A colorful department isn’t always good: improvements at Novaprint.

Federica Distefano

EXAM WORK 2013

Production Systems
A colorful department isn’t always good: improvements at Novaprint.

Federica Distefano

This exam work has been carried out at the School of Engineering in Jönköping in the subject area of Production Development and Management. The work is a part of the two-year university diploma of the Master of Science program within the field of engineering.

The authors take full responsibility for opinions, conclusions and findings presented.

Examiner: Glenn Johansson

Supervisor: Johan Karltun

Scope: 30 credits (second cycle)

Date: 2013-06-03
Acknowledgements

First of all I would like to thank my supervisor Johan Karlton for his guidance and availability along this master thesis.

I would like to thank my classmates who supported me during those two-year program and with who I spent a good time inside and outside the university.

In the end, I want to say a big thank to my boyfriend and my family for their motivational support.
Abstract

Today, the competition between companies are very strong and fought. In particular, small-medium size companies (SMEs) need to upgrade continuously in order to be in line with new technologies and new strategies that tends to develop companies in terms of productivity and quality.

SMEs need, indeed, to be always competitive in a changeable market and to achieve competitive advantage through implementation of new technologies and theoretical methods or techniques. The implementation of those methods leads the company to increase its level of productivity and quality in order to achieve a competitive place within the market.

The Gunasekaran framework is a tool which is useful in order to achieve a higher level of productivity and quality within a SME. This framework was studied and analyzed in order to be applied in a real life situation.

This research focuses on the application of the same framework in a Mexican small company with the aim to develop and increase the level of productivity and quality of one department.

Within the application of this framework, were applied the main concepts explained by the same Gunasekaran and they were analyzed in order to understand if a possible application could be useful to achieve success within the department.

Keywords

Gunasekaran, Productivity, Quality, Action Research, 5S strategy, JIT, ABM, Hoshin Kanri, Inventory Control Management.
# Contents

## 1 Introduction ................................................................. 6
1.1 BACKGROUND ...................................................................... 6
1.2 AIM AND RESEARCH QUESTIONS ......................................... 10
1.3 DELIMITATIONS ................................................................ 10
1.4 OUTLINE ......................................................................... 10

## 2 Theoretical background .................................................... 12
2.1 JUST IN TIME ................................................................. 14
   2.1.1 JIT process ............................................................. 15
   2.1.2 Material Management ............................................... 17
   2.1.3 Safety stock and Inventories ...................................... 19
2.2 5S .......................................................... 20
   2.2.1 Sort ................................................................. 21
   2.2.2 Set in order ......................................................... 21
   2.2.3 Shine ............................................................. 22
   2.2.4 Standardize ......................................................... 22
   2.2.5 Sustain ............................................................. 23
2.3 ACTIVITY-BASED MANAGEMENT ..................................... 23
2.4 HOSHIK EXERCISE .......................................................... 24

## 3 Method and implementation .............................................. 27
3.1 WHAT’S A RESEARCH? ..................................................... 27
3.2 CASE STUDY AND ACTION RESEARCH .............................. 27
3.3 COLLECTION OF DATA .................................................. 29
   3.3.1 Collection of theoretical data .................................... 29
   3.3.2 Collection of Empirical data ...................................... 29
3.4 GAINTT CHART ............................................................. 31
3.5 VALIDITY AND RELIABILITY ............................................ 32

## 4 Findings and analysis ......................................................... 33
4.1 COMPANY BACKGROUND ................................................ 33
4.2 COMPANY PRODUCTION PROCESSES ............................... 33
   4.2.1 Production Departments ......................................... 34
   4.2.2 The principal warehouse ......................................... 35
   4.2.3 The final production line ......................................... 35
4.3 PAINT DEPARTMENT ........................................................ 35
   4.3.1 Paint Department Processes ...................................... 37
   4.3.2 Activities process .................................................. 38
   4.3.3 Inventory Management and control .......................... 41
   4.3.4 Paint Production Processes ...................................... 42
   4.3.5 Warehouse system development ............................... 46

## 5 Discussion and conclusions ................................................ 50
5.1 IMPLEMENTED METHOD .................................................. 50
5.2 FINDINGS AND IMPROVEMENTS ..................................... 50
5.3 FUTURE RESEARCH ....................................................... 53

## 6 References ..................................................................... 54

## 7 Appendices .................................................................. 56
7.1 E-MAIL INTERVIEW TO THE GENERAL DIRECTOR .......... 56
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.2</td>
<td>INTERVIEW WITH THE WORKER WITHIN THE PAINT DEPARTMENT</td>
<td>57</td>
</tr>
<tr>
<td>7.3</td>
<td>PROCESS FLOW CHART</td>
<td>58</td>
</tr>
<tr>
<td>7.4</td>
<td>ORGANOGRAM</td>
<td>59</td>
</tr>
<tr>
<td>7.5</td>
<td>INVENTORY CONTROL SYSTEM</td>
<td>60</td>
</tr>
</tbody>
</table>
I Introduction

Small and medium-size enterprises (SMEs) are considered as a major component of all the economies and they are known as the “life blood of modern economies” (Ghobadian & Gallear, 1995). In general, these companies are considered flexible and adaptive organizations and they are famous for their ability to innovate and change. Indeed, innovation and change is a need for those enterprises in order to develop their management and their productivity (Gunasekaran et al. (2000).

Ghobadian & Gallear (1995) stated that the globalization of markets developed the interrelation between the economies and changed the international environment, which is increasing its competitiveness. For these reasons the SMEs need to make important changes and improvements regarding their operations, in order to survive to the variations of a competitive environment.

The amount of investment that companies need, to make changes and improvements, is the main limitation for SMEs. While large companies are capable to invest big amount of capital to develop their systems, SMEs possess limited capital, manpower and resources to make a change. That’s the reason why those companies need “tools” that require limited budgets and that can be implemented quickly and with a little use of resources. (Shing, 1997)

Maranto-Vargas & Gómez-Tagle Rangel (2005) carried out a study based on the development of capabilities and resources of SMEs in Mexico in an increasingly competitive environment. They considered 55 SMEs located in Central Mexico as a sample and they found that most of the firms increased their level of competitiveness through using a combination of tangible and intangible assets. The firms that had developed strategies and techniques for continuous improvement, innovation and change and development of capabilities, increased the level of their competitive advantages very fast and they reached better profits, productivity level, quality level and other financial goals.

1.1 Background

In order to compete in international markets and increase their competitiveness, SMEs can utilize different productivity and quality improvement strategies or methods. In this study a conceptual model, which is aimed to improve the operation in SMEs, is presented and tested in a specific case. The model is known as the “Gunasekaran framework” and it suggests strategies and methods that contribute to the improvement of the operations in a SME.
The Gunasekaran framework provides an example of how a small company can improve its productivity and quality with limited resources and budget. Indeed, the strategies described within the framework need only a small investment but they also require a deep change regarding the traditional way of working. Gunasekaran et al. (2000) conducted their study in a small company (Valeo) and they implemented the strategies and method described within the framework. (Gunasekaran et al., 2000). The study experimented the effectiveness of this framework in a SME, since it was implemented in a real-life situation, and this is the main reason why this framework was chosen in the project company.

The project highlighted two important types of work: the theoretical and the practical work.

The theoretical work was based on an analysis of the framework by Gunasekaran, which suggests the main methods to apply in a SME in order to develop its productivity and quality. Before choosing this framework, other models were studied and analysed but Gunasekaran framework resulted the most appropriate because it includes successful strategies and methods which allow to develop the processes within a SME. Those methods and strategies are presented in figure 1.1:

![Figure 1.1: Gunasekaran framework (Gunasekaran et al., 2000).](image)

As can be seen in figure 1.1, the main methods suggested to improve productivity and quality in SMEs are:

- Just-in time;
- 5S Strategy;
- Hoshin Kanri;
• Activity-Based Management.

Just-in time is a method that developed in Japan first and then it spread all over the world. The principal goal of JIT philosophy is the achievement of zero inventories of raw materials, WIP products and final products. To maintain the level of inventory at zero results sometime is difficult and unreachable for many companies since there is always a big amount of raw material stoked in the warehouse to prevent any issues such us inaccurate forecasting, machine breakdown etc… That makes JIT method and ideal state. Sometimes companies cannot reach it because of some conditions that do not fit with the ideal state. However, JIT is a method used today by a large amount of companies since it reduces different costs within a company such us scrap, rework on repair, warranty, inspection and design modification. (Hutchins, 1999)

5S system aim is to create discipline, make everything cleaner and well-ordered within a workplace. For instance many workplaces in today’s companies present issues of waste and disorganized or unplaced WIPs. All those issues lead the organization in problems such us: long lead-times, low level of productivity, high operation cost, rework, late deliveries, safety issues and ergonomics challenges. 5S system is based on avoiding all those issues and develop the system make it sorted, in order, shined, standardized and sustainable.

All these techniques contribute to help SMEs to increase productivity and quality, to make the job tasks easier for the worker, to develop their production process system. (Chapman, 2005)

Hoshin Kanri (HK) is a method, born in Japan, that regards quality planning and management.

