Process Analysis and Operations Productivity

A real case study in the retail distribution industry

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Abstract

The increasing competitiveness and globalization of the supply market addresses the quality and price of products as their major differentiator factors in the logistic chain of a retail distribution company. The way to maintain profit will be improving the efficiency and productivity of the logistic chain.

This paper is a study in the field of productivity and performance of a retail distribution company. It starts with an overview of the company and its singularities, to focus on the warehouse operations and in its optimization level. This work follows a reformulation in the company logistics strategy and develops possibilities to improve quality and performance in a retail distribution center making use of tools as quality management, layout planning and statistics.

After analyse the present conditions of the warehouse under study some solutions are proposed to improve the operations. The productivity of the employees is studied and new ways to explore and measure warehouse operator’s work are proposed so as to develop fairer and more accurate methods of motivation and compensation of human resources.

Key words: SCOR method, layout planning, quality, productivity, performance metrics.

1. Introduction

This paper pretends to present and analyze options to increase productivity in the logistics operations of a retail supply chain. It reviews the procedures and identifies the changes that occur in the company allowing for an adjustment of all related operational activities (Carvalho, 2004).

The analyses are developed on the real case of Jerónimo Martins company, the retail distributer of Pingo Doce, Feira Nova and Recheio. The logistics operations are initially defined in accordance with the international Supply Chain Operations Reference (SCOR) method (Samuel H. Huanga, Sunil K. Sheoranb, Harshal Keskar, 2005).

Topics of relevance in the organization’s operation and layout definition are analysed
and possibilities of implementing the changes that will increase productivity are studied (Hales, 2006). The ultimate objective is to review and propose a new model for assessing the operational performance in the warehouse, making the reward system fairer and goal oriented. This study is an attempt to lower costs in material handling as well as increase efficiency and synergy in the warehouse. To really increase the efficiency we have to create conditions for rapid flows and organized storage since the productive factors are mainly people (Tompkins, 2003)

The study tries to monitor their productivity over time to recognize the success of optimizations, at the same time it questions the units that are used to measure operator’s performance and try to adjust productivity compensation with the needs of the company (Murphy, 1993).

This article will introduce theoretical factors and summarize optimizations to them develop the productivity case study, it’s ways of application, limitations and practical concerns.

1. Quality Tools
The productivity of a system is typically defined as the ratio of output/input. If we want to keep a constant production (output), we will have to increase the productivity by using fewer resources, produce faster, at lower costs, or all of them. For process optimization, will need to increase the efficiency.

Another concept that is generally confused with productivity is performance, this is not intended to be a relation exit/entry, but a relation between the expected and what really happened with output. To apply measures of performance we need to establish a set of metrics and expected values that can be compared with the actual operation. Efficacy refers to the scope of which the objectives or goals are achieved according with what was previously planned.

A product has quality if aligned with customer needs, in economical terms, functional, service, and other expectations. The well known quality control ideas arise with demanding people in stimulating business. They are usually associated with acronyms such as TQM (Total Quality Management), QFD (Quality Function Deployment), ISO, Six Sigma or Lean Manufacturing. They emerge as lines of thought, philosophies and systems that try to use continuous improvement to align company objectives with costumer requirements. (Tague, 2005).

Total quality management TQM is a system that often promotes tools to control and increase quality using cause-effect diagrams of Ishikawa, Pareto diagrams, graphs and histograms of control, diagrams, flowcharts of operations, among others (James, 1996).

For example, the Six-Sigma approach to quality specifies exactly how the managers should address their effort to improve the company. The use of important technical data and the application of statistical analysis allow estimating expected results and targets for the reduction of errors in operations. Its main process of improvement is known as DMAIC (Define, Measure, Analyze, Improve and Control) and follows well structured actions such as:
- Setting goals and objectives according to customer needs;
- Measuring the present process and establish metrics to measure progress in meeting the established targets;
- Examining the current process to understand the problems and their causes;
- Improving the process identifying possible solutions and monitoring;
- Controlling the improvements with the control tools created.

Six-Sigma methodologies uses data processing with emphasis on statistical tools and analysis such as 5 Why’s?, ANOVA, cause-effect diagrams, control charts, correlations, clusters analysis, flowcharts, linear regression models, etc (Tague, 2005).

2. Layout Planning

It is generally known that the main way to increase operations productivity of a company is to improve the way materials are handled around the warehouse, improving quantities displaced, paying attention to the rotation and the quality of work performed.

If we actually focus on Warehouse planning, it’s known that 20 to 50% of all costs of production are related to materials handle in storage, and the appropriate planning of the plant can reduce these costs by 30% (Tompkins et al., 2003). The optimization of storage continues to be a promising field, which could reduce up to 15% of production costs. The aim will be to increase the facility performance to minimize costs of material travel, using space efficiently and increase workers performance, eliminate overcrowding, reduce the cycle of operation and improving service level.

