POLITECNICO DI TORINO

Collegio di Ingegneria Gestionale

Master of Science Degree in Engineering and Management

Master of Science Thesis

Analysis and Planning the Production Process of Car Seat Frame Manufacturing

Advisor:
Prof. Franco Lombardi

Co-Advisor:
Dott.ssa Giulia Bruno

Candidate:
Pouya Tafreshi

Academic year 2017-2018

Index

1 INTRODUCTION 7

2 METHODOLOGY AND BACKGROUND CONCEPTS 8

2.1 Lean Manufacturing 8
2.2 Single minute exchange die (SMED) 9
2.3 Single operator action (SOA) 11
2.4 Material requirement Planning (MRP) 11
2.5 Enterprise resource planning (ERP) 13

3 COMPANY PROFILE AND INTRODUCTION 14

3.1 Business production 15
3.2 Business divisions: 17
3.2.1 R&D 17
3.2.2 Quality 17
3.2.3 Prototyping 18
3.3 Machinery and production hall 18
3.4 Production and assembly line at a glance 18
3.5 Production and process control 19
3.6 Supply chain 19
3.7 Customers 20

4 MANUFACTURING PROCESS DESCRIPTION 21

4.1 Bending process 24
4.1.1 Running the process 25
4.1.2 Preparation before production process 25
4.1.3 After bending process 25
4.2 Assembly-welding process 25
4.2.1 Preparation before production process 26
4.2.2 After assembly-welding process 27
4.3 Delivery process: painting, packaging, and shipping to customers 27

5 MANUFACTURING PROCESS ANALYSIS: 28

5.1 Production cost estimation analysis 28
5.2 Production process analysis 29
5.3 Production waste time points analysis 34
5.3.1 Bending work cell 34
5.3.2 Assembly-work cell 35
5.4 Fishbone analysis 36

6 PREVENTION AND SOLUTIONS TO REMOVE WASTE TIME: 38

6.1 Bending work cell 38
6.2 Assembly-work cell 40

7 IMPLEMENTATION OF ODOO: 42

7.1 Instruction using Odoo 42
7.2 Creating the company and user name 43
7.3 Defining internal modules and submodules 45
7.3.1 Defining products 45
7.3.2 Defining work centres 46
7.3.3 Defining routings 46
7.3.4 Defining bill of material (BOM) 47
7.3.5 Creating manufacturing order 48
7.4 Defining external modules and submodules 49
7.4.1 Defining sales management and invoicing 49
7.4.2 Defining purchase management 50

7.5 WAREHOUSE MANAGEMENT 50
7.5.1 Managing stock inventory and full view of stock levels *51*
7.5.2 Getting to complete traceability *52*
7.5.3 Inventory control by using FIFO, LIFO and FEFO approach and stock value *52*
7.5.4 Handling several logistics units (Pack, pallet, or box) *52*
7.5.5 Exchange and deal with warehouses and stock locations *53*
7.5.6 Automate the stock management *53*

8 CONCLUSION 54

REFERENCES 55

APPENDIXES 56

APPENDIX 1 - PRODUCTION PLANNING OF WEEK 8TH 56
APPENDIX 2 - PRODUCTS BOMS 61

ACKNOWLEDGEMENTS 70

Index of Figure

FIGURE 1"THE LEAN SYSTEM STANDS ON LEAVING NON-VALUE ADDED AND INEFFECTIVENESS ACTIVITIES 8
FIGURE 2 SINGLE DIGIT FRAMES 9
FIGURE 3 IMPACT OF CHANGE OVER 10
FIGURE 4 INTERNALLY CHANGEOVER VS EXTERNALLY 10
FIGURE 5 MRP PROCEDURE 12
FIGURE 6 MALFE S.R.L. 14
FIGURE 7 DESIGNED ORGANIZATION CHART 15
FIGURE 8 MALFE PRODUCTION IN AUTOMOTIVE AND RAILWAY INDUSTRY 16
FIGURE 9 MEASURING ARM - DIMENSIONAL CONTROL TESTING 17
FIGURE 10 DUROMETER 12
FIGURE 11 MICROGRAPHICS MACHINE - WELDING PENETRATION ANALYSIS 17
FIGURE 12 PRODUCTION LINE AT A GLANCE 19
FIGURE 13 CUSTOMER AND MARKET CONTRIBUTIONS 20
FIGURE 14 BORDIONATO SAB Q5 21
FIGURE 15 PANIRE FIL ASSISE DROIT PEINT 21
FIGURE 16 ROTATIVE CUSHION ASSY 22
FIGURE 17 THE INITIAL PRODUCT BOM FOR ROTATIVE CUSHION ASSY 22
FIGURE 18 PRODUCT TREE OF 193021981/2 PANIRE FIL ASSISE DROIT PEINT 23
FIGURE 19 BENDING WORK CELL 24
FIGURE 20 ASSEMBLY-WELDING WORK CELL 26
FIGURE 21 INITIAL PO FORM BEFORE APPLYING ODOO 30
FIGURE 22 THE CONTRIBUTION OF MACHINE USED IN MANUFACTURING PROCESS IN FEBRUARY 2018 33
FIGURE 23 FISHBONE DIAGRAM 37
FIGURE 24 THE CHANGEOVER BEFORE AND AFTER USING DEVICES DURING COLLECTING BENT COMPONENTS FROM MACHINE ZONE 38
FIGURE 25 NEW BILL OF WORK (BOW) 39
FIGURE 26 CREATION DATABASE 42
FIGURE 27 ODOO GENERAL SETTING APPS 43
FIGURE 28 CREATING COMPANY 44
FIGURE 29 DETERMINING USERS 44
FIGURE 30 ACTIVATING MANUFACTURING SETTING 45
FIGURE 31 CREATING PRODUCTS. 46
FIGURE 32 CREATING WORK CENTERS 46
FIGURE 33 DEFINING ROUTINGS 47
FIGURE 34 CREATING BOM STRUCTURE 47
FIGURE 35 CREATING MANUFACTURING ORDER 48
FIGURE 36 SALES ORDER REPORT 49
FIGURE 37 PURCHASE ORDER, RFQ. 50
FIGURE 38 WAREHOUSE MANAGEMENT, ALL OPERATION DASHBOARD 51
FIGURE 39 WAREHOUSE MANAGEMENT CONFIGURATION, FULL TRACEABILITY CONTROL 52
FIGURE 40 DETERMINING THE UNIT'S MEASURE AND PACKAGING METHOD 53

Index of Table

TABLE 1 PRODUCTION COST CONTRIBUTION ACCORDING CONFIRMED ORDER ON FEBRUARY 2018 29
TABLE 2 MACHINE OCCUPATION CONTRIBUTION IN FEBRUARY 2018 31
TABLE 3 COMPONENT PRODUCED IN MONTH FEBRUARY 2018 32

1 Introduction

Nowadays competition in the industry is significantly increased due to rapid changes and growth in manufacturing technology. In fact, the company's demand increasing is involved in developing the whole level of manufacturing system through optimizing their business model strategies. The Lean manufacturing with the aim of minimizing waste times and non-added value tasks in production line and manufacturing process by several tools and techniques will recognize the arguments of loss and non-effectiveness within the process. Therefore by applying the intelligent tools like Odoo which facilitates management of the manufacturing system to obtain the optimized production planning in shop floor to integrate departments in the company.

Hence, implementing individual techniques aligned to material requirement planning (MRP) in the manufacturing process expedite achieving the optimized production line with regards to managing the flows in such way the cycle time has reduced, the wastes have minimized or abandoned, and the tact-times have accomplished enormously faster than the old model. This research will discuss on the main challenge in production planning of the vehicle seat frame manufacturing process in MALFE S.r.l and the solutions toward Lean manufacturing modules to find an optimized model for production planning and balance the assembly line.

2 Methodology and background concepts

This research entails the specific of methodology to obtain the goal of Lean manufacturing system. This chapter will discuss about the relevant definitions and concepts about applied approach.

2.1 Lean Manufacturing

Let consider that business is going well through the current manufacturing system, the company's management takes the decision to expand the business to meet customer's demands. So, what would be the reaction of the company? Shall the company add new machines to production line by investing a large amount of money? Or might be better to hire more human resources? Or even, if they should continue in current mood, shall they ask their staffs work more, harder, and overtime to prepare the customer's demand at the due date?

Obviously that this situation is the riskiest time for most of the companies, adapting themselves by new conditions and environments so eventually, it is the time that most of them could not survive by this transition. The answer to these questions led to born the phenomenon of the Lean manufacturing system. Among different definitions, there are two important statements that express purely the core concept of Lean approach:

1. The classic definition of the Lean Manufacturing System is "a systematic approach to identifying and eliminating waste or non-added value activities through continuous improvements by moving the production at the pull of customer in pursuit perfection." [1]

2. According to Toyota the concept of Lean will express "An operating philosophy in which the best quality, cost, and delivery of product or service are achieved through shortening the production flow by eliminating waste." [1]

Therefore, above definitions address the logic meaning of the Lean, letter by letter. In fact, *Figure 1* represents the word Lean composed by

- L that stands on Leaving
- E lays on the ineffectiveness
- A emphasizes the activities
- N expresses the non-added value

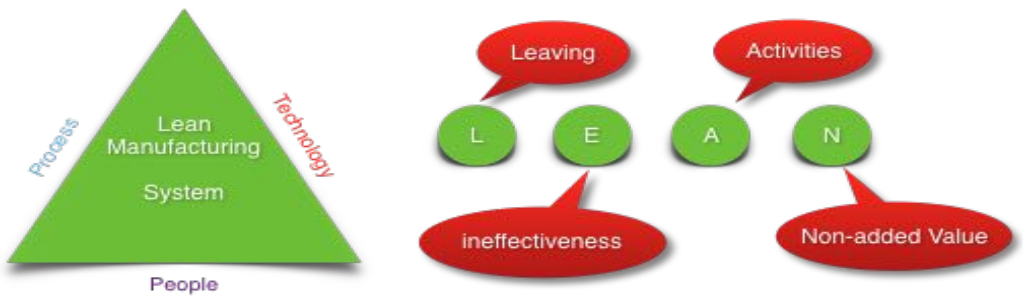


Figure 1"The LEAN system stands on Leaving non-value added and ineffectiveness activities

So, the Lean system encapsulates to the techniques will be led to leaving the non-added value and the ineffectiveness activities.

Hence, according to the din of the Lean manufacturing system, abolish of waste time, generate value stream based on customer's demand, and finally, take into consideration continuously improve the process will ensure obtaining the utilities and advantages by the following fundamental measurements. It begins by taking a configuration of the Pull system. In fact, at the first step rather than manufacturing higher than production capacity or immediate demands, allow to customer's demand pull the goods and service through the manufacturing process so in this way the surplus production inventory working capital will be minimized. One-piece flow or better to express standardizing the workflow is the second action in such a way that process just concern on one single piece at the time, that will also minimize work in progress (WIP), interruptions, and waste time while will increase the productivity, quality, and the flexibility of the outcomes. The Takt time is the third one. Indeed, it is the heartbeat of the Lean system, it determines the velocity of the manufacturing of the products to meet customer's demands. Also, it allows to balance works content, achieve a continuous flow, and respond flexibility to change in the marketplace. Zero defects, mistakes always are happened, but the Lean company never passes on defects, mistakes from previous steps must be fixed before going onto next one, also it is conducted with the robust continuous improvement the process, that would be the fourth principle that will help the company stays ahead of the competition, constantly developing, and changing their marketplace.

Overall, according to above explanation, Lean is the tool that will determine what customer needs and what company should do and it empowers the company for radically changes. In addition, Lean manufacturing system has widespread application in sectors such as factories, hospitals, offices, business process outsourcing (BPO), and agriculture Industry.

2.2 Single minute exchange die (SMED)

A methodology or way of thinking and a set of technics designed to reduce changeover times. "SMED is set up reduction and quick changeover system, designed to bring the changeover time for a machine to less than 10 minutes (*Figure 2*). This is minimizing time is done while the process is being changed from one product to another one." [1]

Figure 2 Single digit frames

In fact, the object of this methodology is creating the possibility to reduce changeover times, to produce via the lower volume and higher product diversities, that is also the core of Lean manufacturing system. It would be involved a some physically and mentally transformation simultaneously within the workplace (traveling between workplace). However, if SMED is implemented completely correct finally the framework of

the Just-in-Time (JIT) will be obtained that is nowadays an ideal and admirable target for all companies. In practice, SMED attempts to reduce changeover times to less than 10 minutes or with a single digit range, in other words, it is also called single digit time frames. SMED does this action by analyzing critically the setup procedures, departing and streamlining changeover tasks and physically altering machinery.

SMED was born by Mr. Shigeo Shingo over a period for 10 years during working as an efficiency consultant in Japan in 1969 where he has been developed these techniques as complete approach where and when converting 1000-ton press changeover, from four hours to three minutes at TOYOTA factory. It was the blockbuster in his research that shown in *Figure 3*. During the development process, he got wind on that there are two most effective classes of changeovers have been had hugely impacts on the production line and they are divided as Internally or Externally setup changeovers.

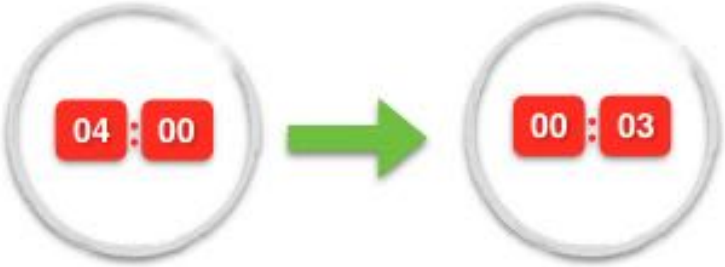


Figure 3 Impact of change over

While Internally setup changeovers lay on those tasks or activities that can fulfill internal to the downtime of the machine, it means performing these activities can only be done when the machine is fully stopped, the Externally setup ones emphasize on the tasks or activities that can accomplish while the machine is running without requiring to stop the machine. This difference is illustrated graphically in *Figure 4*.

Figure 4 Internally changeover vs externally

The most difficult issue is evaluating the changeover to find out which tasks can be separated accurately from the Internal to machine downtime to which activities are actually external one. Once this classification is done the points of change according to SMED will be awarded. Subsequently, promoting the production line acquires of some simultaneous changes physically and mentally. Hence, the physical changeovers include remodeling and reorganization machines and tools layout to dump any waste of time, surplus changeover procedure, and while the productivity will be enhanced significantly. Some of the potential alternatives to internal changeovers are utilization fast quick connection to devices and reorganizing their location and position in such a way their accessibility is increased.

On the one occasion, the tasks sorting has occurred into the group of internally or externally changeover, they are qualified to put back into the streamline. Indeed, it is the time to identify the solution in order to convert tasks from internally to externally as much as possible. Ultimately, after executing all the changeovers, the reduction will freeze up to the time to perform more changeover with less time in higher variety.

Furthermore, it allows achieving the low volume but higher product diversity that is conducted to the Lean manufacturing system. The Mentally changeovers are associated with the human resources moreover the operators who are working in the shop floor they have high interaction coincidentally with the process. So, the willingness of any workers in any changes will lead to reducing the time excessively. Conclusively, their act is highlighted as part of change plan by considering their ideas as the valuable asset in developing the production line and exploitation of further changes.

Eventually, the SMED is one of the gateways to implement the Lean system and Just-in-time (JIT) in the manufacturing process. When changeover is entirely done then the expectation of production line will be boosted by fabricating widespread production in small enough quantities. Also, the opportunity to get wind of flexibility in operating and producing based on customer's demand will be gained. These bells and whistles are underlying on the SMED, Flexible manufacturing system(FMS), JIT as a core of Lean manufacturing configuration.

2.3 Single operator action (SOA)

As mentioned in previous part the necessity to reach SMED approach is making changeover simultaneously both physically and mentally (in human resources). Moreover, according to the object of this research, production planning operation in the assembly line involves exploiting the combination of machine and labors. Therefore, the human resources like the machinery play the most important role in the manufacturing process. Hence, Following the SMED strategy, single operator action (SOA) will boost worker efficiency and increase their productivity. In fact, the idea of SOA is not Taylorism rather than it permits operators to narrow down to their action rationally and nevermore think wrongfully about them. Therefore, they will be engaged with their tasks entirely and they do concentrate on performing them as well as expectation, precisely based on the process map. In this way, the nutshell of the Lean thinking of reducing the waste times will obtain by eliminating the errors stemmed from human resources. Meanwhile, they are encouraged to brainstorm and execute more immeasurable than current. Additionally, they will more enthusiast to be more innovative or creative. The essential core of this method consists of:

1. Describing the tasks breakdown description means brightly defining the job.
2. Determining the standards and key performance indicators (KPI) for each job or group of the jobs as well as executors (workers).
3. Oriented instruction through discipline plan for the operators according to their functions and activities. The training will create an opportunity to prepare high skill resources and increase their self-confidence.
4. The primary investigation plan will be done during the training course to identify the resource capabilities and abilities.
5. Job allocation. Using the right skill in the right profession as well as using the right tool for the right job.
6. The secondary assessment procedure will be happened after dedicating the tasks to the resources during the deterministic period. In fact, in this step, the performance of each resource or group of them should be appraised periodically to identify the improvements based on considered KPIs.
7. Illuminate the improvements. following the outcome of the second evaluation, the advantages should be supported and the disadvantages have to replace with new solutions.
8. Documentation and iterating the steps.

2.4 Material requirement Planning (MRP)

Following the development of using computer-aided solution to accounting and further in inventory control management, The Material Requirement Planning born by IBM and it becomes the fundamental of production planning. Due to problem of traditional planning and lack of complete information on inventory of the raw materials or the final products because of the unpredictability of the market demands, creation of MRP tools

help manufacturing system in controlling these issues in such a way the MRP can ensure availability of the raw material in order to process particular final product for the manufacturers. In fact, the key functionality of MRP will start from looking on the end product and then breaks it down to details of components in producing the final product, it means that MRP creates the link between Jobs (demands) and Purchased order (raw materials). Therefore, the main concern of MRP is scheduling jobs and purchase orders to satisfy material requirements generated by external demand. [2]

In practice MRP process started by creating the bill of material (BOM) which rather than graphically illustration the components and the subcomponents of the end products, it shows when and where part or subpart are going to use in the manufacturing process (*Figure 5*). This information in addition to master demand and on-hand inventory which lay on independent demand will be determined by master production schedule (MSP) based company demanded from the market. The principal MRP technique is classified briefly as below: [2]

1. Netting: Determine net requirements by subtracting on-hand inventory and any scheduled receipts from the gross requirements. The gross requirements for level-zero items come from the MPS, while those for lower-level items are the result of previous MRP operations.
2. Lot sizing: Divide the netted demand into appropriate lot sizes to form jobs.
3. Time phasing: Offset the due dates of the jobs with lead times to determine start times.
4. BOM explosion: Use the start times, the lot sizes, and the BOM to generate gross requirements of any required components at the next levels.
5. Iterate: Repeat these steps until all levels are processed.

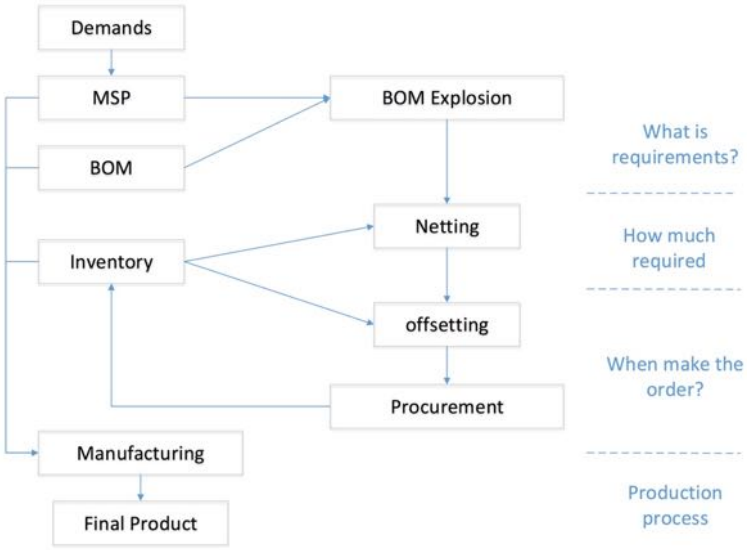


Figure 5 MRP Procedure

Despite all advantages of MRP in manufacturing systems, it has remarkable critical concerns such as the lack of feasibility in martial capacity, increasing the scheduled lead time, and the sensitivity of MRP, it means the small change by MSP will generate large change on planned order. That is led to the development of MRP to enterprise resource planning (ERP) with the aim of integrating wider functionality in the manufacturing process.

