EUROPEAN ACADEMIC RESEARCH
Vol. VII, Issue 6/ September 2019

Impact Factor: 3.4546 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

# The Benefits of a Paperless Environment in an Automotive Welding Line

BRUNA JULIANE CARLOS
Faculdades Integradas Einstein de Limeira (FIEL)
CAROLINE FERNANDA MARQUES PEREIRA
Faculdades Integradas Einstein de Limeira (FIEL)
VANESSA MORAES ROCHA DE MUNNO
Faculdades Integradas Einstein de Limeira (FIEL)
IVAN CORRER
Faculdades Integradas Einstein de Limeira (FIEL)

**Abstract**

*Increasingly, companies are seeking to develop operational procedures to ensure product traceability and reliability due to the standards and regulations required by their customers. In many companies, these procedures are not well managed and controlled, directly interfering with the reliability of the information flow between business sectors (planning, design, purchasing and manufacturing), leading to duplicate document issues, outdated documents and high volume of paper in process. One of the existing approaches that help standardize and integrate operating procedures across the enterprise is the application of the Virtual Manufacturing concept that integrates product planning, design, and manufacturing activities. With the integration of the Virtual Manufacturing approach, paperless Manufacturing can be implemented, which enables direct and immediate communication between sectors, looking to increase the reliability of the information flow between the company sectors. Therefore, this paper aims to present a proposal for the application of the concept of paperless manufacturing in a welding line of automotive exhaust system, aiming to identify and quantify the benefits generated with the proposed environment. The methodology used in the development of this research was action research. The results obtained with the implementation of the improvement proposal developed, will*

*allow a reduction of 28% in the filling time of documents in the welding line, as well as a reduction of the company's annual consumption of paper by 5%, in addition to other benefits related to improving internal communication, document control, the work environment and routine activities.*

**Keywords**: Virtual Manufacturing; Paperless; Operational procedures.

## 1. INTRODUCTION

The world market is increasingly competitive, encouraging organizations to increase their productivity and quality, reduce production time and meet product demand, with shorter lead times, and with more complex and increasingly demanding products product and process traceability to ensure reliability. (CONCEIÇÃO et al., 2009).

To ensure product and process traceability, companies develop and regulate manufacturing processes to internal and external standards. These documents are defined as operating procedures, and are important in the production system of any company, as it favors the standardization of processes and assist in preventing failures and waste in the production system, as they facilitate the understanding of activities. (FREITAS, GUARECHI, 2012).

Typically, these procedures need to be updated periodically whenever changes occur in the product process or design, thereby generating a high volume of paper records. This volume of information, if not well managed and controlled, can interfere with the reliability of the information flow between business sectors (planning, design, purchasing and manufacturing) due to issues of document duplication, outdated documents, disorganization of manuals, among others. (JERICÓ, PERES and KURCGANT, 2008; MELLO, 2012; JONHSON, 2012).

One of the existing approaches that help standardize and integrate operating procedures across the enterprise is Virtual Manufacturing. This enables the connection between all sectors involved in the activity of planning, designing, updating and

documenting all information and process specifications and product manufacturing on a computational basis. (BANERJEE and ZETU, 2001; CONCEIÇÃO et al., 2009; GROOVER, 2011).

With the integration of the Virtual Manufacturing approach, paperless Manufacturing can be implemented, which enables direct and immediate communication between sectors, reducing the response time between those responsible for the areas involved and the execution of planning activities, product development, testing, and manufacturing, as well as increasing the reliability of information flow across enterprise sectors. (DJASSEMI, SENA, 2006; BRILINGER and PACHER, 2013; SKA, 2016).

Therefore, this paper aims to present a proposal to apply the concept of paperless manufacturing in a welding line of automotive components, aiming to identify and quantify the benefits generated with the proposed environment.

## 2. REFERENCE

### 2.1. Operational procedures

Operating procedures are important documents in the production system of any company, as it favors the standardization of processes and assist in the prevention of failures and waste in the production system, as they facilitate the understanding of activities. (FREITAS, GUARECHI, 2012).