The Hoshin Process presented by Jolayemi (2008) is shown as a flow chart of seven steps of Hoshin planning and management (HPM). Those steps are:

1. Establish organization Vision
2. Develop 3-5 year plan
3. Develop annual objectives
4. Deployment/Roll Down to Depts. To develop plans including targets and means
5. Implementation
6. Regular Progress review
7. Annual Review
HK is so a quality planning and management tool but it also represents a quality strategic planning and management system. HK focuses on the PDCA cycle (Plan, Do, Check, Act), which is a very popular method that controls the processes and the implementation of improvements or changes. HK helps to identify the activities within the organization as micro activities (activities in different departments within the whole company) and try to fix problems and issues that concern each small department. It is based on the concept that big problems are caused by many small problems and there is the need to focus on those problems from the bottom of the organization. (Jolayemi, 2008)

Activity Based Management (ABM) is a method that identifies and evaluates activities that are carried out within a firm. It helps to manage activities and business processes in order to achieve organizational objectives, reduce costs and non-value resources. Moreover it assists in creating performance measures for cost, time, quality, output in the way that everyone within the company can understand what’s going on within the company and so that they can contribute to achieve the company goals. Activity Based Costing (ABC) is closely related with ABM and it is a method that assigns costs in a different way from the traditional cost allocation. With the ABC method, costs are assigned depending on the activities (planning, engineering, manufacturing etc…) which are associated with specific products or services. (Alabbadi & Areiqat, 2010)

Other 4 concepts are related with these 4 methods and help the companies to implement them. Those concepts shown by Gunasekaran are Kaizen, Reengineering, Self Quality and Education/training. Those concepts help the company to implement the techniques listed before and they support them in order to help the company to achieve competitive advantage after its changes and improvements.

It is important to integrate the practical and the theoretical work within the project. The main methods that are included in the Gunasekaran framework were used and applied in a SME in Mexico. This company is called Novaprint and the implementation of the Gunasekaran framewok was done within the Paint Department in order to develop its productivity and quality. This department needed to be improved because it hadn’t grown like the other departments within the company. The department worked with a poor planning system, long lead-times and a poor inventory management system. In fact, the department had problems with an unreliable inventory control system, without any form of stock tracing and a high level of inventory obsolescence. The development of this department was very important because it contributed to improve the coordination between the other departments and a development of the whole company regarding productivity and quality.


1.2 Aim and research questions

The aim of the project is to use the framework defined by Gunasekaran et al. (2000) with the strategies and methods described and test the implementation of them in a specific case. This specific case was represented by the Paint Department within the company of Novaprint. The most suitable strategies and methods described in the framework were implemented within this department.

The research questions, listed below, are organized based on the phase of the project and the research.

- **RQ1**: How can the improvement strategies and methods in the model of Gunasekaran be used in order to bring appropriate results in a SME?
- **RQ2**: What results were reached concerning quality and productivity within the paint department of Novaprint?

Those research questions are answered within the report in order to satisfy the aims of the project.

1.3 Delimitations

Since the framework contains different strategies and techniques that can be regarded as very extensive to describe and focus on, the report doesn’t go in deep about those topics but is limited to underline the facts that are related to the company issues. For instance one of the topic that will be used is JIT that can be seen as an envelope in a wider topic or philosophy which is lean thinking. The project will thus not cover such a wide topic but the limitation is to focus just on the methods presented, which are parts of the entire topic. Moreover, concerning the company, the change process and the implementation of those changes and improvements regarded just the paint department (a small part of the company) since the project was basically focused on that. However, the theoretical support and the methods explained can also be used for others departments or for a wider vision of the whole company.

1.4 Outline

The following chapters within the report are:

- **Chapter 2: Theoretical Background**

  In this chapter, a literature review is presented. The Gunasekaran framework is further elaborated and all the methods that concern the framework are highlighted. After that, each method is described with the most used and important concepts.

- **Chapter 3: Method and Implementation**
This chapter highlights the method used to write this thesis and, more in general, to carry out the project. The research approach is explained in terms of how the researcher carried out the project collecting both theoretical and empirical data. In particular, how all the types of data used in the project were analyzed and described.

**Chapter 4: Findings and Analysis**

In this chapter a description of the company and its processes is carried out by the use of an appropriate collection of data. Then the main issues are described carefully and theoretical methods (by Gunasekaran framework) are applied to those issues in order to develop them.

**Chapter 5: Discussion and Conclusion**

In this chapter the results of the previous analysis and the implemented improvements are discussed and related to other findings. In the end a conclusion is made and the academic contribution of this project is analyzed.

**Chapter 6: References**

In this chapter a list of references used within the project is made.

**Chapter 7: Search Terms**

In this chapter a list of the most used terms within the report is made.

**Chapter 8: Appendices**

In this section additional documents, data and tables are collected.
Theoretical background

2 Theoretical background

After the major economic crisis in the 1970s, SMEs started to be considered very important within the market. In fact, those companies have proved that they could be successful, like large companies, and achieve competitive advantage. In general SMEs are different from large companies for several reasons. Firstly SMEs are considered to be organic and the main characteristic of an organic organization is the presence of informal work relationships and the lack of standardization. The division of activities is limited and unclear since there are not formal rules and procedures. Usually, there is a difficulty in the coordination between the various departments and the structure is very centralized with low level of responsibility division. The top management, moreover, has the opportunity to build strong relationships with the employees but interpersonal conflicts can also increase (Ghobadian & Gallear, 1995).

According to Negron (2009), during the last few years, companies went through a strong technological development and they adopted new tools that contributed to develop companies’ production systems. Those new tools, such as JIT, process reengineering, total quality and others, contributed to an impressively development of operational efficiency within the SMEs. In order to make the production system more efficient, it is necessary to consider different dimensions and measure the level of efficacy within each one. Those dimensions and the relative tools or improvements are showed in table 2.1:

Table 2.1: Competitive dimensions of a production system (Negron, 2009).

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>IMPROVEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low production cost</td>
<td>• Automation</td>
</tr>
<tr>
<td></td>
<td>• Modernization of the plan and the equipment</td>
</tr>
<tr>
<td></td>
<td>• Reduction of waste</td>
</tr>
<tr>
<td></td>
<td>• Optimization of resource utilization</td>
</tr>
<tr>
<td></td>
<td>• Process standardization</td>
</tr>
<tr>
<td>Short lead time</td>
<td>• Appropriate inventory level</td>
</tr>
<tr>
<td></td>
<td>• Developed information system</td>
</tr>
<tr>
<td></td>
<td>• Inventory and production control</td>
</tr>
<tr>
<td></td>
<td>• Reduction of production cycle time</td>
</tr>
</tbody>
</table>
Theoretical background

<table>
<thead>
<tr>
<th>High level of quality</th>
<th>Innovation and flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Better quality control system</td>
<td>• CAD/CAM system</td>
</tr>
<tr>
<td>• Employees education and training</td>
<td>• Layout development</td>
</tr>
<tr>
<td>• Problem solving teams</td>
<td>• Development of a “pull system”</td>
</tr>
<tr>
<td>• Supplier system development</td>
<td></td>
</tr>
</tbody>
</table>

The dimensions and the relative improvements described in table 2.1, are included in new methods and strategies that need to be implemented within SMEs in order to make the company operation more efficient. Some of those methods/strategies were described by Gunasekaran et al. (2000), who developed a conceptual model that can help SMEs to improve their productivity and quality. It contains the most used strategies and methods that could be implemented in SMEs in order to gain productivity and quality improvements.

As it can be seen in the model, the main strategy and methods that could be used to improve productivity in SMEs are: JIT (Just-in-Time), 5Ss (sweep, sort, spotless, standardize and step), Hoshin exercise and Activity-Based Management.
2.1 Just In Time

According to Hirano (1988) the real power of Japanese industry were the small firms and subcontractors known as “shitauke”, even if when thinking about Japan the names that come to our mind are “Toyota” or “Matsushita”. Of those small-medium companies, about 200 (90% of subcontractors) contributed in a project called “JIT Factory Revolution” aimed to develop a new concept of production system. The conventional description of “just-in-time” (JIT) is defined as a system that distribute products that are needed, when it is needed and with the right quantity (Hirano, 1988).

During the first years of the Japanese industrial revolution, it was said that “manufacturing is the business of making things” since there was a lack of raw materials and anyone who could get those materials, also could make products and sell them. Successful manufacturers were thus those that had access to raw materials. Today things are changed, since globalization and international exchanges have made raw materials accessible to anyone all over the world. This means that the market of manufacturing products became more competitive and manufacturers need to make big changes in their way of thinking in order to become more competitive and achieve success. For these reasons it is important to hypothesize that “manufacturing is a service industry” (Hirano, 1990).

To achieve and maintain their competitive advantage, firms focus in strategies that reflect the issues of their system and address any kind of problem within the factory. Developing a manufacturing strategy consists of two phases: set-up the goals and achieve those goals. It is important to underline that strategic decisions affect not only the company, but also its suppliers, materials management, level of automation and customers. Those are the critical operation areas and they need to be well prepared, planned and coordinated to render the manufacturing strategy useful. One of those strategies is the Just-in-time strategy, which is a wide strategy that affects operation of many departments within the company. (Hernandez, 1989).

Hirano (1990) shows an approach that was used in many companies and which is called “the PQCDS approach”. It is a service-oriented approach that focuses on:

- Diversification of Products since customers want a wider variety of products within the market;
- High level of Quality;
- Low level of Costs;
- Faster Deliveries in the way that firms try to replace stocked products as soon as they are sold to the customer with short delivery schedules;
- Improved Safety regarding the factory and the products.
In few words, the PQCDS approach helps manufacturers to produce desired products (P) of high level of quality (Q), with low cost (C), fast deliveries (D) and guaranteed safety (S).

### 2.1.1 JIT process

According to Hirano (1990), implementing a JIT system means also change the old production methods into JIT production methods. While traditional production methods are inductive (based on current conditions) and based on statistical data, JIT production uses a deductive approach that leads the company towards a goal of an ideal system.