Overall, the MRP will associate the external of the company with the internal company according to demand functionality as a dependent (internally) or independent (externally). Hence, rather than inventory control and production planning, the MRP will manage the purchasing process as well.

2.5 Enterprise resource planning (ERP)

In the previous part has been addressed that the main obstacles of the MRP led to the creation of the MRPII concept. The new idea mostly concentrates on MRP in addition to procurement process to meet the manufacturing requirements. Therefore, the MRPII inclinations to employ computerized process and began more huge and effective than MRP in such a way it so-called manufacturing resource planning. General speaking, the MRPII in comparison by MRP, has been designed through a wider vision on processes like predicting current and future demand, production capacity, and MSP therefore, it is also called on long-range planning. [2]

Following the growth of MRPII in managing manufacturing process and increasing in company's demands, the necessity of the system with the ability to manage wider interaction internally and externally has deliberated. Hence, at the earlier evolution, the supply chain management (SCM) has appeared to develop the traditional idea of inventory control into widespread functions involves distribution, warehouse management, diversified production location management and finally logistic management. Furthermore, the business process re-engineering (BPR) has invented which is the second requirement of the firm to rapid approach to change in the process and operation during their manufacturing system. Ultimately, merging the above trends to exploit the computer system to link the company's inside to outside with the aim of increasing manufacturing productivity lead to generating the ERP.

ERP stands on enterprise resource planning, with the aim of integrating company's department to save the cost of expenses of the whole process flows during the company's life whether they are internally or externally. In fact, ERP has an impact on improving the business insight, enhancing collaborations, and increasing efficiency. Also, use of the computer correspond to management software becomes significantly important in implementing the system since the invention of the ERP and especially ERP software supports companies move deeper into the digital age, more visibility, and rapid processing at a lower cost.

In future chapters, this research will introduce the ERP tools and the instruction of implementing Odoo ERP in the business.

3 Company profile and introduction

This chapter will introduce the MALFE Srl the manufacturer of vehicle seat structure and frames. The company is born in 1995 as a family business and started with handcraft production. Over a decade has acquired important customers that allow the company to increase production volumes, equipment, and personnel. Also, the tremendous coordination between company and suppliers lead to being significantly faster in the production process and time entry to the market to earn the higher market share, the tagline of today's reality.

Since 2005 Malfe have had more than 100 customers, nowadays it is grown up as well as equipped the plant by special machinery included welding robots, bending machines, wrapping machines, and automatic presses from all round of the world that made the firm as a leader company in the region of Piemonte. Furthermore, the strong reputation that the company has built over the years has granted to attain stable position between customers and among several competitors in the automotive sectors as well as diversification in products and enhancing company's knowledge in this field. Overpassing a few years, Malfe ensures reasonably the requirements of clients in different sectors of the industry.

The Figure 6 illustrates the company's plant is located in the area of 5,000 square meters to meet the market demands. The whole production process from design to end product, finishing process, purchasing raw materials, quality aspect and delivery process, are accomplished internally to offer high-quality solutions and ensure maximum efficiency, durability and excellent performance of the final product. Malfe applied an ERP to merge innovation technology with human knowledge and the new generation of machinery to achieve viable production. The company's productions include a wide range of diversified and complex items built according to the customer's design. The experience consolidated by 20 years of activity in the processing of steel wire led to customers satisfactory correspond to growing number of products. The company's goals emphasized on:

- Modernization and extending of accessible resources
- Growth in profession and skills in the company
- High specialization in the processing of the wire metal

Figure 6 MALFE S.R.L.

Applying the advanced technology and machinery allow the company to perform a rapid and accurate production from predominant raw material in the steel rod. The quality of the products and their surface protection, the continuous search for technological innovations in favor of the result, are certainly determining factors for choosing supplier partners. All this, followed by the flexibility in production with the guarantee in time and reliable deliveries, means that Malfe is chosen both by companies operating in the Italian market and those operating in the international market. All items,

including accessories for wardrobes, counters and refrigerated display cases (for supermarkets and shops in general), remains for hospital beds and nets for metal containers (for storage), are built to customer design, in wired steel with the following finishes (optionally):

- Non-toxic white or ice-white lamination
- Painting with epoxy-polyester powders
- Electrolytic galvanizing with a non-toxic transparent coating baked at 180 °
- Topicalization
- Chromium plating
- Chromed protected with transparent painting coated at 180 °
- Construction of the polished grids stainless steel AISI 304 or AISI 316
- Raw grids

Malfe is ranked as SME company included 20 employees and 3000 sqm production hall which equipped by series of welding robots and bending machines will be described in detail in next chapter. In addition, the company has granted by IS9001:2008 since 2000 and looking forward to winning IATF 16949. The financial sales by end of 2017 earned 2,100,000 Euro and this amount of predicate like 2,400,000 by the end financial year 2018. The *Figure 7* illustrates the recent organization chart in the company.

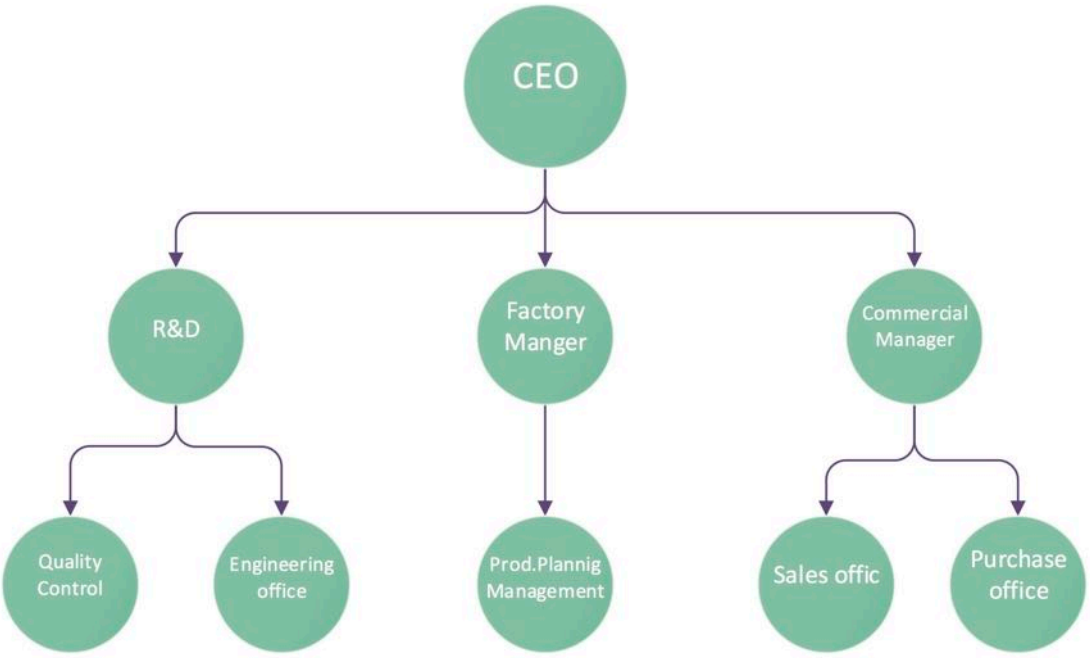


Figure 7 Designed Organization chart

3.1 Business production

The company production focuses on various items, often complex and made to customer design. Among the main end products, components and accessories of machines and plants, threaded, bent and shaped stand out. Recently, the production phase of Malfe it consists of over 350 contracts, mostly destined for the automotive sector and the railway sector (*Figure 8*). Some of the main outputs related to these orders are:

- Vehicle seat structures and frames

- Head support structures
- Various supports
- Seat release levers
- Hooks of various diameters and dimensions
- Cars anti-intrusion grids

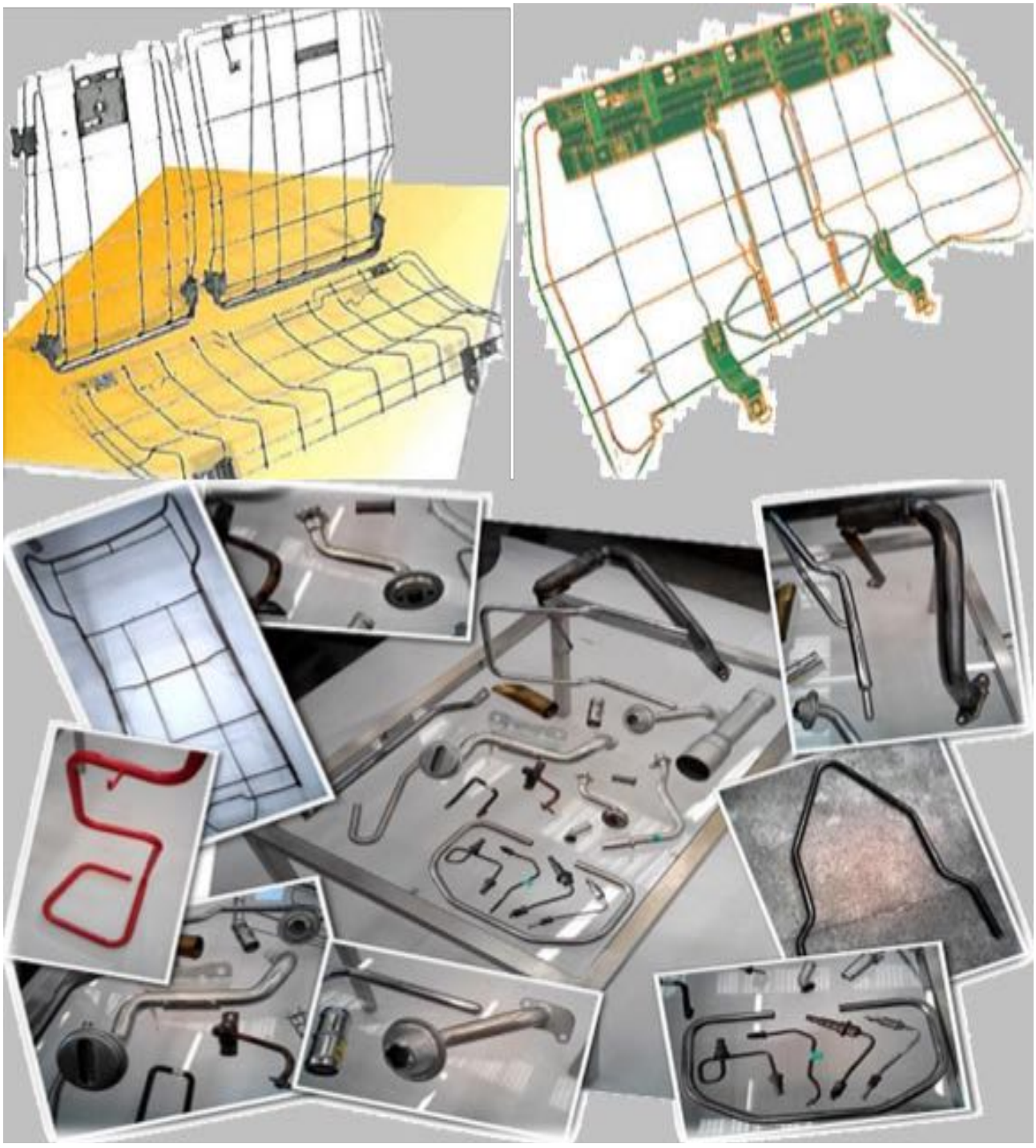


Figure 8 Malfe production in Automotive and Railway Industry

3.2 Business divisions:

The company business division underlying on main activities in R&D, Quality, and prototyping the components and final product then correspond to them the manufacturing shop floor will reinforce correctly.

3.2.1 R&D

The R&D technicians will provide the innovative technical solutions for customers by considering the high efficiency and conveniently via applying the CAD/CAM design software. The team follows all the phases of drawing, simulation and full validation of the technical solutions to be introduced. The main advantage, which makes differentiation for Malfe away from its competitors, is laying on the capacity and ability to meet any customer's requirements followed by customizing the final product for any specific requests.

3.2.2 Quality

Fundamentally, the company concentrated remarkably on the quality control aspects. The lab is equipped with high precision instruments to satisfy plentiful the customer's needs via compliant products. The equipment inside this laboratory are the following:

- Measuring arm (*Figure 9*) for dimensional inspection
- Durometer (*Figure* 10) able to measure the hardness of materials
- A Micrographics machine (*Figure* 10) that allows analyzing the welding penetration

Figure 9 Measuring Arm - Dimensional control testing

Figure 10 Durometer

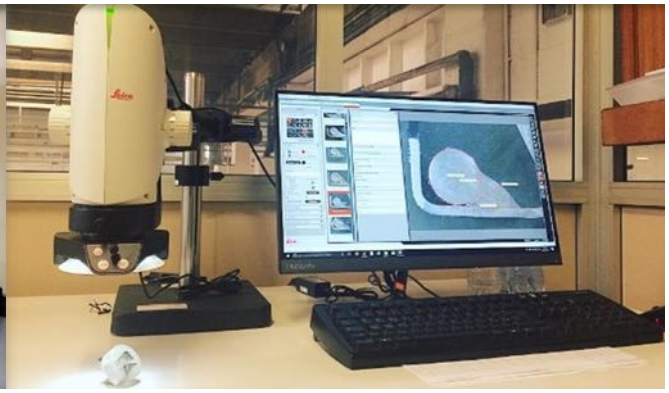


Figure 11 Micrographics machine - Welding penetration analysis

3.2.3 Prototyping

The prototyping phase in Malfe will proceed carefully by analysis the customer's prerequisites. This operation is extremely significant based on the company's goal of endeavoring to offer the best solution for the customer then manufacturing high-quality products to increase the productivity and reducing the waste time. These tasks will carry out by the engineers in a technic office where also the will determine the raw materials according to the customer requirements and final product application.

3.3 Machinery and production hall

The production hall has designed in such a way as to guarantee the coverage of whole production obligations. It has divided into two work cells include bending work cell for the forming of the metal wire built by numerical controlled machine centers as well as the assembly-welding work cell to join bent components by welding robots.

The experiences have gained over the years in the processing of metal wire and the high technology equipment allows company to endeavor the best solutions to the customers, to fabricate prototypes in very short times pertain on the complexity occasionally in a few hours for uncomplicated components or a few weeks to make intricate parts such as railway seats.

3.4 Production and assembly line at a glance

The production line has composed of the processes such as bending, assembly-welding, painting, and packaging. Commonly, the majority of them fulfill internally besides, the painting process that has carried out toward partner's plant as an external service based on outsourcing contract. *Figure 12* illustrates the production line at a glance. The brief description of process sequences entails:

1. Cutting and bending stainless steel wire.
2. Bending the cutting robots for stainless steel wire.
3. Assembly-welding process. In fact, those bent components, exited from the previous step will be assembled and welded by robots
4. Quality assurance that will do after finishing the lot by inserting the finished part onto the gage. (each welding machine and also cutting process have a particular gage to check the dimension of the

Following the above process, the production line has divided into two main zones, the bending work cell, and assembly-welding. The machines have exploited in the production line are listed as below:

1. Six Orbital machines
2. Six CNC double-head bending machines
3. Seven Bending machines
4. Six Welding robots (three projection and three electric CO2)
5. Three Presses from 30 to 80 tons
6. Six Sets of mechanical machines with cams for wire and strip
7. A set of the cutter for pieces, max 2,000 diameters.
8. Eight Welding machines sets
9. Six Portable welder sets from 80 to 250 KWA tooling for construction equipment and small maintenance

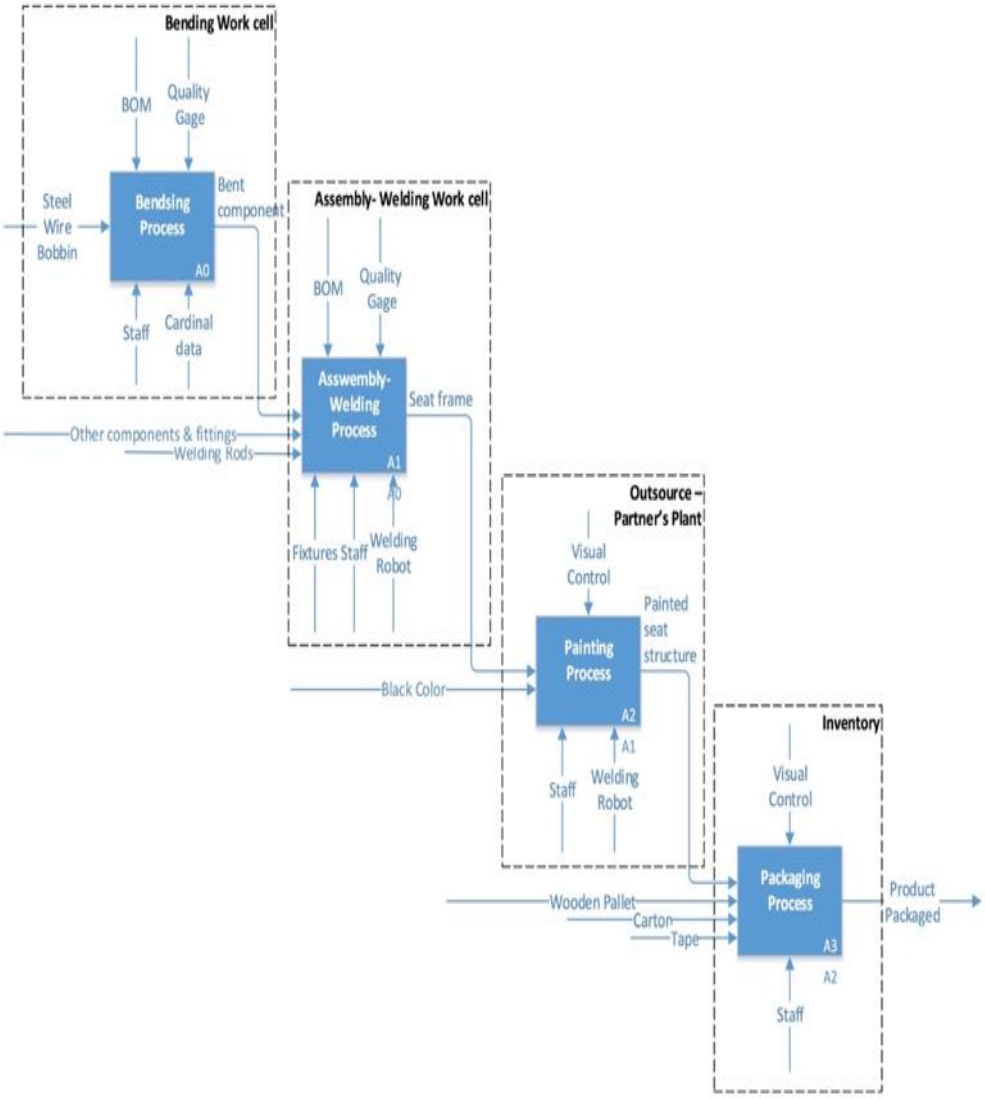


Figure 12 Production Line at a glance

3.5 Production and process control

The quality aspects have performed during the manufacturing process at the same time throughout the operations and process. They include the quality control and assurance over the industry standards and customer's preference level.

Consequently, the measurement to confirm expected requisites has verified for whole phases through systematic inspection that carried out by the shop floor operators via periodical process then final product audits accomplished by assurance quality formers. The attained results have kept as documentation and procedures for each product from start to end.

3.6 Supply chain

The high-quality products have manufactured because of the link between the company with the main qualified suppliers. Indeed, the supply chain of the department will purchase raw materials from the best sources that have selected according to customer's requirements and ability to ensure the technical

specifications to avoid the extra process.

3.7 Customers

Malfe Srl boosts its market with over 100 customers. The company is collaborating with leading suppliers and prestigious brands whether in Italy or abroad. The majority of Malfe products have used in the automotive sector in European vehicle manufacturers. The production has mounted on different vehicles in several markets. The main customers have included in the FCA group, Maserati, and other famous factories in Italy, PSA group, and Renault in France, and Audi AG in Germany. Also, in the Eastern countries that the components directly ship to Toyota's partner plant (Tychy) in the Czech Republic and Poland. Overall, the financial sales contribution of Malfe have earned 40% of the international market and 60% by domestic that has illustrated in *Figure 13*.

