of fine finishing, sandpaper with decreasing particle size or abrasive pastes such as diamond paste used for a scratch-free surface finish. Line balancing is required for layout reorganization and the pursuit of increased production efficiency and to make the process more organized by reducing the backlash at each workstation [17-18].

III. MATERIALS AND METHODS

In the forging industry, the following parts are stored for sanding and polishing by production order. The produced parts receive two finishes. The first is a polished model, Figure 1(a), after blasting the piece goes through grinding wheel and sandpaper, receiving a glossy finish. The second is a sandblasted model, as shown in Figure 1(b), where only the anvil, eye and ear receive a sanding and the remainder of the hammer body receives a rough finish, free of the forge scales and shells by the blasting process.

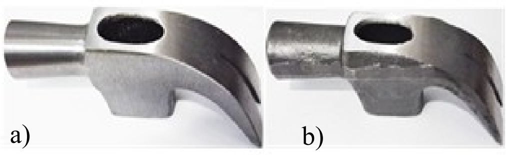

Fig. 1: Models of a hammered hammer. a) Polished model; b) Sandblasted model without polishing.

The polished hammer is the model that demands the most time and the most production steps. The part goes through four machines, requiring eight steps for its production, and its processing time is approximately 140 seconds per piece. The blasted hammer, in turn, uses three machines, requiring four steps for its creation, and its processing time is about 23 seconds per part.

For steps where the hammer's ear and the hammer's body are sanded, brackets must be used. The supports serve to allow the worker to apply higher pressure of the part against the abrasive sandpaper used in the process, thus allowing the roughing of the piece. Also, the bracket is responsible for finishing the top of the hammer ear roughing and correcting imperfections in the forging process caused by block wear.

The initial layout of the sector consisted of five belt-type sanders, each holding two workstations and a grinding wheel, as shown in Figure 2. Of the five sanders, two were deactivated but remained on the production line layout.

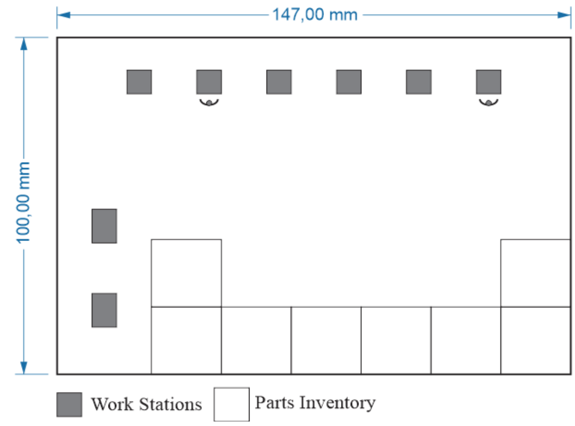

Fig. 2: Initial layout of the sanding and polishing sector.

The reduction in the workforce, due to the low demand for forged products that pass through the sector, led to a change in the production flow. The number of employees increased to two, but the structure and form of production did not have to be adjusted, causing losses mainly in the way of excess employee movement between production stages. The distance traveled identified between the production steps of the sanding line, and hammer polishing was 13.2 meters for each piece produced.

Figure 3 shows the supports used in the process. These parts have the shape of the lower curves of the hammer and serve as the basis for roughing and polishing the parts. These were produced by hand. The piece is secured to the bracket by the hammer socket, the eye hole, and the lower ear support and hammer stop body.

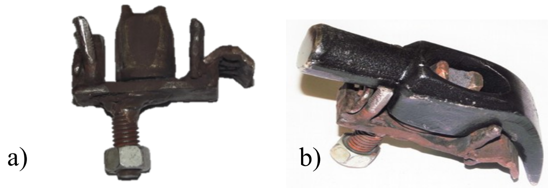

Fig. 3: Supports used for roughing parts.

Application of the MASP Method
The Problem Analysis and Solution Method (MASP) followed the steps: 1 - Identification; 2 - Observation; 3 - Analysis; 4 - Action Plan; 5 - Action; 6 - Verification; 7 - Standardization and 8 - Conclusion.

1) Problem Identification

To identify the problem of the sanding and polishing sector of the company under study, it was decided to perform Brainstorming, due to the lack of records and the scarcity of data and information related to production methods, failures, defective production, among other factors.

