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ANALYSIS OF THE ACTIVITY AS A SUBSIDY FOR THE IMPROVEMENT OF WORK SYSTEMS: A CASE STUDY IN THE WAREHOUSE OF A PRINTING INDUSTRY

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Abstract

This article aimed to analyze the warehouse activities of a printing industry, identifying the determinants that generate malfunctions, impacting the warehouse workers' activity and production, and proposing improvements. The methodology used was based on Ergonomic Work Analysis. To analyze the activity, interactional methods and techniques (conversational action, listening to spontaneous and provoked verbalizations), observational methods (global and systematic observations aided by photographic records) and documentary analysis were used. The analysis of the warehouse sector activities identified malfunctions related to personnel (lack of training and prescriptions for performing tasks), work methods (absence of related prescriptions and auditing of processes) and the layout of the sector (lack of a specific place for storage, due to excessive purchase of material, which implies problems related to unnecessary movement of material, storage in separate places and unidentified materials), rework, among others. The recommendations are mainly aimed at staff training, creating technical support, developing a problem-solving methodology for the DANFE release routine, and using the software to requisition materials. The work brought about a reflection on the importance of analyzing the activity of warehouse operators and it was possible to perceive that the extra time spent performing their tasks caused by malfunctions leads to workflow problems, generating an overload of work at certain times of the month, which can interfere with the quality and productivity of the printing company's production activities and product delivery times.

Keywords: Ergonomics; Activity Analysis; Printing Industry; Warehouse.

1. INTRODUCTION

The Printing Industry is a dynamic segment that involves activities related to the reproduction of information in texts or images, including creation, pre-press and finishing or post-printing (RIGHI; RODRIGUES; SCHMIDT, 2009). The Printing Sector, in Brazil, is made up of 20,295 companies, being responsible for the generation of 277 thousand direct jobs. The sector is mainly made up of micro and small companies. An important characteristic of this

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sector is the low barriers to entry into the market, enabling and facilitating the emergence of companies through small entrepreneurs, with the regional market being predominant (ABIGRAF, 2009). In the northeast region, 12.5% of the productive units are concentrated (ABIGRAF, 2009).

The warehouse is a support sector that does not aim at profit, however, this sector is essential for the proper functioning of the company. Inadequate functioning impacts production, which can cause losses in productivity and product quality, delays and missed delivery times, thus impacting the company's results (BORGES; FIELDS; BORGES, 2010). Souza et. al. (2015) points out that workers in this sector complain of musculoskeletal pain, especially in the lumbar region, which may be related to frequent load handling and sitting posture maintained for a long time, justifying the analysis of the activities developed by these operators, to recompose the way they organize themselves and to understand the way they manage the processes.

Ergonomics, according to the IEA (2000), is the "*scientific discipline that deals with the understanding of the interactions between human beings and other elements of a system, and the profession that applies theories, principles, data and methods, to projects that aim to optimize human well-being and the overall performance of systems, contributing to the planning, design and evaluation of tasks, jobs, products, environments and systems to make them compatible with people's needs, abilities and limitations*". According to Vidal (2001), the effectiveness of ergonomics consists in the fact that it causes positive transformations in the work environment in its broad sense, which includes technology and organization as its components.

The field of organizational ergonomics, where this article is inserted, is built from a realization that all work activity occurs within organizations, which comprise three levels: operational, tactical and strategic. To ensure its functioning, it articulates, at all times, its basic processes that constitute its operational levels, with decision-making, which is materialized at the strategic levels. This articulation is made possible by regulation and control structures that constitute its tactical levels, which establish the interface between production and strategy, a structure that enables the passage of top-down decisions, as well as bottom-up interactions (ROCHA, 2017). Through the modeling of real work, resulting from the analysis of the activity, it will be possible to study the chains of informal regulation, formalizing and even standardizing some of these procedures, especially in an effort to codify informal practices, however, most of the time, essential for the good progress of production.