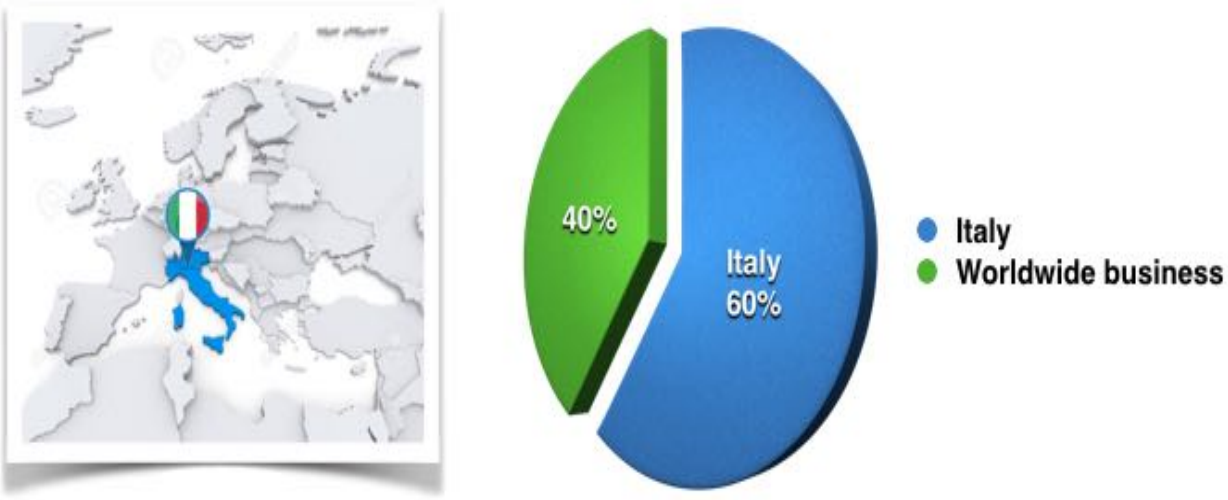


Figure 13 Customer and market contributions

4 Manufacturing process description

This chapter will describe the manufacturing process in Malfe. Among entirely different final productions, the main products of the company have divided toward two industry sectors automotive and railway. The research will concentrate on approaching production planning for the manufacturing process of the car seat structures for the different types of vehicles like Maserati, Fiat, Audi, and Toyota are explained. Furthermore, toward the company's privacy, in the whole analysis, the exact name of the buyers and related production cost, and sales price have neglected, will endure as the secret and the only name of projects have used instead.

Hence, among whole sorts of production and according to differences in customer's requests, the following objects includes Bordionato SAB Q5 (*Figure 14*), Panire Fil Assise Droit Peint (*Figure 15*), and Rotative Cushion Assy (*Figure 16*) have selected to analyze by taking into consideration the annually mass amount of product orders and their delivery due date that frequently has determined in advance either weekly or monthly.

1. 38103715/16 Bordionato SAB Q5, High RIGHT/LEFT
2. 38103722/23 Bordionato SAB Q5, Low RIGHT/LEFT
3. 193021981/2 Panire Fil Assise Droit Peint
4. 193032211/21 G/J RHD Rotative Cushion Assy
5. 193032212/22 G/J LHD Rotative Cushion Assy

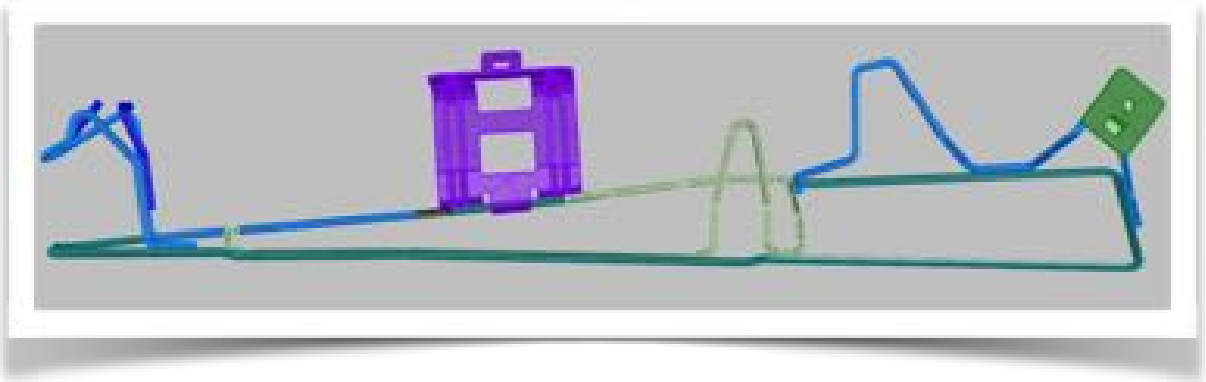


Figure 14 Bordionato SAB Q5

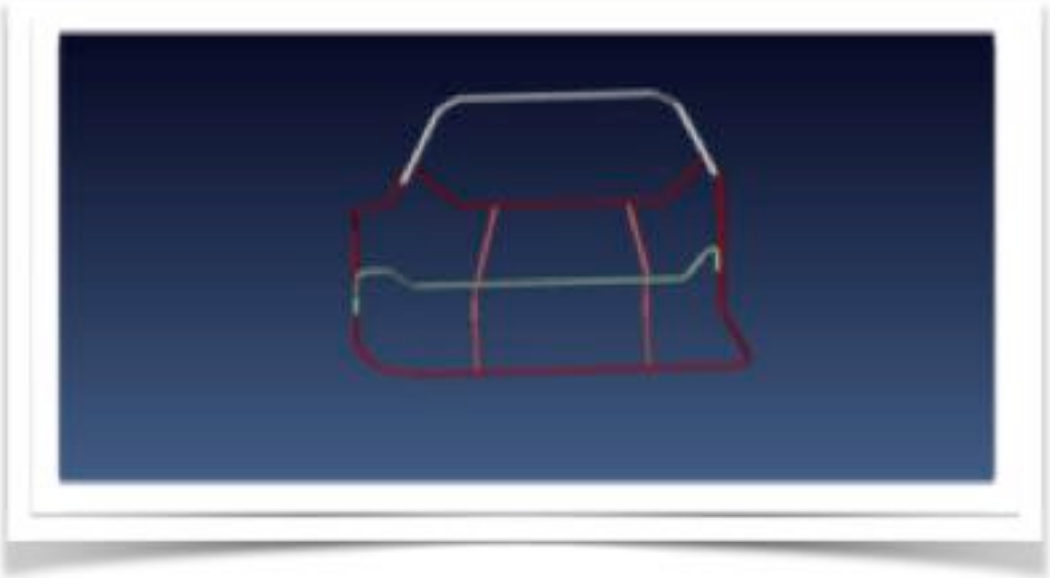


Figure 15 Panire Fil Assise Droit Peint

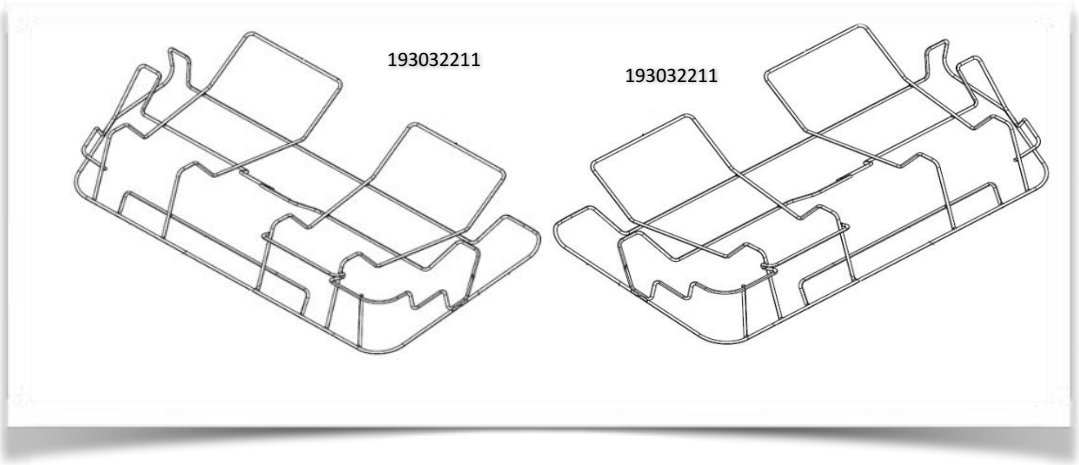


Figure 16 Rotative Cushion Assy

Following elected objects, concerning the better comprehension of production components, subcomponents, and the associated raw materials, the current bill of materials (BOM) before implementing Odoo have represented in infra *Figure 17*.

MALFE S.r.l.

DISTINTA BASE

Denominazione	RHD ROTATIVE CUSHION ASSY
Disegno	Esp.
[redacted]	G
CLIENTE	
GRUPO ANTOLIN	

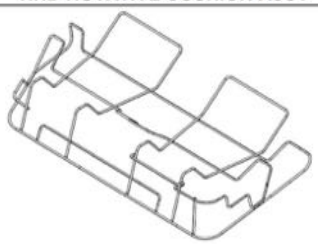


Figura	Rif.	Disegno	Esp.	Descrizione
	1	151010580	G	Cushion Wire Basket
	2	151011250	D	Turn-In Wire
	3	151010451	G	Turn-In Wire RHD

MALFE S.r.l.

DISTINTA BASE

Denominazione	LHD ROTATIVE CUSHION ASSY
Disegno	Esp.
[redacted]	J
CLIENTE	
GRUPO ANTOLIN	

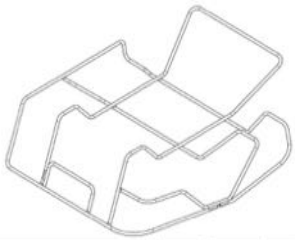


Figura	Rif.	Disegno	Esp.	Descrizione	Quantità	sp/ diam.	UM	Peso	Classe Materiale
	1	151011032	H	LHD Cushion Primary Wire	1,00	5	kg	0,212	C4D
	2	151010422	F	LHD Cushion Transversal Wire	1,00	5	kg	0,115	C4D
	3	151010400	F	Trimming Wire	1,00	5	kg	0,029	C4D

Figure 17 The initial product BOM for Rotative Cushion Assy

As noticed in last chapter3 part3.4, toward manufacturing one final product, following conventional processes have to perform bending, assembly, welding, painting, and packaging as well as illustrated in the figure. Moreover, since both assembly and welding operations will be done in the same work center simultaneously hence, for the sake of simplicity, the work cell and the center are so-called assembly-welding. *Figure 18* illustrates product tree includes the sequence of convectional process for manufacturing a unit of final product named as Panire Fil Assise Droit Peint.

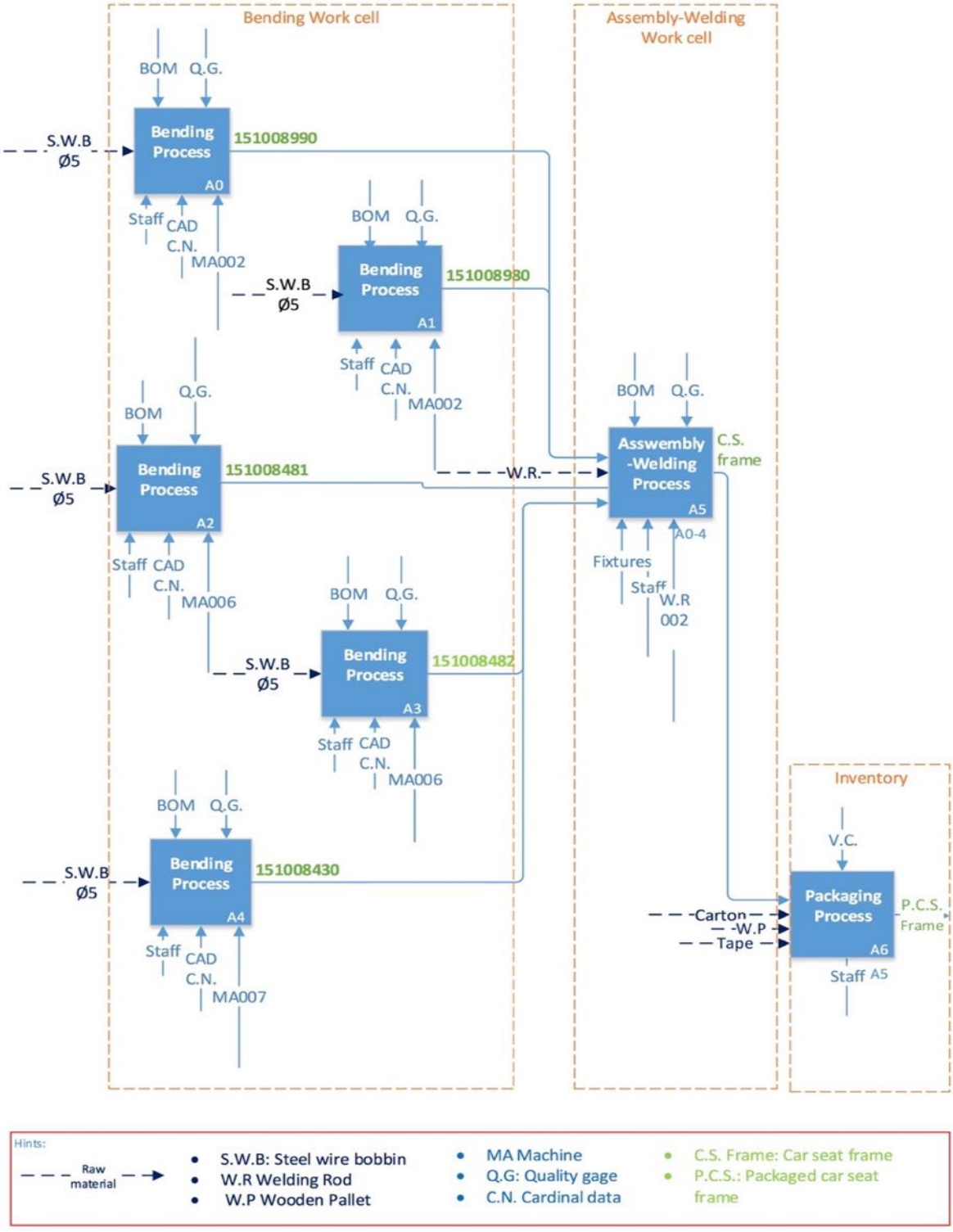


Figure 18 Product tree of 193021981/2 Panire Fil Assise Droit Peint

4.1 Bending process

This work cell (*Figure 19*) has equipped with different automatic bending machines to increase the efficiency and higher precision in the manufacturing of the components for other work cells. Hence, the machine work by a numerical control system (NC) in such way the cardinal data will insert in machine controller then by submitting the data process will start.

Regularly, the machine composed of following three main parts, bending head, PLC unit, and rotary wire feeder. The bending head has classified as circular with 360 degrees rotation or straight travel head (push and pull wire feeding) based on the product complexity, the velocity, either the capacity. Moreover, the variation between heads leads to performing the different process sequence. It means the rotary head begins by bending process and then cutting while in the other hand, straight head the bending process starts after cutting. Accordingly, some of features and specifications have listed in infra:

- Product name
- Constructional
- Machine-tool efficiency
- Highly dynamic rotary straightening system with push and pull rollers for wire feed
- CNC-controlled wire insertion
- Highly dynamic bending head drives High-performance electronics
- Bending head distance and travel
- Minimum distance from bending head center to bending head center 138 mm
- Maximum bending head distance 3500 mm
- Very large bending space
- Rotary gripper
- Servo drive for infinite rotation
- Servo drive for wire clamping
- Bending heads
- Rotary bending mandrel
- Large Z-axis stroke with electronic servo drive
- Software
- Bending simulation with real-time calculation
- Simple programming of asymmetric bending sequences
- Simple change of tools insertion arm
- Wire supports are mounted on a guide rail for rapid and easy retooling

Figure 19 Bending work cell

4.1.1 Running the process

Fundamentally, the machine requires to set up for each component before running each cycle. In doing this, the component's dimension will be inserted by operators also the following parameters will indicate the length, the wire's thickness, radiuses, and angle's types. The cycle time according to the geometry of components have defined in CAD drawing later the process will start toward the trial test. Initial bent wires will test by laying into quality gages. In fact, it should be load and unload easily and the angles have located correctly. Once the dimension has approved the cycle will start to produce the defined amount as piece per hours based on the machine's capacity. The production planning will be updated day to day according to real demands.

4.1.2 Preparation before production process

There are some measurements should be done before running the machines. Ordinarily, the setup machine per each cycle according to the complexity of the components will take place optimistically in 30 minutes.

1. Setting the parameters and data
2. Loading the wire bobbin on the rotary feeder
3. Tooling adjustment
4. Insertion of the wire via push and pull system and rollers into the rotary gripper
5. Trial test bending process
6. Controlling the dimension by the Gage
7. Setting the cycle time and running the machine
8. Collecting the components into the container

4.1.3 After bending process

Following the preparation machine to bending operation, there are some significantly prominent tasks have to complete at the end of each cycle precisely to the documentary the parameters toward future manufacturing process:

1. Activate the safety button
2. Note the new parameters
3. Unloading the wires
4. Transferring the filled container to assembly welding work centers
5. Cleaning the machine and surface

Moreover, the maintenance and regular daily services such as cleaning the machine is extremely valuable. It has to fulfill toward the end of the process to retain machine safe and available for next cycle. This operation catches in 20 minutes.

4.2 Assembly-welding process

This work cell (*Figure 20*) involves several kinds of arc welding robots to accomplish joining process through the spot, MIG, and TIG welding method. In fact, in these centers, the assembly and welding process are coupled together and fulfilled simultaneously.

The adjustment of the industrial robot is one the most difficult circumstances in the welding operation, and so the higher accuracy, reliability, and repeatability in process pertain to this precise regulation. In fact, any welding centers composed of HMI unit control, a rotary table, and welding robots head. The table has

equipped of pair sets of fixtures toward assembling a group of components and subcomponents that has produced in bending process. The loading will do according to the BOM related to each end product. Conventionally, meanwhile, the components have fully mounted, through the pneumatic locking leverages, the frame settles fixed toward welding process. The machine will set up according to the parameters such as material resistance, and welding penetration rate, moreover welding head movements. Therefore, once the settings have done the process will start by twisting the table a during the welding process new set of the components will load into fixtures. The process will continue based on machine's capacity per hours. Considerably, the assembly-welding operation is the main bottleneck in this manufacturing process.

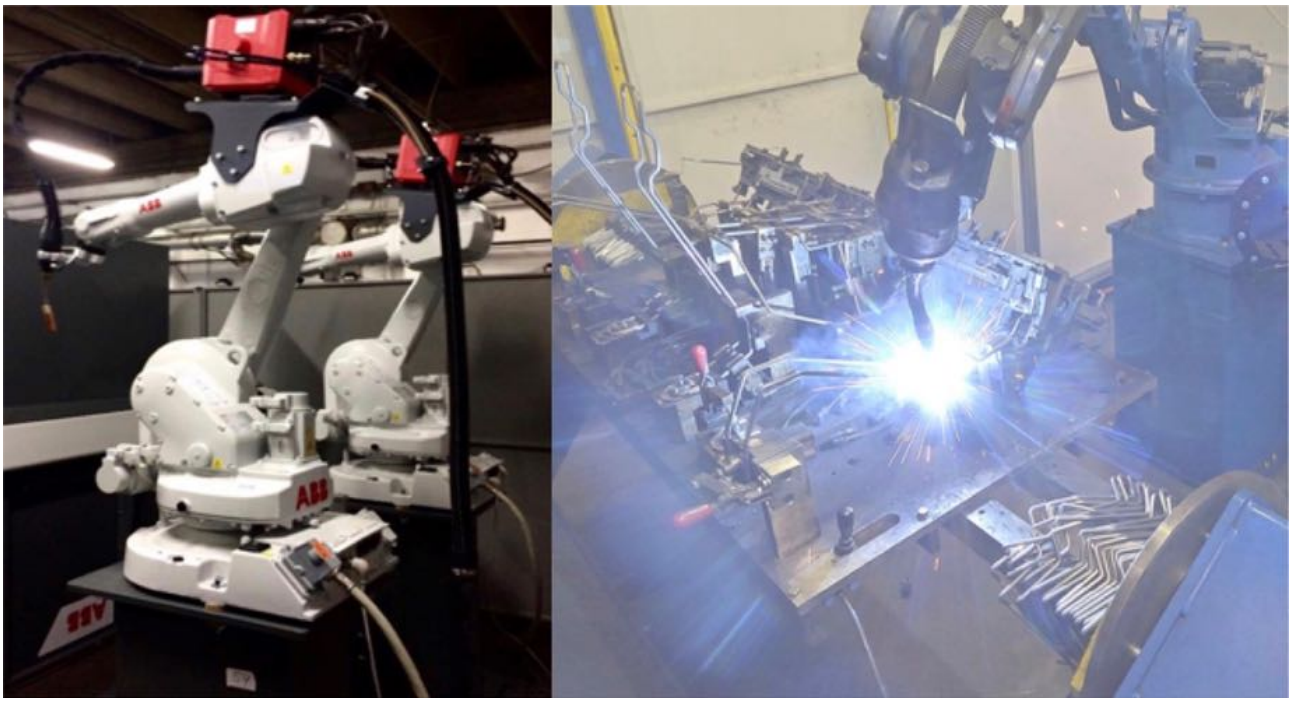


Figure 20 Assembly-Welding work cell

The operations in assembly-welding work cell have tied to operators and welding robots. It means operators are involved to pick and place components in or out to fixture and so depends on the complexity of the product, the number of operators will determine. Since machinery has equipped with safety barriers exactly on entrance sides, to run the process the operators have to step back of work center zone with respect to safety and security aspects. Therefore, by pushing the start button, the welding process will run. Meanwhile, the second fixture becomes ready to mount order. Once the welding operation has finished, before hanging them on the stands, the operator will inspect the part, especially welded zones. Then the part will put over quality gage to ensure the welding points have met the standards. Shortly as the lot has terminated, products will transform in the container to get to the next operation.

