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Analysis of the operation processes and application of optimization tools to improve the productivity of operations in an Automotive Service Center

Análisis de los procesos de operación y aplicación de herramientas de optimización para mejorar la productividad de las operaciones en un Centro de Servicio Automotriz

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Abstract

The management of operations in any business unit has been a fundamental element that contributes to increasing its productivity. In order to establish improvement action plans that contribute to generating more efficient operations that improve productivity and the quality of the service provided, it is important to understand how these operations are carried out and the productive factors that intervene to optimize them within organizations. This article shows an analysis on the analysis of operations in an automotive service center, through a study of times carried out on the technical staff of the center, identifying productive and unproductive times, making an analysis of the sequence of operations, identifying operations that represent bottlenecks in the process, as well as the elements available to the staff to carry out their work. An analysis will be carried out of the work carried out in accordance with the repair orders entered at the service center from receipt to delivery, so that an opportunity area is established in the processes that are carried out to generate improvements that contribute to optimization of the resources.

Time study, Operations analysis, Productivity, Optimization

Resumen

La administración de operaciones en cualquier unidad de negocio ha sido un elemento fundamental que contribuye a incrementar su productividad. Para establecer planes de acción de mejora que contribuyan a generar operaciones más eficientes que mejoren la productividad y la calidad del servicio suministrado, es importante comprender cómo se realizan dichas operaciones y los factores productivos que intervienen para optimizarlos dentro de las organizaciones. El presente artículo muestra un análisis sobre el análisis de operaciones en un centro de servicio automotriz, mediante un estudio de tiempos efectuado al personal técnico del centro, identificando los tiempos productivos e improductivos, haciendo un análisis de la secuencia de las operaciones, la identificación de operaciones que representan cuellos de botella en el proceso, así como de los elementos con que cuenta el personal para efectuar su trabajo. Se realizará un análisis de los trabajos efectuados conforme a las órdenes de reparación ingresadas al centro de servició desde su recepción hasta su entrega, de forma que se establezcan área de oportunidad en los procesos que se llevan a cabo para generar mejoras que contribuyan a la optimización de sus recursos.

Estudio de tiempos, Análisis de operaciones, Productividad, Optimización

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Introduction

Today, business units are facing a changing, more competitive and globalized economic environment, making the management of operational-productive issues a key element for the proper functioning of the business, directing their efforts towards productivity, taking care in at all times the quality of the products or services supplied in such a way as to satisfy the needs or requirements of the client. However, the challenge becomes greater for companies that seek to remain in the market, since customers have a greater number of possibilities where they can purchase the products and services they want, they have easy access to information that allows them to make purchasing decisions. Therefore, improvements in the operation of operations within the organization have been vital to increase productivity in companies in any market sector.

Productivity is measured considering the degree of efficiency with which material and human resources are used, machinery, as well as the methods to achieve organizational objectives. Tools must be applied to measure their degree of efficiency, which leads to balancing the lines or work stations, reducing or eliminating movements that do not add value to the process, thus improving uptime, therefore, it is important to calculate in the process their standard production time, in order to separate productive time by identifying unproductive time.

The objective of this study is to establish strategies that contribute to improving the productivity of the automotive service center operations, through the study of the operation processes that are carried out and the application of elements that contribute to optimization, which allows identifying and eliminate activities that do not add value to them, in order to reduce cycle times and increase the quality of customer service.

Literature review

We could define productivity as the relationship between the outputs of goods and services in a production process and the input elements or productive factors necessary to carry out said processes.

Kanawaty (1996) defines productivity as the relationship between production and inputs, applicable to an organization, an economic sector or the economy in general. Therefore, the measurement of productivity helps to identify the degree to which a certain product can be obtained from an input used, making this measurement easier when both the product and the input have tangible characteristics, however, the identification of the Productivity levels become difficult to calculate when intangible assets are involved in the measurement.

Drucker (1999) establishes that the most important asset in 20th century organizations consisted of their production apparatus, for the 21st century, the most valuable asset of any organization is in the knowledge workforce, as well as the productivity of these . Gutiérrez (2014), for example, establishes that wealth is generated from knowledge and information, intangibles that give rise to aspects such as leadership, productivity and quality improvement.