In view of this, this article aims to analyze the activity carried out by the warehouse operators of a printing company, characterizing the technical, organizational and human determinants that generate malfunctions that impact the activity of the warehouses and, consequently, the company's production, and propose solutions for global improvement of the system.

2. METHODOLOGY

The methodology used in this research was based on the method of Ergonomic Analysis of Work (AET) (WISNER, 1987, 1994; GUÉRIN et al, 2001; VIDAL, 2003). The ELA comprises a set of global, systematic and intercomplementary analyses that allow the operational modeling of the work situation, that is, the modeling of the real activity in its context, considering the technical, human, environmental and social factors (VIDAL, 2003), comprising the following stages: instruction/construction of demands, modeling of the activity and design and construction of solutions adapted to the company in focus.

The demand for this work is characterized as provoked (SALDANHA et al, 2012) and was sustained by the process of social construction (VIDAL, 2003; SALDANHA, 2004). In the analysis of the activity, interactional methods and techniques were used (conversational action, listening to spontaneous and provoked verbalizations), through the application of dynamic scripts and socio-economic questionnaire, observational methods and techniques (global and systematic observations aided by photographic records) and documentary analysis.

3. FINDINGS

The company studied is a medium-sized family printing company located in the central region of a capital city in the Northeast region of Brazil. It has 30 (thirty) years in the market and 190 (one hundred and ninety) employees, working in the promotional, editorial and, eventually, industrial segments. Its main customers are located in the states of Paraíba, Ceará, Rio Grande do Norte, Pernambuco, Alagoas, Sergipe and Bahia, all in the Northeast region.

The company is divided into the following sectors: prepress, printing, finishing, warehouse, logistics and administration. The first three are part of the productive sector, while the subsequent three refer to the staff or support area. Table 1 presents a summary of the main activities of each sector and Figure 1, the layout of the company.

Table 1: Sectors of the printing plant

Area	Sector	Employees	Main Attributions

Production	Prepress	27	Receipt and treatment of the digital service; Embossing of printing plates.
	Impression	24	Printing of production orders; Application of varnish and lamination; Laboratory analysis.
	Finishing	101	Application of cutting, creasing and folding on the printed sheet; Application of square spine or staple in notebooks; Manual activities; Final cutting and packing.
Staff	Warehouse	04	Receipt of materials; Storage; Internal distribution of materials; Inventory management.
	Logistics	13	Issuance of DANFE (Electronic Invoice Auxiliary Document) packaging, transportation and service delivery.
	Administration	21	CTP (Sorting and Planning Center), Commercial and Purchasing, Occupational Health and Safety, Building Maintenance and Cafeteria; Human resources Marketing, Finance, Tax, Treasury and Board.

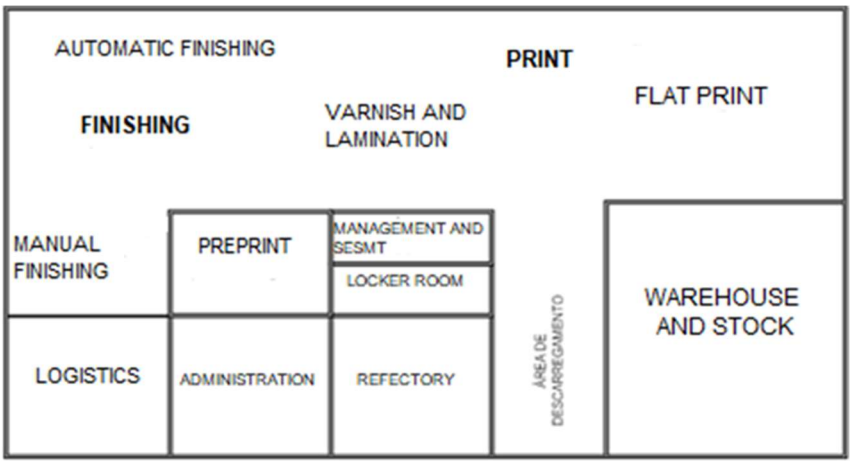

Figure 1: Layout of the Printing House

The Warehouse Sector, object of this study, is composed of four employees, 3 of whom are warehousemen aged between 22 and 25 years, and one supervisor who is 42 years old. The length of experience in the activity varies from 6 months to 8 years, and two of the warehousemen (A1 and A2) had previous experience in other companies. The general profile of the employees in the Warehouse sector is described in Table 2.