3. Productivity Measures

Despite being limited to research carried on the performance of industrial operators, mainly in storage, we find some studies that took attention to the need to define well the compensation systems. These will permit the improvement of productivity with the motivation and choice of appropriate evaluation units, developing observation work, data processing and proposing solutions.

According to the literature search on human resources for storage, we found that in the storage business, particularly in little automated warehouses, the work is labor intensive and it represents a good slice of the logistics costs of operation (Paul and Richard, 1993). This study conducted in 1990 by the Council of Logistics Management and published in the American Public Warehouse Register, involved 400 warehouses distributed along the United States of America, with 40% of respondents warehouses (with long cycles of storage) and 60% distribution centers (with shorter cycles of storage). This study indicated that there were undoubtedly positive relations between training, motivation and evaluation of employees, when done in the right way. The warehouses with bonus money had fewer problems in operation, lower levels of employee’s turnover and greater satisfaction for the managers and workers. The use of threat of dismissal was not good because increases aggressive behaviour (which increases work accidents) and

4. Operational Improvements
Before improving employee’s productivity measurement system, the daily operations should be optimized. There are studied improvements while researching on the warehouse, like:
• The layout of the shops in the execution should take into account the volumes of historical shops. Shops with bigger amount of pallets with mixing products should be closer to the door so that more products will travel smaller distances.
• The order of execution of received products in the mixing must take into account characteristics such as weight and fragility of the material, facilitates the pallet assembly and minimize defects.
• The main operations are measured by factors of productivity to track the performance and, if possible, use it as motivation tool for operators.

5. Productivity Case Study
The concern with performance evaluation systems only makes sense for an optimized operation without problems. Nevertheless, the fact that it appears as the last form of optimization of a company does not reduce its value. The motivation of the workforce is an increasingly important asset for a business organization and the definition of the variables to consider is not always direct and empirical.
The concerns and planning of daily production normally leaves no time to interpret data and find new solutions. This case shows that the more quick response or just-in-time philosophy a system is, the more important is to have well defined performance compensation measures.
During data gathering, was always clear that there were important features that contribute to productivity as the weight or volume of the boxes. It was also a concern of the operational manager the fact that there were people of his trust that when distribute fewer boxes per store received no additional bonus. But it was not clear how to correct these injustices.
When finally the information was aggregate in types of work done, grouped boxes per store at intervals and established a linear regression, it seemed clear that the more boxes the operator let in a shop the more boxes he distribute in the same hour.
To understand the viability of the model, there was the question on what would change the parameters of the line $y = mx + b$ estimated. Adjusting the linear model to the warehouse, we understood that: when $x$ is equal to 1 (the operator let one box in each store), the $y$ value (UMC / hour) would be bigger or smaller depending on the layout the employee travels, so this value can measure the efficiency of the layout and the distances travelled.
Despite the slope of the regression line varied over the four months observed, the values estimated for $x = 1$ increased (155, 172, 176 and 190 UMC/hour to 1 UMC/shop) and that indicates increasing layout efficiency and gives an average of 174 UMC/hour. This is the minimum that should be required from an operator, because it represents that he distributed the worst pallet, where he needed to leave a box in each stop on the layout.
The slope \( m \) depends on the layout but also on the volume handled. The approximation to the linear model can be made because the majority of events are limited to a very small range. However, if the volume of sales increases and the number of stores remains constant, operators will gain some more boxes to distribute per store. In this context, the points that are now mainly in the range of 1 to 3 boxes per store will move to the right. But we do not know if the occurrences of UMC/hour values will follow the regression model.

It is risky to propose any model different from the linear, as the number of samples that we have bigger than 3 boxes / shop is so small and variable that we would propose a statistical model without meaningful data, with very low number of occurrences and big variability.

We can say that the actual data suggests smaller increases of UMC / hour when UMC / shop increases values higher than 3. This feature can be a lack of adaptation between what happens on the warehouse and the bonus system or can actually be a characteristic of the system, since:

\[
\text{Slope } m = \frac{y}{x} = \frac{\text{UMC/hour}}{\text{UMC/shop}} = \text{shop/hour}.
\]

It is easy to understand that if the number of boxes per store increases, the operator can go through fewer stores in the same time, the slope decreases through the \( x \) axis. The best solution would be the company to apply this linear model in order to improve the reward system and verify if the behaviour of operators to higher UMC/shop ranges really decreases the slope with the increase of sales (increase of umc/stop) through time.

### 5.1. Model Applications

The truth is that the linear model is the one that best explains the correlation with the available data and is the easiest to understand in the company.

For workers with poor instruction, it is not easy to understand all the successive changes and all the dependencies. The current system of reward is a value added to the base salary that is defined in UMC / hour, as the Figure 1 shows in the horizontal blue line. The values used are historical averages and they were at the moment of study on the level of 250 UMC / hour. All operators that have an observation above the blue line receive additional money as a bonus for being productive.