The meetings involved the company's director, the administrative manager, representing the company's top management, the two mechanics responsible for maintaining, altering, or adapting the company, the employees, and the researcher. The meetings took place in three stages, primarily involving the researcher and the director. In a second moment, they met the researcher, mechanics, and employees and, in the third moment, all involved.

Thus, the free formation of opinions was sought, without any form of inhibition. In these meetings, the ideas converged to losses related to excessive movement in the sector itself and between the process steps. After searching for the root causes of the detected problem, we proceeded to the next phase of the MASP application.

2) Observation

To understand the operation of the sanding and polishing industry, observations were made in the process as well as meetings in the workplace. Thus, we sought to identify the production steps and the time taken of each phase for each hammer model produced as well as the sector organization. At first, the polished model was time-taken, and the steps and production time were graphically represented, as shown in Table 1.

Table 1: Time analysis graph versus polished model steps.

Activity	Time (s)
Sanding Hammer Anvil	7.2
Sanding ear	5.1
Sanding eye, nail and base	7.3
Sanding Hammer Anvil	2.4
Sanding Hammer body	17.2
Open ears	2.4
Hammer Anvil polishing	4.2
Polishing hammer	37.3

Each of the lines in table 1 represents a step on the production line. All of them are performed manually. Each new step means a new movement of the part and also the employee.

The total production time per piece of the model found was approximately 140 seconds using eight production steps. Of this time, only 83 seconds were actually used in the process, and 57 seconds were lost in the process, as shown in Figure 4.

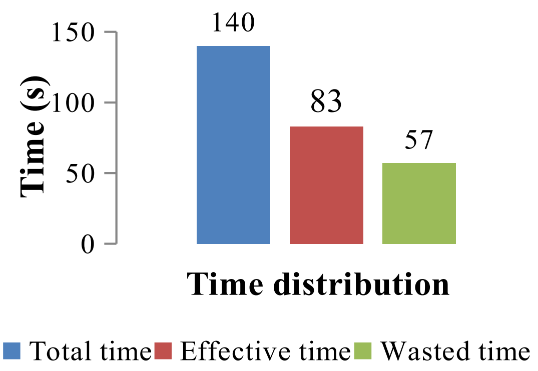

Fig. 4: Time analysis graph of polished model.

The same procedure was performed with the blasted model, seeking to identify the production steps and times, as shown in Table 2.

Table 2: Blasted model time analysis graph.

Activity	Time (s)
Sanding Hammer Anvil	2.6
Sanding ear	5.4
Sanding eye, nail and base	5.4
Open ears	2.5

The sandblasted model presented processing time per piece of approximately 23 seconds, using four production steps, of which about 15 seconds represented the effective time and 8 seconds the wasted time, as shown in Figure 5.

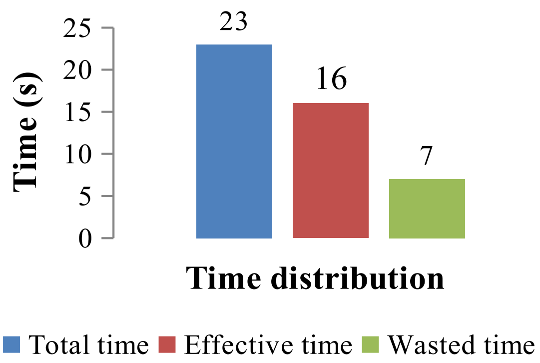

Fig. 5: Time *versus* steps analysis graph of the blasted model.

3) Analysis

After this data collection, they were presented to the brainstorming group to identify the essential causes of the problem. For this, we used the quality tool called Ishikawa Diagram or Cause and Effect Diagram, seeking to present a relationship between the factors that cause a particular effect. The main factors identified as influencing over-movement are concentrated in the method, starting with the unbalanced production flow caused by improper layout. This method did not change after the reduction in forged demand, even after the sector had reduced its employees. The unbalance of the line causes excessive movement between the steps; therefore, it is clear that several measures could be performed in the same equipment, reducing processing time.

Another identified factor is related to the machines. With the reduction of employees in the sector, the number of belt-type sander machines used increased from 5 to 3, but idle machines remained on the production line and between stages. Thus, the employee has to shift greater distance between the hammer sanding steps. There is also the problem of the lack of tools to change supports, causing the employee to move to the maintenance sector in search of them.