Table 2: Profile of Warehouse employees

Features	Storekeeper 1	Storekeeper 2	Storekeeper 3	Supervisor
Age	22	25	23	42
Education Degree	High School	High School	Upper(tempo)	Upper(tempo)
Time in the profession	1 year and 8 months	2 years and 4 months	6 months	8 years
Time in the Company	1 year and 8 months	2 years and 8 months	3 months	3 months
Previous roles in the Company	No	Finishing Assistant	No	No

Previous Experience	No	Production Assistant Finishing Assistant	Storekeeper Professor	Stockist, Warehouse Inventory Supervisor

The opening hours of the production sector and the warehouse are from 6 am to 10 pm. The working hours of the warehouse employees are distributed as follows: warehouse 1, from 6 am to 2 pm; storekeeper 2 from 2 pm to 10 pm; Storekeeper 3 and the Supervisor work during business hours, which go from 8 am to 6 pm, as shown in Table 3.

Table 3: Distribution of working hours of warehouse employees

Functionary	**Working hours (hours)**																
	6	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Storekeeper 1																	
Storekeeper 2																	
Storekeeper 3																	
Supervisor																	

It is observed that in most of the workday (8:00 am to 6:00 pm), which corresponds to business hours, the sector works with three employees, two warehousemen. The exception,

It corresponds to the beginning and end times of the workday, when only one storekeeper is available, however, at these times the workflow is smaller.

All warehousemen take turns in the development of the four groups of tasks that make up the sector's prescription: receiving, storing and distributing materials, and inventory management, as shown in Figure 2 on the Task Flow of the Warehouse Sector. The Supervisor, in turn, is responsible for managing the sector, ensuring that activities are developed as expected.