In a globalized and competitive market, a good number of consolidated companies establish key performance indicators as measurement of their processes, allowing thus follow up on vital aspects within the organization that lead them to meet their objectives, identifying areas of opportunity within operations seeking to be more productive while reducing operating costs, having the possibility of offering their customers products high quality at competitive prices.

In their work Chase, Jacobs and Aquilano (2009), they indicate that to create a competitive advantage in business operations, it is necessary to understand how the operations and supply function allows to increase their productivity. According to Niebel and Freivalds (2009), the way in which an organization can increase its profits is by increasing its productivity. The increase in the amount of production per hour of work employed is an indication of the improvement in productivity.

When the organization dedicates efforts to improve its processes, a positive effect is achieved that can represent benefits, by reducing rework, waste, delays, reducing scrap and reducing the possibility of presenting customer complaints.

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By having fewer defects, costs are reduced and there is the possibility of allocating the material and human resources available to develop more products, address other problems, reduce and improve delivery times or offer better customer service, thus increasing productivity , increasing the satisfaction of the company's internal and external customers (Gutiérrez, 2014).

Methods engineering is a technique that seeks, through the study of operations, to improve the processes and procedures of the workplaces, through the analysis of the design of the equipment, the facilities and the conditions in which productive operations are carried out, contributing to the establishment of strategies that allow the performance of the productive factors of the business unit to be made more efficient, allowing the processes to flow in a simpler and safer way, generating more productive, profitable and safe environments.

According to Peralta, López, Alarcón, & Rocha (2014), the result of this analysis will allow the identification of critical points in the process that represent areas of opportunity, by finding bottlenecks, losses, waste or simply activities that contribute to that the system becomes unproductive.

On the contrary, in his publication, Kanawaty (1996) establishes that Productive Time is that in which activities are carried out that will add value to the production process.

Smith (1988) mentions that the productivity of technical personnel is the ratio of the speed with which technicians perform a job and the qualities or capabilities they have.

Methodology

This study was carried out with a quantitative approach, data collection was based on standardized instruments, through observation, measurement and recording of measurements. Instruments that have been validated and demonstrated their reliability in previous studies were used (Hernández, Fernández & Baptista, 2010).

The operations for the operation of an Automotive Service Center were studied, during a week the information was collected through the data of the repair orders that were raised in the Service Center when a unit entered the workshop. Monitoring them by registering in previously designed formats. The analysis of the information was another important activity of the study, so that areas of opportunity are identified and to complete this study, proposals for improvement are generated.

The scope of this analysis was divided into two moments:

a. Determination of Standard Times of operations for repairs.
b. Optimization of car repair processes.

The compilation of the information involved areas that intervene in the service, among which the departments of reception of units, head of the workshop (control of operations), spare parts warehouse, workshop, quality control and customer service were analyzed. For each operation, the time taken was carried out, from the moment the unit is assigned to the technician, until the completion of the entire maintenance service. The time recording was generated continuously, analyzing the services depending on the level of complexity based on the replacements and inspections recommended by the manufacturer according to the mileage of the unit, including the alignment and balancing service.

Through interviews, information is collected from the areas that contribute to the service, especially the spare parts warehouse and customer service, the cycle times and operating times, the sequence of activities were analyzed considering the procedures already established in the workshop, as well as the perception that the client has with the aspects of the service. Flow charts and path diagrams were used to support the analysis of operations.

In the Automotive Service Center, 9 technicians collaborate, 2 of them are specialists in Nissan-Renault units, with this workforce an average of 800 repair orders are attended per month. The units that enter the service center commonly demand minor and major maintenance services, depending on the mileage they have, Table 1 shows the activities carried out in each maintenance.

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Maintenance service under 5,000 km includes:	Maintenance service for more 10,000 km includes:
Oil change, Oil filter, Suspension adjustment, Brake cleaning and adjustment, Checking lights, Checking levels, Washing and vacuuming the body	Oil change, oil filter, air filter, fuel filter (if the model requires it, they do not include filters that are installed in the fuel tank), major tuning, spark plugs, suspension adjustment, cleaning and adjustment of brakes, inspection lights, Level check, Body wash and vacuum

Table 1 Description of scope of minor and major maintenance
Source: Own Elaboration [Microsoft Excel]

Figure 1 shows the flow chart with the description of the activities that are followed from the moment the unit is received until the completion of the repair and delivery to the customer.