Figure 2.3 shows the 5 principal steps that a company needs to adopt in order to implement a JIT production system.
Theoretical background

Figure 2.3: Steps to follow in a JIT system implementation (Hirano, 1990)

The first step represents the base of this process since a JIT system is not possible to implement if everyone within the company and also outside (suppliers, customers etc.) are not aware of this revolution and participate in the innovation. Obviously, it is important that anyone within the company take part of the innovation, including the workers at the bottom of the organization, but the best place to start is at the top management of the whole organization (Hirano, 1990).

According to Hirano (1989), there are 5 important points to follow in order to cast aside the traditional way of thinking and change it to a JIT way of thinking:

- Assume that the current system is not working well;
- The top manager needs to change his way of thinking since he’s the leader of this revolution;
- All the executives and supervisors have to work hard to strengthen the working areas;
- Workers have to learn new methods through training meetings and learning seminars;
- Keep clear the policy and the principles since any change or revolution cause resistance.
Moreover, Hirano (1989) highlighted 10 development principles to follow:

1. Turn down traditional concepts about manufacturing methods;
2. Think about how new methods will work;
3. New methods are totally against the “status quo”;
4. Don’t look for perfection;
5. Adjust errors where they are found;
6. Don’t invest lots of money for the improvement;
7. Problems will give the possibility to use intelligence;
8. Ask “why” for five times (5W rule);
9. Ideas from ten people is always better that just one person idea;
10. Improvements do not have limits.

The second step is following the 5S philosophy that highlights 5 basic principles to adopt in order to implement a JIT system. Those principles are represented by 5 words that begin with “S”. The 5S are: method arrangement (seiri), orderliness (seiton), cleanliness (seiso), clean-up (seiketsu) and discipline (shitsuke) (Hirano, 1990), see section 2.2.

The third step is about manufacturing flow that, according to Hirano (1990), means “bring the factory’s underlying waste to the surface”. For instance, big batch production tends to hide waste while flow manufacturing reveals it. Manufacturing flow process is based on handling the production piece by piece. It is important to study how the product is made during the manufacturing process in order to detect the bottlenecks, which can cause issues in the product flow.

The fourth step is about leveling the production in the way that it will be as close as possible to the customer demand. To achieve this the company needs to reduce the inventory level to zero. Reducing the inventory level leads the company to decrease warehouse costs, and at the same time, the company can offer a high level of diversification and shorter lead-times. (Hirano, 1990)

The fifth and last step regards the ability to standardize the operations. According to Hirano (1989), “Standard operations are rules and methods to safely produce products of high quality at a low cost through an efficient organization of people, products and machines.” According to Hirano (1990), standard operations are standards that join to a series of standard operating procedures (SOPs) into a specific order to build a product.

### 2.1.2 Material Management

To understand the JIT system it is important focus on the difference between two types of system:

- Push System
- Pull System
Both systems are about how to move materials within a factory. Companies that adopt push systems, use material requirement planning (MRP) to handle their production flow and control the material movement throughout a factory. In a push system, the production planning sends the information of required volume planned directly to the various stations. One issue that regards the “push” system is the risk of high level of inventories. This happens because the forecasts are uncertain and the “push system” does not produce based on customer orders. Usually, a “push system” produces more than just what the customer requests. This excess of products is converted into inventories.
In a pull system the customer request drive the flow throughout the process. In this type of system the production line will handle only the material requested to meet the customer demand and if a problem will show up during the production, all the process will stop itself. In this way the excess material produced will be less than in a push system (Hernandez, 1989).

JIT support a pull system where materials are moved from one work center to another in the smallest possible quantities and with the shortest possible lead-time.

There are two types of material movements in a manufacturing environment: the external movement of material from supplier to customer, and the internal movement of material throughout the several workstations within a company. Regarding both types of movement, according to JIT system, the time that a material spends travelling does not add any value to the final product and it is just a waste (Hernandez, 1989).

### 2.1.3 Safety stock and Inventories

According to Hernandez (1989), JIT considers also safety stock as one of the major wastes. Safety stock is a quantity of inventories that remain in the warehouse in order to feel safe in a manufacturing environment. There are two types of safety stocks:

- **Voluntary**: inventories are kept voluntary in order to cover any hole in the production planning or in the supplied material;
- **Involuntary**: the material department send to the production line more parts than the production capacity can use.

Experience show that the quantity of voluntary or involuntary inventories is larger in a push-system than a pull-system since the pull-system tends to produce only what is needed from the customer without any excess. But what happens in a real production line? How does the pull-system work? The pull-system works thanks to a card called Kanban that helps to make the process work (Hernandez, 1989).
2.2 5S

In order to make the factories adapt to the changing environment, they must move on from the old and traditional organizational systems and try to implement new methods that can help them to survive in a more competitive environment (Hirano, 1995). According to Chapman (2005), most of the companies face problems regarding waste of time and resources within the workplace. For instance, within a workplace, workers, most of the time, look for missing tools or components, do not take care of obsolete parts, do not find WIP so the work order are incomplete etc. All these problems are triggered by a lack of organization and standardized rules. In a long-term approach all those issues will affect the productivity and the quality of the company negatively and in particular they will:

- Increase lead-times and delivery-times;
- Decrease productivity and quality level;
- Increase costs;
- Increase equipment break-downs and set-up times;
- Increase safety risks;
- Increase space constraints issues.

To avoid or correct all those issues, one solution is implementing a 5S system that leads the company to improve its activities and way of working (Chapman, 2005). The 5S system is based on 5 “pillars”, as Hirano (1995) defined them, and they are represented by 5 words, relatively referred to specific standards:

<table>
<thead>
<tr>
<th>5S Pillars</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sort</td>
<td>Distinguish needed from unneeded items.</td>
</tr>
<tr>
<td>Set in order</td>
<td>Put things in the correct and assigned place for easy and faster retrieval.</td>
</tr>
<tr>
<td>Shine</td>
<td>Keep the workplace clean.</td>
</tr>
<tr>
<td>Standardize</td>
<td>Maintain the first three pillars standardized.</td>
</tr>
<tr>
<td>Sustain</td>
<td>Maintain 5S pillars as established procedures</td>
</tr>
</tbody>
</table>
The implementation of a 5S system is fundamental to highlight inefficiencies and wastes within the workplace and to solve them. Indeed, when a company implements a good-workplace organization, the process defects can be reduced by 50% (Chapman, 2005).

### 2.2.1 Sort

According to Hirano (1995) “sort means that you remove all items from the workplace that are not needed for current production operations”. The first thing to clarify is what is needed and what is not; as a matter of fact, employees often misunderstand it. For instance, Chapman (2005), said that, most of the time, a workspace is full of parts, WIP, scrap, document, tools, packaging materials, and other items that represent material that is not needed to meet production objectives. This material make just chaos within the workspace impeding the workflow. According to Hirano (1995), those items tends to accumulate in the following locations:

- Corners next to the entrance/exit;
- Along walls;
- Along warehouse’s shelves;
- In toolboxes that are not clearly sorted.

Those items need to be identified and collected in order to take a decision about what to do with them. The red-tag strategy is a simple method to identify and collect material (signed with a red-tag) from the warehouse or the whole factory. After creating a “red tag area” (where the unneeded or obsolete material is collected), the material is evaluated and decisions about what to do with it are taken (Hirano, 1995).

### 2.2.2 Set in order

According to Chapman (2005), “set in order means that there is a place for everything and everything is in its place”. The location of machines, inventories, tools, files and other items should be clear so that anyone can easily find what he is looking for and replacing it without any difficulty. Hirano (1995) defined the “set in order” pillar as the core of standardization since it is impossible to implement any form of standardization if the workplace is not in order before.

After finding the appropriate location for those materials, it is important to clearly sign the location boundaries so that it is easy to know where to go or where to find the item that is looked for. The signboard strategy, for instance, is used to identify locations such as:

- Work areas;
- Inventory locations;
- Equipment storage;
Theoretical background

- Standard procedures
- Layouts.

For example, when “set in order” inventory locations it is important that every shelf have a signboard to identify the section. Moreover every space into the shelf needs to have an address signboard (return address) useful to make easier returning an item to the right place once it has been removed. Moreover, it could be useful to mark the “walking areas” and the “working areas” by painting the floor in order to easily identify locations (painting strategy). In the end, outlining and color-coding strategies are useful to identify the tools’ or materials’ location by marking their shape and the purpose of using such a tool or part. (Hirano, 1995).

2.2.3 Shine

This pillar is aimed to develop activities that keep everything clean and swept, in the way that also equipment is in top condition and ready to be used. According to Hirano (1995) cleaning targets are represented by:

- Warehouse items (raw materials, inventories, components, semi-finished and finished products)
- Equipment (machines, tools, instruments, chairs, desks, etc.)
- Space (floors, working areas, walking areas, walls, shelves, etc.)

While employees are cleaning they also should make inspection of the equipment or the controlled space, for example, using checklists to standardize the tasks. (Chapman, 2005).

2.2.4 Standardize

This pillar is used to maintain the first three pillars and it is useful in order to create a consistent way that tasks and procedures are done. The main aim of this pillar is to combine “sort”, “set in order” and “shine” into an integrated system, after the three pillars are properly maintained. In order to implement standardization, it is important to follow 3 steps:

- **Assign responsibility**: everyone must be aware of who is responsible, for what, when, where and how to do that job.
- **Integrate 3S duties into regular work duties**: the maintenance of the three pillars must be considered as a natural part of everyone’s work tasks.
- **Check the 3S maintenance level**: apply maintenance tasks after the 3 pillars are implemented as an everyday work routine.