Thus, standardization contributes to the stability of processes, reducing their variations, and it is important to emphasize that standards should be best practices and changes for improvements should be recorded and documented. (ALBERTIN, 2016).

The Standard Operating Procedure is a document used to define operating standards that guide employees about their responsibilities at each stage of a process, describing characteristics and detailing the corresponding activities. (ZANETTE, 2010).

According to Rocha (2012), the structure of a Standard Operating Procedure should contain definition, purpose, materials used, description of technical operations, recommendations, determination of responsibilities and reference.

Jericó, Peres and Kurcgant (2008), Mello (2012) and Jonhson (2012) emphasize the importance of maintaining the standardization

of processes, describing each activity clearly and precisely. However, they have some limitations that can be found in the daily lives of companies, such as procedural documents with outdated techniques, difficulty in retrieving and disorganizing manuals.

Jericó, Peres and Kurcgant (2008) state that Procedures should be kept in manuals and need to be updated periodically following specific formatting criteria, which generates high volume records in papers used as evidence of processes.

Vieira Filho (2010) and Silva, Duarte and Oliveira (2004) state that documents should be made available in print, as they are one of the means of evidence in audits and aimed at promoting the perspective of processes, products and services.

According to Djassemi and Sena (2006) the procedures available and stored in paper, whose purpose is to release and track the productive processes in the organizations, may impair the flexibility of the production system impacting the reliability and storage of data, depending on required amount of this type of material in the process. Brilinger and Pacher (2013) say that the procedures can be available electronically, which contributes to their updating and access.

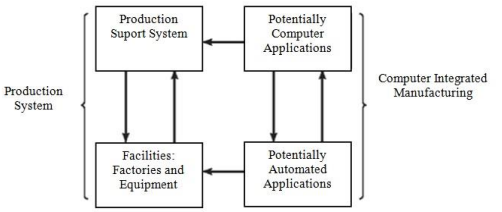
One of the proposals that assists in the standardization of operating procedures, from product conception to the production process is Virtual Manufacturing. (CONCEIÇÃO et al., 2009).

## 2.2. Virtual Manufacturing

Virtual Manufacturing began to be used in the 1990s to create a strategy for integrating various stages of manufacturing into the creation of a new product, following the concept of designing, planning and documenting all information by computer. (BANERJEE and ZETU, 2001; BROWN, 2013).

Groover (2011) showed that the implementation of computer integrated manufacturing for production systems assists in execution of several tasks, such as project development, product manufacturing, sector management, final inspection, among others, as shown in Figure 1.

**Figure 1- Computer Integrated Manufacturing Opportunities**




Source: Adapted from Groover (2011)

In order to reduce the amount of manual and bureaucratic effort employed in the design stages, Computer Integrated Manufacturing (CIM) highlights the use of software such as Computer-aided design (CAD) to support manufacturing and its phases, helping projects to be done directly on the machine reducing and / or eliminating paper use. Thus, companies aim to restrict production costs, improve productivity, provide employee safety, eliminate or ban routine activities, and increase product / process quality. (GROOVER, 2011).
With the integration of information, the use of paper documents is increasingly being replaced by electronic records. The concept of paperless manufacturing allows direct and immediate communication between sectors, reducing the response time between those responsible for the areas involved and the execution of activities in product planning, development, testing and manufacturing. (SKA, 2016).

### 2.3. Paperless

According to Granieri (2016) the paperless concept, ie the elimination or reduction of paper is a policy adopted in organizations that through the aid of technology, such as software, applications or online resources allow the management and storage documents for the purpose of optimize processes.

Arney, Jone and Wolf (2009) state that in addition to the advancement in technology providing new alternatives for reducing paper use, it also results in cost savings. However, this concept is still resisted by some companies, due to difficult of changes in management and culture, as well as the large consumption of paper resulting from the increased flow of information throughout the value chain.

With new technology options and the ever-diminishing requirement for physical document printing, the marketplace already offers affordable answers to organizations wishing to deploy this concept. (GRANIERI, 2016).

Transitioning to the paperless environment requires the company to draw up a plan to evaluate and make viable investments such as storage software with significant capacity, such as OCR (Optical Character Recognition), which converts scanned records into accessible text. computer, and even applications and devices for document maintenance and drafting, and even investments in staff training related to the program adopted and also investment in digital security. (CHUCK, 2014).