In some used machines, brackets are installed, where the hammer is affixed, being used in order to assist in applying higher pressure of the part against the sandpaper, making the initial roughing on the surface of the piece. These machines are not organized for a production sequence, and there is no record of the last maintenance on them, being in poor condition for use, no longer performing the function for which they are intended.

Another factor is related to the way the forged parts stock is stored. The parts are moved from the forging sector to the sanding and polishing sector using handcarts by the tempering process manager. In this handcart, an average of 100 pieces is transported, considering that the production batches range from 1800 to 2500 pieces and that the distance between the starting point and the end is approximately 80 meters. In addition, the parts are deposited on the sector floor, being separated by wooden guides. There is also the risk of an ergonomic problem of this process, linked to inadequate posture by improper weight transportation.

The displacement of the parts between the steps of the sanding process is done in boxes, which are placed on the sector floor, causing a slower movement of the piece because it is farther from the operator. Industry employees to move the box to the next step.

4) Action Plan

Once the causes are prioritized, the next step is to search for solutions that are within reach of the organization. The tool adopted for this MASP step is 5W2H. The proposed solutions were of consensus of the group, after analysis of the several possibilities. Usually, at this stage, only the root cause of the problem is attacked, but in this case, an action plan has been prepared to address the possible reasons that emerged in the Ishikawa and Brainstorming Diagram, as they are easy to apply and inexpensive. Implementation, allowing improvements that will contribute to the proper functioning of the sector studied. Seven Action Plans (AP) were established.

AP_1, Action Plan 1, aims at organizing the area of the sanding and polishing sector by organizing the parts produced. The pieces were transported into containers from the company's outdated sector. Thus, the transportation previously performed several times manually during the production of a particular batch, started to be done once at the end of batch production, using the company's forklift.

After organizing the stock of forgings, we sought to present the 5S tool, according to AP_2, in order to mobilize the participants of the sector for the need to create a new culture of organization and cleaning, as a way to maintain a more working environment healthy and favorable for daily living. Thus, the last business day of March was intended to put into practice the concepts presented, mainly referring to the three initial ideas of the tool. The walls of the sector were cleaned, where many residues from the process were found. Wastebaskets and demarcations were also identified in the sector for organizing the boxes used to transport parts. It was collected the abrasive material used in the process, previously spread throughout the sector, defining a specific place for storage and day of the week to transport it to the collection place held in the company.

The elimination of decommissioned machines, in AP_3, aims at layout organization and workflow definition. These machines were two belt-type sanders, which were no longer being used in the process, but were in the midst of the workflow between production steps.

The balancing of the production line, according to AP_4, aims to determine the correct number of jobs, based on the historical average monthly demand of the previous year. Thus, with an average of 8800 pieces/month and a Takt time of 1.27 minutes for the required time, in order to produce the polished model and the sandblasted model, we obtained a number of jobs higher than two. Thus, the similar steps were joined, reducing the processing into three positions.

The maintenance of the supports carried out in the company's matrix sector, mentioned in AP_5, sought primarily to improve the quality of the finish by correcting imperfections arising from the forging process due to the wear of the dies. It also aimed to eliminate the movement caused by the search for adaptations, handcrafted, performed incorrectly by employees in the sanding and polishing sector. The new brackets made it easier to fit and secure the workpiece, so the workpiece did not move during pressure on the sandpaper, maintaining standard and uniform workpiece roughing.

The transportation of the pieces between the workstations was carried out in boxes accommodated on the sector floor. For his movement, the employee performed the ergonomically harmful action by raising it until the next step or needed the assistance of another employee, who must necessarily leave his job. The construction of side tables is in AP_6, seeks to bring the boxes closer to the employee, limiting the movement between picking and dropping the pieces. With transport cars, the aim was to facilitate transportation between workstations, in addition to eliminating ergonomic risks.

The tooling was organized through the construction of a metal rack with hooks with the demarcation of the pieces in AP_7. Thus, supports and tools used to exchange them became organized, visible, and identified. Therefore, all mechanisms used in the sector are exposed. Thus, we sought to eliminate the time spent identifying the necessary parts or moving to other sectors in the search for the required tool. The action plans had a cost of materials in the amount of approximately R$ 1,210.00 being realized at the company's premises, using available material and equipment.