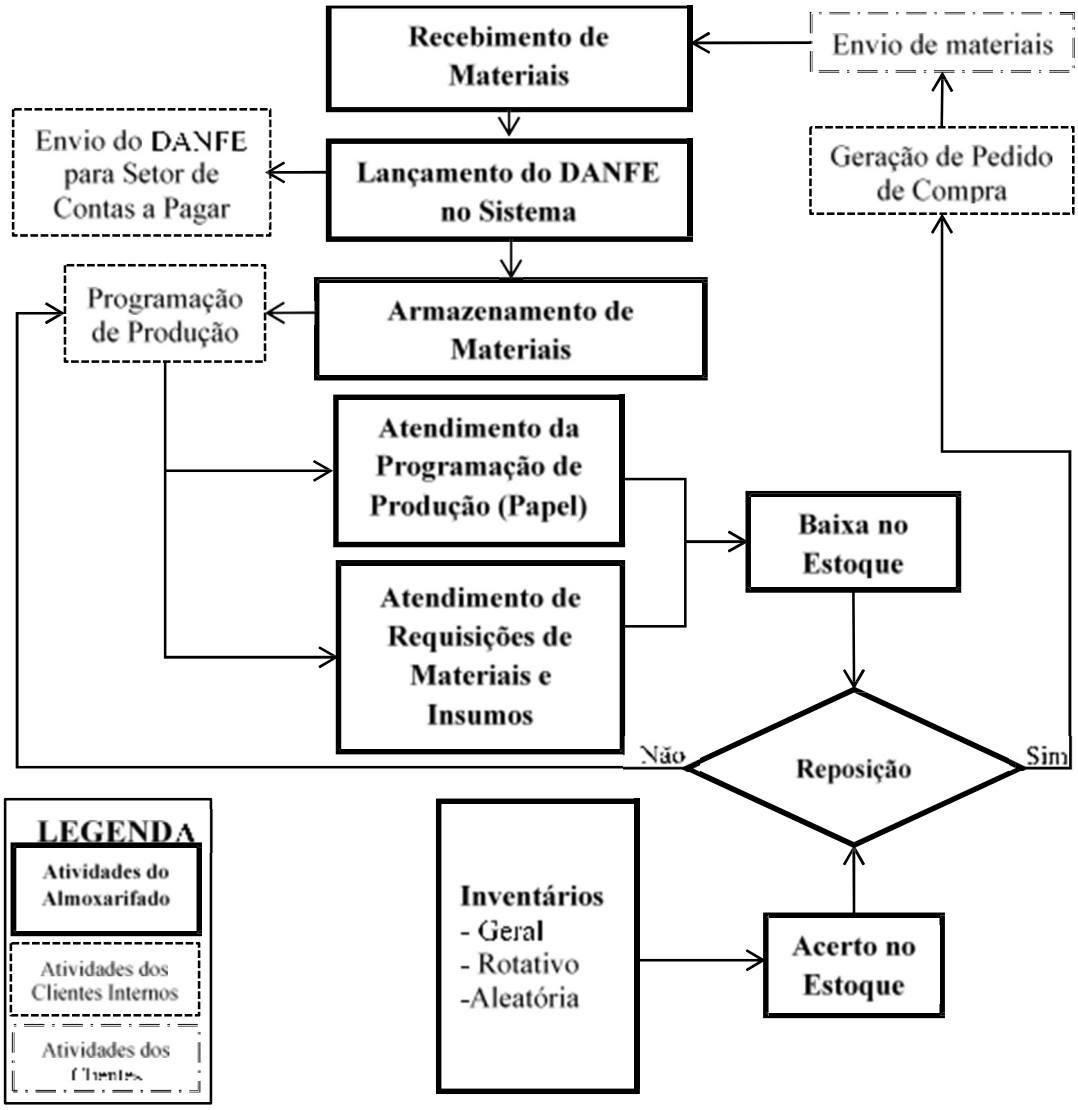

Figure 2: Prescribed Material Flow

The "receipt of materials" consists of receiving the materials and checking if the items and quantities received converge with the purchase order made by the purchasing sector. After receipt, the DANFE is entered in the company's information system so that the stock can be updated. DANFE is the acronym for Electronic Invoice Auxiliary Document, which is a graphical representation of the NF-e (Electronic Invoice). After the release of the DANFEs, they are forwarded to the accounts payable sector. Finally, the material is identified and stored in the specified locations.

The materials are stored in the materials shed, where the shelves are arranged so that all items of the same product family are grouped together, in order to monitor the consumption of the purchase lots. The areas were established based on the

lot sizes determined by the Purchasing and Warehouse Sector. In addition, in the stock of papers, there is a subdivision of the space to store the papers by type, format and weight.

The distribution of materials is initiated from the Production Schedule. Each production sector (pre-press, printing and finishing) sends requisitions of materials and inputs necessary for production and the warehousemen separate and deliver the requested items and update the stock in the system.

Inventory management is carried out on the basis of the posting and write-offs of materials. From the stock update through the write-offs of materials, it is checked if there is a need for replacement. If there is a need for replacement, the Warehouse communicates the Purchasing Sector, which in turn generates a purchase order, which authorizes the purchase of materials, which in turn enters the receipt schedule. In addition, when the commercialization of a graphic service is being negotiated, the Company's Sales sector verifies with the Warehouse, if the quantity available in the stock of materials is sufficient to fulfill the order. If the stock of materials does not meet the customer's service requirement, a purchase order is generated.

Another task performed by Storekeepers, related to inventory management, is inventories, which can occur randomly, rotationally or generally. Random inventory occurs when the Storekeeper or by a user identifies the possibility of divergence in stock. The rotating inventory is developed weekly in the various product families that are registered in the Information System. Finally, the general inventory occurs annually, when all stock and its accuracy are checked.

