POLITECNICO DI TORINO

Master of Science in Engineering and Management

Master Thesis

Technological Innovation in the Integrated Laundry Services Industry: a Case Study on an Italian Company

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1 INTRODUCTION

1.1 PROJECT GOALS AND OBJECTIVES

Many are the benefits that companies could gain by integrating todays technologies in business processes. However, successful implementations require many actions to be undertaken, starting from choosing the most suitable technology in accordance to business strategy and ending up with change management practices aimed at building knowledge and changing behaviours.

The aim of this project is to understand and analyse the technological innovation that a company operating in the integrated laundry services industry has decided to pursue, relating the choices to industry characteristics and business requirements.

In fact, almost two years ago, the company decided to buy and ERP system for managing, through a single software application, all its business processes. The advantages of adopting an ERP can be briefly identified in integrated and updated data which extremely improve the quality of information the company can access.

Moreover, the integrated laundry services industry imposes companies to tightly control inventory levels and costs in order to be able to effectively and efficiently manage operations and meet customer demand. In fact, for suppling services to customers, each day the company performs activities such as soiled garments and linen picking up, items processing, quality checks and shipments to customers' facilities.

However, many are the factors that challenge the company ability in inventory management and control (thinking for example of volumes of items processed and hygienic conditions). Therefore, in line with the innovation strategy that the company has decided to pursue two years ago for improving business processes and remain competitive, two additional investments in technology have been planned in the short term.

In fact, the RFID technology, which wold provide the company the ability to implement items traceability and thus improve stock monitoring and management, is going to be implemented for the garments supply process. Once visibility is improved, to better exploit the benefit arising from installing an ERP system, the MRP (material requirement planning) system will be implemented for providing the company the possibility to plan orders in order to meet customers demand and stock requirement.

1.2 ERP System – Enterprise Resource Planning

Enterprise Resource Planning systems can be considered as the evolution of MRP systems thanks to the improvements achieved over time in computers computing power. In fact, MRP and MRPII (respectively material and manufacturing requirement planning) were implemented to allow companies to manage material requirement and production capacity and resources. An ERP system instead, integrate this information with data related to the organization financial resources, thus enabling companies to manage all business processes with a single software application collecting data into a relational database.

ERP systems are structured as a set of modules that interact each other and provides functionalities related to all the company functional areas, such as:

- finance and accounting;
- project management;
- manufacturing;
- supply chain management;
- customer relationship management;
- human resources management.

Figure 1.1 Functional Areas Managed by an ERP System.

The system provides companies the possibility to incrementally activate the different modules or use just some of them.

The system functioning is based on standard functionalities that, at the occurrence, can be customized to reflect the company needs.

The advantages provided by a centralized and integrated system are many:

- links existing between the modules provide updated data that are shared and thus accessible by users belonging to different units;
- therefore, more accurate and reliable information can be extracted by the system in order to support the decision making process;
- given that all business processes are managed through a single application, no more data export and import activities are required; therefore, an ERP system allows both to save time and avoid data leakage while performing data migration activities;
- in a fast changing environment, it provides companies the flexibility to adapt the system functioning by modifying existing settings, customize and/or implement additional functionalities.
- organizations have the possibility to manage data access as well; in fact, access to modules can be limited to certain users, therefore avoiding that unauthorized personnel obtain and/or manipulate information.

1.2.1 Microsoft Dynamics 365 for Finance and Operations

The ERP system installed by the company is Microsoft Dynamics 365 for Finance and Operations. The system functionalities are the ones of a standard ERP system and customers can purchase the solution which would either be deployed on premise or hosted in the cloud.

Microsoft offers different ERP solutions and Dynamics 365 for Finance and Operations is the one that provides the biggest set of functionalities. It is therefore suggested for medium-large companies.

2 AS-IS SYSTEM

2.1 COMPANY OVERVIEW

The company has been operating in the integrated laundry services industry for more than 30 years. It provides its customers a wide range of services as for example:

- full-service work clothes and linen rental, during which the company manages as well logistics operations as picking up and deliver back the products from and to the customer;
- design, build and management of sterilization plants;
- surgical equipment sterilization and rental;
- PPE (personal protective equipment) processing.

Due to the variety of industries it supplies, the company has developed the flexibility to adapt its services over time. Food service, healthcare, public and private hospitality, pharmaceutical and automotive are examples of industries the company has gained experience with.

Therefore, not only does the type of services the company delivers impact the variety of products that are processed, but the different customers' requirements also entail differentiated products. In fact, taking public and private healthcare as an example, both are supplied the same product typologies (that is bath towels, patient gowns, sheets, pillowcases and so on). However, the latter is concerned about the fabric products are made of and is willing to be charged a higher price for being supplied better quality products (while the former is not). Other factors that increase the variety of products the company processes might be related to security and/or hygienic issues.