5) Action

The next step in drawing up the action plan is practice. For this, the listed actions for the involvement and collaboration in the accomplishment of the defined steps occurred to the involved ones. It was necessary to conduct training and follow up of activities to contemplate the schedule and the success of the implementation.

6) Verification

The next step in implementing the MASP method is to verify the actions taken. This phase was carried out after the completion of the action plan actions. The check consists of checking if the root cause block was useful, or if the results were satisfactory. A new time survey of the production steps and an analysis of the scenario after completion of the listed actions was required.

7) Standardization

The standardization step happens after approval of the verification step. Thus, the standardization of the sanding and polishing process was performed through training of the employees involved, seeking to maintain the new flow, eliminating unnecessary movements, as well as the use and the correct organization of tools and templates of the sector.

IV. DISCUSSION OF RESULTS

After the process analysis and the application of the MASP steps, associated with the quality tools and applications of improvements in the sector organization, it was possible to reassess the production process, identifying advances in the sector quality and productivity. After balancing and organizing the workflow, as well as maintaining the templates used in the process, the layout was modified as shown in Figure 6.

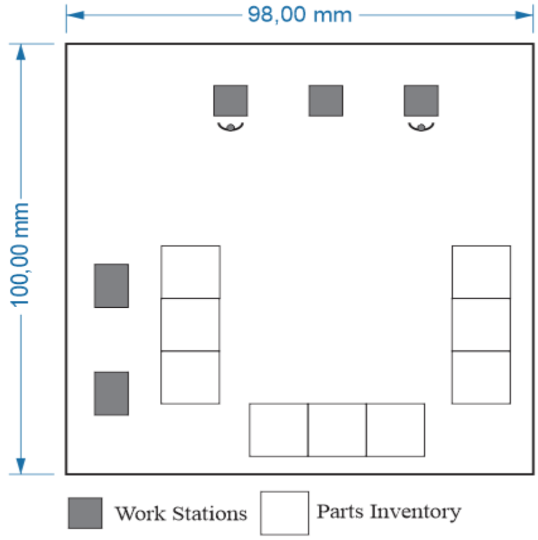

Fig. 6: Time analysis graph of polished model.

New sanding and polishing industry layout The new layout made it possible to reduce the displacement of employees in the sector, from the first 13.2 meters, as shown in Figure 7a, to 4.5 meters, as shown in Figure 7b, following proposed changes to the Action Plan.

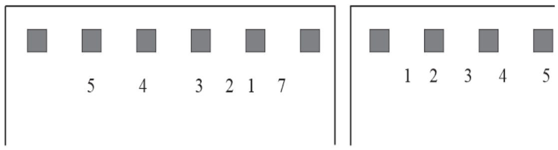

Fig. 7: Comparative layout displacement in the sanding and polishing sector.

The workstations went from four to three, thus reducing the process steps, from the initial eight to four in the polished model and from four to two in the sandblasted model.

There was a joining of operations, first, second, and fourth stages of the production process of the polished model. Stages were grouped according to the similarity of reducing the manual movement of the piece between workstations. There was a significant reduction in model processing time.

The reduction in movement is most evident with a flow map presentation of the polished and sandblasted models, after applying the proposed improvements in the action plan. In both cases, the parts need transport with the aid of boxes and carts to move between the machines, but follow a linear flow, eliminating the back and forth that previously occurred.

By changing the layout, eliminating machine downtime, thereby reducing unnecessary movement between process steps and maintaining the templates used in the sanding and polishing process, it was possible to minimize hammer processing time for both the polished model as for the sandblasted model. Figure 8, presents the comparison of the results obtained after applying the proposed actions in the action plan.

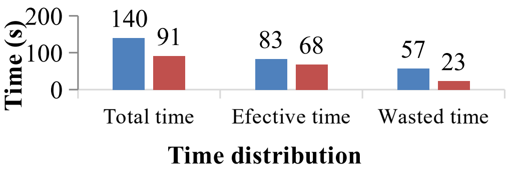

Fig. 8: Comparison of Polished Model results.

The blue columns indicate the time survey at the beginning of the study, used for the production of the polished model, which involved a more significant number of production steps and longer processing time.

After the changes, a new time survey was performed, shown in Figure 9, the orange columns of the chart.