Table 4 presents a summary of the tasks prescribed for the warehouse sector, their procedures, their purpose, those responsible for their execution, the time when the task must be performed and the place of execution. Through this table, it is possible to understand how each task influences the flow of tasks in the analyzed sector.

Table 4: Distribution of Warehouse Tasks

Task	Procedure	Purpose	Accountable	A moment	Local
1. Receipt of Materials	Check the material received with the Purchase Order.	Avoid divergences in receipt.	Storekeeper	On demand	Warehouse
2. Launch of DANFE at System	Enter the DANFE information in the system and check the postings.	Re-feed the system with stocked items and quantities	Storekeeper	After Receiving Materials	Management Software

3. Material Storage	Identify and store the items in the specified locations.	Facilitate the identification of materials in the fulfillment of requisitions.	Storekeeper	After the launch of DANFE	Stock
4. Programming Attendance Production (Paper)	Analyze in the Production Schedule, the materials to be made available for production.	Compliance with production deadlines.	Storekeeper	According to the demand of the schedule	Paper Stock
5. Fulfillment of Material Requisitions	Separate the requested materials and deliver them to the requesting sectors.	Meet production needs.	Storekeeper	According to the requisition demands	Warehouse Stock
6. Down on Stock	Enter the requested and delivered materials in the system.	Keep the system up to date.	Storekeeper	After separation	Management Software
				and delivery of materials	
7. Inventory (General, Rotary, and Sampling)	Count the materials in stock and compare them with the system quantities.	Check and correct system stocks from actual inventory	Storekeeper	Programming, rotating or sampling	Stock
8. Inventory Correction	Posting the divergences found in the system	Correct stock divergences.	Supervisor	After Inventory	Management Software

From the analysis of the activities developed in the warehouse, malfunctions were identified that interfere with the performance of the procedures as prescribed in tasks 1, 2, 3, 4 and 6 of Table 4. These malfunctions generate difficulties in execution and rework, with consequences for the operation of the company, impacting the quality and productivity of services and the health of warehouse employees. These activities, their malfunctions and their consequences are listed in table 5.

Table 5: Malfunctions in the Activities carried out in the Warehouse

Procedures	**Malfunctioning**	**Consequences**
1-Check the Request for Purchase with material received.	- Lack of identification in DANFE, by the Ordinance, and communication for the warehouse of the purchase order number; - Difficulties in accessing the purchase order for DANFE conference; - Failure to train the conference of the material to be received.	- Receipt of material with divergent specifications and quantities; - Increase in the time to check the Purchase Order and the material received; - Difficulty in identifying the material of the specification presented at DANFE.
2-Enter the Information from DANFE at System and check the	- Absence of DANFE conference with the purchase order, generating divergence and making it impossible to enter it in the system; - Problems in the entry of taxes generated by DANFE;	- Rework of the Purchasing Sector to change purchase orders; - Contact with the Tax Sector to identify divergences; - Compromise in the inventory update flow,

Releases.	- Absence of internal support from the management system to identify and solve the problem.	due to lack of entry of DANFE's in the system;
3-Identify and store materials in the specified locations.	- High diversity of materials and storage locations; - Absence of standard identification label. - Lack of planning in the process of acquiring materials, generating receipt of materials exceeding the storage capacity; - Inadequacy of equipment or people to move materials.	- Unnecessary relocations of materials in the inventory. - Difficulties in identifying and separating materials in the fulfillment of requisitions. - Adoption of inappropriate postures and handling of excessive loads due to lack of planning in the separation of materials.
4-Check on Programming Production, Orders Production scheduled each machine.	- Lack of information for the warehouse of changes in the Production Schedule; - Disorganization of the warehouse's work routine to meet production changes, not previously communicated.	- Delay in meeting requests for generating conflicts between the Sectors. - Errors in the entry and/or interpretation of the data in the system; - Risks of accidents in the care of urgency of changes in production.
5-Throw and give Write off in the system, of materials requested and Delivered.	- Digitization of all required items, because the requisitions are manual; - Delays in the release and write-off of items in the system due to the high demand for Requests; - Interruption in the separation of materials required to receive materials	- Stacking of items to be posted in the system, generating its outdatedness; - Complaints regarding the outdated system by the Purchasing and Production Planning and Control. Divergence between actual and actual quantities informed by the system.