4.2.1 Preparation before production process

The assembly-welding process Likewise, the bending operation acquires some measurements have to do before running the machines. Ordinarily, the setup machine per each cycle according to the complexity in the geometry of the final product and welding zone adjustment at least need two or three hours.

1. setting the parameters and data and welding zone and needed time
2. Loading components into fixtures and luck up them via gears and presses
3. tooling adjustment
4. Insertion the welding material
5. Trial test of the welding process

6. Controlling the dimension of the welded frame by the Gage Fixture
7. Setting the cycle time and running the machine
8. Collecting the components into container

4.2.2 After assembly-welding process

Logically similar to bending process, following the preparation machine to run welding process, there are some significantly prominent tasks have to complete precisely by ending current cycle to the documentary the parameters toward future manufacturing process.

1. Activate the safety button
2. Note the new parameters
3. Unplug the machine
4. Unloading the fixtures and transferring to inventory
5. Transferring the filled container of the final product to inventory
6. Cleaning the machine and surface

Moreover, the maintenance and regular daily services such as cleaning the machine is extremely valuable. It has to fulfill toward the end of the process to retain machine safe and available for next cycle. This operation catches in 20 minutes.

4.3 Delivery process: painting, packaging, and shipping to customers

Upon the customer's request, some product demanded to paint. Occasionally, this is the only process has carried out in the plant of supplier's partner. The shipping container and painting process usually takes within three or five working days. After painting final quality control have to do in packaging zone in the company production hall. Ultimately, following operation have done in packaging zone.

- settling product into cartoons box
- palletizing and weighing the boxes
- barcode label tagging
- ship to customers

5 Manufacturing process analysis:

In this chapter by studying the processes of each work cells in details, according to the main problem in scheduling and planning process to indicate the various reasons led to malfunctions in Malfe manufacturing system.

The assessment has started by analyzing the cost of picked projects to get wind a model to predict production process cost in comparison with the sales price. Therefore, the production process has investigated separately to prove the advantage of precise scheduling in bending work cell over the manufacturing process has a blockbuster impact on the assembly welding process toward keeping balance the inventory of final product throughout feasibility to holding safety stock to dominate variations in market demands. Moreover, it has extended to attain a result by recognizing the point of waste time the objective of the Lean manufacturing system. Furthermore, the fishbone analysis will illustrate visual justification of the cause and effects of waste time on the process. Additionally, all analyzes have done toward below products[1] items by considering the annual order quantity that they have confirmed for February 2018.

1. 38103715/16 Bordionato SAB Q5, High RIGHT/LEFT
2. 38103722/23 Bordionato SAB Low SAB RIGHT/LEFT
3. 193021981/2 Panire Fil Assise Droit Peint
4. 193032211/21 G/J RHD Rotative Cushion Assyy
5. 193032212/22 G/J LHD Rotative Cushion Assy

5.1 Production cost estimation analysis

As notified the analysis is done based on derived information of the final products including components and subcomponents to observe the comparison between the production cost versus sales price. In the same vein to create cost estimation model for incoming projects (*Table 1*). In doing this, following data are analyzed:

1. The number of orders confirmed by customers on February 2018,
2. Product's BOM including the information of the components, subcomponents, and the raw material types.
3. Acquired cycle time in bending work cell.
4. The cycle times added to the cost of assembly welding work cell including expenses of the welding operation, soldering material, labors, painting, transportation, and packaging.

Eventually, the model illustrates the examination of the products sales price without weighing either fixed cost or overhead costs.

Besides analyzing the current project, this model significantly has employed in estimating the new project cost. In fact, the company has the opportunity to get wind over products that create the lowest margin because of some issues in the production process such as lack of high-quality tooling or equipment, led to obstacles in manufacturing process throughout more scraps in production. Moreover, the machines have never used in parallel that attained a result in longer cycle times. Hence, in plenty of time, the company remained behind of schedule unexpectedly. Although to overtake the customer's demand and withdrawing of penalty stemmed from delay in the delivery, occasionally, the company has continued production in the night shift that increased overhead cost reasonably as well as human resources expense merely to meet delivery. It has a side effect in company price strategy they suddenly forced to take the position of stock in the middle to remain in the market competition.

[1] The products have illustrated in chapter 4 (*Figure 12, Figure 13,*and *Figure 14*.)

Table 1 Production cost contribution according confirmed order on February 2018

PROGRAMMA DI PRODUZIONE

Gennaio 2018

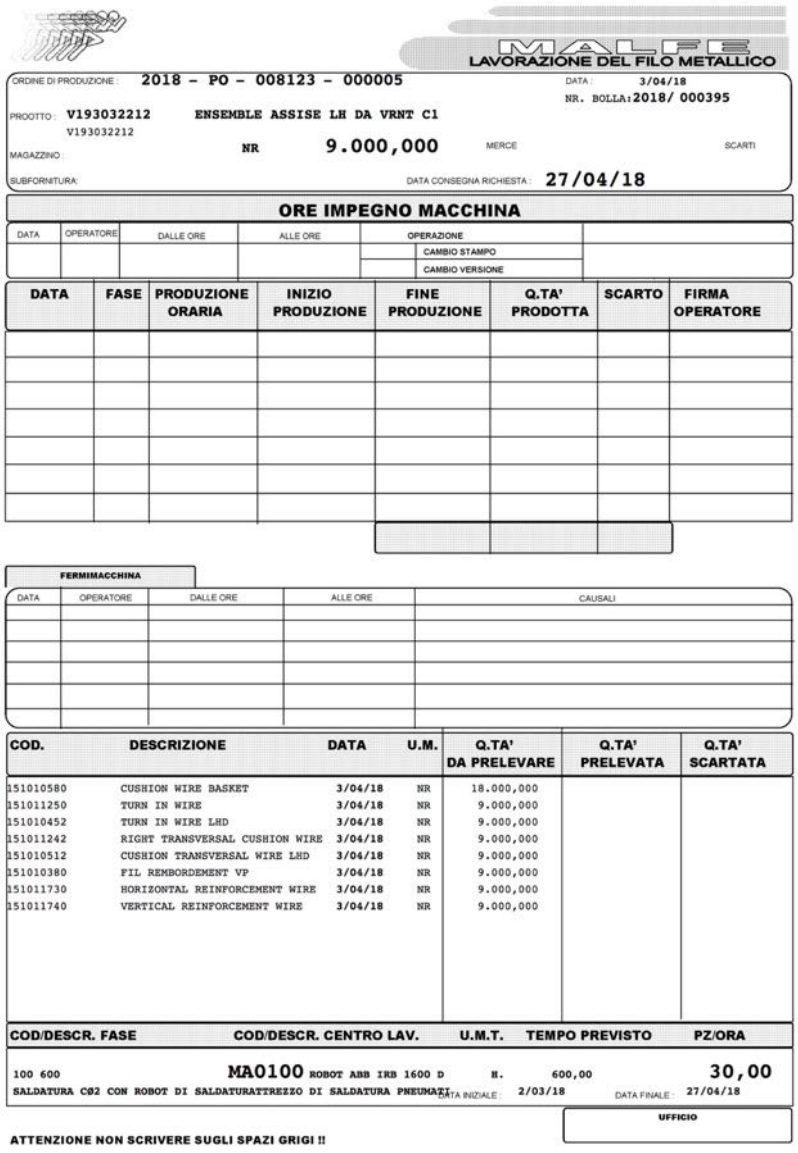
	NR °	CODICE	Ø	Impianto	Impianto Backup 1	Utensili	Q.tà Richiesta	Q.tà da Prodotta	P/H old	P/H 1 new	ORE Necessarie	ORE Prodotte	pc/h	New machine 50 €/h	Old machine 35 €/h	costo/pz	Peso	Costo Mat pcs	Totale pcs +mat	Tot Ass	pc/H	€/h welding	Vm	Trasporti	Box	Totale	MDO	Finito	componets sales cost estimation	€/h welding	Assembly cost Estimation	Final product cost Estimation
		C9D 4 0.63	C9D 4.5 0.63	C4D 5 0.63	C9D 5 0.63	C9D 6.5 0.63																							Sales cost estimation according to 35% margin			
981 982	35	151008450	6.5	MA002	MA004	Fissa 6 1/2	9,200	1	463	750	20.00	0.00	460	50	35	0.076	0.136	0.086	0.162	1.309	60	35	0.3	0.36	0.045	2.014	0.19	2.204	0.218	47.25	2.72	2.97
	36	151008271	5.0	MA006	MA007	D5 R6 DITO 21L	9,200	1	1146		8.03	0.00	1146	50	35	0.031	0.058	0.037	0.067										0.091			
	37	151008280	5.0	MA006	MA002	D5 R8 DITO 26L	9,200	1	611	295	15.06	0.00	611	50	35	0.057	0.0843	0.053	0.110										0.149			
	38	151008272	5.0	MA006	MA007	D5 R6 DITO 21L	9,200	1	1100		8.36	0.00	1100	50	35	0.032	0.058	0.037	0.068										0.092			
	39	151008261	5.0	MA006	MA005	MA 8.5 RS DITO 26	4,600	1	211	176	21.80	0.00	211	50	35	0.166	0.2408	0.152	0.318										0.429			
	40	151008262	5.0	MA006	MA005	MA 8.5 RS DITO 26	4,600	1	212	176	21.70	0.00	212	50	35	0.165	0.2408	0.152	0.317										0.428			
990	42	151008481	4.0	MA006	MA007	D4 R4 DITO 18L	8,400.00	f	225	272	37.33	0.00	225	50	35	0.156	0.136	0.086	0.241	1.7113	60	35	0	0.225	0.045	1.981	0.36	2.341	0.326	47.25	1.6748120570024	3.035
	43	151008482	4.0	MA006	MA007	D4 R4 DITO 18L	8,400.00	f	235	264	35.74	0.00	235	50	35	0.149	0.136	0.086	0.235										0.317			
	44	151008890	4.0	MA002		FISSA 4/5	8,400.00	f	118.5		70.89	0.01	119	50	35	0.295	0.2405	0.152	0.447										0.603			
	45	151008430	4.0	MA002	MA007		12,800.00	f	1800	3200	7.11	0.00	1800	50	35	0.019	0.206	0.130	0.149										0.201			
	46	151008980	4.0	MA006	MA002	D4 R4 DITO 21L	12,800.00	f	1125	507	11.38	0.00	1125	50	35	0.031	0.0396	0.025	0.056										0.076			
715	94	38103715/1A	4.5	MA005		D5 R4 R4 DITO 21	2400	1	276		8.70	0.00	276	50	35	0.127	0.1514	0.095	0.222	2.873	20	35	0	0.225	0.061	3.159	0.36	3.519	0.300	47.25	4.265	4.625
	95	38103715/2A	4.5	MA002		FISSA 4/5	2400	f	187		12.83	0.01	187	50	35	0.187	0.0935	0.059	0.246										0.332			
	96	38103715/3A	4.5	MA005		D5 R4 R4 DITO 18	2400	1	715		3.36	0.00	715	50	35	0.049	0.018	0.011	0.060										0.081			
	97	38103715/4A	4.5	MA005		D5 R4 R4 DITO 18	2400	1	353		6.80	0.00	353	50	35	0.099	0.0448	0.028	0.127										0.172			
	98	38103715/5A	4.5	MA005		D5 R4 R4 DITO 18	2400	1	310		7.74	0.00	310	50	35	0.113	0.0722	0.045	0.158										0.214			
	99	38103715/6A	4.5	MA005			6800	1	2640		2.58	0.00	2640	50	35	0.013	0.004	0.003	0.016										0.021			
	100	38103715/7X	4.5	MA005		D5 R4 R4 DITO 18	3400	1	997		3.41	0.00	997	50	35	0.035	0.01	0.006	0.041										0.056			
		38112118						1	1			1.00	1	50	35				0.217										0.293			
		38112120						1	1			1.00	1	50	35				0.035										0.047			
716	101	38103716/1A	4.5	MA005		D5 R4 R4 DITO 21	2400	1	276		8.70	0.00	276	50	35	0.127	0.1514	0.095	0.222	2.746	20	35	0	0.225	0.061	3.032	0.36	3.392	0.300	47.25	4.246	4.608
	102	38103716/2A	4.5	MA002		FISSA 4/5	2400	1	187		12.83	0.01	187	50	35	0.187	0.0935	0.059	0.246										0.332			
	103	38103716/3A	4.5	MA005		D5 R4 R4 DITO 18	2400	1	599		4.01	0.00	599	50	35	0.058	0.018	0.011	0.070										0.094			
	104	38103716/4A	4.5	MA005		D5 R4 R4 DITO 18	2400	1	291		8.25	0.00	291	50	35	0.120	0.0448	0.028	0.148										0.200			
	105	38103716/5A	4.5	MA005		D5 R4 R4 DITO 18	2400	1	310		7.74	0.00	310	50	35	0.113	0.004	0.003	0.115										0.156			
	106	38103716/7DX	4.5	MA005		D5 R4 R4 DITO 18	3400	1	997		3.41	0.00	997	50	35	0.035	0.01	0.006	0.041										0.056			
		38112119											0	50	35				0.217										0.293			
722	107	38103722/1A	4.5	MA005		D5 R4 R4 DITO 21	1000	1	187		5.35	0.01	187	50	35	0.187	0.1616	0.102	0.289	3.005	20	35	0	0.225	0.061	3.291	0.36	3.651	0.390	47.25	4.287	4.647
	108	38103722/2A	4.5	MA005		D5 R4 R4 DITO 18	1000	1	185		5.41	0.01	185	50	35	0.189	0.087	0.055	0.244										0.329			
	109	38103722/3A	4.5	MA005		D5 R4 R4 DITO 18	1000	1	299		3.34	0.00	299	50	35	0.117	0.054	0.034	0.151										0.204			
	110	38103722/4A	4.5	MA005		D5 R4 R4 DITO 18	1000	1	277		3.61	0.00	277	50	35	0.126	0.0573	0.036	0.162										0.219			
		38112123											0	50	35				0.217										0.293			
723	111	38103723/1A	4.5	MA005		D5 R4 R4 DITO 21	1000	1	206		4.85	0.00	206	50	35	0.170	0.1616	0.102	0.272	2.962	20	35	0	0.225	0.061	3.248	0.36	3.608	0.367	47.25	4.376	4.736
	112	38103723/2A	4.5	MA005		D5 R4 R4 DITO 18	1000	1	195		5.13	0.01	195	50	35	0.179	0.087	0.055	0.234										0.316			
	113	38103723/3A	4.5	MA005		D5 R4 R4 DITO 18	1000	1	360		2.78	0.00	360	50	35	0.097	0.054	0.034	0.131										0.177			
		38103723/4A	4.5	MA005		D5 R4 R4 DITO	1000	1	269		3.72	0.00	269	50	35	0.130	0.0573	0.036	0.166										0.224			

5.2 Production process analysis

Herewith the analysis that is done based on the delay have happened in the products delivery in February 2018. The company found out that bending work cell is the main circumstance in manufacturing planning moreover, what components had been produced by what machines. In the other word, it would be understandable to shadow the production line and machine as well as the component's inventory. The following data used in this appraisal:

1. Scheduled orders.

2. The PO[2] (*Figure 21*) cards toward production hall for each work centers.
3. On-hand inventory as well as inventory on January and stocks.
4. The number of customer's orders.
5. the production quantity for each machine.
6. final inventory.



LAVORAZIONE DEL FILO METALLICO

ORDINE DI PRODUZIONE: 2018 - PO - 008123 - 000005 DATA: 3/04/18
NR. BOLLA: 2018/ 000395
PROOTTO: V193032212 ENSEMBLE ASSISE LH DA VRNT C1
V193032212
MAGAZZINO: NR 9.000,000 MERCE SCARTI
SUBFORNITURA: DATA CONSEGNA RICHIESTA: 27/04/18

ORE IMPEGNO MACCHINA

DATA	OPERATORE	DALLE ORE	ALLE ORE	OPERAZIONE
				CAMBIO STAMPO
				CAMBIO VERSIONE

DATA	FASE	PRODUZIONE ORARIA	INIZIO PRODUZIONE	FINE PRODUZIONE	Q.TA' PRODOTTA	SCARTO	FIRMA OPERATORE

FERMIMACCHINA

DATA	OPERATORE	DALLE ORE	ALLE ORE	CAUSALI

COD.	DESCRIZIONE	DATA	U.M.	Q.TA' DA PRELEVARE	Q.TA' PRELEVATA	Q.TA' SCARTATA
151010580	CUSHION WIRE BASKET	3/04/18	NR	18.000,000		
151011250	TURN IN WIRE	3/04/18	NR	9.000,000		
151010452	TURN IN WIRE LHD	3/04/18	NR	9.000,000		
151011242	RIGHT TRANSVERSAL CUSHION WIRE	3/04/18	NR	9.000,000		
151010512	CUSHION TRANSVERSAL WIRE LHD	3/04/18	NR	9.000,000		
151010380	FIL REMBORDEMENT VP	3/04/18	NR	9.000,000		
151011730	HORIZONTAL REINFORCEMENT WIRE	3/04/18	NR	9.000,000		
151011740	VERTICAL REINFORCEMENT WIRE	3/04/18	NR	9.000,000		

COD/DESCR. FASE	COD/DESCR. CENTRO LAV.	U.M.T.	TEMPO PREVISTO	PZ/ORA
100 600	MA0100 ROBOT ABB IRB 1600 D	N.	600,00	30,00
SALDATURA C02 CON ROBOT DI SALDATURATTREZZO DI SALDATURA PNEUMATI		DATA INIZIALE: 2/03/18	DATA FINALE: 27/04/18	

UFFICIO

ATTENZIONE NON SCRIVERE SUGLI SPAZI GRIGI !!

Figure 21 Initial PO form before applying Odoo

The prime consequence of the investigation attains the optimized solution toward tracing POs to get wind what the machines have exploited to fabricate the orders through current scheduling method that would rely on just in time delivery but in fact, they have a delay on manufacturing moreover, saturation percentage (*Figure 22*), means what machine works more than others (*Table 2* and *Table 3*). There are some hints that have explained in below:

- The production is started on January 1st to meet the confirmed demand that will be delivered by the end of February (the current situation is middle of February).
- The zero (0) stands on that the customer's order is entirely satisfied.

[2] PO stands on page order. These cards have identified the allocated production plan for each machine and the quantity orders. The production planner will update them daily *(Figure 21*).

- The negative numbers have identified as being behind of schedule of customer's order.