It is easy to see that if this new regression model is correct, productivity UMC / hour is dependent on the type of work they do (UMC/shop) therefore an operator who randomly had the misfortune to pick up a pallet that demands to leave a box in each store has a result in the left extreme of the pink line (Figure 1) and will not receive a bonus, while at the same time an operator who had the fortune to get a pallet on which leaves more than 3 boxes/store will receive bonus independent of his effort. This can be avoided with the application of the linear model that is proposed next.

![Figure 1. Reward systems](image)
To define the productivity of operators running in the layout JIT:

1st Chance – Regression Implementation

- If box/shop > 6 and box/hour > 93 * 6 + 83 has bonus otherwise
- If box/shop > 3 and box/hour > 93 * 3 + 83 has bonus otherwise
- If box/shop < 3 and box/hour > 93 * box/shop + 83 has bonus otherwise does not have bonus.

The ranges are set in 3 and 6 boxes/hour, because the number of incidents is low and the variance is high. For observations at the range of less than 3 boxes/shop the number of incidents are so high and the cloud so dense that it makes sense to apply the regression line. The regression line position (b = 83 – yy interaction) may go up or down if the company respectively wants to give less or more bonus.

2nd Chance – Apply straight intervals

If the manager prefers can create a chosen number of intervals, which are easier to understand and evaluate the performance. The advantages are limits perception; the disadvantages become the lack of distinction within operator’s performance in the same range.

3rd Chance - Several regressions

Another issue that the company should consider is leaving the binary receives/does not receive and apply more than one regression line to reward more than one level of productivity. Implementing several parallel lines and split the rewards in several layers.

5.2. Limitations and Practice

If the model seems simple and useful to who had done it, it must be submitted in a more simple and practical way to decide for its implementation.

Therefore, the workers should realize they will be measured in number of boxes distributed over a period of time, depending on the number of boxes they leave in the layout each time they stop in a store. The manager and operational responsible must make them understand the issues of arbitrariness between several pallets that are executed in the layout and that the system will bring more benefits and justice in the evaluation of people, because those
who leave more boxes in each store have
to distribute more boxes in one hour, on the
other hand those who leave one box in
each store will have more chances to win a
fair bonus (the limit drops from 250 to 176
UMC/hour).

The practical questions of calculating the
bonus should be taken in attention after
decide the best alternative or combination
of the above. The simple regression lines
are easy to implement using the Microsoft
Excel or WPMS system.

Another issue is keeping the system
updated when operational changes occur.
Therefore the manager should plot the
graph of occurrences dispersion to analyze
trends and means.

It is clearly visible that the study found a
relationship that explain the work done at
the operational warehouse in a better way;
however it still requires steps like approval
and tests before it can be actually implemented.

6. Conclusions

The issue of productivity is not often studied
in literature, perhaps because it is specific
to each industry or because it is the last
form of optimization to a company.
Throughout this work was studied the
productivity of a real warehouse in the retail
distribution industry at Jerónimo Martins.
We realize that it does not make sense to
spend resources establishing better
measures if the company does not have an
optimized production.

So the work begins at defining the process
and understanding the whole routine of the
store under study to identify possible
overlapping and redundant functions.
After the processes are well defined, the
area of work should not overlap so that the
workers in the operational area did not
need to wait for the release of space.
The company showing proactivity and
seeking to solve their issues proceeded to
layout adjustments in order to travel smaller
distances in the shortest time possible.
Other improvement was to develop a
product distribution order that facilitate the
placement of boxes on pallets, increasing
productivity, reducing losses and increasing
products quality and service level.
Successive optimization changes in the
company causes growing productivity in the
operators. The average monthly historical
values were raising, in six months the
productivity of handling operators almost
doubled, from 190 boxes per hour to 300
boxes per hour.

With all the improvements and resources
available to operators, the company was
able to look at new issues. Improving
continuously the overall performance, as is
the philosophy of total quality management,
releases time for more improvements,
turning the company into a sustained pro
active mechanism.
The issue defined the relevant variables so
that the incentive for employees will be
fairer and more efficient, while its
application should be simple and objective,
so that it is possible to implement it.
The application of the model showed that
the minimum number of required boxes
distributed to an operator who had left a
box on each pallet (shop) of the layout was
176 boxes per hour and that each extra
box/shop required the distribution of 93
additional boxes in one hour.
The possibility to adapt the study to other warehouses, led to collect data from other distribution centers, to conclude that the regression would vary depending on the warehouse, as the xx axis for x = 1 reveal the efficiency of the layout as time travel between shops.

The slope of the regression line was not decided because there were not sufficient data available and the few occurrences could be influenced by incorrect measurement of present productivity system. So at this point the work let suggestions for keep monitoring.

Possible implementations of work by the company were identified and developed; the company must combine the best way depending on their interest.

Productivity studies are not common in operations, because there are a huge number of priorities in process improvements. However the growing need for employee’s satisfaction and the company dependence on that to succeed should stimulate future studies in the area. This work was an example on productivity measurement systems.

7. Bibliography


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