Johnson (2012) and Granieri (2016) demonstrate some goals that can be considered for the strategy of choosing a system that supports the paperless environment, such as reduced operating times, document history traceability, and improved collection and generating control reports, improving process context and promoting a sustainable attitude.

## 3. RESEARCH DEVELOPMENT METHODOLOGY

This research has a quantitative and qualitative approach and explanatory character and was applied in a multinational auto parts company, manufacturer of car exhaust system, located in the interior of the state of São Paulo. The survey was conducted from April 2018 to April 2019.

For this study, we used action research procedure that as defined by Thiollent (1985) and Gil (2010) is a participatory or cooperative experimental verification methodology that provides the development and change of the studied environment / object.

Mello et al. (2012), Coughlan and Coghlan (2002) and Thiollent (2007) establish the following steps for the construction of an action research: Exploratory phase; Formulation of the problem; Hypothesis construction; Hold seminar; Select samples; Collect data; Analyze data; Elaborate action plan; Implement and evaluate the results.

### 3.1. Situation found

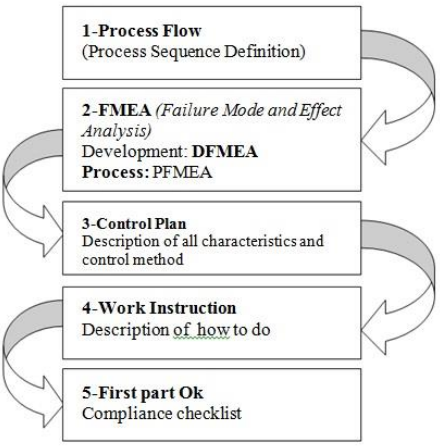
The company studied has internal policies, certification body systems and customer-specific requirements that require a large number of documentation such as procedures, instructions and records, and currently all such documentation is printed.

This condition requires efficiency in control, monitoring and revisions as design, development and production process changes.

Within the organization there is a mix of over 1000 products that are produced daily, from capacitive lines, which are the assembly operations of the subsets that supply the welding lines of finished products.

In the company's Quality Management System (QMS) for each product registration code it is necessary to create at least five documents according to Figure 2:

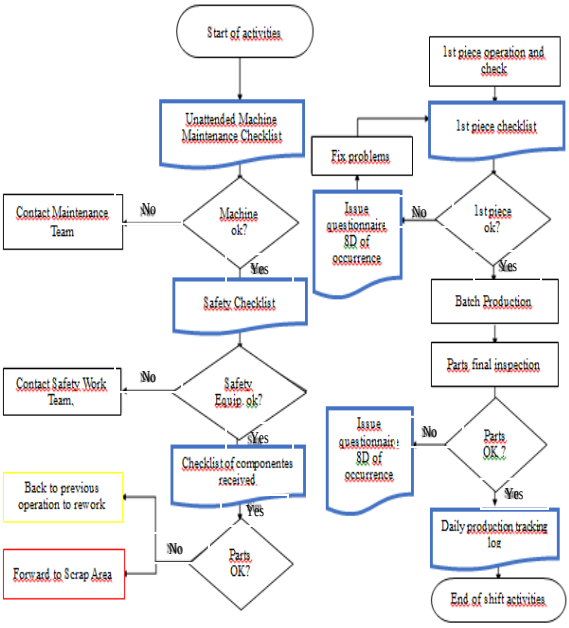
**Figure 2- QMS Documentation Sequency**




Source: The authors, 2019

In addition to the QMS documents are production line records that are completed by the leaders of each line and the operators, represented in Figure 3 in blue boxes.

**Figure 3- Production line record filling flowchart**




Source: The authors, 2019

Chart 1 represents the average time of manual completion of the necessary daily documentation, totaling 1h08m29s.