Table 2 Machine occupation contribution in February 2018

Maccine

FEB	2	4	5	6	7
1		1500	###	1600 1740 840 480 450 5980	
2			1800	60 1110 1860	
3				200	
4					
5			2000 2000 ### 300	3600 6399	
6			1500 1000 1000 880	800	
7		2400 2750	120		
8		2000 2225	1000	1630	1650
9	1375	6710 1890		4770	150
10	1600 800 225	5290 885		5000	2810 1465
11	1600				
12	800 1600	565		3200	2400 800 800 545
13		235			1840
14		800			
15					
16		1600			
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
TOT	8000	28850	23800	39719	12460

Table 3 component produced in month February 2018

Produtto in Febraio

	codice	production quantity	Feb + Genaio	ordine	stock
1	382881	800	800	800	0
2	281924	7200	7200	7200	0
3	151008280	9400	13400	12000	1400
4	382968	800	800	800	0
5	390601	800	800	800	0
6	152008740	2400	2400	2400	0
7	382965	1600	1600	1600	0
8	151008210	12000	12000	12000	0
9	382966	800	800	800	0
10	151008271	5000	10567	11000	-433
11	151010512	2010	4510	4000	510
12	382970	800	800	800	0
13	382969	1600	1600	1600	0
14	151009101	1800	1800	1880	-80
15	151008262	1950	4450	2500	1950
16	15200870	12000	12800	12800	0
17	5801561516	1500	2000	2000	0
18	151008261	480	3110	2500	610
19	38103715/6A	2000	2000	2000	0
20	38103715/7SX	2000	2000	2000	0
21	151008810	450	600	600	0
22	38103715/7DX	2000	2000	2000	0
23	L0327862/D	1800	1800	1800	0
24	L0327862/N	1000	1000	1000	0
25	151008790	1000	1000	1000	0
26	L0389790/G	1000	1000	1000	0
27	L0389790/H	1000	1000	1000	0
28	L0503116AA	2400	2400	2400	0
29	151008450	4750	10300	9000	1300
30	151010422	1650	4300	4500	-200
31	151012681	20639	20639	44800	-24161
32	151008960	5000	5000	5000	0
33	382971	1600	1600	1600	0
34	390597	1600	1600	1600	0

1

The analysis unveils plenty of prominent errors in resource allocation by current planning approach. It

means the machine7 the high-speed but it has allocated for producing the components required less cycle time that it can perform by both machines 5 or 6. For instance, the component code151008280 has produced by machine5 while if it has allocated to machine7, it produced 1.5 more at the same cycle rate. Herewith this experiment, curious ambiguities become frequently appeared such as tracking the number of parts in traveling between bending work cell and assembly-work cell. Moreover, the deluded cycle times in the company's MRP system have discovered. Ultimately, following the revision of the data, the real cycle time of each work centers have substituted.

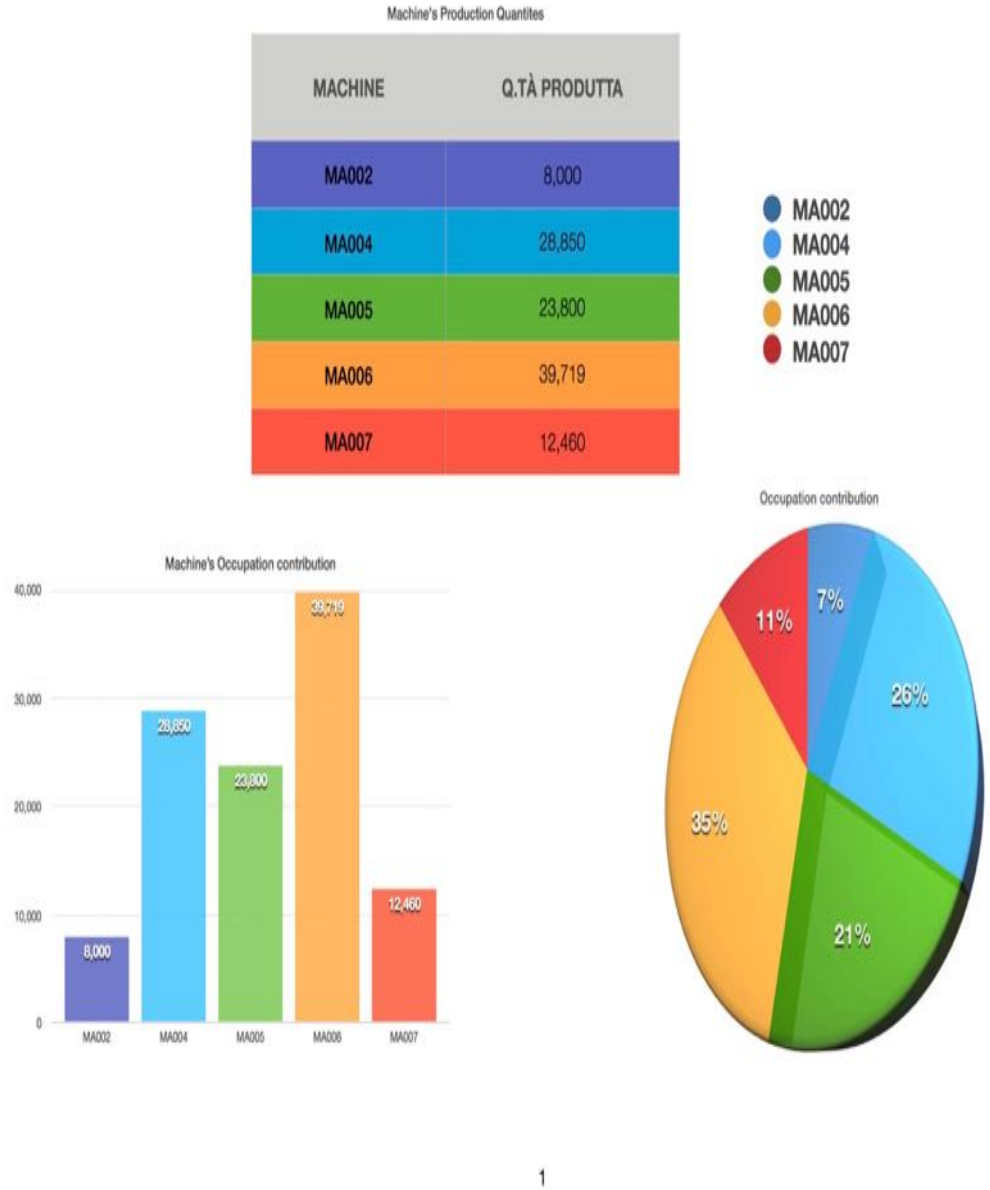


Figure 22 The Contribution of machine used in manufacturing process in February 2018

in terms saturation percentage and quantity have been produced.

5.3 Production waste time points analysis

In the aim of optimizing, the production line based on the goal of the Lean system, reduction waste time, as conditioned in chapter 3 part 3.4 toward manufacturing process, the line had divided into two principal zones, the bending work cell, and assembly-welding.

Presently, following the search on work cells, plenty of potentialities to waste time during the process has arisen. Interestingly, the attained result approved the most puzzles have happened toward the bending process. Once, this work cell has organized completely then the timeliness to launch over the next work centers will achieve.

5.3.1 Bending work cell

This work cell composed of 6 machines. As result of some bans such as various cycle times, wire's diameters, and machine's tooling, it is tricky to determine the unique sequence for an individual product in advance. Hence, the scheduling involving each machine has always done day by day toward completing assembly-welding work cell requirements. Infra following assessing the process some arguments have become visible:

- Errors in computing cycle times for some work centers. The problem got won after the production analysis to determine what machines have occupied according to the production plan and then led to stay behind of the schedule in orders until the problem has removed and met the customer's requirement by the long delay.
- The logistic problem inside work centers has become crucial. In fact, during the collecting the built components then meanwhile transferring them into the containers, the machine has to stop after every 50 pieces then after evacuating machine zone, the process will run again. Ordinarily, it takes 5-8 minute for each time per each machine. The matter rather than the logistic obstacle was born toward the ergonomic quandary for operators too.

- Employing only one machine for manufacturing all parts of one product instead of applying machines parallel. Despite company schedules based on real-time, it means to make toward demands, misallocation machines parallel between work centers lead to decrease machine's efficiency, productivity and frequently having no stock led to delay in delivery.

- A mistake in production planning is more prominent than notified circumstances in point 3. In fact, the company has a huge concern in resource allocation. For instance, while the high-speed center has exercised to produce component required low cycle time, the part expected higher time has built by a low-speed work center. It led to getting in problem toward balancing indoors bending work centers following by delay in feeding assembly welding centers.

- The high-quality tooling following by enough pieces of equipment for each machine are the most distinctive features to meet quality control insurance aspects. In the same vein, the opportunity for using two machines simultaneously to produce similar components will achieve. The argument has become visible, once operators inserted the tooling of the wire 4.5 to wire 5, suddenly has the plenty side effect on the quality of the bent component, led to dissatisfactory of the quality perspectives and increase the production cycle times.

- Lack of traceability system for tracking PO cards. Regularly the plan of each work centers determined based on customer orders. The PO card includes customer's order number, order quantity, due date, cycle time, machine capacity, and work center. In fact, this information allows operators to get wind what production has planned for what machine when it has started or finished. The operator will complete data such as start time, end event, product quantity, scraps products, and if the machine

has stopped during the process, or even for any other kind of problems they can leave comments in PO cards. Henceforward, every three machines will control by one operator who is also in charge of completing PO either. But it becomes a dramatical problem while the production planner is going to make report performance of the line. Since some information on the cards has written wrongfully or either missed, it was difficult to understand the changes inside the line, especially when producing a particular code is finished and another component code is started that becomes difficult to track the machines tasks.

- Lack of integration system to trace and storing the process parameters and information to set up machine rapidly. The machines will run by the cardinal numbers. Moreover, the operators should enter dimension on the machine unit control based on the CAD data. Occasionally, as notified in the previous chapter, it takes 30 minutes to set up the machine before production, it so-called adjusting the process. While the existence of integration and traceability system supported manufacturing process to store the parameters in the database then preparing the machine will perform rapidly moreover, the changes or modifications demands less time.

- The quality control gages have positioned Incorrectly. In fact, all gages and the original production samples are stored in the specific area farther than work cells. Therefore, always transferring them into each machine centers has taken a long time.

- The gaps between MSP and MRP planner becomes an issue. The president of the company acts as MSP since they received the orders from customers. The fact is that they frequently signed the contract for the deterministic amount of production with different delivery time weekly or monthly that in general, the relevant due dates will be informed to the company one month in advance. Meanwhile, as soon as customers confirmed the contract, the CEO makes the MSP for new order according to contracted quantity order whereas the MRP responsible who rather than final order he makes scheduling based on the delivery time during the month. At a glance, this planning term is correct because the planner tried to keep shop floor in the calm situation and also meet customers demand. But practically this knowledge never let the planner consider safety stock. So, while customers due to their condition mad change by rising demand of month the production hall couldn't approach because they had not corrected anticipation.

5.3.2 Assembly-work cell

The assembly-welding work cell composed of six welding machines. Indeed, scheduling the welding process is more convenient than bending centers. Assuredly, to produce in shorter time span, the process will start while all components and subcomponents of the lot size[3] have built. Soon as following the study on the process, plenty of inclinations to waste time during the process has identified.

- The logistic problem inside work center has tended to make a bit problem. In fact, to put components into the container, they have to perform following three actions. Firstly, put on the stand. Secondly, controlling the quality on the gage and lastly, put them into the container. This approach was adopted because of the limitation in the container's volume and capacity either. As it becomes visible the time between put on stand and control gage is a waste.

- Allocating only one machine for manufacturing complex components. The issue was born in one of the most critical projects where the dependent process involved loading components simultaneously in two separate fixtures that are neither symmetric nor equal in the components number terms. In fact, the product A composed of ten components while product B has eighteen parts, but it had a

[3] The amount of lot size will determine based on customers order and machine capacity, usually for 100 pieces of final products.

larger volume, and more welding points then frequently demand more time for both processes assembling and welding in comparison with product A. Toward manufacturing of this product, the firm has assigned two operators, but it led to lack of coordination. However, the operator worked on product A performed his tasks faster than another one but and the end of the day, the welding process will start when both fixtures have loaded entirely.

- Lack of identical sequence to assembly parts for operators. In fact, the stands in welding centers include sort of components that they only have signed by their figures. The logistician recognizes what part should charge in where, while they should have the clear sequential identification to shows the queue of assembly. Assuredly, the assembly process has involved toward BOM for each product but lacks the identification numbers for components and subcomponent frequently for new operators led to increasing scraps on production and waste time until learning the queue.

- Once welding process has finished the parts should pass the quality control, therefore, they will be assorted as a good product or scraps, or probably, the ones acquire more finishing operation to repair. The necessity of having the precisely inspecting approach toward separating final products become visible throughout delivery the orders to the customer, she has encountered by collecting the scraps instead that led to refusal the packs and transmitting them to the factory.

- Similarly to bending work cell, the quality control gages have positioned Incorrectly. In fact, all gages and the original production samples, and fixtures are stored in the specific area farther than work cells. Therefore, always transferring them into each machine centers has taken a long time.
- Lack of traceability system for following PO cards. Regularly, the plan of each work centers determined upon customer orders and scheduled delivery. Similarly bending centers operator was in charge to complete the cards, they include customer's order number, order quantity, machine center. In fact, this information accumulated to product's BOM allows operators to get wind what production has planned for what machine. As notified, the planning and the pursuing the assembly-welding process are straightforward in comparison with bending process, but it becomes a significant confusion while registration data into MRP's software has never executed by production planner then tracing the process turned to the crucial subject.

5.4 Fishbone analysis

Fishbone diagram has employed to address the malfunctions inside production line concerning multiple visions and the side effects on the process either exposed to fall into ruts or increase waste time (the aim of Lean manufacturing).

In fact, the analyst composed of two essential parts head and fishbones. The head will describe the concept of the enigma then the bones illustrate causes that can state particular circumstances precisely. The following arguments frequently will brainstorm in evaluations in industries:

- Machine
- Method
- Material
- Man m
- Measurement
- Mother nature (environment)

Therefore, according to the waste time has discussed in last part following fishbone diagram (*Figure 23*) will reveal the problem. Moreover, next chapter will narrow down into causes and so the potential solution and prevent activities will be discussed.

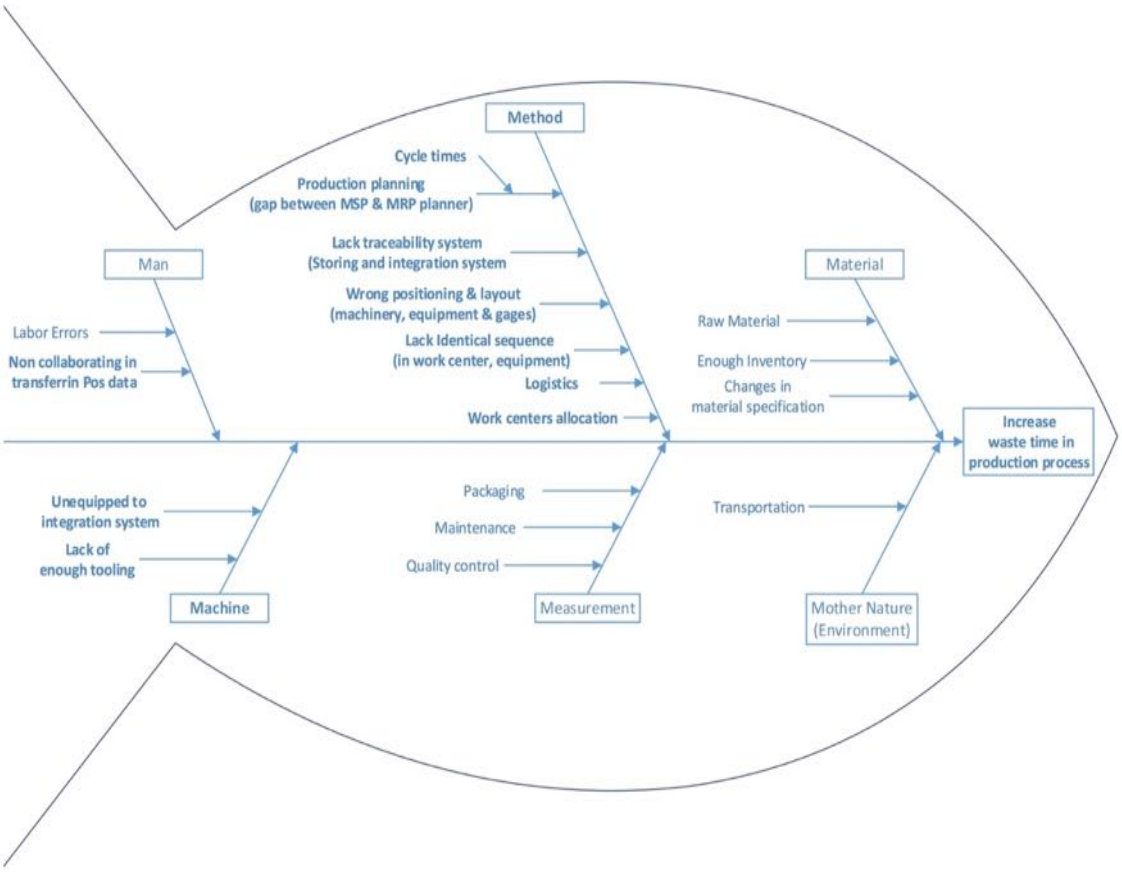


Figure 23 Fishbone diagram

6 Prevention and solutions to remove waste time:

Once, the potential waste time points have defined within the production process analysis (previous chapter in part 5.3) according to the chosen approach, SMED, to achieve the Lean advantage, the wastes in the production line have to eliminate as well as the internally changeovers in process have to convert to externally one as much as possible. Therefore, following the division of the work cells in the previous section, this chapter will describe the prevent operations and activities for each dilemma respectively.

6.1 Bending work cell

As far as information has expressed in the last chapter, the bending work cell is the most important in this production process since once we have the proper scheduling in producing and preparing components and subcomponents, we can feed the assembly work cell as well as meeting customer's demand delivery. So, based the issues arose in chapter 4, following preventive activities are considered during production planning of the week 8[th4].

- Herewith computing the correct cycle times for each machine, firstly, the real lead times for each process has attained, then eventually, the inaccurate data for each profession center have substituted by the revised cycle times in the MRP software. The new planning has executed after modifications, and the on-hand inventory for all projects are on schedule.

- Using a chain or a belt conveyor is the prevailing solution to eliminate the logistic dilemma in centers to make the machine zone empty of parts and carrying into the container. Another innovative approach is creating tools to collect all components in specific corners of the machine to evacuate machine faster and then transferring into containers. The creative solution has made for two machines (*Figure 24*), rather than mentioned advantages, transporting has improved, the process works continuously, and human ergonomic factors have done.

Figure 24 The changeover before and after using devices during collecting bent components from machine zone

[4] Appendix 1 illustrate the production plan of week 8[th].

- The logic rules of assembly line balancing "longest cycle time should perform by highest speed machine and vice versa" solved the problem in dedicating only one machine for manufacturing by allocating parallel production planning. So, following this prevention, we could increase the production capacity to make logic safety stock.

- To overcome toward necessary enough tooling, it has suggested to the company to consider the cost of tooling for each project based on order quantity in advance.