Most of the malfunctions are related to the launch of the DANFES and their respective conferences, and to the launch of material requisitions (Table 5). Thus, we sought to deepen the investigation of the malfunctions related to this activity.

According to information from the company's G-Print inventory management software, the number of DANFEs received in the warehouse sector between the months of January and March was 324, ranging from 93 to 125 as shown in Table 6.

According to the Warehouse Supervisor, the largest number of DANFEs movement occurs on Mondays and Tuesdays, mainly between the 25th of the current month and the 10th of the following month.

The average time to launch a DANFE is approximately 5 minutes, however, due to the disconnections identified during launch, the launch time can reach 40 minutes. According to the Warehouse Supervisor, about 50% of the DANFEs have problems in their entry, requiring the interference of the Purchasing Sector and the Financial Sector to solve problems related to taxation and registration codes. Table 6 presents a demonstration of the impact of malfunctions in different situations, i.e., the launch of DANFEs with and without malfunctions (normal).

Table 6: Monthly Time to Launch DANFEs

Month	DANFES / Month			Time Fill	Monthly time allocated	
					Min.	Hours:min
January	93	Normal	47	5	235	3:55
		w/ Malfunction	47	40	1.880	31:20
Brewer	125	Normal	63	5	315	5: 15
		w/ Malfunction	63	40	2.520	42
March	106	Normal	53	5	265	4:25
		w/ Malfunction	53	40	2.120	31:20

The main malfunctions related to the launch of the DANFES are:

- The lack of identification of the purchase order number by the concierge;
- Difficulty in accessing the purchase order for DANFE conference;
- Lack of training of warehousemen to check material and launch DANFE;
- Problems in the release of DANFE taxes;
- Absence of internal support from management systems;
- Communication problem between the PCP (Production Planning and Control sector) and the warehouse sector;
- Interruption of the routine of activities to solve various problems of other sectors.

The process of requisitioning materials also has malfunctions that impact the activity of warehousemen. The requisition of materials is carried out manually, however, employees from all sectors of the company who request materials have access to the company's Information System (SI), the G-Print software, being able to check the materials and the respective balances available in stock. Thus, all Sectors and Departments manually generate their requisitions and send them to the Warehouse so that the materials are separated, delivered and the balances updated in the company's Information System.

To analyze the routine of requisition of materials, data for the months of January, February and March were taken as a basis. Table 7 shows the number of requests generated, referring to the aforementioned months and distributed by sectors and departments. Thus, on average, about 14,800 requests were generated in the months analyzed.

Table 7: Material requisitions generated in the period from January to March

Area	Sector / Department		Number of Requests Generated			
			January	February	March	Average
Production	Prepress		54	43	20	39
	Impression		101	72	92	88
	Finishing		569	406	282	419
Staff	Warehouse		5	6	13	8
	Logistics		10	20	6	12
	Administration	Administrative	713	565	542	606
		CTP	13.857	12.244	18.442	14.847
Total Requests Generated per Month			15.309	13.356	19.397	16.019
Total Requests fulfilled by the warehouse			1.452	1.112	955	1.155
Average daily requests fulfilled by the warehouse			56	43	37	44

The CTP, the Finishing and Administrative Sectors account for the largest number of requests generated by the Sectors and Departments. Disregarding the CTP requests, which are processed by the aforementioned Sector at the time the programming is made, an average of 1,155 requests generated during the months analyzed was reached, ranging from 955 in March to 1452 in January, that is, a variation of 52%. Considering an average of 26 days worked, we have an average of 44 requests generated per day. It is worth mentioning that production demand in this period was low, so at peak times, demand can be increased by about 35% to 40%.