**Chart 1- Fill time of printed documents**

| Documents | Frequency | 1st shitf | 2nd shitf | 3rd shitf |
|---|---|---|---|---|
| Machine Maintenance Checklist | Daily | 00:05:18 | 00:05:46 | 00:05:54 |
| Safety Checklist | Daily | 00:05:35 | 00:04:47 | 00:03:06 |
| Parts Received Checklist | Daily | 00:03:25 | 00:04:42 | 00:03:14 |
| Check list 1º peça ok | Daily | 00:10:07 | 00:10:34 | 00:10:59 |
| 8D Form | When necessary | 00:15:00 | 00:15:00 | 00:15:00 |
| Production Tracking Record | Daily | 00:28:41 | 00:29:32 | 00:28:48 |
| **Average Time** | | 01:08:06 | 1:10:21 | 1:07:01 |
| | | **01:08:29** | | |

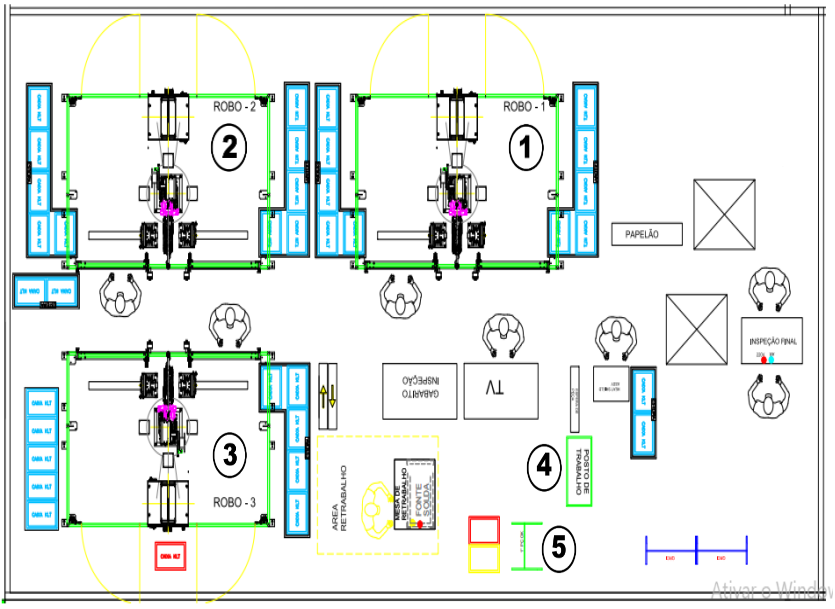
Source: The authors, 2019

Due to the necessary procedures and the methodology used by the company to generate, document and control these records, problems and limitations regarding data reliability, interrelationship between documents, communication between sectors, storage control, recovery were identified too much time to fill in the records.

Some of the problems and limitations generated are related to the detection of nonconformities in audits related to the lack of documentation and lack of interrelationship between documents, outdated work instructions generating non-specification items, lack of clarity of standard information generating non-conforming parts to customers.

From this scenario, one welding lines was defined for the implementation of the paperless concept, which presented a high rate of recurring product and process quality problems. Figure 4 shows the layout of the manufacturing cell studied.

**Figure 4- Current welding line layout**




Source: The authors, 2019

As can be seen in positions 1, 2 and 3 are located next to the welding robots the safety checklists, unattended maintenance and check of components received from the previous operation. Work instructions and daily production monitoring forms are stored at the workstation indicated in position 4. The checklist of the "1st piece OK" is made available at the workstation listed in position 5.

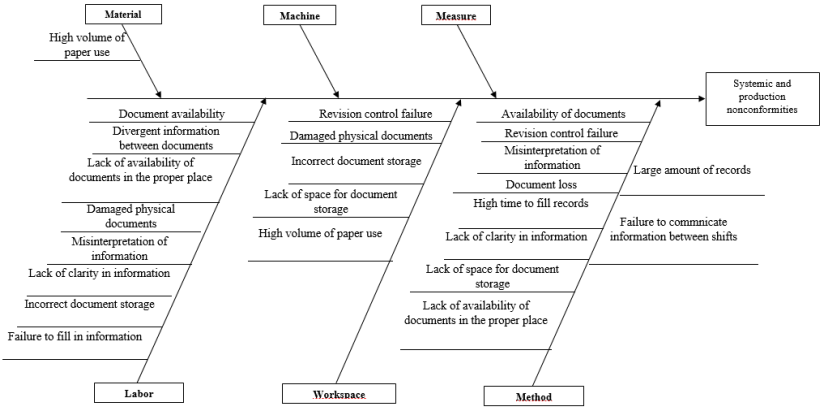
The company has 95 productive cells and for the updating of the factory documents, the annual paper consumption (A4 and A3) is over one million sheets, representing an annual cost of R$ 47,350.00 (reais). Of this amount, 5% corresponds to the consumption of the chosen line.