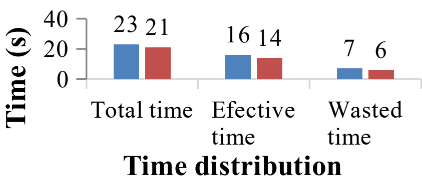

Fig. 9: Comparison of results for Sandblasted Model.

A significant reduction of 35% in the total processing time compared to the initial time was observed and a substantial decrease of 59% in the time wasted during processing, thus increasing the current process time. These results are due to the elimination of unnecessary movement between workstations, which led to excessive motions of manually picking and dropping the piece.

For the blasted model, there was also a reduction in the total processing time, increasing the effective time and reducing the wasted time, but with a smaller percentage. This is because the model involves fewer production steps and jobs, thus less manual movement of parts.

The reduction of the processing time, especially of the polished model, contributes to the decline of the production batches and, consequently, to the decrease in the finished products inventory in the company's shipping sector. This allowed more flexibility of the production line, being possible to work with batch sizes and varied models, facilitating the service to the retail market that unlike the wholesaler requires immediate deliveries, with smaller but diverse quantities.

The daily production capacity of polished model parts increased from 226 to 347 pieces, representing a 53.5% increase in the production capacity of this model. In a monthly analysis of 22 business days, this growth in production capacity represents just over 2660 pieces over the previous production. For the blasted model, the daily size went from only over 1370 pieces to about 1540, representing a 12.5% increase in production capacity, totaling just over 3700 pieces/month over the previous production. The maintenance of the jigs allowed for quality gains in the final product, reducing imperfections from the forging process, especially hammer ear deformations. This was because with the jig correction, the part became firm and fixed in the jig, maintaining standard format between the pieces.

Another significant result obtained from the actions implemented was the reduction of manual movement of forgings between the forging sector and the sanding and polishing sector. With the use of containers, transportation started to be performed by forklift only at the end of the production batch. In addition to contributing to the organization of the sector, since the pieces are no longer scattered on the floor of the sector, there was the elimination of ergonomic risks to employees who previously transported the parts, using handcarts as a means of transport, need to lift weight incorrectly.

Both changes in layout, as well as the storage and transportation of parts, contributed to the reduction of the occupied area, from initial 176 m² to 118 m². Thus, 58 m² of free space was provided for the introduction of the necessary equipment for the introduction of new products.

V. CONCLUSION

This paper proposed to identify opportunities for improvements in the organization and productivity in the sanding and polishing sector. By applying the problem analysis and problem-solving method in conjunction with quality tools such as the Ishikawa Diagram, 5W2H, and 5S, actions were taken to reduce problems identified jointly with the work team. These were simple and inexpensive actions applied in the sanding and polishing sector, such as the elimination of two decommissioned machines located next to the production line, the relocation of parts stock in containers and the identification and organization of tooling. These actions resulted in improvements in workflow organization and forged parts inventory, contributing to a reduction in floor space by 58 m², as well as reducing the possibility of ergonomic problems with incorrect lifting and weight transportation. Measures were also taken to reduce movement between work steps.

Reduction of the polished model's processing time from the initial time by 35% and a reduction of the wasted time by 59% was the result of layout reorganization and line balancing. As a result, higher productivity was achieved, reducing the inventory of finished products in the company's expedition, as well as allowing greater flexibility of the line.

The processing of the polished model initially used eight steps and then, after the changes, to five. The blasted model, on the other hand, went from four initial stages to two, after the application of the proposed actions. Higher productivity and increased quality of the final product, maintaining the symmetry of the parts produced occurred through the standardization of the templates used and the production steps.

The application of the concepts of the 5S tool contributed to the dissemination of a new culture, regarding organization and cleanliness, cultivating critical thinking about the actions taken in the daily life of the sector.

Finally, the MASP method, in combination with the implementation of analysis tools is most effective in finding problem solutions that affect the smooth running of processes linked to the pursuit of continuous improvement.

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REFERENCES

[1]. V.F. Campos, Controle da Qualidade Total (no estilo japonês). 8ª ed. Nova Lima: INDG Tecnologia e Serviço Ltda, 2004.

[2]. J.D. Souza, D.P.F. Hadlich, T.R. Maahs, Analysis of the replacement of conventional pallets of wood for cardboard pallets [in Portuguese]. Revista Liberato Vol. 17, Issue 28, (2016) pp 01-134. DOI: 10.31514/rliberato.2016v17n28.p177.