Regarding the fulfillment of requests and write-offs in the system, the interviewees stated that the average routine time is 7 minutes. Thus, considering the average number of 44 daily requests, an estimate of 308 minutes was reached, which represents more than 5 hours of work, without interference. As interferences are part of the work routine of these professionals, consequently, the fulfillment of requisitions consumes practically all the work time of a warehouseman.

Table 8: Variation Time Attendance Daily requisitions in normal and high production demands

Situation Daily Demand Requisitions	Number of Requisitions	Fulfillment Time Requests	
		Unit (min.)	Total (hours)
Normal Production Demand	44	7	5 hrs: 8 min
High Production Demand	62	7	7 hrs : 15 min

4. SUMMARY OF THE ANALYSIS AND RECOMMENDATIONS FOR IMPROVEMENTS

To analyze the effects related to the release of DANFEs and material requisitions, the Ishikawa Diagram was used, with the objective of analyzing the cause and effect of the problems identified in the processes. Figure 3 shows that the causes are related to Personnel, Materials, and Methods. The sub-causes that contribute to the aforementioned problems are presented as elements that signal the reasons for the problems to persist.

Regarding the causes related to personnel, the lack of training, both of the doormen and the storekeepers are the main reasons for triggering the malfunctions identified.

In addition, Figure 3 also presents the implications related to lack of training. These are presented as difficulty in identifying the Purchase Order, entry and receipt of divergent material, difficulty in entering taxes in the information system, absence of technical support and interruption of routines.

Regarding materials, the lack of a specific place for storage is highlighted, due to the excessive purchase of material, which implies unnecessary movement of material, storage in separate locations and unidentified materials.

Finally, regarding the methods related to the problems analyzed, the absence of auditing in the processes triggers a cycle of dysfunctions in the processes developed in the sector and in the organization. Of these, the absence of internal audits, generation of manual requisitions, and adoption of decisions different from the procedures adopted by the company can be mentioned.