### 3.2. Proposed Situation: Paperless Environment

Analyzing the scenario presented, it was proposed to the defined welding line a totally paperless environment, focusing on reducing the daily filling time of documents, increasing data reliability and information transfer between shifts, preventing nonconformities and eliminating the consumption of paper.

For this, a multidisciplinary team was established and composed by the production leader, manufacturing specialist, IT assistant, warehouse supervisor and two of the authors of the present work. The purpose of this group was to discuss probable causes of systemic and production problems involving documentation. In this case, an Ishikawa diagram was prepared to identify possible causes related to systemic and production nonconformities (Figure 5).

**Figure 5 – Ishikawa Diagram: Causes related to systemic and production nonconformities**




Source: The authors, 2019

As can be seen in Figure 5, it was identified that the major causes related to systemic and production nonconformities are linked to the

Method, characterized by failure of revision control, divergent information between document correlation, loss of physical documents, long time for completing records, lack of clarity in the information described, lack of physical space for storing documents, lack of availability of documents from the appropriate post of use.

After analysis of the presented data, the development of a paperless concept application proposal was started in a welding line, from the collection of the filling time of the necessary documentation with the aid of a tablet. Chart 2 presents the time to fill in the electronic documents.

**Chart 2- Electronic document fill time**

| Documents | Frequency | 1st shitf | 2nd shitf | 3rd shitf |
|---|---|---|---|---|
| Machine Maintenance Checklist | Daily | 00:03:46 | 00:03:28 | 00:05:54 |
| Safety Checklist | Daily | 00:02:23 | 00:02:55 | 00:03:15 |
| Parts Received Checklist | Daily | 00:03:17 | 00:03:19 | 00:03:16 |
| Check list 1º peça ok | Daily | 00:07:02 | 00:07:57 | 00:07:47 |
| 8D Form | When necessary | 00:15:00 | 00:15:00 | 00:15:00 |
| Production Tracking Record | Daily | 00:15:41 | 00:16:32 | 00:15:26 |
| **Average Time** | | 00:47:09 | 0:49:11 | 0:50:38 |
| | | **00:48:59** | | |

Source: The authors, 2019

As can be observed, the documentation filling time using the paperless concept was 48min59s compared to 1h08min29sec using the traditional procedure (Table 1) which represents a 28% reduction in the filling time from the traditional concept to the paperless concept.

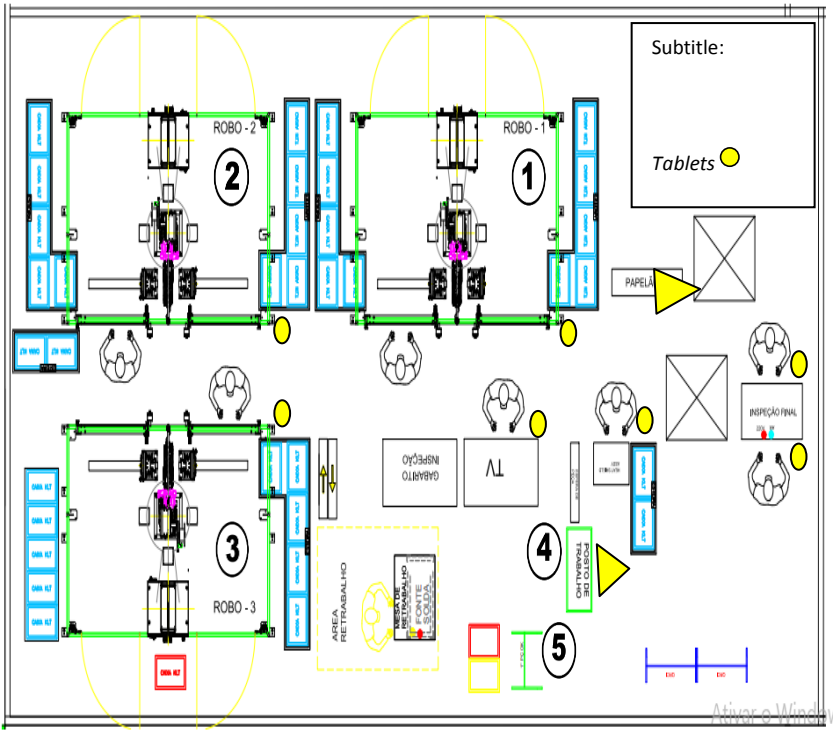
Regarding the reliability of the data, it was proposed to install a touchscreen on the welding line so that all the information needed for production, such as work instructions, control plan, visual standards and other data indicative of results and customer information made available in a single medium.