“Implementing an unbreakable standardization means making Sort, Set in Order and Shine unbreakable procedures” (Hirano, 1995).
2.2.5 Sustain

This fifth pillar is considered as a guide of how to standardise the first three pillars. It gives a sort of guide that sustain the implementation of the other pillars. However, the results of the implementation of this pillar are not measurable and visible. The most useful conditions to apply sustained pillars are:

- **Awareness** of everyone of how important it is to sustain the four pillars;
- **Time** that is needed to make the implementation of 5S pillars;
- **Structure** to implement the 5S strategy;
- **Support** in terms of leadership, resources and acknowledgement;
- **Rewards** since efforts always need to be recognised;
- **Satisfaction** of the implementer and the whole company in order to involve more people.

Even if the four pillars are implemented very well, it is not sure that the 5S system will work for long without an applied and well used sustainability (Hirano, 1995).

2.3 Activity-Based Management

Activity Based Management (ABM) is a method that identifies and evaluates activities that are carried out within a firm and it determines their cost and performance. The idea is to manage those activities and business processes in order to achieve organizational objectives, reduce costs and non-value activities. Activity Based Costing (ABC) is closely related with ABM and it is a method that assigns costs in a different way from the traditional cost allocation. With ABC method, costs are assigned depending on the activities (planning, engineering, manufacturing etc...), which are associated with specific products or services (Alabbadi & Areiqat, 2010).

Enterprises are usually organized with a rigid separation and specialization between the various departments, in the way that each department has different objectives, which lead them to have a lack of coordination. This separation of responsibility leads the different departments to compete and not to collaborate and coordinate. This is caused by lack of knowledge about the interrelated activities within the whole process. Indeed, all the activities that concern each department are interrelated and the need of an integrated system is, today, fundamental in order to achieve a harmonious flow throughout the organization. This integrated system contributes to shut down the barriers between departments and it involves all the workers and the activities in a strong collaboration (Brimson and Antos, 1994).

According to Brimson and Antos (1994), activity-based management aims to breaking down the organization into activities. Each activity is an explication of what the enterprise does and how much time it spends. The activities can be classified as:
Theoretical background

- **Repetitive**: those activities that the organization carry on a continual basis and they involve repetitive processes.

- **Non-repetitive**: they are one-time activities, usually managed during a project.

- **Primary**: activities that contribute directly to the department mission.

- **Secondary**: activities that support primary activities within a department (administration, training, supervision).

As said before, activity based costing is an instrument of activity-based management and it is becoming very important within SMEs. In particular, the implementation of ABC method is growing within those firms that aim to improve their productivity and quality. One of the advantages of implementing ABC method is that it allows firms to produce parts with better consistency and conformity to quality specification; but the most important advantage is that ABC drives the reduction of time between customer order and delivery (Gunasekaran et al., 1999).

ABC provides the bases for achieving enterprise excellence and improving cost and performance. Moreover it provides a clear view of how services and activities are used within an organization and it provides a non-value-added analysis and analysis of best practices. (Brimson and Antos, 1994).

### 2.4 Hoshin Exercise

According to Witcher and Butterworth (2001) Hoshin Kanri is a strategy that combine strategic and operational management objectives. Since in many companies top management goals do not correspond to the daily operational ones, Hoshin Kanri aims to consider top management goals at operational level.

According to Hutchin (2008) the term Hoshin Kanri has four components:

1. Ho: direction;
2. Shin: focus;
3. Kan: alignment;
4. Ri: reason.
Hoshin Kanri is closely related with Total Quality Management (TQM), which is founded on the principles that each person within an organization is considered an expert on his job or task and that he wants to be part of the success of a firm by giving a small contribute. At a higher level, each department within a company has its own goals, targets and way of working, usually different from the other departments and sometimes from the top management. In a company where Hoshin Kanri is not used, each department will be separated from the other departments in the way that they don’t share the same goals. This lead to conflicts between departments and managers of each department will focus only on the local goals rather than be in line and interested in the goals of the whole organization. Moreover, each department just perform its own activities in its own way without considering if its way of working could negatively affect the next department. This is caused by a lack of communication between departments that leads to that they don’t understand each other’s needs (Hutchin, 2008).

Figure 2.8 shows how conflicting departments affect the whole company when Hoshin Kanri is not applied:

![Figure 2.5: Non-Hoshin Kanri management (Hutchin, 2008)](image)

The various vectors represent the goals of each department and, as it can be seen, those vectors have different directions. That means that each department within this company does not share the same goals and departments do not communicate (Hutchin, 2008).
On the contrary, if the organization chooses to implement the Hoshin Kanri model, the different vectors will be aligned to the same direction. That means departments will start to communicate, share problems and solution to those problems, and share the same goals aligned also with the organizational goals. The management will pass from a management by function to a management by process where departments’ functions are integrated and where the performance process output will be higher than a management that does not use Hoshin Kanri. The differences between those two types of management style (Hoshin and Non-Hoshin) are showed in figure 2.9.

![Hoshin policy for the organisation](image)

**Figure 2.6**: Differences between Hoshin and Non-Hoshin Management (Hutchin, 2008)

In general figure 2.9 shows the typical organization, with conflicting departmental goals, and the ideal organization where the departmental goals are aligned with corporate goals. It is important to implement a Hoshin Kanri method within a company, in the way that every department aligns its own goals with the other department goals.
3 Method and implementation

3.1 What’s a research?

According to Williamson (2002), research can be described as one of the fundamental activities of human beings. The need to know, interpret the environment through exploring and comparing things is called research. While the “basic research” is about gaining new knowledge and tends to focus on theory building, “applied research” is based on solving problems in real-life situations and it is much more pragmatic and concrete.

3.2 Case study and action research

According to Yin (2009) a case study is “an empirical inquiry about a contemporary phenomenon, set within its real-world context, especially when the boundaries between phenomenon and context are not clearly evident”. According to Yin (2012), the main reasons why to choose this research method are related to:

- Research questions;
- Collection of data
- Aim of the research

The type of research questions that the study will address must be descriptive questions (“What results will be reached concerning quality and productivity within the paint department of Novaprint?”) or explanatory questions (“How can the improvement strategies and methods in the model of Gunasekaran be used in order to bring appropriate results in a SME?”), in the way that they highlight the problem, describe it, and focus on how to solve it. Moreover, the collection of data must be done in a natural setting, since the study is based on a real-world context, and it must not be based in data that has been used before. In the end the “case study” method is usually used to conduct evaluations and it is used also as a source of authoritative studies. (Yin, 2012)

According to Williamson (2002) “Action Research” is a hermeneutical approach that is based on the study of human actions and social practices and it has been applied in fields like organizations and organizational behaviors. The main objectives of action research are the action in practice and the generation of knowledge. The action research process is based on four steps closely connected in cycle. Figure 3.1 shows the process of action research method:
The important thing that is shown on this figure is that from results of an action, some reflections (knowledge) are generated and, with those reflections a plan for another action research cycle is generated. This approach makes the study more practical and concrete based on traditional theories but, the reflections on previous studies are also considered as an important source (Williamson, 2002).

According to Benbasat et al. (1987) the action research method differs from the case study because it involves actively the researcher within the study. In this way, the researcher becomes an active participant within the project rather than just an observer. Indeed, he will help and collaborate to solve problems and concerns in order to be an active part of the entire project.

Coghlan and Brannick (2005) said: “action research may be defined as an emergent inquiry process in which applied behavioral science knowledge is integrated with existing organizational knowledge and applied to solve real organizational problems. It is simultaneously concerned with bringing about change in organizations, in developing self-help competencies in organizational members and adding to scientific knowledge. Finally, it is an evolving process that is undertaken in a spirit of collaboration and co-inquiry”.

For this last reasons this study research is based on combination of a case study and an action research since it satisfies all the requirements of a case study and, at the same time, it involves actively the researcher in the research project as a participant.
3.3 Collection of Data

3.3.1 Collection of theoretical data

Within the project, the collection of theoretical data was conducted by the researcher though a literature review. According to Creswell (2003) “the literature review in a research study accomplishes several purposes. It shares with the reader the results of other studies that are closely related to the study being reported. It relates a study to the larger on-going dialogue in the literature about a topic, filling in gaps and extending prior studies”.

Regarding this project, the literature review was conducted collecting different types of materials. As references books and articles were used from two different libraries. The majority of the books used came from a library in Mexico City and some e-books, which were found on the web. The scientific articles came from both the library in Mexico City and the one in Jonkoping University. All this material was selected by several criteria. For what regards books, they were selected through the topic name and, then, just the chapters suitable with the topic were read and reported. The articles were searched in the on-line library and they were selected through a “cited by” selection method in order to highlight the most referenced and used papers. Within the on-line library, the “Scopus” database was used for a wider research of scientific articles. The most used search terms were: “JIT improvements”, “Hoshin Kanri method”, “ABM implementation”, “5S strategy”, “Productivity improvement”, “Quality development”, etc...

Mostly, the literature review was used to write the “Theoretical Background” chapter and in particular the topics showed by Gunasekaran et al. (2000) in his framework were individually searched and studied in order to have a strong base of theory and apply it to the project.

3.3.2 Collection of Empirical data

The empirical investigation and collection of data was conducted during 5 months, from January 2013 until May 2013. At the first interview with the General Director, the project was discussed and defined.