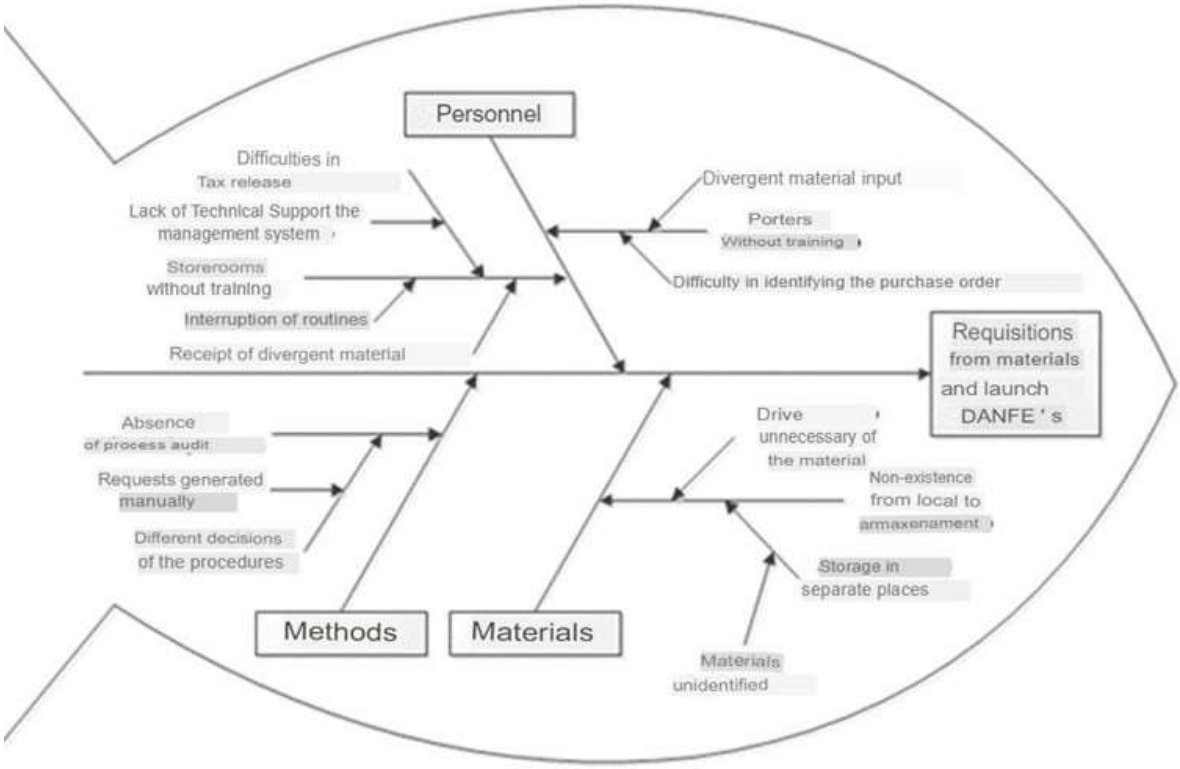

Figure 3: Cause-and-effect relationship of the release of DANFEs and material requisitions

In view of this, a list of recommendations was prepared in an attempt to propose improvements for a better functioning of the sector and the company as a whole:

- Training for the concierge sector to identify the purchase order before forwarding the material to be delivered to the warehouse.
- Training of warehousemen for the launch of DANFEs and material conference;
- Training for launching DANFE taxes;
- Creation of internal Technical Support for the Management Software to assist users in clarifying doubts and solving problems;
- Greater integration between Technical Support and users, in order to adapt the systems to the needs, capabilities and limitations of the company and the sector;
- Development of a problem-solving methodology in the routine of launching DANFEs of the Management Software;

- Generation of material requisitions via Management Software to reduce the time of Warehouse workers in the use of management software and inform the amount of materials available in real time;
- Organization of the warehouse stock areas, defining zoning and specific areas for each family of materials, facilitating the identification and selection of materials requested by the various sectors of the company and the realization of material inventories;
- Standardization of the form of identification of materials;
- Carrying out periodic inventories of existing materials in the warehouse;
- Creation of routines for the company's related sectors, establishing deadlines for the sectors to request materials, enabling warehousemen to select materials in advance;
- Establishment of work routines for warehousemen, in order to avoid the paralysis of activities to solve problems;
- Establishment of audits for continuous improvement of processes.

5. CONCLUSIONS

The objective of this work was to carry out an analysis of the activities of the warehouse of a printing industry, to identify the technical, organizational and human determinants that generate dysfunctions in the sector that impact the activity of the warehouses and, consequently, on the company's production and, consequently, to propose an improvement in the workflow in this work sector.

The analyses showed that the extra time spent to carry out activities caused by malfunctions and the lack of training lead to workflow problems, generate work overload for the warehousemen at certain times of the month, internal conflicts between the company's sectors with consequences in production.

It was found that the need for adequate training supported by materials planning, in addition to inspections through audits can provide positive results for the organization. In addition, the implementation of the proposed improvements can positively influence the organization of work and consequently factors related to productivity and compliance with deadlines, in addition to aspects related to the health and safety of the work of warehousemen.

The malfunctions identified through the analysis of the activity, generate difficulties in execution and rework with consequences for the operation of the company's sector and with impacts on the quality and productivity of the service and the health of the warehouse employees. It is worth highlighting the list of ergonomic recommendations whose principles are the basis for the implementation of improvements by the managerial sphere, thus aiming to increase the quality of life at work for employees as well as increase the quality of their

products offered and delivery times by the company.

This work had as practical contributions the improvement of the operation of the warehouse, with impacts on the improvement of the overall effectiveness of the company and the working conditions of the employees of the warehouse. In addition, it presents an ergonomic analysis in unusual sectors, showing the potential of activity analysis and organizational ergonomics to solve problems in administrative sectors, generating improvements in production, productivity, working conditions, that is, in the effectiveness of the company.

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