- The traceability problem, especially tracking the PO cards has eliminated over creating a temporarily new BOW[5] (*Figure 25*) for each machine center to get wind precisely what components produced by what machine, therefore, the correct cycle time has estimated for each process during the determined weeks. Hence, at the first step, the improvised approach has executed via providing the blank pages for operators toward each machine to complete the requested information included the components code numbers, cycle times, started and finished times, the quantity of product, process scraps and leaving the comment if the machine has stopped. Therefore, to get coordination, the information has pursued though inserting data into online google docs and then MRP software to modify incorrect data.[6]

	MA002		Hours Worked 287.37						
	Codice	Tempo Ciclo	Inzio del Produzione	Fine del Produzione	Hours Worked	Q.Ta Prodotta	Scarto	Data	Fermo Macina
1	8440		6:00 AM	10:00 AM	4.00	4630		15-02	
2	8220		10:00 AM	5:04 PM	7.07	10000		15-02	
3	8440		6:00 PM	10:00 PM	4.00	1500		15-02,16-02	
4	8440		10:00 PM	6:00 AM	8.00	3000		16-02	
5	8440		6:00 AM	2:45 PM	8.75	12000		16-02	
6	151008990	31.3	6:01 PM	10:00 PM	3.98	370		16-02	
7	151008990		10:00 PM	4:30 AM	6.50	705		16-02	
8	151008440		6:00 AM	2:45 PM	8.75	12000		16-02	
9	151008990	31.3	6:01 PM	1:00 AM	6.98	370		16-02	
10	151008990		10:00 PM	2:00 AM	4.00	705		16-02	
11	152009250		7:35 AM	3:00 AM	19.42	1280		19-02	
12	152009250		1:30 PM	4:00 AM	14.50	160		19-02	
13	152009250		2:00 PM	5:00 AM	15.00			19-02	
14	151008450		10:45 AM	6:00 AM	19.25	3325		19-02,20-2	
15	151008450		6:00 AM	7:00 AM	25.00	475		20-02	
16	151010250	14.7	11:50 AM	8:00 AM	20.17	480		20-02	
17	151010250		2:00 PM	9:00 AM	19.00	2225		20-02	
18	151010250		10:00 PM	10:00 AM	12.00	300		20-02	
19	151010250	14.6	1:40 PM	11:00 AM	21.33	1150		20-02-21-02	
20	151010250		6:00 AM	12:00 PM	30.00	1850		21-02	
21	L0327862/L	20.6	2:10 PM	10:00 PM	7.83	765		21-02	
22	151008680	16.2	12:00:00 AM	1:00 AM	1.00	185		21-02	
23	151008680	16.2	8:40:00 AM	2:00:00 PM	5.33	1190		22-02	
24	151008680	16.2	2:00:00 PM	10:00:00 PM	8.00	1085	30	22-02	
25	151008680	16.2	10:30:00 PM	6:00:00 AM	7.50	1410		22-02, 23-02	
26			4:00:00 AM						
27			5:00:00 AM						
28									
29									
30									
	Total					61160			

Figure 25 New bill of work (BOW)

[5] BOW stands on bill of work.

[6] In the same vein of approaching Odoo MRP, the company current MRP software AS/400 from IBM group has employed. In comparison with Odoo, AS/400 is more powerful but enormously complicated rather than Odoo as both user-friendly and user-oriented software features. Therefore, the company's information from the early of the year 2018, more than 300 pages have registered in both software, and now company production line works in real time. It has done by the end of March during the university internship period.

- Creating an integration system is the only reliable solution in eliminating the absence of traceability in production line through storing the process parameters via adding a computer system to each center or group of them and connect them to barcode reader to transfer derived date in a database.

- According to SMED, we have to take in consideration the particular machine that will apply to manufacture the products, the free spaces behind of each work centers have reserved to maintain gages, samples, and any necessary tooling for each machine. Eventually, led to access rapidly to the instrument.

- The gape stemmed from miscoordination MRP planner with MSP has revised by implementing the philosophy of safety stock to engage with any changes in customer's demand and additionally to avoid making inventory cost.

6.2 Assembly-work cell

Correspond to make prevention in bending work cell the following improvements had been considered for the assembly-welding work cell as well.

- Similarly to bending work cell, the logistic issue will solve by the comprehensive solution by employing a conveyor to eliminate excess actions to move parts out of centers. Meantime, designing continuous production line is extremely expensive and acquires the long-term plan and big-hearted investment. But the immediate and less cost preventive measurements to decrease cycle times will achieve by elimination the first action, it means once the product has unloaded from the fixture, they control them over the quality gage, and instead of hanging good parts on stands, they directly transferred into the container. To ensure the positioning in the container will support by creating some holder guide to aid the operator in the way of setting product similarly. The holding guides can be portable, it means using some screws to fasten them to bottom of the container then when their space becomes full, the operator can open the guides and install them in another one. The creative approach has tested for the small product that the operator transferred good part much faster than current approach.

- Allocating only one machine for manufacturing final products instead of employing machines parallel or adding new welding center to eliminate lack of enough resource dilemma bear remarkable investment. In the same vein, in the mentioned project in the last chapter, the process has changed by using a machine with two welding robots for product B, and a single robot for welding smaller product A, but at the end, the cycle time did not have significantly change.

- Installing ID numbers on each stand in each welding center to get the clear and identical queue toward assembly part for operators. This prevention activity has done once the new operator joined to the production line and then it has extended to every machine.

- In fact, the operators have addressed how to place products correctly by creating the visual concept. In doing this, some stickers with standard colors such as green[7], yellow[8], and red[9] have attached over each container. Therefore, they can distinguish what products should locate where.

- Similarly, to bending work cell, according to SMED, we have to take in consideration the particular machine that will apply to manufacture the products, the free spaces behind of each work centers

[7] Green stands on the good products.
[8] Yellow lays on those defect products and they require an extra operation.
[9] Red emphasis on process scraps.

have reserved to maintain gages, samples, fixtures and any necessary tooling for each machine. Eventually, led to access rapidly to the instrument.

- The traceability dilemma in assembly working cell has removed precisely via the similar preventive measurements of in bending work cell by creating a BOW.[10]

[10] In the same vein of approaching Odoo MRP, similar to bending work cell the information from the early of the year 2018 have registered in both software, and now company production line works in real time. It has done by the end of March during the university internship period.

7 Implementation of Odoo:

This chapter is dedicated to introducing the ERP software and will describe easy and fast instruction about implementing Odoo 8 on Windows.

As introduced in the earlier chapter, the ERP tool employed to make an integration between the company's departments with a various capacity, range, and inconsistent application. In fact, the ERP will create the internal link to bolster communication, from the top-level management to the shop floor simultaneously and vice versa to meet the market demands.

Implementing ERP systems seems costly though It has prominent various advantages and value added for the company, precisely following core of Lean manufacturing, thinking, and management terms to reduce valueless tasks, relations, and activities among departments. Moreover, ERP is the most beneficial tool for the analysis of internal and external behaviors toward the companies to distinguish what is their actual situation and position in the market competition. There are different kinds of ERP software have employed in industrial markets such as SAP, Oracle, IBM AS/400, Odoo, and ... with a diverse adaptability feature to company's largeness.

7.1 Instruction using Odoo

The Odoo is an open source software. Hence, the series applications have designed for industry diversification with various users. Ordinarily, it has classified in two sections Enterprise and Community. Although enterprise version supports business trends then most of the applications are in access via purchasing an original license but the community has created for the educational system to support learning and universities goals, therefore, selected functions and modules will available freely for instructors and students.

Getting started with Odoo acquired a software suited on computer operating system, Windows or Linux have supported by Odoo. Therefore, the packages should install completely. This research applied Odoo 8 that the license has provided by the Polytechnic University of Turin, as stand only software means it only runs for one computer, without the feasibility to connect to the server. Soon as the installing the Odoo has begun the software and required database will install simultaneously, it also so called all-in-one installation. It is necessary to remind that if installing software and server have done separately the Odoo will not proceed.

Once installing process is ended, the Odoo Automatically will run through the web browsers such as Google, Google Chrome, Firefox, and ..., that is one of the prime differentiation and impressive features herewith the software that provides satisfactory feeling between whether Odoo offline users and its online users. Consequently, by connecting to server localhost (http://localhost:8069) and creating a database as well as *Figure 26* the Odoo has set up.

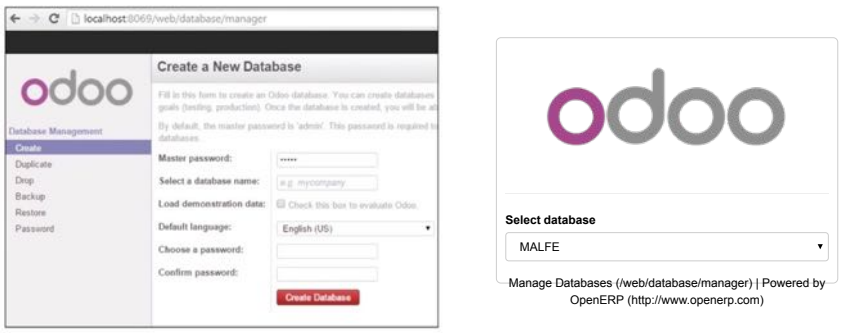


Figure 26 creation database

The installation mode will continue by moving over the setting *(Figure 27*) a where get introduced plenty of the modules. In fact, In Odoo8, MRP stands on manufacturing modules, by clicking, rather than MRP the associated modules will download automatically too, functions such as:

- Product name
- Warehouse and inventory management
- Invoice
- Reporting
- Messaging
- Sales management
- Purchase management

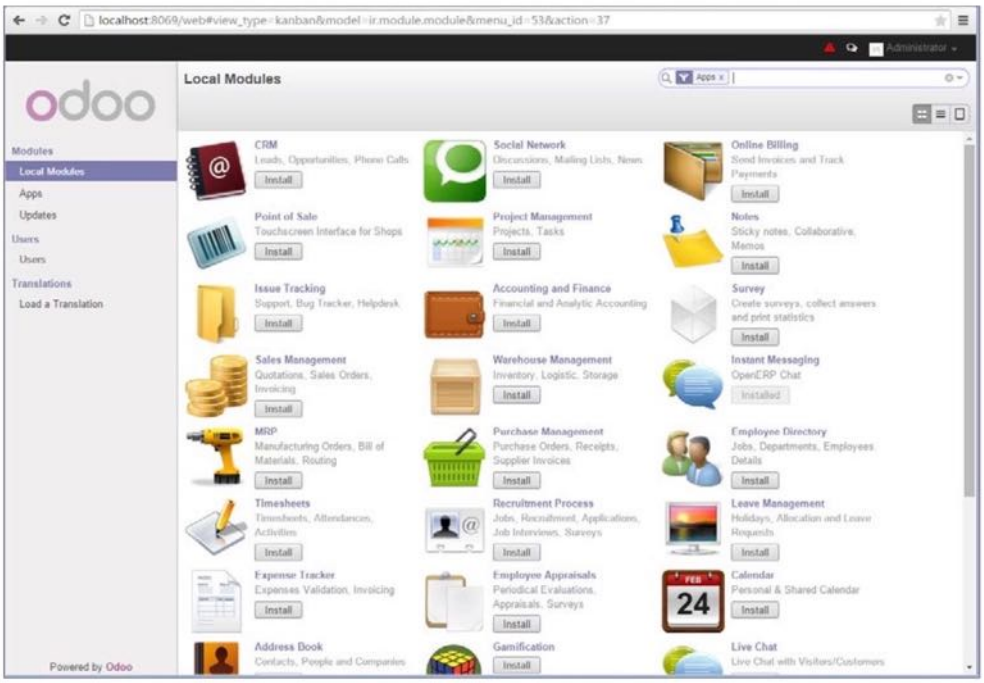


Figure 27 Odoo general setting apps

In addition to straightforward access to modules, Odoo actually, provides users to fast interfacing with various departments in the enterprise. Assuredly, there is a prospect to define prohibition admittance toward any departments to ensure higher security.

7.2 Creating the company and user name

In general speaking, the ERP business model in any company is the consequence of the integration between internal and external activities to catch a market share in industry rivalry[11]. In this regard, in Odoo the company (*Figure 28*) will create by completing following information:

- Company name
- Contact information
- Tagline

[11] As notified in part 2 section 2.5

- Website
- Bank account (accounting information)
- Tax

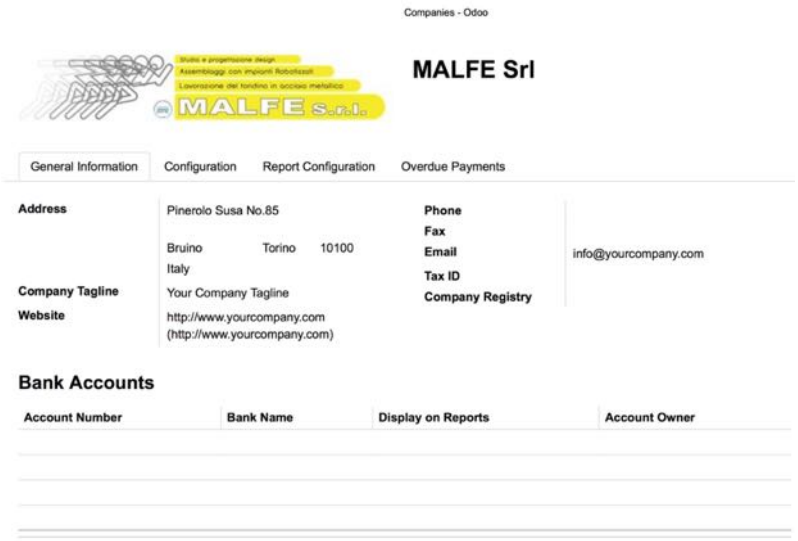


Figure 28 Creating company

Therefore Aligned to creating the company, in Odoo the users (*Figure 29*) have defined through below information and selective access and prohibitions:

- User name
- Accesses rights (responsibility) and actions
- Preferences

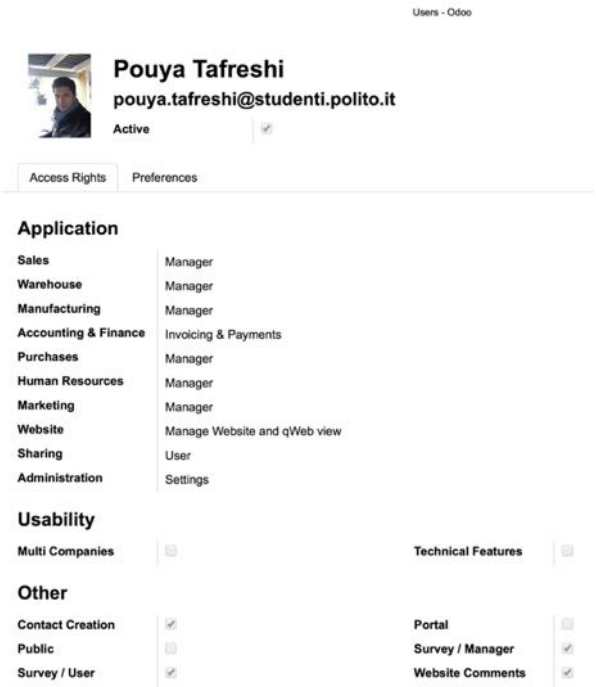


Figure 29 Determining users

7.3 Defining internal modules and submodules

Hence, for better understanding this alliance, following installing MRP and establishing company's profile in Odoo, the instruction will describe approach to define MRP submodules toward horizontal integration and manufacturing process a final product as internal integration. Therefore, form manufacturing general setting the manufacture order and master data (*Figure 30*) should activate and then following information will appear manufacturing tab:

- Creating products
- Defining BOM
- Introducing work centers
- Creating routings
- Creating manufacturing order

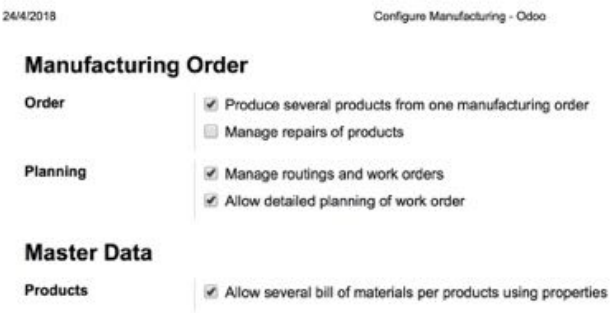


Figure 30 Activating manufacturing setting

7.3.1 Defining products

Products will include following by below information for all components, raw materials, packaging, and external or outsource services (*Figure 31*):

- Product name
- Determining if it can order or manufactured
- General information (product type consumable or stock-able or service, sales price, unit of measure, active or inactive, barcode, internal reference)
- procurements (cost method such as standard, average or real price, units, routes (buy or make to order), supplier information, and lead time)
- Inventory (stock and expected variation, status storage location, weights)
- Sales (sales health, consumer lead times, Pos, sale price)
- Accounting

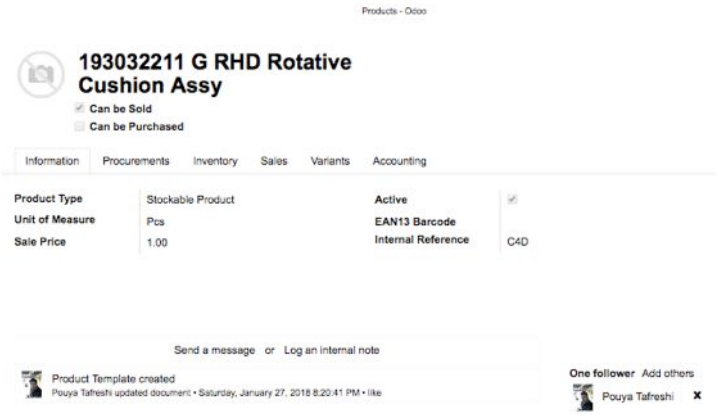


Figure 31 Creating products.

7.3.2 Defining work centres

This tab stands on the machine has allocated to each process to perform each operation. Herewith following information the work centers (*Figure 32*) will create:

- Center name, resource type (whether human or material, working time, code, active or inactive)
- Capacity information (efficiency and time per cycle, the time before and after production)
- Cost information (center of the product cost per hour, per cycle, accounting information)

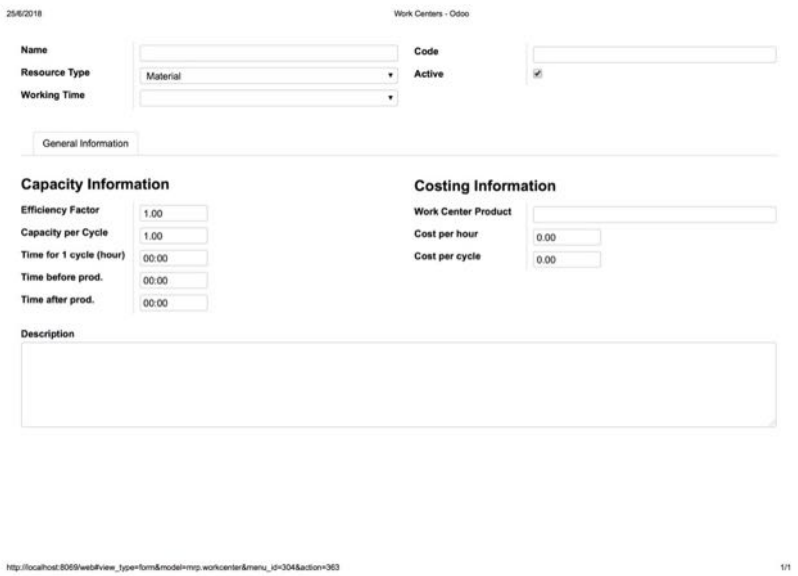


Figure 32 Creating work centers

7.3.3 Defining routings

This tab will define the series of the function will operate in each work centers whether to manufacture components or assembly parts of the final product. Occasionally, the following information has arisen in routings (*Figure 33*) tab, also appears in BOM:

- Routings name
- Code

- Bing active or inactive
- Product location (inside production hall of the company or in the partner's plant means outsourcing)
- Work center operations (sequence, name, work centers, number cycle and hours)

28/4/2018 Routings - Odoo

Name	BC/MA 715/716/722/723	**Production Location**	WH/Production
Code	BC56/23	**Active**	☑

Work Center Operations | Notes

Sequence	Name	Work Center	Number of Cycles	Number of Hours
0	BC/MA005-715/1	BC/MA005-715/1	276.00	1.00
0	BC/MA002-715/2	BC/MA002-715/2	187.00	1.00
1	BC/MA005-715/3	BC/MA005-715/3	715.00	1.00
2	BC/MA005-715/4	BC/MA005-715/4	353.00	1.00
3	BC/MA005-715/5	BC/MA005-715/5	310.00	1.00
4	BC/MA005-715/6	BC/MA005-715/6	2640.00	1.00
5	BC/MA005-715/7SX	BC/MA005-715/7SX	997.00	1.00
6	BC/MA005-715/7DX	BC/MA005-715/7DX	997.00	1.00
7	BC/MA005-716/1	BC/MA005-716/1	276.00	1.00
8	BC/MA002-716/2	BC/MA002-716/2	187.00	1.00
9	BC/MA005-716/3	BC/MA005-716/3	599.00	1.00
10	BC/MA005-716/4	BC/MA005-716/4	291.00	1.00
11	BC/MA005-716/5	BC/MA005-716/5	310.00	1.00
12	BC/MA005-722/1	BC/MA005-722/1	187.00	1.00
13	BC/MA005-722/2	BC/MA005-722/2	185.00	1.00
14	BC/MA005-722/3	BC/MA005-722/3	185.00	1.00
15	BC/MA005-722/4	BC/MA005-722/4	185.00	1.00
16	BC/MA005-723/1	BC/MA005-723/1	206.00	1.00
17	BC/MA005-723/2	BC/MA005-723/2	195.00	1.00
18	BC/MA005-723/3	BC/MA005-723/3	360.00	1.00
19	BC/MA005-723/4	BC/MA005-723/4	269.00	1.00