The project started with a deep observation of the processes and the activities carried out within the whole company in order to understand the process flow. At the same time questions were asked while the processes were observed. The second part of data collection regarded exclusively the department to which the project was assigned. At this phase pictures were taken in order to fix the actual situation of the environment that need to be developed and then, to see the differences between the old system and the after-project system. According to Creswell (2003), the collection of visual material, such as pictures, represents a discrete method of collecting data and, moreover, it is an opportunity for participants to share their reality. It, also, captures attention visually since it is creative.
Also documents were collected such as flow charts, organograms and other documents which contributed to get a clearer vision of how the processes worked within the company, how people are involved in those processes and how the main procedures works and are controlled within the departments.

3.3.2.1 Interviews

According to Kvale (1996) an interview is a conversation between two parts or people that are represented by the interviewer (most of the case a researcher) and the interviewee. The researcher has the task of asking questions and gain information from the interviewee. Interviews are considered as a systematic procedure to talk and listen to people in order obtain knowledge and information about a specific topic.

According to Williamson (2002), there are many types of interviews and they differ from each other based on the structure of questions or the number of interviewees. In this project unstructured interviews and E-mail interviews were used.

Semi-structured interviews are interviews that start with planned questions but the interviewer does not always follow the structure of the questions. Based on the answer of planned questions, the researcher can ask the next question (the answer will generate the next question) (Williamson, 2002). This type of interview was carried out by the researcher during the whole project in order to gain knowledge about the company, its processes and the issues that concern them. The interviewees were represented by the worker responsible for the paint department, and the responsible for the big warehouse, who had knowledge about all the processes regarding the various production departments.

E-mail interviews are used when there is impossibility for the interviewer and the interviewee to meet and talk face-to-face. They can also generate in-depth data and they consist of an exchange of information, gained through questions and answers, by e-mails (Basit, 2010). In this case study, e-mail interviews were conducted in different times of the project each time that the researcher had doubts about the processes or if he needed some company data, material or information. The e-mail interviews were conducted with the company-managing director and an on-line relation was maintained also with the warehouse responsible.

3.3.2.2 Observations

As interviews, observations are a primary source of data in qualitative research. Observation is a systematic research tool since it must answer to specific research questions. The main reason to conduct observations is to achieve some knowledge of a specific context and also to understand issues within the phenomena. Moreover observation can be very useful in a context where people may not feel free to talk or to be interviewed about a topic. In this way the observer can catch struggles and problems, among a group of workers, that an interview could not reveal (Merriam, 2009).

According to Creswell (2003) observations have the following advantages:
• Researcher can record information as it is revealed;
• Researcher can notice unusual aspects;
• Researcher can explore topics, which are uncomfortable for participants to discuss.

According to Merriam (2009) a researcher has to observe several elements such as:
• The physical setting and which resources or technologies are in that setting;
• The participants and their organization within that context;
• Interactions between workers and their activities;
• Conversation between workers perhaps through a recorder;
• Subtle factors such us informal and unplanned activities;
• Researcher behaviour since she is part of the scene as a participant.

At the moment when the researcher becomes familiar with the phenomenon and the setting, she starts to, gradually, be involved in the activities that have been observed. In this way the observer becomes a participant that is entirely involved in the same environment as the other participants (Merriam, 2009).

### 3.4 Gantt Chart

The Gantt chart shows how the project was carried on. Usually a project is divided in many activities and each one of them has a particular time period in which it should be completed. Figure 3.2 shows the Gantt chart made for this project with the different activities and dependencies between them. These dependences between activities are showed by an arrow connecting them.

![Figure 3.2: Project Gantt Chart](image-url)
3.5 Validity and Reliability

Williamson (2002) defines the concepts of validity and reliability as the following:

- Validity is the capacity of a research to measure what is set by the researcher to measure.
- “Reliability refers to the consistency of results produced by a measuring instrument when it is applied more than once in a similar situation”.

Validity can also be measured as internal or external. While the internal validity refers to collection of data that regards only the local context (company or department), the external validity refers to the applicability of data, collected in a specific context, in an external context (another company) (Williamson, 2002).

The aim of reliability is that, if a researcher carry out a study with particular procedures, a later investigator should arrive at the same results and findings of the first researcher, using the same procedures. Moreover it is important to document these procedures in order to avoid a possible repetition of work and to make the reader aware of where that results really comes from (Yin, 1994).

This thesis was conducted with a good validity and reliability. The collection of data was conducted with a close relation with the responsible of the department and even more of the all company (General Director), who gave the right information about the research. It was possible visit many times the company and observe personally the processes within the department, participating actively to the project. All those reasons made the research valid and reliable.
4 Findings and analysis

4.1 Company Background

The project was based on a case study conducted in Novaprint, a Mexican company that produced packaging material for the pharmaceutical industry. Novaprint was a small company and needed to develop one of its departments following a theory-based research of methods and techniques, which could help the company to achieve the expected results at the end of this project.

Novaprint was a Mexican Company with more than 30 years of experience that produced pharmaceutical packaging material and distributed it to pharmaceutical industries. The biggest plant, situated in Mexico City, was 3000 m² and 90 employees were working in 2 shifts (45 workers for each shift), since the plant was open from 6 in the morning to midnight, from Monday to Saturday. There was also a small plant situated in Guadalajara but it was about 1/5 of the biggest plant in dimension and production capacity.

The principal objective of the company was achieving competitive advantage by making a strategic connection with its customers, offering a big variety of packaging products with good quality, high level of flexibility and short delivery time. Novaprint had contacts with many important pharmaceutical industries in Mexico and also abroad. The company, moreover, offered direct exportation to other countries such as Brazil, Peru, Ecuador, Nicaragua, Colombia, Dominican Republic and also USA. In 2012 the company had a growth of sales of 15% compared with the past year and it run 6900 work orders.

Basically, the company production area was divided in three production departments working together in order to send the semi-final products to the final production line that consisted in a process of printing, rewinding and cutting the blister rolls. The project focused on one of the company departments: the Paint Department. This department included the production of various paints and their location in a small warehouse. This warehouse was separated from the central warehouse, where materials and final products were stocked, physically as well as in terms of type of organization and inventories handling.

4.2 Company Production Processes

The whole production process to get to the final product was divided in sub-processes handled in different production departments where the semi-final product was stored and sent to the final production line. For these reason, each production department had a specific production process, more or less complex, and a relatively small warehouse where the products were stored. Moreover, there was also a big warehouse where the supplied materials and the final products were stored. Each department sent their products to an area, placed in the big warehouse, where the materials from the different departments were combined with the supplied materials. This combination of material represented a work
order that was assigned to a specific printing machine and then sent to the final production line.

Figure 4.1: Company Production Processes

A work order was a kit of materials ready to be sent to the final production line. The material kit was composed by rolls, paper cylinders and paints put on a pallet, which was assigned to a printing machine and ready to be sent to the production line. Only when the pallet was complete with all the materials requested, it could be send to the production line.

4.2.1 Production Departments

Basically there were three different production departments: the roll department, the paper cylinder department and the paint department.

The rolls were produced in the roll department. They had different engravings based on the customer request. These rolls were produced and then stored in a small warehouse ready to be sent to the big warehouse directly in the work orders place.

The paper cylinder department was located in a small area where the big paper cylinders were stored and then cut by a semi-automated cutting machine based on the diameter of the foil coil that was going to be worked. Also these paper cylinders were sent to the work orders area.
In the end there was the paint department where requested paints were produced and stored in a warehouse of approximately 300 locations.

4.2.2 The principal warehouse

The principal warehouse was the place where the majority of material and final products were stored. The materials consisted of rolls of blister foil aluminum, plastic or laminated foil and the final products were, basically, printed and cut coil foils ready to be sent to the final customer. The maximum stored capacity was about 3000 tons of material in the principal warehouse, where 1500 tons were used for printed coils and about 1500 for only cut coils.

In the principal warehouse there was also an area where all the materials, divided by orders, were placed. The different work orders, as said before, consisted of a combination of materials put on a pallet that was sent directly to the final production line. These work orders were assigned to the respective printing machine where they were going to be run.

4.2.3 The final production line

The final production line was located in a big area where the coils were printed, cut, rewound and sent to the warehouse ready to be delivered. In the final production line there were ten printing machines, two cutting machines and three rewind machines.

The printing machines varied based on the number of paints to print on the coils. The width and the speed of the machine depended on the number of paints that could be used to print the coil. For example, there were printing machines for one paint, two paints, four paints and six paints. A printing machine of only one paint was smaller and produced with lower speed than the one with six paints. Moreover, the number of paint buckets and the number of rolls depended on how many paints the machine was going to print on the foil. Each year about 1500 tons of coils were printed in this production area. Some customer orders did not include the printing activity but only the cutting one.

4.3 Paint Department

The project focused on the paint department since it was the department less developed in comparison with the other departments.

The paint department was situated near the big warehouse on the second floor and it had access through a small spiral staircase. This made the material handling difficult since they needed an elevator to move the paint from the department to the big warehouse.
Findings and analysis

The paint department covered a small area of about 80 m² and it included the area where the paints were produced (paint-production area) and the area where the paints were stored (paint warehouse). The paint warehouse included the storage of basic paints, solvents and final paints.

Final paints were the produced paints and they were composed by mixing basic paints and solvent. All those paints were stored in buckets of 20 kg capacity in different locations within the warehouse. To each location was assigned two or three buckets depending on the space. The paint department presented almost 300 locations with 450 paint buckets. Even if each bucket had a capacity of 20 kg, not all the buckets were full or even at the half. For this reason it was assumed that the quantity average was 15 kg for each bucket. The average was calculated based on a sample of 20 buckets.