23.250.000 kg	64.450.000	795.000
Linen processed each year	Garments processed each year	Surgical instruments processed each year

The garments and linen rental service includes all the phases of the process. The company picks up, by using its own fleet, soiled garments/linen and brings them to the facility where they will be washed, dried and eventually

ironed; in case of need, repairs and quality checks are performed as well. When all the tasks have been successfully performed products are delivered back to the customer. To make the process more efficient and reduce the lead time between the purchase order and the effective availability of the products coatrooms are installed by customers' facilities. Therefore, they can be used as storage system by the customer.

When customers rent surgical equipment, given the higher price compared to other services, the company customizes the surgery kits according to specific needs. Moreover, the procurement of surgical instruments represents a significant investment for the company. Therefore, in order to extend their useful life, instruments are subject to both preventive and corrective maintenance.

2.2 THE LINEN AND GARMENTS SUPPLY INDUSTRY

The profitability of companies operating in the linen and garments supply industry depends on the efficiency and effectiveness they gain in operations. In fact, since large players in the industry serves institutions such as hospitals and hotels, they must be able to provide a constant flow of clean linen and working clothes. Moreover, effective and efficient processes are the primary source of costs reduction which is key for gaining market share in the industry. In fact, the acquisition of new customers is based on whether the contract proposed to the client is more attractive than the other offers made for the public/private bid. All other things being the same, price becomes the differentiation factor and low operational costs are likely to allow the company to be competitive on prices. The acquisition of a single new customer could significantly impact the company volumes.

To provide an idea on numbers and figures, data on the requirement of a medium-large institution operating in the personal services industry can be used as support.

Concerning the linen supply service, 6 different products must be supplied:

- Bath towel;
- Towel;

- Sheet;
- Pillowcase;
- Bedspread;
- Mattress cover;

The estimated yearly requirement for each product is:

Product	**Yearly Requirement (units)**
Bath towels	35.000
Towels	195.000
Sheets	150.000
Pillowcases	77.000
Bedspreads	30.000
Mattress covers	26.500

Table 1 Estimated requirement.

Concerning garments, that is all the items of clothing required for workers and operators in the structure, many different products are expected to be supplied given the different needs depending on gender and role.

More specifically, 4 group of workers/operators can be identified:

GROUP	**ROLE**	**GENEDER**		**TOTAL**
		M	**F**	
Healthcare Professionals	Professional Nurse	4	38	42
	Nursing Coordinator	-	5	5
	O.S.S.	1	38	39
	A.S.A	19	189	208
	Physiotherapist	3	24	27
				321
Ancillary Staff	Cleaning Staff	-	7	7
	Kitchen Staff	8	9	17

	Laundry Staff	2	4	6
	Entertainer	0	2	2
				32
Front Desk Personnel	Front Desk Personnel	1	2	**3**
Others	Maintenance Provider	1	-	1
	Gardener	1	-	1
	Warehouse Personnel	4	-	4
				6

Table 2 Groups identification.

Some of the required items (since listing all of them would require so much time and detailed information) are:

Product	User	N. of changes
White Unisex Trousers	Healthcare Professionals + Ancillary Staff	**Daily** for kitchen staff; **3/week** the rest
Unisex Jacket (different colours)	Healthcare Professionals + Ancillary Staff	**Daily** for kitchen staff; **3/week** the rest
Crew-Neck Whit T-Shirt	Healthcare Professionals + Ancillary Staff	**Daily** for kitchen staff; **3/week** the rest
Worker Trousers	Others	**2/week + if needed**
Worker Shirt	Others	**2/week + if needed**
Worker Jacket	Others	**2/week + if needed**
Sweater	Others	**2/week + if needed**
Long sleeves blue shirt	Front Desk Personnel	**3/week**
Short sleeves blue shirt	Front Desk Personnel	**3/week**
Winter Trousers	Front Desk Personnel	**2/month**
Summer Trousers	Front Desk Personnel	**2/month**

Cotton Sweater	Front Desk Personnel	**2/month**
Wool Sweater	Front Desk Personnel	**2/month**

Table 3 Products requirement.

By aggregating the previous information, the company working in the linen and garments supply services and winning the tender will have to provide

- Linen supply: more than 500.000 items per year;
- Garments supply: more than 167.000 items per year;

Moreover, if it is taken into consideration that data on footwear, additional items of clothing, tablecloths, cooking aprons and others that are not shown in the previous tables, numbers increase and reach more or less a million of items required each year by the customer. That is to say, an additional million of items that the company processes each year.

2.3 VOLUMES AND PRODUCT LIFECYCLE

Given the inherent characteristics of the industry and the services supplied many are the critical aspects the company has to deal with.