This centralization of online information would make it possible to standardize access to the same level of information among employees, generating more efficient communication and homogeneity, thus contributing to the prevention of repeat errors, quality improvement and safeguarding of documents.

Figure 6 presents the proposed layout for the application of the paperless concept, and its components, in the welding line, and it can be observed that tablets must be made available to each operator to fill in the required documents online and a touchscreen must be

installed at the workplace. As a result all printed documents would be removed from the layout.

**Figure 6- Proposed layout of welding line in the concept Paperless**




Source: The authors, 2019

To assist in the process of creation, registration and control of documents, software will be used to adapt the formats of records in order to provide convenience in filling, assist in the creation, correlation and updating of process and product documents.

With the application of the paperless concept in the chosen line, the cost reduction related to the annual consumption of paper sheets of the factory would be reduced by 5%, from a total cost of R $ 47,350, which meets the concepts related to sustainability.

In addition to the quantitative benefits presented, the implementation of the paperless concept would make it possible to enhance qualitative benefits, as can be seen in Chart 3.

**Chart 3 – Environmental Paperless benefits and improvements**

| Way Of | Benefits and Improvements |
|---|---|
| **Communication between shifts and sectors** | -Same level of information between managers, leaders and operators trough a single communication vehicle;<br>-Fast information between shifts and sectors;<br>-Data Reliability<br>-Updated information in real time. |
| **Documents control** | -Easy document creation, updates and monitoring;<br>-Document safeguard;<br>-Easy document recovery. |
| **Workplace** | - Productive cell cleaning and organization by reducing or eliminating paper;<br>- Gain physical space;<br>- Sustainability. |
| **Daily Activities** | -Provide convenience in filing records;<br>-Clarity in data interpretation and visual patterns. |
| **Costumer** | -Product compliance assurance due to simpli-fied information. |

Source: The authors, 2019

## 4. FINAL CONSIDERATIONS

The present research considered to present a proposal application of concept of paperless manufacture in a welding line of automotive components, aiming to identify and quantify the benefits generated with the proposed environment.

Based on the research conducted, concepts presented, as well as study and analysis of the reality presented of the studied company, quantitative and qualitative benefits to be obtained with the implementation of the demonstrated proposal were quantified and identified, such as:

- The fill time of the welding line records would be reduced by 28% with the proposed paperless concept through the use of tablets, as shown in Chart 2;
- The reduction in annual consumption of paper sheets used in the process would be 5% of the total paper consumption of the factory as described in the results of the proposed situation;

- Other benefits would be possible as a result of improved communication, document control, work environment, daily activities, and customer relationships, as shown in Chart 3.

The benefits presented are expected to directly and positively interfere with increased productivity by reducing setup time and reducing nonconformities due to the application of the paperless concept.

The present proposal is being implemented in the studied company, and new results of the application will be published in congresses and magazines.