![Figure 4.2: Average of buckets weight.](image)

The total quantity of paint within the warehouse was calculated as the total number of buckets multiplied with the average weight quantity of each bucket:

\[ 444 \text{ buckets} \times 15 \text{ kg/bucket} = 6660 \text{ kg.} \]

In total the warehouse contained about 6660 kg of paint.
Findings and analysis

The average cost of this paint was 7,00 $/kg, according to the interview with the general director. This meant that the value of the paint inventory was:

\[
7,00 \, \text{$/kg} \times 6660 \, \text{kg} = 46620 \, \text{$}
\]

However the value of the paint inventory that was calculated above is not real since there was a big quantity of paint that had become obsolete for months or even years. Those paints lost their value due to the time passed that affected the properties of the paints.

The buckets’ locations were not registered in an IT archive system but they were registered in a handwritten notebook and this made difficult the placing and picking-up of the different buckets.

4.3.1 Paint Department Processes

When a request was sent to the paint department, there were two ways to satisfy the same request depending on the exiting stock of the requested paint. The process flow of this department is showed in figure 4.3.

![Figure 4.3 Paint Department Process Flow.](image)

As it can be noted there were two different ways to satisfy a paint request:
Findings and analysis

• If the paint bucket requested was already stocked in the paint warehouse (red line), then the operator needed to pick it up and send it to the big warehouse (order area).

• Otherwise, if the paint bucket was not stocked (blue line), then the operator needed to produce it using raw materials that were located in the warehouse and following a production process procedure. In the end, the produced paint was sent to the big warehouse.

Obviously, if the paint was already stored in the warehouse, the worker would spend few minutes to pick up it and send it to the order area. At the contrary, if the paint was not stored, the time to send it to the order area would be a lot longer because of the production procedure that the worker had to follow.

4.3.2 Activities process

Regarding the case when the paint was already stored, it was not possible to get information about how much paint needed to be sent to the production line. The problem was due to the fact that it was currently not possible to calculate how much paint would be used to complete a customer order since it depended on the depth and the type of engraving of the roll. For instance, some rolls needed more or less use of paint comparing with others and the company lacked methods for calculating the exact amount of paint needed.

Since the buckets’ capacity was 20 kg, in some cases it resulted that it was too much to send a bucket of 20 kg of paint because a big quantity would be returned to the paint department to be stored again. For this reason, in some cases the paint department, instead of sending buckets of 20 kg of paint, sent buckets with the capacity of 10 kg (small buckets) to the printing process. For instance, if the printing would imply just a small text and the coil foil would be small, it was sure that not much paint would be used to print and so, the paint department would send the small bucket.

When considering an Activity-Based Management approach it is important to evaluate each activity and the costs involved for each activity. In this case study, activities were represented by what the worker needed to do in order to follow a process or a procedure and to complete a task. The analysis was limited due to the fact that the case study was based on a single department and there was a need to define boundaries for what regards the ABM strategy. The procedure that the worker had to follow, in order to send a bucket to the production line (if the bucket is already in the warehouse), was the following:

1. Receive the paint bucket request;
2. Pick up the big bucket from the warehouse;
3. Pour the paint from the big to the small bucket;
4. Send the small bucket to the final production line;
5. Receive the small bucket when it is returned;
6. If there is paint left, pour it again into the big bucket and store it.

All the activities were analyzed through an ABM approach in order to understand which activities could be considered as "non-value added" activities. Those activities could be changed in order to be more valuable and less costly or, directly, removed from the whole process, by using some types of improvements. The activities listed before were studied and analyzed in terms of time needed and if they were necessary or unnecessary activities. This evaluation is reported in table 4.1:

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TIME CONSUMED</th>
<th>IS IT NECESSARY?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive the paint bucket request</td>
<td>30 sec</td>
<td>YES</td>
</tr>
<tr>
<td>Pick up the big bucket from the warehouse</td>
<td>2 min</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>(depending on the location)</td>
<td></td>
</tr>
<tr>
<td>Pour the paint from the big to the small bucket</td>
<td>2 min</td>
<td>NO</td>
</tr>
<tr>
<td>Send the small bucket to the final production line</td>
<td>30 sec</td>
<td>YES</td>
</tr>
<tr>
<td>Receive the small bucket when it is returned</td>
<td>30 sec</td>
<td>YES</td>
</tr>
<tr>
<td>If there is paint left, pour it again into the big bucket and store it</td>
<td>3 min</td>
<td>NO</td>
</tr>
</tbody>
</table>

As it can be noticed in table 4.1 two of those activities are considered as not necessary activities. This means that, after an analysis of those activities, it was found a way to avoid the two selected activities through small but, at the same time, effective improvements. Those improvements were analyzed, discussed with the director and the paint department responsible, and implemented.

The improvements consisted of the transfer of the majority of the paints from the big (20 kg) to the small (10 kg) buckets. However, the small buckets could not be used in the two biggest printing machines because they did not fit. Hence, a number of paints remained within the big buckets. In figures, starting with 444 buckets, 151 did not change, while 293 big buckets were converted in small buckets.
Thanks to this change, the two activities considered as “non-value added activities”, were removed and the time to deliver the bucket to the production line was reduced consistently. It is important to specify that this change was applied to the small buckets and for the big buckets the activities (and the time consumed) remained the same as before. While sending a big bucket the operator would spend about 8.5 min, sending the small one the operator would spend 5 min because the activities of pouring from the big to the small bucket and vice versa had been cancelled. In this way, when the operator had to send a small bucket, he would spend 3.5 min less than before the implemented change. In other words, with a daily request of about ten small buckets per day, the paint department would be able to save:

\[
3.5 \text{ min/bucket} \times 10 \text{ buckets/day} = 35 \text{ min/day}
\]

\[
35 \text{ mins/day} \times 25 \text{ day/month} = 875 \text{ mins/month} = 14.6 \text{ h/month}.
\]

In the end, with this small change, the paint department would save

\[
175 \text{ h/year}
\]

\[
(14.6 \text{ h/month} \times 12 \text{ months/year}).
\]

Moreover, this improvement affected positively and developed other aspects of both the inventory management and the production of paint. For instance, this improvement could also be considered as part of the Just-in-time system implementation. Indeed, JIT is an approach based on the philosophy of “just what is necessary in the right quantity and at the right time”.

Before the project, the production process didn’t focus on a JIT system. Paints were produced in big quantities and sent to the production line. The overproduction was due to the fact that the paint production was done for buckets of 20 kg and it was difficult to estimate how many kg of paint were needed for one order. In that way the operator produced 20 kg of paint and sent it to the production line. According to the interview with the worker, most of the time the buckets returned to the paint storage almost full or half full and the remained paint were stored in the warehouse. In this way the amount of paint produced was too large compared with the paint requested from the production line.

The use of small buckets affected also the production quantity of paint. If the paint department started to use mostly small buckets, also the production of paints needed to fit to this change. The worker would start to produce 10 kg paint buckets which represent less paint but also in the right quantity and he would avoid overproduction.
4.3.3 Inventory Management and control

The paints buckets list and their locations were registered in a handwritten copybook and that made the control of inventory system very poor and difficult as well as the physical search for a stored product. The control of the inventory system was done when there was not space to locate other paint buckets and the storage seemed to be full. This fact underlined the lack of organization and control system regarding this department.

The paint inventories were not registered in the warehouse database system and this made the paint department independent, with a poor organization, not updated with the existing technology and low-controlled. Like a consequence there could be many obsolete paints that could be produced ones in large quantity, never used after that and became obsolete without any control on them.

The inventory control within the paint department was almost absent in the way that there was just a sort of localization of inventories within the warehouse but there was not knowledge about the existence in terms of kg of each paint. Hence, the worker was able to find the inventory location but he didn’t have any clue of how much paint there was inside the bucket. This issue made complex the production planning of paint since was not easy to know how much paint was needed. Collection of data is needed to make improvements and to evaluate performance measurement or KPIs. However, some data collection was not possible to make due to the lack of inventory control. Without knowing how many kg were sent and how many were returned, it was impossible to know the stock existence in the warehouse and, even more, how much paint was used in a week, month or year. The lack of inventory control was also a source for the existence of obsolete inventories in the warehouse, which could be stored and never used for months or even years.

The inventory control regarded also the purchase of basic paints. The purchase of those basic paints was requested by the worker without a standardized procedure. In fact, the worker sent the request of purchasing needed paints to the purchase department, which sent the purchase order. The worker determined the quantity to purchase depending on how much paint was still left. Usually, he requested those paints each week after he evaluated which paint were almost finished and which were enough for another week. The need of such paint was not measured in a good way and that was why the worker usually purchased more paint than it was really needed. The problem here was the lack of control of the purchasing basic paints and their use to make a final paint. The paint department, in fact did not register or control how much basic paint was purchased or how much basic paint was used to produce a pantone.

Inventory control, in general, it is important to develop in order to have a sort of track about warehouse rotation and paint use. Beyond the importance of JIT regarding the production in the right quantity and at the right time, the philosophy of just-in-time focuses also on the process and inventory control. Hence, it was necessary to implement this type of strategy within the paint department in order to control and keep in track items that went out from the department or that entered in.
An IT system was implemented in order to develop the inventory control system. A computer was located within the department and two excel files were implemented. These two files made it possible to register the stock movements. In particular the two files regarded respectively the control for final paints and the control for basic paints. The two types of paints were treated differently because of the different way of considering the in/out of paints. This interpretation is showed in table 4.2.

Table 4.2: IN/OUT interpretation depending on the type of paint.