Large volumes of items are handled every day. In fact, given that the company manages all the phases of the process, each day the following operations are performed:

- Soiled linen and garments picking up;
- Clean linen and garments packaging and delivery;
- Items processing.

Taking into consideration the figures displayed in the previous paragraph, and multiplying numbers for 1200 customers that the company supplies, the result is:

- 70.000 operators are provided working clothes, leading to **64.450.000** garments processed each year;
- 20.000 beds are managed which entail that the company processes **23.250.00 kg** of linen each year.

Therefore, volumes are the first critical aspect the company has to deal with.

Further challenges arise when considering that the sector the company operates in is the one of the integrated laundry services industry. In fact, supply chain management becomes as important as in manufacturing and retail since the company business entails that physical objects are moved from a location to another. However, there is a major difference: products are not sold to final customers, but the company does supply services to make use of these products. That is, products keep remaining property of the company throughout their lifecycle. Even though they are delivered to customers, exit from the company facilities is not definitive. On the contrary, each product enters the different phases of its lifecycle many times throughout its useful life.

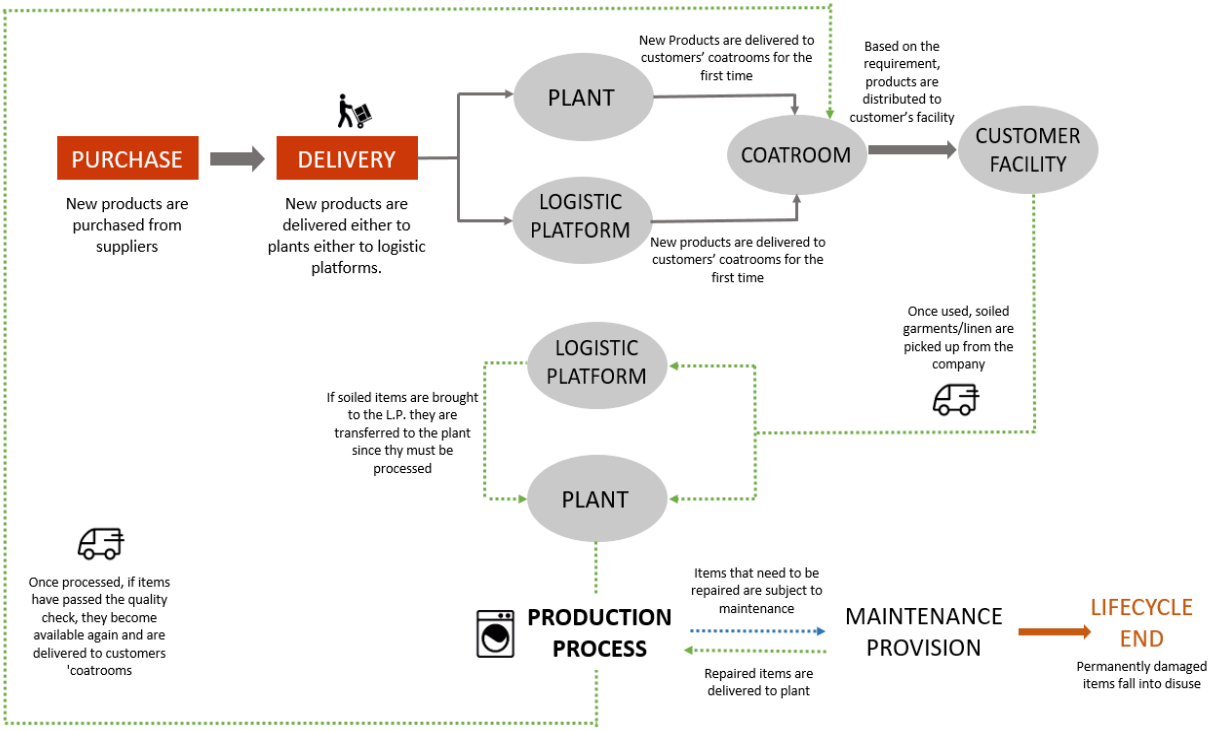


Figure 2.1 Product Lifecycle.

Therefore, not only are linen and garments the working capital through which the company performs its business activities, but they are part of the company physical asset. More specifically:

- *At the end of 2017, linen accounted for 47 million of the company fixed asset; additional products for a value of 1.8 million were acquired during the past year.*

- *At the end of 2017, assets belonging to the garments category were worth 24.5 million; in the past year, 3.5 million of additional assets were acquired by the company.*

  Supply chain management would provide two main benefits though: first of all, it would allow to effectively manage the flow of products; then, it would give the company the ability to properly monitor a large portion of its assets.