Figure 33 Defining Routings

7.3.4 Defining bill of material (BOM)

Once the creating the products have defined, the opportunity to identify the relationship amid each final product by components or subcomponents. Therefore, BOM structure (*Figure 34*) includes following items:

- Product
- Product variant
- Quantity and units
- Components
- Subcomponents
- Internal name
- The type BOM (Normal or kit that means the group of materials uses at the same time for any products)
- Reference

2018-01-25 13:17 MALFE Srl 1 / 1

BOM Structure

BOM Name	Quantity	BOM Ref
193032212 G LHD Rotative Cushion Assy	**1.000 Unit(s)**	
[ ] V193032212 G LHD	1.00 Unit(s)	
[ ] 193032212 G LHD	1.00 Unit(s)	
[C4D] 151010580	2.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011250	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010380	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011730	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011740	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010452	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011242	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010512	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[Box] Carton	1.00 Unit(s)	

Figure 34 Creating BOM structure

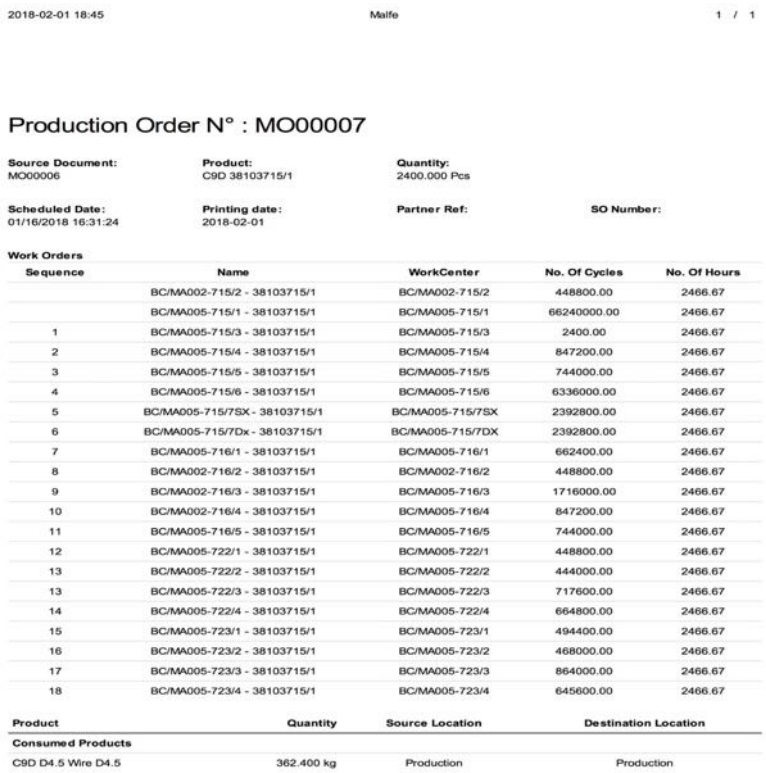
Here in this tab, the prominent point will address that any products will purchase have no BOM while if it acquires any operation to become the superior component it has to define in advance as a product.

7.3.5 Creating manufacturing order

The manufacturing order (MO) toward to customer's demand. Therefore, this procedure will start by creating an invoice. Moreover, once, customer confirmed their order, manufacturing order will create based on the delivery terms and conditions. The tab consists of the following information:

- BOM
- On-hand Inventory
- Routings
- Work centers
- Client information
- Quantity of the order,
- Schedule or delivery date (due date), and
- Internal references

As result of new BOM structures, following updating the on-hand inventory, production cycle numbers, real-time inventory stock (JIT and FIFO) structure, the model has prepared to process the manufacturing order (*Figure 35*). Moreover, for better perception the concept of figure It should be added the time frame numbers have based on seconds and the working shift considered for eight hours per day.



2018-02-01 18:45 Malfe 1 / 1

Production Order N° : MO00007

Source Document:	Product:	Quantity:		
MO00006	C9D 38103715/1	2400.000 Pcs		
Scheduled Date:	**Printing date:**	**Partner Ref:**	**SO Number:**	
01/16/2018 16:31:24	2018-02-01			

Work Orders

Sequence	Name	WorkCenter	No. Of Cycles	No. Of Hours
	BC/MA002-715/2 - 38103715/1	BC/MA002-715/2	448800.00	2466.67
	BC/MA005-715/1 - 38103715/1	BC/MA005-715/1	66240000.00	2466.67
1	BC/MA005-715/3 - 38103715/1	BC/MA005-715/3	2400.00	2466.67
2	BC/MA005-715/4 - 38103715/1	BC/MA005-715/4	847200.00	2466.67
3	BC/MA005-715/5 - 38103715/1	BC/MA005-715/5	744000.00	2466.67
4	BC/MA005-715/6 - 38103715/1	BC/MA005-715/6	6336000.00	2466.67
5	BC/MA005-715/7SX - 38103715/1	BC/MA005-715/7SX	2392800.00	2466.67
6	BC/MA005-715/7Dx - 38103715/1	BC/MA005-715/7DX	2392800.00	2466.67
7	BC/MA005-716/1 - 38103715/1	BC/MA005-716/1	662400.00	2466.67
8	BC/MA002-716/2 - 38103715/1	BC/MA002-716/2	448800.00	2466.67
9	BC/MA002-716/3 - 38103715/1	BC/MA005-716/3	1716000.00	2466.67
10	BC/MA002-716/4 - 38103715/1	BC/MA005-716/4	847200.00	2466.67
11	BC/MA005-716/5 - 38103715/1	BC/MA005-716/5	744000.00	2466.67
12	BC/MA005-722/1 - 38103715/1	BC/MA005-722/1	448800.00	2466.67
13	BC/MA005-722/2 - 38103715/1	BC/MA005-722/2	444000.00	2466.67
13	BC/MA005-722/3 - 38103715/1	BC/MA005-722/3	717600.00	2466.67
14	BC/MA005-722/4 - 38103715/1	BC/MA005-722/4	664800.00	2466.67
15	BC/MA005-723/1 - 38103715/1	BC/MA005-723/1	494400.00	2466.67
16	BC/MA005-723/2 - 38103715/1	BC/MA005-723/2	468000.00	2466.67
17	BC/MA005-723/3 - 38103715/1	BC/MA005-723/3	864000.00	2466.67
18	BC/MA005-723/4 - 38103715/1	BC/MA005-723/4	645600.00	2466.67

Product	Quantity	Source Location	Destination Location
Consumed Products			
C9D D4.5 Wire D4.5	362.400 kg	Production	Production

Figure 35 Creating manufacturing order

7.4 Defining external modules and submodules

As mentioned in the previous section of this chapter, the company's indoor processes have linked tougher. This part will explain external integration that underlies on supply chain management, business marketing, and commercial activities such as:

- Purchase management
- Sales management and invoicing
- CRM[12]

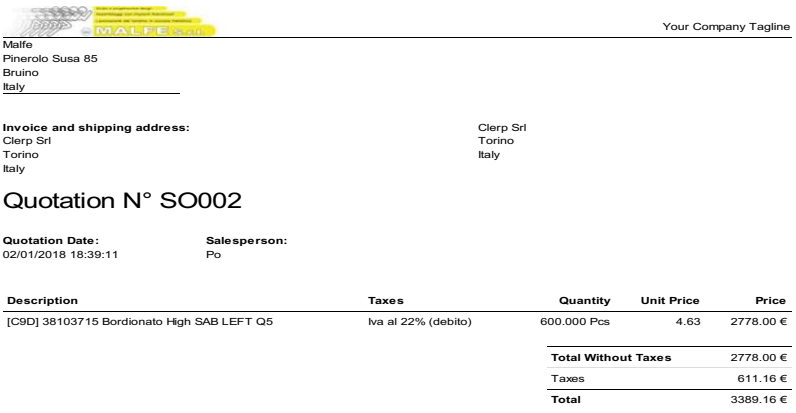
Furthermore, as a result of doing user-oriented and real state ERP system, it is conceivable to build the website as the public portal as a universe gate of communication between company, suppliers, and customers, so-called customers relationship management (CRM), Human resource management, and product lifecycle management (PLM).

7.4.1 Defining sales management and invoicing

As noticed in the last section, the MO will create toward customer's demand. In fact, the process we will start following a request for quotation from customers. Therefore, the sales forces in the commercial department have to create an invoice (*Figure 36*) referenced to customer's inquiry then once the orders have confirmed with the client, the request for producing demand will be announced to shop floor.

So in this module includes information concerning customers and clients such as:

- Customer name
- Private customer or company
- General contact information
- The contact person who had executed the order
- The salesperson who creates the invoice and proforma invoice (PFI)
- Warehouse (whether the customer or supplier location)
- Costumer's accounting information (fiscal position, last date of full reconciliation, account receivable, customer payment term, total receive, credits, last date of full reconciliation, account payable, supplier payment term, and total payable)



Your Company Tagline

Malfe
Pinerolo Susa 85
Bruino
Italy

Invoice and shipping address:
Clerp Srl
Torino
Italy

Clerp Srl
Torino
Italy

Quotation N° SO002

Quotation Date: 02/01/2018 18:39:11

Salesperson: Po

Description	Taxes	Quantity	Unit Price	Price
[C9D] 38103715 Bordionato High SAB LEFT Q5	Iva al 22% (debito)	600.000 Pcs	4.63	2778.00 €

Total Without Taxes	2778.00 €
Taxes	611.16 €
Total	3389.16 €

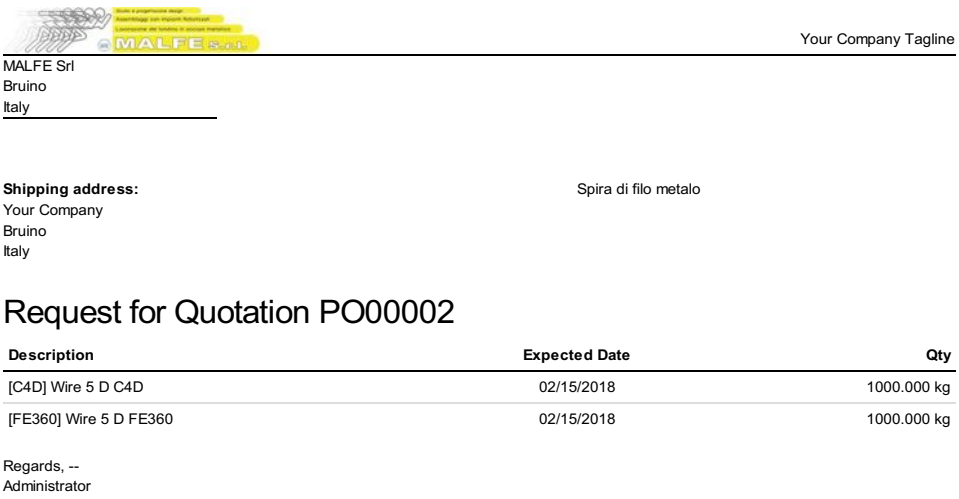
Figure 36 Sales order report

[12] This module did not cover respect to the scope of the research and PLM has created for new version of Odoo (Odoo10).

7.4.2 Defining purchase management

In the same vein sales management function, to produce a MO company required to determine and purchase the amount of raw material according to product's BOM. Odoo will illustrate the inquiries to meet MO, by comparison, the on-hand inventory of raw material with the order quantity. Commonly, if the depository was not sufficient to engage in producing the customer's demand, it will be illustrated by red color in MO. It means supply chain management has to create a purchase order. Frequently, the company will make their orders by creating RFQ (*Figure 37*). Hence, this tab will manage the creation of procurement process through completing following information:

- Supplier name
- Private supplier or company
- General contact information
- The person in charge to purchase
- Minimum order quantity (MOQ)
- Delivery lead time
- Supplier's product code
- Accounting information (paid account, payment method whether in cash or in bank, date and payment reference)
- Warehouse location (whether company or supplier)
- Pickup arrangement, receiving and positioning in the factory



Your Company Tagline

MALFE Srl
Bruino
Italy

Shipping address:
Your Company
Bruino
Italy

Spira di filo metalo

Request for Quotation PO00002

Description	Expected Date	Qty
[C4D] Wire 5 D C4D	02/15/2018	1000.000 kg
[FE360] Wire 5 D FE360	02/15/2018	1000.000 kg

Regards, --
Administrator

Figure 37 Purchase order, RFQ.

7.5 Warehouse management

The is one most key module in Odoo, in fact, the link between internal and external integration will end to warehouse management as result of inventory stock in sending or receiving whether the raw material or products. It is based on the concept of double entry that revolutionized accounting: "Nothing lost, everything moved."

Hence, The Odoo through warehouse management application will facilitate following actions:

- Managing stock inventory full view of stock levels
- Get to complete traceability
- Inventory control by using FIFO[13], LIFO[14] & FEFO[15] approaches and stock value
- Handling several logistic units (Pack, pallet, or box)
- Exchange and deal with in plenty of warehouses and stock Locations ((whether company or supplier or partner's plants)
- Automate the stock management

7.5.1 Managing stock inventory and full view of stock levels

According to Odoo modules and structures, once the products, BOM, routings, work centers, suppliers, and customers are defined, therefore, the inventory stock and controlling will start through updating information of inventory directly from stock inventory or form each production tab by clicking on each product and updating on-hand and forecasted inventory in creating manufacturing through following definition:

- On-hand inventory: the available physical quantity of products in inventory
- Forecasted quantity: the real amount of product quantity to sell, in fact this amount as result of summation the deference of on-hand inventory with outgoing inventory

The blockbuster advantage of Odoo is conveniently providing access to all operation in warehouse management through the all operation dashboard (*Figure 38*). In fact, any time receipt, delivery order, and the internal transaction will appear during any purchase or sales orders.

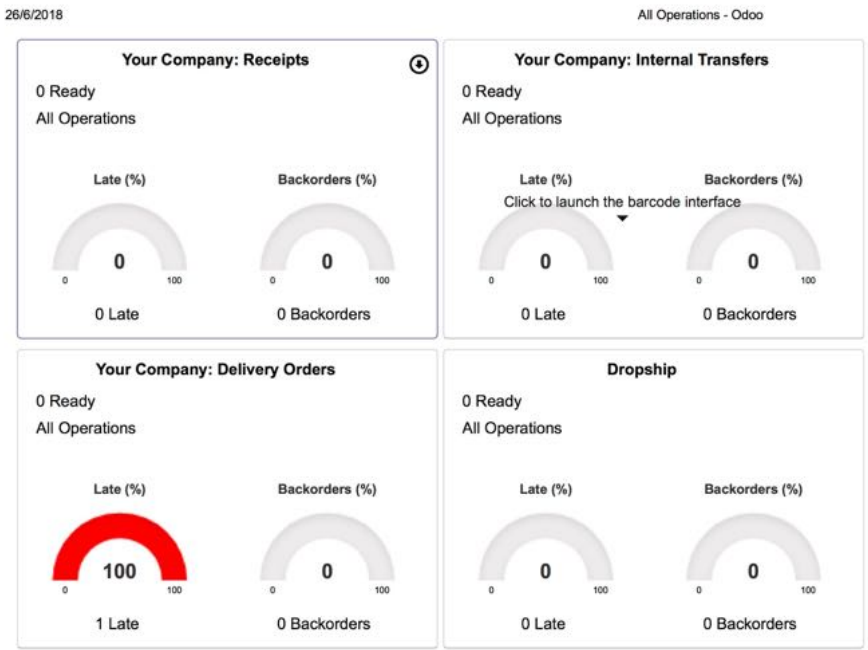


Figure 38 Warehouse management, all operation dashboard

[13] First in first out.
[14] Last in first out.
[15] First Expired, first out.

7.5.2 Getting to complete traceability

Jam-pack trackability (*Figure 39*) system by Odoo will report any changes in process in real time through the visual perspective via following approaches

- Following the quants through Identifying a particular stock inventory of similar product as soon as received by warehouse at any time and via any change regarding any further operation
- Tracing the product movements via the lot ID[16]
- Creating packaging system for products

Figure 39 Warehouse management configuration, Full traceability control

7.5.3 Inventory control by using FIFO, LIFO and FEFO approach and stock value

In same vein, all ERP software follow the removal strategy for inventory control. In Odoo, it is set by default through FIFO but pertain to production categories there is opportunity to define other inventory systems for various locations and inventory places.

Moreover, stock assessment can define toward cost evaluation approaches such as standard price or average accordingly to product's cost price. It means by selecting the cost as standard or in another word real price, Odoo will set the value of the inventory stock toward purchasing price.

7.5.4 Handling several logistics units (Pack, pallet, or box)

Following this approach, all units related to picking up arrangement, receiving and shipping to customers toward packaging system will define (*Figure 40*).

[16] In Odoo it is so-called as serial numbers.

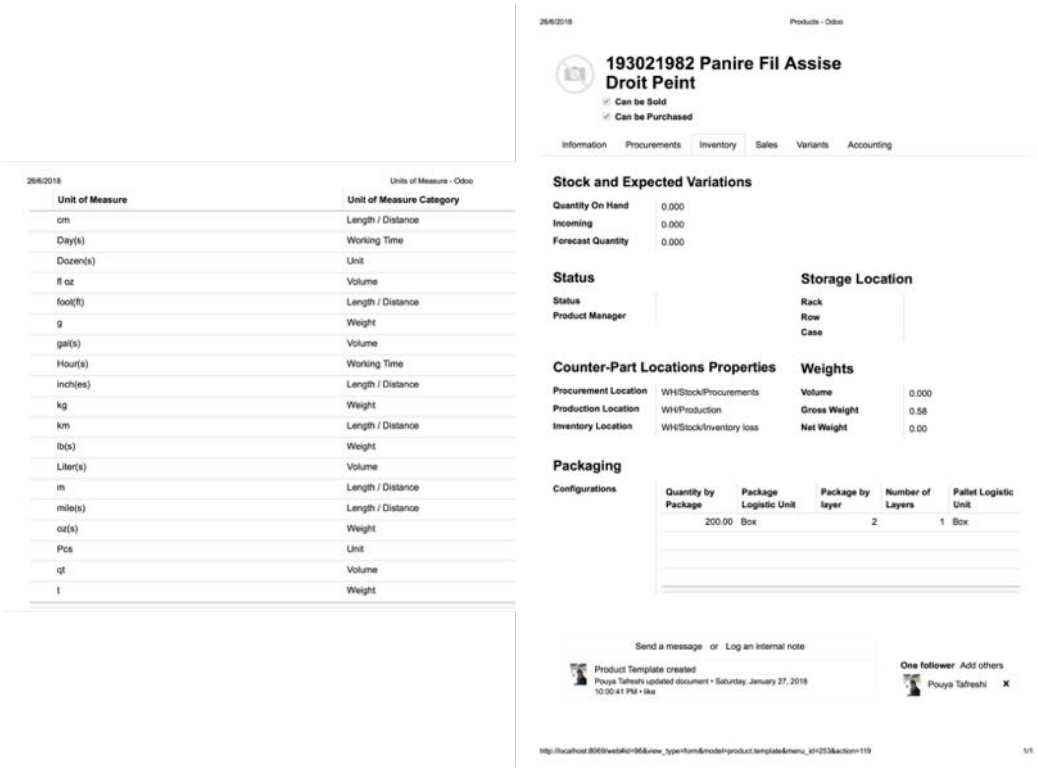


Figure 40 Determining the unit's measure and packaging method

7.5.5 Exchange and deal with warehouses and stock locations

Following linking the internal and external of the company any change, movement, or even transformation can trace from this tab regarding:

- Internal location stands on place that products have stored tangibly.
- Partner location rely on customers, supplier warehouse or even partner's plant.
- Virtual location is an equivalent place of production tracking down or stock inventory transform.
- View location emphasis on temporarily location for a moment cannot detain actual inventory.
- Inventory location it is another word of internal location.