## REFERENCES

1. ALBERTIN, M. R. **Management of processes and techniques of lean production.** Curitiba: InterSabares, 2016.
2. ARNEY, J.; JONES, I.; WOLF, A. Going green: paperless technology and feedback from the classroom. **Journal of Sustainability and Green Business**, 2009.
3. BANERJEE, P.; ZETU, D. **Virtual manufacturing**. New York: John Wiley & Sons, 2001. 320p
4. BRILINGER, C. O .; PACHER, J. C. **Standardization of the Billing Process in a Private Clinic**. Federal Institute of Santa Catarina, 2013. 77 f.
5. BROWN, S. et al. Administration of the production and operations. **A strategic focus on manufacturing and services**. 2.ed. Rio de Janeiro: Elsevier , 2005, p. 333 e 343.
6. CONCEIÇÃO, S. V. et al. Development and implementation of a methodology for rapid tool change in contract manufacturing environments. **Management and Production Magazine**, São Carlos. v. 16, n.3, p.357-369, jul-set. 2009.
7. COUGHLAN, P., COGHLAN, D. Action research for operations management. **International Journal of Operations & Production Management**, v. 22, n. 2, p. 220-240, 2002.

8. CHUCK, C. Why You Should Be Running a Paperless Company. USA: **Forbes**, 2014. Available in:
9. https://www.forbes.com/sites/chuckcohn/2014/09/03/why-you-should-be-running-a-paperless-company/#22603f1c6f83. Access in: 20. mar.2019.
10. DJASSEMI, M.; SENA, J. The Paperless Factory: A Review of Issues and Technologies. **International Journal of Computer Science and Network Security**, v.6, n. 12, p. 185-191, dez. 2006.
11. FREITAS, S. L.; GUARECHI, H. M. **Standardization of Processes in the Public Service through the Use of Manuals:** UTFPR Event Manual Feasibility – Francisco Beltrão's Fields. Systemic Organization Magazine. Curitiba, v.2, n.1, 2012.
12. GIL, Antonio Carlos. **How to design research projects.** 5.ed. São Paulo: Atlas, 2010.
13. GROOVER, P.M. **Industrial Automation and Manufacturing Systems**. 3.ed. São Paulo: Pearson Prentice Hall, 2011. p. 7 a 9 e 18.
14. GRANIERI, R. **New opportunities for paperless companies.** Cio From IDG, 2016. Available in: https://cio.com.br/novas-oportunidades-para-empresas-paperless/. Access in: 25.mar.2019.
15. JERICÓ, M. C., PERES, A. M., & KURCGANT, P. Nursing service organizational structure: reflections on the influence of power and organizational culture. **Journal of the University of São Paulo School of Nursing**, 2008, p 569–577.
16. JOHNSON, W. **The Paperless Factory: using technology to improve efficiency in high mix and CTO production** - Spectrum Assembly, Inc., Carlsbad, California, USA – octuber 2012.
17. MELLO, C.H.P., TURRIONI, J.B., XAVIER, A.F., CAMPOS, D.F. **Action Research in Production Engineering:** structuring proposal for its conduction. Production, São Paulo, v. 22, n. 1, p. 1-13, 2012.

18. ROCHA, F. C. V. **Nursing Standard Operating Procedures Manual of Getúlio Vargas Hospital.** 1 ed. Terseina: HGV, 2012. 149p.
19. SILVA, W. L. V.; DUARTE, F. M.; OLIVEIRA, J. N. Standardization: an important factor for method engineering. **Qualit@s - Web magazine**, v. 3, nº 1, p. 01-15, 2004.
20. SKA. **Engineering Automation Technology.** 2016. Available in:
21. http://www.ska.com.br/ska/busca?keys=Tecnologia%20para%20automa%C3%A7%C3%A3o%20de%20engenharias. Access in: 20 mar.2019.
22. THIOLLENT M. **Action Research Methodology**. São Paulo: Cortez, 1985.
23. THIOLLENT, M. **Action Research Methodology**. São Paulo: Cortez, 15ª Ed., 2007.
24. VIEIRA FILHO, G. **Total quality management:** practical approach. 3 ed. Campinas, São Paulo: Alinea, 2010.
25. ZANETTE, F. **Standard Operating Procedure in Hotel Governance and Sustainability.** (Dissertação). 2010. Universidade de Caxias do Sul. Rio Grande do Sul. 110p.