[3]. R.B. Ribeiro, J.D. Souza, A. Beluco, L.V. Biehl, J.L.B. Medeiros, F. Sporket, E.G. Rossini, F.A.D. Amaral, Application of the Single-Minute Exchange of Die system to the CNC sector of a shoe mold company Cogent Engineering, Vol 6, Issue 1 (2019) DOI: 10.1080/23311916.2019.1606376

[4]. C.E. Reis, G.L. Krumenauer, J.D. Souza, Planning and Production Control (PPC) on a footwear industry microenterprise: A case study [in Portuguese]. Espacios Vol. 37 nº 16 (2016) pp. 17

[5]. R.B. Ribeiro, J.D. Souza, A. Beluco, L.V. Biehl, J.L.B. Medeiros, F. Sporket, E. G., Rossini, F.A.D. Amaral, Application of the Single-Minute Exchange of Die system to the CNC sector of a shoe mold company Cogent Engineering, Vol 6, I 1 2019. DOI: 10.1080/23311916.2019.1606376

[6]. P. Trombeta, J.D. Souza, L.V. Biehl, J.L.B. Medeiros, Redução do tempo de troca de moldes com SMED - Single Minute Exchange of Die and Tool em uma indústria de calçados, Revista Iberoamericana de Ingeniería Mecánica, [In Press] 2019.

[7]. J.D. Conceição, J.D. Souza, Inventory management in the sector of injection moulding of a footwear company, Brazilian Journal of Operations & Production Management [In Press] 2019.

[8]. M.A.M. Oliveira, V.K. Santos, Redução do alto índice de absenteísmo utilizando o método MASP. SADSJ - South American Development Society jornal – Vol. 1, Nº. 2 - 2015. São Paulo, Brasil.

[9]. T.R.S. Silva, A.L.L. Souza, Gestão da qualidade como estratégia de competitividade: caso da baixada fluminense. 34º Encontro Nacional de Engenharia de Producao. Curitiba - PR. 10/2014.

[10]. J.Z.N, Oliveira, J.C. Toledo, Metodologia de análise e solução de problemas (MASP): estudo de caso em uma empresa de pequeno porte do setor eletroeletrônico; Anais do XV SIMPEP - Simpósio de Engenharia de Produção. São Paulo, 2008.

[11]. N.S. Romeu, G.P. Breyer, C.S. Caten, O uso do Seis Sigma para redução da variabilidade no processo e aumento da qualidade do produto no processo Forjaria. Revista Negócios e Talentos, 2013.

[12]. J.D. Souza, L. Schaeffer, Study for the manufacture of special cylinders for biomethane [in Portuguese]. Revista Liberato Vol. 11, Issue 15 (2010) pp. 33-38 DOI: 10.31514/rliberato.2010v11n15.p33.

[13]. D.F. Ramos, Desenvolvimento e aplicação de um método de redução de falhas em produtos de forjados. Graduação em Engenharia de Materiais pela Universidade Federal de Santa Catarina. Santa Catarina, 2011.

[14]. G.H.R. Serizawa, J. Gallego, Análise estrutural da aplicação do processo de jateamento com granalhas de aço (shot peening) em rotores hidroelétricos. XII Congresso Nacional de Estudantes de Engenharia Mecânica – 22-26/08/2005 - Ilha Solteira – SP.

[15]. M.C.S. Alves, M.T.T. Gonçalves, F.M.F. Varasquim, L.F.F. Santiago, L.D. Varanda, E.C. Bianchi, Análise da influência da velocidade de corte, da granulometria da lixa e da pressão específica de corte no processo de lixamento. V I Congresso Nacional de Engenharia Mecânica, Campina Grande, PB, 2010.

[16]. A. Sadovski, Teor crítico de cloretos para iniciação da corrosão do aço no betão. Influência do estado de superfície da armadura. Dissertações de

Mestrado em Engenharia Química e Biológica. ISEL Instituto Superior de Engenharia de Lisboa. Lisboa, Portugal, 2014.

[17]. C. Becker, A. Scholl, A survey on problems and methods in generalized assembly line balancing. European Journal of Operational Research, v. 168, 2006.

[18]. N. Boysen, M. Fliedner, A.A. Scholl, Classification of assembly line balancing problems. European Jornal of Operational Research, v. 183, 2007.

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