<table>
<thead>
<tr>
<th>TYPE OF PAINT</th>
<th>IN</th>
<th>OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Paint (Pantone)</td>
<td>Returned from the production line.</td>
<td>Sent to the production line.</td>
</tr>
<tr>
<td>Basic Paint</td>
<td>Bought from a supplier.</td>
<td>Used to make a pantone.</td>
</tr>
</tbody>
</table>

For example, when the worker produced a pantone, the quantity of basic paint that he would use to produce it, would be registered as an “outflow” of paint while it would be an “inflow” when the paint department would receive the basic paint from the supplier. For what regards the pantone, the worker would register the paint quantity as an outflow when the bucket would be sent to the production line and, on the contrary, when the bucket would be returned it would be registered as an inflow.

In order to implement and initiate this IN/OUT control process, it was necessary to register the initial quantity of paint (basic and final) that existed within the warehouse. In order to do this, the researcher participated in the process of weighting all the buckets and registered them as an initial inflow. This process was necessary in order to have an initial stock of items and to implement the IN/OUT control system.

4.3.4 Paint Production Processes

In order to produce paint, it was necessary consulting formulas that showed how large percentages of basic colour, varnish and solvent were needed. The time to produce one paint took from 30 minutes to one hour and this time varied depending on the complexity of the paint. For instance, sometimes the worker had difficulties achieving the right tonality or viscosity of the colour. This issue made the process slow and, consequently, long. Another problem here was that there was only one worker in the first shift that produced those paints and that made the job very difficult to do by another person and, like a consequence, that particular job was closely dependent to one worker.
Findings and analysis

When paint was requested and there was no bucket of that paint stored in the warehouse, the worker needed to produce that particular paint. Each particular paint had a code and it was called “pantone”. Within the warehouse about 300 different pantones were used that differed from one another depending on the combination and mix of components. The main components of a pantone were:

- Basic paints
- Varnish
- Solvent

To make a pantone the worker used a “pantone form” that showed the formula to make each pantone. In particular, on each pantone form it said what percentage of each component was needed. The components presented in the pantone form were eight different basic paints (varnish red, rubin red, process blue, reflex blue, rodhamine, purple, yellow, green) and the varnish (or transparent). For what regards the solvent percentage it did not appear on the form cause it needed to be decided by measuring the viscosity (by a particular tool).

![Pantone Form](image)

Figure 4.4: Pantone Form

Each time that the worker needed to make a pantone, he needed to follow these steps:

1. Receive the request of the pantone that needs to be produced;
2. Look for the pantone code into the form;
3. Look for the percentage of each component;
4. Choose the total quantity to make a sample (for example 10 grams)
5. Calculate the quantity of each component in grams based on a percentage;
6. Produce the sample and test the quality;
7. If the quality is not good return to the step 5;
8. If the quality is good, re-calculate the quantity in kg of each component and produce it.
Table 4.3 shows the time consumed for each activity listed above.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TIME CONSUMING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive the request and look for the pantone code into the form</td>
<td>30 sec</td>
</tr>
<tr>
<td>Look up the percentages</td>
<td>1 min</td>
</tr>
<tr>
<td>Calculate quantity for the sample</td>
<td>5 mins</td>
</tr>
<tr>
<td>Prepare and mix the sample</td>
<td>10 mins</td>
</tr>
<tr>
<td>Test the sample quality</td>
<td>5 mins</td>
</tr>
<tr>
<td>Re-calculate the requested quantity</td>
<td>5 mins</td>
</tr>
<tr>
<td>Prepare and mix the paint</td>
<td>10 mins</td>
</tr>
<tr>
<td>Test the final paint quality</td>
<td>5 mins</td>
</tr>
<tr>
<td><strong>TOT</strong></td>
<td><strong>41 mins and 30 sec</strong></td>
</tr>
</tbody>
</table>

The lead-time for the production of the paint resulted 41 min. and 30 sec. One main cause of the lead-time was the time spent to make calculations from the percentage to the quantity in grams or kg. In particular the problems were:

- Calculation was made with calculator by the worker;
- Calculation was made twice (first for the sample and then for the requested quantity).

The bottleneck of this process was the calculation without any form of standardization that could help the worker to make the same process in an easier way and with short lead-time.

Revising the different activities for the paint production, and studying the paint production process, it was found that the long lead-time (41.5 min) could be decreased by implementing some changes. An Excel file was created in which the worker just had to insert the different variables and, in the end, obtain the final formula to make the paint. Those variables were represented by the percentages from the pantone form and the desired total quantity of the paint. The worker only needed to look at the pantone form and insert the same percentage in the right space within the excel file without doing any calculation, since those calculation were already programmed within the file. Table 4.4 shows how the final lead-time, to make the paint, decreased with just the implementation of this IT tool.
Findings and analysis

Table 4.4: Production process activities and relative time consumed after IT tool implementation.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>TIME CONSUMING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive the request and look for the pantone code into the form</td>
<td>30 sec</td>
</tr>
<tr>
<td>Look up the percentages</td>
<td>1 min</td>
</tr>
<tr>
<td>Insert the sample quantities (in percentage) for each colour component and the desired total sample quantity.</td>
<td>1 min</td>
</tr>
<tr>
<td>Prepare and mix the sample</td>
<td>10 mins</td>
</tr>
<tr>
<td>Test the sample quality</td>
<td>5 mins</td>
</tr>
<tr>
<td>Change the desired total quantity</td>
<td>10 sec</td>
</tr>
<tr>
<td>Prepare and mix the paint</td>
<td>10 mins</td>
</tr>
<tr>
<td>Test the final paint quality</td>
<td>5 mins</td>
</tr>
<tr>
<td><strong>TOT</strong></td>
<td><strong>32 mins and 40 sec</strong></td>
</tr>
</tbody>
</table>

As it can be seen the lead-time is shorter than before the implementation of this IT tool. With this type of improvement, the total paint production lead-time decreased of about 9 min per single pantone production. With an average of two pantones produced per day, the time saving is the following:

\[
2 \text{ pantones/day} \times 9 \text{ mins/pantone} = 18 \text{ mins/day}
\]

This means that the paint department, thanks to this improvement will save

\[
18 \text{ mins/day} \times 25 \text{ days/month} = 450 \text{ mins/month} = 7.5 \text{ hours/month}
\]

with a total of

\[
7.5 \text{ hours/month} \times 12 \text{ months/year} = 90 \text{ hours/year}
\]
Beyond this time saving every year, the issue regarded, basically, the coordination between the different departments. In fact, the order area waited for the components that were sent from the different production departments. Usually the departments sent the components almost at the same time. The order kit, ready to be processed in the final production line, was sent directly to the printing machine assigned, only when it was complete. This happens when the paint department had the paint requested already in stock. On the contrary, if the paint department had to produce the paint requested, the waiting time would increase because the order kit was incomplete and it had to wait for the paint requested while the other components were ready.

Basically the problem could be seen as a weak coordination between the different departments. Hoshin Kanri method could be a good solution in order to avoid this bottleneck. The different departments needed to communicate, collaborate and share the same goals in order to achieve a high level of coordination and increase the productivity.

### 4.3.5 Warehouse system development

As was said before, the paint warehouse had about 500 big buckets in stock at the beginning. All those buckets were placed on different shelves assigned at specific locations. Each location was marked with a number and 2 or 3 buckets were assigned for each place. The production area (where the worker produced the paints) was placed at the entrance of the warehouse in a small space.

The first impact, when the researcher made the analysis, from a physical point of view, regarded the general disorder and the low level of organization that affected the department. The locations were very difficult to identify and the buckets were soiled and it was very difficult to read the code of each paint, since stains of paint covered it. Moreover, there were many buckets of paints without a place, put just down in the corridors between the shelves. The reason was because the warehouse was so full that there were no empty places left. One of the causes found was that the warehouse was full of buckets almost empty or just full of obsolete paint.

Because of those issues, the implementation of a 5S strategy was considered necessary. The first thing to do was sorting the inventories by using a red-tag strategy. All the buckets were registered in an Excel file in order to have measurable data to analyse after the 5S implementation. Moreover, for each bucket analysed, decisions were taken, mostly by the operator responsible of the department. Those decisions taken, varied from:

- Transfer the paint from a big bucket to a small one or just throw away the leftover paint (if it was paint used not very often);
- Transfer the paint from a big bucket to two small ones (if was a widely used paint);
Findings and analysis

- Keep the paint in the big buckets (if it was paint used on the big printing machines);
- Throw away all the paint from a big bucket (if it was obsolete paint).

The result of those decisions were that 151 buckets were kept big, while 293 were transferred to small ones and 53 buckets of paint were thrown away. Table 4.5 summarizes the actual situation of types of buckets within the warehouse after the red-tag strategy implementation:

Table 4.5. Inventory situation after using the red-tag strategy

<table>
<thead>
<tr>
<th>PAINT</th>
<th>TYPE OF BUCKET</th>
<th>QUANTITY (NO BUCKETS)</th>
<th>QUANTITY (KG OF PAINT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good quality</td>
<td>Small</td>
<td>293</td>
<td>2344</td>
</tr>
<tr>
<td></td>
<td>Big</td>
<td>151</td>
<td>2265</td>
</tr>
<tr>
<td>Obsolete</td>
<td>Big</td>
<td>53</td>
<td>795</td>
</tr>
</tbody>
</table>

As it can be seen in table 4.5 there was 795 kg of paint selected as obsolete paint. This quantity of paint was directly sent away to an external enterprise, which deals with recycling and scrapping. The quantity of paint that was thrown away was considerably high and this fact shows the poor quality of the inventory control that regarded the paint department.