7.5.6 Automate the stock management

Following the straightforward approach to managing inventory of stock and movement between different location, these bells and whistles underlay on

- Automatically transforming production point to point
- Defining accurate location to place received raw materials to be in fast access for process
- Managing operation simultaneously

8 Conclusion

Generally speaking, the Lean conformity reasonably addresses Pull strategy in company's process through a reduction in waste, ineffectiveness, and non-added value activities to shrink the total lead times by employing value stream mapping. Although this research discussed while the main approach has readjusted on pull system but to survive during the transformation and market changes, the company has to incline to Push strategy toward estimating the safety stock in warehouse management. Hence, occasionally to meet market changes proceeding demand, the converging both strategies Push-Pull in same time significantly boost the advantages of Lean thinking and manufacturing.

Moreover, rather than well organizing the company, applying MRP system will reinforce the production planning by creating the following main advantages for manufacturing process:

1. Withdrawing to be rush in processing the orders. In fact, Accurate production planning following meeting time aspects will reduce whether the risk of losing time or imposing overtime to work centres in the plant.
2. Avoiding of creating the bottlenecks in the process, following getting to accumulating the incomplete tasks and works during workflow
3. Increase effectiveness and the productivity of resources, by making coordination to reduce waste time stemmed from waiting for raw materials and improving operator’s concentration. Moreover, ensures better costumer’s service through conducting manufacturing time schedules with the date of the delivery system.
4. Process cost reduction toward applying production planning software by minimizing the human resource's leisure corresponds to the idleness of the machines. Moreover, make balance inventories that lead to better managing the flow of raw materials, reduces costs of storing, and materials handling. Furthermore, provide consistency in products quality and eliminate rejection, therefore will attain a result in a reduction in the unit cost of production.

As Can Be Seen, both production planning and scheduling are prominent approaches to get Lean manufacturing. As matter of fact, implementing ERP tools will dismiss the weaknesses of MRP system within SMEs by creating consistency and integration linking company's departments together.

Meanwhile, ERP market has composed of various low-cost ERP software but abandons to achieve efficient results, the appearance of Odoo ERP as an open source software initiated toward spectacular features such as being user-friendly and user-oriented that broadly have accepted by the companies. The bells and whistles of Odoo have extended by creating differentiation through the online approach that has used rarely in another ERP software. Indeed, Odoo creates an opportunity to access tools anywhere, anytime, and runs on computer operating system. Furthermore, the cost-effectiveness benefits of Odoo services becomes a blockbuster and feasible for SMEs to gain more satisfaction in comparison with other that imposed remarkably investment for SMEs.

References

[1] J. R. Henry, ACHIEVING LEAN CHANGEOVER PUTTING SMED TO WORK, CRC Press is an imprint of Taylor & Francis Group, an Informa business, 2013.

[2] W. J. Hopp and Mark L. Spearman, FACTORY PHYSICS: FOUNDATIONS OF MANUFACTURING MANAGEMENT SECOND EDITION, IrwinfMcGraw-Hill, 2000.

[3] G. Moss, Working with Odoo, Packt Publishing Ltd..

[4] “AllaboutLean.com,” [Online]. Available: https://www.allaboutlean.com.

[5] W.Grzechca, Assembly Line - Theory and Practice, InTech, 2011.

[6] N. T. Thomopoulos, Assembly Line Planning and control, Spinger , 2014.

Appendixes

Appendix 1 - Production planning of week 8th

PROGRAMMA DI PRODUZIONE

Febbraio 2018

Scheda n° 43 Ed. 04

NR°	CODICE	ø	Impianto	Impianto Backup 1	Utensili	Q.tà Richiesta	Q.tà da Prodotta	P/H	PIH 1	ORE Necessarie	ORE Prodotte	Q.tà Saldo Ordine	Lunedì	Martedì	Mercoledì	Giovedì	Venerdì	Ore Saldo Ordine
5	L03278621F	6.0	MA005					500		0.00	0.00	0						0.0
6	L03278624G	6.0	MA005					475		0.00	0.00	0						0.0
9	L03278623L	5.0	MA002	MA006	Fissa 4/5	2000		180		11.11	0.00	2000						11.1

/Volumes/IMCAR/untitled folder/Programma di produzione Pegaflo Febbraio 2018 week 8X.xlsx

PROGRAMMA DI PRODUZIONE

Febbraio 2018

Scheda n° 43 Ed. 04

NR°	CODICE	Ø	Impianto	Impianto Backup 1	Utensili	Q.tà Richiesta	Q.tà da Prodotta	P/H	P/H 1	ORE Necessarie	ORE Prodotte	Q.tà Saldo Ordine	Lunedì	Martedì	Mercoledì	Giovedì	Venerdì	Ore Saldo Ordine
35	151008450	6.5	MA004	MA002	Fissa 6 1/2	10,000		460	750	21.74	0.00	10000						*21.7*
41	151009400	5.0	MA006					360		0.00	0.00	0						*0.0*
42	151008481	4.0	MA006	MA007	D4 R4 DITO 18L	4,650.00		225	272	20.67	0.00	4650						*20.7*
43	151008482	4.0	MA006	MA007	D4 R4 DITO 18L	4,650.00		235	264	19.79	0.00	4650						*19.8*
44	151008990	4.0	MA002		FISSA 4/5	4,650.00		118.5		39.24	0.00	4650						*39.2*
45	151008430	4.0	MA002	MA007				1800	3200	0.00	0.00	0						*0.0*
48	151008810	4.0	MA002					782		0.00	0.00	0						*0.0*
49	151009101	4.0	MA002					266		0.00	0.00	0						*0.0*
51	5801492686EZ	7 znt	MA004		D7 R3 R3 DITO 7L	11,400		648		17.59	0.00	11400						*17.6*
53	670006025/10	7 znt	MA004					510		0.00	0.00	0						*0.0*
58	30704605	3.4	MA006					400		0.00	0.00	0						*0.0*
59	30696705	3.4	MA006					400		0.00	0.00	0						*0.0*
63	51841972	7 znt	MA004		D6.82 R5 DITO 6	15,000.00		580		25.86	0.00	15000						*25.9*
65	152008730	6.5	MA002					1000		0.00	0.00	0						*0.0*
68	152008880	5.0	MA005		D5 R5 R3 DITO 21	6,400		821		7.80	0.00	6400						*7.8*
69	152009070	8.0	MA004					750		0.00	0.00	0						*0.0*
70	152009250	6.5	MA002		FISSA 6 1/2	3,000		305		9.84	0.00	3000						*9.8*
88	151008960	6.5	MA004		MA 837 DITO 6.5	7,000		640		10.94	0.00	7000						*10.9*
89	L0476356AA	6.5	MA004		MA 837 DITO 6.5	10,000		452		22.12	0.00	10000						*22.1*
91	L0476365AA	5.0	MA006		D5 R14 DITO 16	3400		696		4.89	0.00	3400						*4.9*
94	38103715/1A	4.5	MA005		D5 R4 R4 DITO 21	1200		276		4.35	0.00	1200						*4.3*
96	38103715/3A	4.5	MA005		D5 R4 R4 DITO 18	2400		715		3.36	0.00	2400						*3.4*
97	38103715/4A	4.5	MA005		D5 R4 R4 DITO 18	2400		353		6.80	0.00	2400						*6.8*
98	38103715/5A	4.5	MA005		D5 R4 R4 DITO 18	2400		310		7.74	0.00	2400						*7.7*
99	38103715/6A	4.5	MA005					2640		0.00	0.00	0						*0.0*
100	38103715/7SX	4.5	MA005		D5 R4 R4 DITO 18	6000		997		6.02	0.00	6000						*6.0*
101	38103716/1A	4.5	MA005		D5 R4 R4 DITO 21	1200		276		4.35	0.00	1200						*4.3*

/Volumes/IMCAR/untitled folder/Programma di produzione Piegafilo Febbraio 2018 week 8X.xlsx

PROGRAMMA DI PRODUZIONE

Febbraio 2018

MALFE S.r.l.

Scheda n° 43 Ed. 04

NR°	CODICE	ø	Impianto	Impianto Backup 1	Utensili	Q.tà Richiesta	Q.tà da Prodotta	P/H	P/H 1	ORE Necessarie	ORE Prodotte	Q.tà Saldo Ordine	Lunedì	Martedì	Mercoledì	Giovedì	Venerdì	Ore Saldo Ordine
102	38103716/2A	4.5	MA002		FISSA 4/5			187		0.00	0.00	0						*0.0*
103	38103716/3A	4.5	MA005		D5 R4 R4 DITO 18	2400		599		4.01	0.00	2400						*4.0*
104	38103716/4A	4.5	MA005		D5 R4 R4 DITO 18	2400		291		8.25	0.00	2400						*8.2*
105	38103716/5A	4.5	MA005		D5 R4 R4 DITO 18	2400		310		7.74	0.00	2400						*7.7*
106	38103715/7DX	4.5	MA005		D5 R4 R4 DITO 18	6000		997		6.02	0.00	6000						*6.0*
107	38103722/1A	4.5	MA005		D5 R4 R4 DITO 21	1500		187		8.02	0.00	1500						*8.0*
108	38103722/2A	4.5	MA005		D5 R4 R4 DITO 18			185		0.00	0.00	0						*0.0*
109	38103722/3A	4.5	MA005		D5 R4 R4 DITO 18			299		0.00	0.00	0						*0.0*
110	38103722/4A	4.5	MA005		D5 R4 R4 DITO 18	1500		277		5.42	0.00	1500						*5.4*
111	38103723/1A	4.5	MA005		D5 R4 R4 DITO 21	1500		206		7.28	0.00	1500						*7.3*
112	38103723/2A	4.5	MA005		D5 R4 R4 DITO 18			195		0.00	0.00	0						*0.0*
113	38103723/3A	4.5	MA005		D5 R4 R4 DITO 18			360		0.00	0.00	0						*0.0*
114	38103723/4A	4.5	MA005		D5 R4 R4 DITO 21	1500		269		5.58	0.00	1500						*5.6*
115	151010580	5.0	MA007		R 7.5 UT 2	4000		353		11.33	0.00	4000						*11.3*
116	151011250	5.0	MA002		D5 R8 DITO 26	2500		248		10.08	0.00	2500						*10.1*
117	151010451	5.0	MA006			1000		166		6.02	0.00	1000						*6.0*
118	151011241	5.0	MA007					284		0.00	0.00	0						*0.0*
119	151010511	5.0	MA007					300		0.00	0.00	0						*0.0*
120	151010380	5.0	MA007	MA006	D5 R8 DITO 26			972	1085	0.00	0.00	0						*0.0*
121	151011730	5.0	MA007		D5 R8 DITO 26			1175		0.00	0.00	0						*0.0*
122	151011740	5.0	MA007					2000		0.00	0.00	0						*0.0*
123	151010452	5.0	MA006		D5 R8 DITO 24	5000		166		30.12	0.00	5000						*30.1*
124	151011242	5.0	MA007	MA006	D5 R8 DITO 26	1000		284	241	3.52	0.00	1000						*3.5*
125	151010512	5.0	MA007	MA006	D5 R8 DITO 26	1000		300	300	3.33	0.00	1000						*3.3*
126	151011031	5.0	MA007			1000		103		9.71	0.00	1000						*9.7*
127	151010421	5.0	MA007	MA006	D 5.8 R8 DITO 26	1000		306		3.27	0.00	1000						*3.3*
128	151010400	5.0	MA006	MA007	D 5.8 R8 DITO 26			1034	1565	0.00	0.00	0						*0.0*

/Volumes/IMCAR/untitled folder/Programma di produzione Piegafilo Febbraio 2018 week 8X.xlsx

PROGRAMMA DI PRODUZIONE

Febbraio 2018

Scheda n° 43 Ed. 04

NR°	CODICE	Ø	Impianto	Impianto Backup 1	Utensili	Q.tà Richiesta	Q.tà da Prodotta	P/H	P/H 1	ORE Necessarie	ORE Prodotte	Q.tà Saldo Ordine	Lunedì	Martedì	Mercoledì	Giovedì	Venerdì	Ore Saldo Ordine
129	151011260	5.0	MA007	MA006	D5 R8 DITO 26	2000		325		6.15	0.00	2000						6.2
130	151011032	5.0	MA007		UT 2 RULLI 22 D 15	450		105		4.29	0.00	450						4.3
131	151010422	5.0	MA007		UT 2 RULLI 22 D 15	450		360		1.25	0.00	450						1.3
132	151012680	5.0	MA006	MA007	D5 R8 DITO 26	17200		790		21.77	0.00	17200						21.8
133	151012681	5.0	MA007			25600		659		38.85	0.00	25600						38.8
134	151012682	5.0	MA007			12800		703		18.21	0.00	12800						18.2
135	281933	4.0	MA002	MA006	FISSA 4/5	8800		480		18.33	0.00	8800						18.3
136	382881	4.0	MA002		FISSA 4/5			121		0.00	0.00	0						0.0
137	382966	4.0	MA002		FISSA 4/5			226		0.00	0.00	0						0.0
138	382967	4.0	MA002		FISSA 4/5			339		0.00	0.00	0						0.0
139	382968	4.0	MA002		FISSA 4/5			2400		0.00	0.00	0						0.0
140	382969	4.0	MA002		FISSA 4/5			3600		0.00	0.00	0						0.0
141	382965	4.0	MA002		FISSA 4/5			1090		0.00	0.00	0						0.0
142	281924	4.0	MA006	MA007	D 4.4 DITO 21			275	300	0.00	0.00	0						0.0
143	382970	4.0	MA002		FISSA 4/5			360		0.00	0.00	0						0.0
144	382971	4.0	MA002		FISSA 4/5			313		0.00	0.00	0						0.0
145	390597	4.0	MA002		FISSA 4/5			3600		0.00	0.00	0						0.0
146	390601	4.0	MA002		FISSA 4/5			1800		0.00	0.00	0						0.0
147	5031654	7 znt	MA004		D 6.82 R5 DITO			500		0.00	0.00	0						0.0
148	5031664	7 znt	MA004		BROSCH 6			282		0.00	0.00	0						0.0
149	5031660	7 znt	MA004		BROSCH 6			285		0.00	0.00	0						0.0
150	17Malfe103	4.0	MA005		ND			200		0.00	0.00	0						0.0
151	OMS 002	5.0	MA004		D6 R3 R3 DITO 21			1100		0.00	0.00	0						0.0
152	L0442432	5.0	MA006					100		0.00	0.00	0						0.0
153	L0442431	5.0	MA006					120		0.00	0.00	0						0.0
	Data	6-lug								482.73	0.00							
	Firma	CD						TOT. ORE										482.73
								TOT. ORE Impianto										

Legenda : Produzione | Set-Up | Campionature | cambio ø

/Volumes/IMCAR/untitled folder/Programma di produzione Piegafilo Febbraio 2018 week 8X.xlsx

PROGRAMMA DI PRODUZIONE

Febbraio 2018

Scheda n° 43 Ed. 04

NR°	CODICE	ø	Impianto	Impianto Backup 1	Utensili	Q.tà Richiesta	Q.tà da Prodotta	P/H	P/H 1	ORE Necessarie	ORE Prodotte	Q.tà Saldo Ordine	Lunedì	Martedì	Mercoledì	Giovedì	Venerdì	Ore Saldo Ordine

Legenda : Iltar - Italbox; JARNY; 3 PLUS; Scanferla; Eurostamp; Tecnomec; Proma Poland
GEMINI; 2 PLUS; MAC; LBL; GMC; Antolin loire; STAT

PO	TOT. ORE PER IMPIANTO		MA002	109.00	MA004	98.26	MA005	102.30	MA006
			Saturazione	99.09%	*Saturazione*	89.33%	*Saturazione*	93.00%	*Saturazione*
	Ore Prodotte	% Perdita per impianto	MA002	0.00	MA004	0.00	MA005	0.00	MA006
			Perdite	100.00%	*Perdite*	100.00%	*Perdite*	100.00%	*Perdite*
	Ore Prodotte Totali	% Perdita Toale							

Ore Versate h	0.00
Perdita %	0.00%
Efficienza %	0.00%

/Volumes/IMCAR/untitled folder/Programma di produzione Piegafilo Febbraio 2018 week 8X.xlsx

Pouya Tafreshi
s202007

Appendix 2 - Products BOMs

BOM Structure

BOM Name	Quantity	BOM Ref
38103715 Bordionato High SAB LEFT Q5	**1.000 Unit(s)**	
[C9D] 38103715 High SX	175.00 Unit(s)	
[C9D] 38103715/1	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/2	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/3	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/4	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/6	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/5	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/7SX	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[Lamiera] 38112118 Staffa grande	1.00 Unit(s)	
[Lamiera] 38112120 Staffa piccola	1.00 Unit(s)	
[ ] Salt	18.00 Unit(s)	
[Box] Carton	1.00 Unit(s)	
[ ] Tape	1.00 Unit(s)	
[ ] Box Separator	6.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
38103715 Bordionato High SAB LEFT Q5	**1.000 Unit(s)**	
[C9D] 38103715 High SX	175.00 Unit(s)	
[C9D] 38103715/1	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/2	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/3	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/4	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/6	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/5	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/7SX	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[Lamiera] 38112118 Staffa grande	1.00 Unit(s)	
[Lamiera] 38112120 Staffa piccola	1.00 Unit(s)	
[ ] Salt	18.00 Unit(s)	
[Box] Carton	1.00 Unit(s)	
[ ] Tape	1.00 Unit(s)	
[ ] Box Separator	6.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
38103723 Bordionato Low SAB Right Q5	**1.000 Unit(s)**	
[C9D] 38103723 Low DX	175.00 Unit(s)	
[C9D] 38103723/1	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103723/2	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103723/3	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103723/4	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/6	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[C9D] 38103715/7SX	1.00 Unit(s)	
[C9D] Wire 4.5 D	1.00 kg	
[Lamiera] 38112124 Staffa grande	1.00 Unit(s)	
[Lamiera] 38112120 Staffa piccola	1.00 Unit(s)	
[ ] Tape	1.00 Unit(s)	
[ ] Box Separator	6.00 Unit(s)	
[ ] Salt	18.00 Unit(s)	
[Box] Carton	1.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
193021981 Panire Fil Assise Droit Peint	**1.000 Unit(s)**	
[ ] V193021981	1.00 Unit(s)	
[ ] 193021981	1.00 Unit(s)	
[C9D] 151008261	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008280	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008271	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008272	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008450	1.00 Unit(s)	
[C9D] Wire 6.5 D	1.00 kg	
[Box] Carton	1.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
193021982 Panire Fil Assise Droit Peint	**1.000 Unit(s)**	
[ ] V193021982	1.00 Unit(s)	
[ ] 193021982	1.00 Unit(s)	
[C9D] 151008262	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008280	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008271	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008272	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C9D] 151008450	1.00 Unit(s)	
[C9D] Wire 6.5 D	1.00 kg	
[Box] Carton	1.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
193032211 G RHD Rotative Cushion Assy	**1.000 Unit(s)**	
[ ] V193032211 G RHD	1.00 Unit(s)	
[ ] 193032211 G RHD	1.00 Unit(s)	
[C4D] 151010580	2.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011250	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010451	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011241	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010511	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010380	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011730	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011740	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[Box] Carton	1.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
193032211 G RHD Rotative Cushion Assy	**1.000 Unit(s)**	
[ ] V193032211 G RHD	1.00 Unit(s)	
[ ] 193032211 G RHD	1.00 Unit(s)	
[C4D] 151010580	2.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011250	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010451	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011241	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010511	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010380	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011730	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011740	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[Box] Carton	1.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
193032212 G LHD Rotative Cushion Assy	**1.000 Unit(s)**	
[ ] V193032212 G LHD	1.00 Unit(s)	
[ ] 193032212 G LHD	1.00 Unit(s)	
[C4D] 151010580	2.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011250	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010380	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011730	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011740	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010452	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011242	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010512	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[Box] Carton	1.00 Unit(s)	

BOM Structure

BOM Name	Quantity	BOM Ref
193032221 J RHD Rotative Cushion Assy	**1.000 Unit(s)**	
[ ] V193032221 J RHD	1.00 Unit(s)	
[ ] 193032221 J RHD	1.00 Unit(s)	
[C4D] 151011031	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010421	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151010400	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[C4D] 151011260	1.00 Unit(s)	
[C4D] Wire 5 D C4D	1.00 kg	
[Box] Carton	1.00 Unit(s)	
[ ] Box Separator	1.00 Unit(s)	
[ ] Salt	1.00 Unit(s)	
[ ] Tape	1.00 Unit(s)	

Acknowledgements