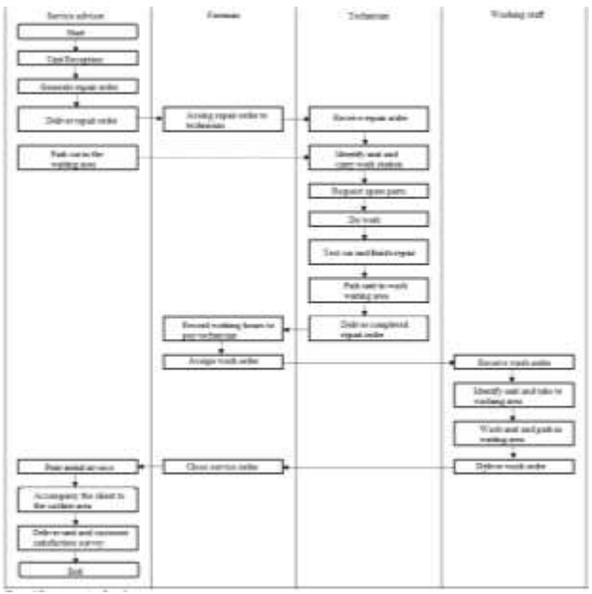


Figure 1 Center operation flow diagram
Source: Own Elaboration [Microsoft Excel]

Results

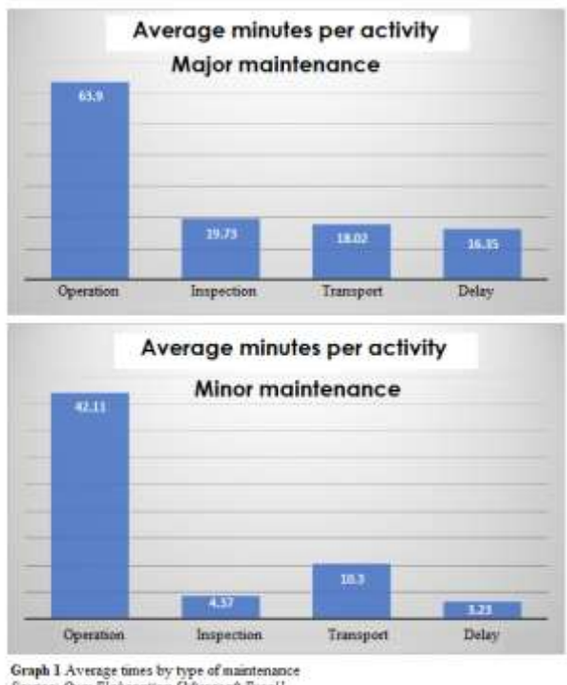
As part of the analysis of the operation processes, among other things, the time of receipt of the vehicles, the time of assignment of the work, the start time of the technician's work, the time the technician finished the work and the time he delivered the the repair order to the personnel responsible for the control of the operations of the workshop, in the same way the movements made to carry out the work, tools and equipment used, the activities in which tools were used, sequence of activities carried out and years are observed and recorded of staff experience.

The data was captured in the system to obtain the results for each order, in Table 2, a sample of the analysis of the operation at the beginning of the study is presented, where the average time for major maintenance was 118 minutes and the lowest 60.01 minute.

Order number	Type of job	Ramp type	Technician type	Years of technician experience	Total activity time	Total frequency	Total travel
2648	Major maintenance	Hydraulic jacks and towers	No specialization	3	02:25:00	73	731.22
2649	Minor maintenance	Hydraulic jacks and towers	No specialization	22	00:00:00	19	88.92
2660	Major maintenance	Hydraulics	With specialization	8	01:11:00	53	362.3
2674	Major maintenance	Hydraulics	With specialization	3	02:18:00	80	578.89
2680	Minor maintenance	Hydraulics	No specialization	7	00:53:00	33	294.19
2897	Minor maintenance	Hydraulics	No specialization	10	00:41:00	18	169.07
3080	Minor maintenance	Hydraulics	No specialization	2	01:29:00	53	557.61