After this sort of cleaning-up from obsolete and unusable inventory, the whole warehouse was re-organized. Each shelf was given a name, which consisted of a letter (A,B,C…) and each location was given a number with the correspondent shelf letter they belonged to (1A, 2A, 3A, 1B, 2B…). Big buckets were kept on the floor level of each shelf because in this way it would be easier to pick them up or re-locate them since they were pretty heavy. In the other part, preferring small buckets instead of big ones, allowed to have more empty space, since for each row were located 2 more buckets that before. That means that at the end of the re-location of buckets, almost an entire shelf remained empty and corridors were freed from the previous unallocated buckets. In this way all the inventories were set in order as the second pillar of 5S.

Moreover, the small buckets were new and clean in order to follow the “shine” of the third pillar of 5S, and also the big buckets were changed to new ones. Even more, a code tag was fixed to each bucket with the code name, the description of the paint, the brand name, the tag date and eventual notes.
In the end the re-location of paints was done depending also on the type of paint. It was tried to put all certain types of paints together. For instance, red paints were located all together, as blue, green etc... Moreover the location of basic paint was changed and moved to another shelf. In fact, before the basic paint shelf was far from the paint production area and this made the internal logistics a little complex. For this reason it was decided to move the basic paints to the shelf right in front of the paint production area in order to make the paint handling and the internal logistics easier in general.

Figure 4.5: Inventory location before and after the 5S strategy implementation

Figure 4.6: Paint warehouse before and after the 5S implementation
Figure 4.5 and 4.6 shows how the warehouse organization was before the project implementation and the results after the implementation of the 5S strategy. As it can be seen the warehouse is orderly with clean and tagged buckets while before the project implementation, there were buckets out of their place, dirty and disorganized.
5 Discussion and conclusions

5.1 Implemented Method

Based on the RQ1 it is important to explain how the methods and strategies within the Gunasekaran framework were used in order to bring results in a SME.

As it was explained in the methodology chapter, the project was carried out as a case study and at the same time using action research. The researcher had a direct participation in the project. A case study can be conducted from an external point of view, with an appropriate analysis of the case and improvements suggestions. The analysis of this project was conducted as a case study analysis. Moreover, there was more than just a suggestion of improvements because these improvements were actually implemented with the direct participation of the researcher. That is the reason why it is right to say that the project was conducted through an action research.

The main advantages of conducting an action research regard the worker (from the paint department) involvement in the implementation. The participation of the researcher in the improvement process was important for the worker. In fact he seemed to be more motivated when the researcher was helping them in the improvement work. Moreover the researcher tried to involve him actively in the decision making process. For instance, each time that a decision was going to be taken, the researcher asked the worker opinions about that decision and if he thought it was useful for the future work. In this way, the worker felt himself active part of the project work and responsible of any changes.

For the reasons explained before, the researcher built a strong level of confidence with the worker. This confidence was important to achieve a high level of reliability from the interview with the worker. The worker answered the asked questions, with sincerity and desire to contribute to the project. This fact helped the researcher a lot since he didn't have to spend so much time in observations. For instance, some observation were avoided because the worker was very willing to describe how a process worked and which problems he faced.

The fact that the researcher was not a native speaker within the company was a limitation at least the first research period. After this period the researcher started to be more familiar with the language. Interviews and dialogues within the company were done in Spanish and this contributed to increase the reliability. The worker, indeed, was not able to speak another language; speaking Spanish language, for the researcher, was a great advantage because without this advantage, he could not achieve the same level of confidentiality with the worker and, consequently the level of reliability would be much lower.

5.2 Findings and Improvements

Regarding RQ2 it is important to discuss the results that were reached concerning quality and productivity within the paint department of Novaprint.
Even though the Gunasekaran framework was used before to improve the productivity and quality of a SME, it was uncertain that the same framework could be applied in a small area of the company. This research was based on the implementation of this framework in a single department within a company. Hence it is reasonable that the analysis of this case study resulted different from the previous studies done by Gunasekaran.

The implementation of the framework in a single department faced up different limitation. In some cases, was not possible to apply some methods within a single department since they suited more in a broader context such as a whole organization. For instance methods like Hoshin Kanri and ABM where not entirely implemented but some parts of the ideology was applied to the case. Also the improvements, made within the case, were, partly, included in those methods. For instance, Hoshin Kanri method was used to highlight the importance to have coordination between the departments rather than implement a goal setting strategy. Moreover the improvement of reducing the lead-time for the paint production process is not directly related with Hoshin Kanri method, but it helped the paint department to coordinate more with the other departments. The same approach was used when ABM method was considered. In this case the aim was to divide the paint department process into activities and evaluate the activities in terms of time consuming and “need level” rather than cost. It was also assumed that the “non-value” activities represented an avoidable cost for the department. For what regards the JIT system, the level of inventory, the obsolescence and the inventory control were considered as important aspects to take into account rather than the kanban system. On the contrary, it is important to highlight the success of the 5S method implementation. This method was wholly implemented within the paint department and the improvements led the department to an important development.

Table 5.1 summarizes the improvements implemented in the paint department. It value also shows the relation with methods by Gunasekaran and what objectives were achieved.

Table 5.1: Summary of improvements and relative results.

<table>
<thead>
<tr>
<th>IMPROVEMENT</th>
<th>RELATION WITH GUNASEKARAN METHODS</th>
<th>DESCRIPTION AND MEANS</th>
<th>FINAL RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elimination of non-value added activities</td>
<td>ABM</td>
<td>Transfer of paint from big to small buckets</td>
<td>Time-saving of 175 h/year</td>
</tr>
<tr>
<td></td>
<td>JIT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inventory management development</td>
<td>JIT</td>
<td>Implementation of in/out system</td>
<td>Higher level of inventory control</td>
</tr>
</tbody>
</table>
Discussion and conclusions

<table>
<thead>
<tr>
<th>Production process development</th>
<th>ABM</th>
<th>Implementation of a new formula standardized system</th>
<th>Time-saving of 90 h/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout development</td>
<td>5S</td>
<td>Implementation of 5s strategy</td>
<td>Increase of order, cleaning, space.</td>
</tr>
<tr>
<td></td>
<td>JIT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Moreover, figure 5.1 shows how the implemented improvements can be related with the methods and strategy described in the Gunasekaran framework, in order to have a clearer vision of how the framework was used within this case study.

Figure 5.1: Summary of the implemented improvements related with Gunasekaran framework.

As it can be seen, the improvements are related to one or more than one method from the Gunasekaran. This relation was highlighted in table 5.1 and, in figure 5.1, it is also visually explained.

The improvements that were implemented in the Paint Department of Novaprint Company contributed to develop the entire department and to make it more in line with the other departments, which were already more advanced. This development turned on the paint department in a more productive area with a higher level of quality.
5.3 Future research

This research was based on the application of Gunasekaran framework to a small department. The framework gave more knowledge to the paint area, improving the company process. However, the department had still few issues that regard the technology system and the automation. Also the communication between the departments is still weak and one of the major reason is the lack of an appropriate technology system within the paint department. While the other departments are connected through a IT system, controlling the whole company, the paint department is not connected with the company IT system. In this way, the other departments does not have visibility of paint inventories, which is an important thing that make the company and the different areas more integrated.

As said before, some methods, such as ABM and Hoshin Kanri, have not been fully implemented within the department. They were useful to make an approach of how handling the company development process. As possible future research could investigate how to implement those methods in all their aspects within a SME department, in order to make the Gunasekaran framework even more useful and effective.

Moreover, it would be a future research defining some other techniques which could be applied in a small department within a SME. Those techniques and methods could develop a department in terms of costs, quality, processes and productivity. For instance, in order to give more support to this thesis, could be a future research focus on other topics such as quality control, cost optimization, inventories models and production/product development processes.
6 References


References


7 Appendices

7.1 E-mail interview to the General Director

Here there are some questions that were asked during the interview that was done by e-mail to the General Director:

1. How the paint department handle the production requests?
2. How the paint department handle its warehouse?
3. How many kg of paint is in the paint warehouse?
4. How many tons of coils are printed in one year?
5. How much is the warehouse capacity in terms of tons per year?
6. How Paint Department manage the basic paints purchase?
7. How many shifts there are? How operators are managed concerning the shifts?
8. How many operators have Novaprint?
9. What is the average value of each Pantone?
10. How the entire Company Process Flow works?
11. How the company organization works? Who are the responsible?
### 7.2 Interview with the worker within the paint department

Here there are some questions that were asked during the interview with the worker responsible of the paint department:

1. Which are your main tasks?
2. How is organized your shift?
3. How do you handle the inventories?
4. Which are the processes to make a pantone?
5. How do you order the basic paints? With which frequency?
6. Can you always handle the amount of work alone? Or do you need an assistant?
7. How much time you spend to make a pantone?
8. Do you think there are any obsolete paints in the warehouse? Why do you think they are obsolete?
9. How do you control the inventory? Do you use any kind of tool?
10. Do you think an IT tool could be useful to manage the inventory and control it?
11. What are the main problems with the production department? How do you think they can be solved?
12. Do you communicate with the other departments?
13. How many paint do you make in a day on average?
14. How many paints do you send to the production line in a day on average?
7.3 Process Flow Chart

This is the Process Flow Chart of Novaprint Company and the surrounded diagram block represents the Paint Department materials (Paints and solvent).
7.4 Organogram

Here there is the representation of how the company is organized regarding the production departments.
7.5 Inventory Control System

Here is the Excel file that was implemented to develop the inventory control. It allowed to register the right quantity of paint that was going to be used and to be purchased, in order to collect a useful amount of data.

![Excel file of inventory control data](image-url)