Table 2 Analysis of the initial operation
Source: Own Elaboration [Microsoft Excel]

Activities carried out by the technician were analyzed, as well as the measurement of the times for carrying out a breakdown of the major and minor maintenance repairs as they were carried out at the beginning of the study. (See Graph 1)



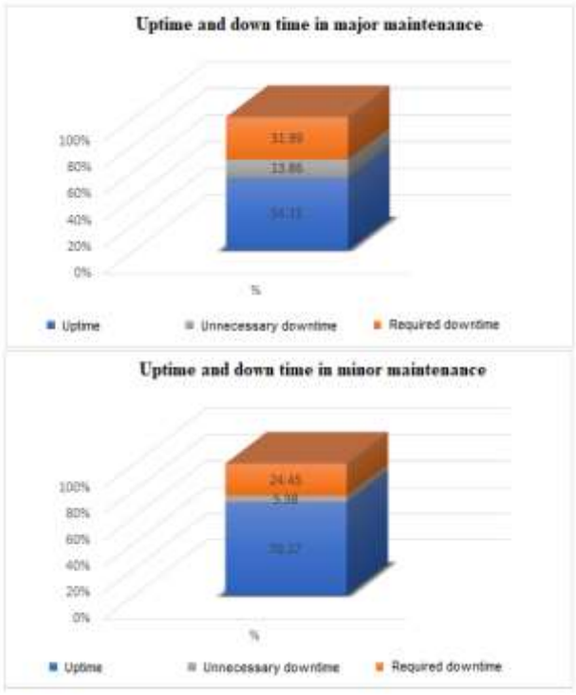
Graph 1 Average times by type of maintenance
Source: Own Elaboration [Microsoft Excel]

Graph 1 Average times by type of maintenance
Source: Own Elaboration [Microsoft Excel]

According to the results, most of the time was spent in the operation, carrying out activities such as mechanics, lubrication, brakes, balancing and inspections for the case of major services because it includes the balancing operation that was carried out in parallel with brake and mechanical activities.

In this analysis, it is important to identify the productive and unproductive times that are incurred within the operation, considering that the Productive Time (TP) is that in which activities that add value to the process are carried out, therefore, the aforementioned activities they are part of this productive time. On the other hand, Unproductive Time can be divided into Necessary Unproductive Time (TIN) composed of activities that do not add value to the process, however, they are necessary to perform and finish productive tasks, while Unnecessary Unproductive Time (TII) refers to the time spent in activities that do not add value to the process, therefore, are considered as waste.

Graph 2 shows the percentages of average productive and unproductive times, when analyzing the operations carried out in the repair services offered by the service center.



Graph 2 Productive and unproductive times of maintenance
Source: Own Elaboration [Microsoft Excel]

Within the TIN, the transfers to the spare parts warehouse are considered, to receive or deliver a repair order, take the tires to be balanced, go for the assigned vehicle and place it in the workplace, as well as the inspections carried out to the unit to verify compliance with the requirements indicated in the maintenance order.

Regarding the TII, the activities of waiting for spare parts, waiting for balancing equipment, interruptions due to rest, waiting to start washing, searching for your tool or work equipment, as well as the waiting time when requiring confirmation of information are identified. . Therefore, all these activities were analyzed to establish improvement plans that contribute to their minimization since they represent wasted time. As an improvement strategy, the proposal is made that one of the workshop assistants support these activities.

Likewise, the activities that are part of the necessary unproductive times were sought to minimize them since transport does not contribute to the objectives of the service center. It is worth mentioning that this time analysis was carried out considering the activities that were carried out at that time in each repair, considering that at that time there was an area of opportunity in the work method. Therefore, these times are used as a reference to establish standard times when having a work method for each type of service or repair of units.

Another important point that was analyzed is the sequence of activities, through the standardization of the repair procedure, by performing the operations with a logical sequence that helps to optimize the total repair times. It was identified that at the beginning of the activities the activities among the technical personnel are very similar, however, in the middle of the procedure the technicians used a different sequence of activities. To address this point, a quality control sheet was generated, which describes the minimum operations that must be carried out in each unit to standardize the service and guarantee quality customer service, identifying if the technical staff makes any omission of operations.

In the spare parts area, for its part, a bottleneck is generated in the mornings when the shift starts since the technicians have waiting times for the spare parts they require for the assigned work to be delivered, therefore the proposal is generated that the spare parts personnel prepare spare parts kits according to each repair order that is entered, having a reduction in waiting times to start with the replacement of the parts necessary to carry out the service.

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In addition to this, containers are installed to pour the motor oil to be replaced, near the work stations of the technical personnel. With regard to machinery, equipment and facilities in general, an inventory is made of the tool commonly used by the staff that is located in the tool store, as well as the tool receipt sheets assigned to each technical staff. identifying material and equipment that is necessary to have at each work station. For maintenance work, air and water intakes are required, therefore, we worked so that the 2 intakes that were previously inoperable, functioned properly and contributed to the fact that the personnel did not have to travel by water, for example to fill the unit deposit levels.

Conclusion

The technical staff is becoming familiar with the new working methods, considering that prior to the study carried out, the staff was used to working without a standardization of operations, putting at risk even the quality of the service provided, knowing that no one inspected their work.

The times that were analyzed in the operations contributed to establish standard operating times considering also the personal needs of the productive personnel as well as a percentage of fatigue, considering that it is a physical job but that it also demands visual and mental wear when submitting their work to an inspection and a degree of concentration to identify the correct sequence of activities to be carried out, without forgetting the environment that can influence its performance such as temperature, humidity, lighting and ventilation of the workplace.

To reduce travel times, the personnel were provided with some mechanic's trolleys with at least 5 compartments so that they could place their tool in shelter and move around the unit to carry out maintenance service, avoiding moving from one place to another to locate the necessary equipment for shop operations.

In order to generate an adequate distribution of work, criteria are established to assign repair orders early in the shift, assigning the jobs that will require less repair time, with the intention of increasing the number of service orders concluded by turn.

These assignments are generated by a single person responsible for scheduling the work carried out in the service center from receipt of the unit to delivery to the customer.

The benefits of implementing these improvement strategies are as follows:

- Activities are carried out on a scheduled basis and operations can be anticipated.
- Delays by technical staff are reduced.
- Production capacity is increased
- Delivery times of the units to the customer are reduced.
- The review of each job is recorded in a control sheet, which allows standardizing operations and inspections.
- Variations in the unit maintenance and repair process are reduced, thus reducing errors at the end of the process and possible customer complaints.
- The technical staff is committed to paying attention to the activities carried out and participates in establishing proposals for improvement in the working methods.
- The reports made contribute to generate training programs, improvements in procedures that affect productivity.

The implementation of the description of procedures for the operation in the service center, the identification of productive and unproductive times, the generation of quality control sheets of the services, are tools that contribute to the operation within the service workshop improve and can be standardized.
It is important that, in this type of organization, where the quality of the maintenance service and customer service are essential for the permanence of customers, it is important that quality service proposals are implemented that contribute to a closer monitoring of repairs carried out by technical personnel.

References

Chase, R., Jacobs, R., y Aquilano, N. (2009). *Administración de operaciones. Producción y cadena de suministros*. (12ª ed.). México, D.F.: McGraw-Hill.

Drucker, P. (1999), *Los Desafíos de la gerencia para el siglo XXI.* Colombia, Editorial Norma.

ISSN-2531-2189

Gutiérrez, H. (2014). *Calidad total y productividad. (3ª ed.).* México, D.F.: McGraw-Hill.

Hernández, R., Fernández, C., & Baptista, P. (2010). *Metodología de la Investigación.* México, D.F.: Editorial McGraw Hill.

Kanawaty, G.(1996) Introducción al estudio del trabajo (4a. Edición Revisada), Ginebra, Suiza, O.I.T.

Niebel, B. y Freivalds, A. (2009) *Ingeniería Industrial: Métodos, Estándares y Diseño del Trabajo.* (12ª ed.), México, D.F.: McGraw-Hill.

Peralta, J. L., López, J., Alarcón, E., & Rocha, M. (2014). *Estudio del trabajo. Una nueva visión.* México: Grupo Editorial Patria.

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