2.4 GOODS HANDLING AND TRACEABILITY

Most of the goods the company processes in its day-to-day operations are small and has a low unit price (apart from surgical instruments). When soiled items are brought to the facility they are usually packed in such a way that counting operations would be hard to perform and time consuming. Moreover, the required hygiene and heath standards usually prevent the personnel from performing these activities.

Therefore, product identification and traceability is hard to achieve, while instead the type of business requires these procedures to be properly performed. In fact, even though each item *per se* is not providing the company a considerable return, they are part of the company assets *(see previous paragraph).* Furthermore, given products dimension and the transfers they are subject to throughout their lifecycle, items loss and theft are likely to occur.

Implementing traceability procedures would allow the company to:

- keep track of products lifecycle;
- mange stock;
- locate each single item;
- draw up financial reports for accounting purposes.

Because of today's technologies allow to gain complete traceability throughout the supply chain the company has decided to take into consideration the advantages it could gain by integrating them into its operations in order to evaluate the derived effects.

2.4.1 Bar Code and Radio Frequency Identification

Bar code and radio frequency identification (RFID) are the technologies that the company is willing to integrate in its business processes to improve items traceability. The adoption of these technologies, combined with application software for data collection would allow organizations to ease inventory operations, improve efficiency, automate processes and collect data while handling goods.

RFID [1], *Radio Frequency Identification*, enables contactless goods identification using radio frequency. RFID tags are electronically programmed with unique information (which might be price, colour, dimension, location) and usually a serial number corresponds to each tag. The tag is then affixed to an item, a machinery and/or a pallet, depending on the information the organization wishes to collect. Antennas are place at checkpoints and emit radio signals which activate the tag so that it sends back information. Given that RFID performs massive and contactless identification of moving objects it could be able to extremely improve items traceability and allow for soiled garments/linen counting operations.

[1] RFID is one of the most promising technologies for supply chain management. Its adoption in recent years has been favoured by lower implementation costs, better performance and an increasing interest in automated data collection processes which improve accuracy and information availability. One of its main benefit is given by its application where human activity is limited or impossible in order to guarantee proper inventory control which is one of the requirement for supply chain management. One of the main issue related to RFID technologies is that its implementation requires a high investment both in terms of financial resources and time. In fact, business process reengineering must be performed if the company wants to exploit the benefit of RFID in supply chain management. Then, for being effective, the RFID system should be integrated with the IT System of the company so to automate the data collection process. Therefore, this represent a further investment for the company, since the IT system must provide advanced functionalities for inventory management. Finally, since RFID tags can be read by using radio signals, there are even privacy issues that company must take into consideration.

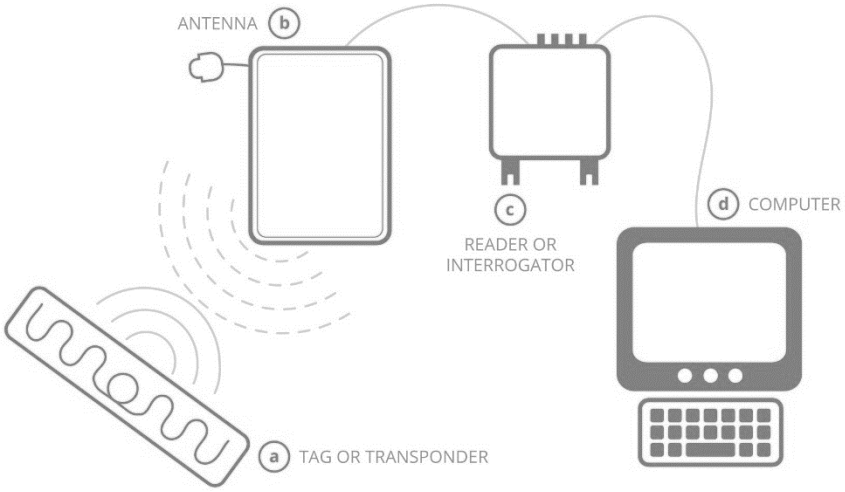


Figure 2.2 RFID System.

Although bar code does not allow contactless items identification and provides less information, its adoption requires a lower investment compared to opting for RFID. Bar code technology can be coupled with RFID. In fact, the former could be used to perform on-hand operations, such as stock counting and item identification, and compare than the data with the one acquired by RFID tags.

At present, the company is not able to exploit the benefits deriving from the adoption of the two technologies due to:

- lack of integration in its operations;
- no combination of the two with the company IT system (therefore, the data collection process is not automated yet).

In fact, implementing full items traceability requires further investments both in process reengineering activities and for the expansion of the system functionalities (since advanced inventory management would be provided).

2.4.2 The Company Information System

Nowadays, ICT systems are key to business operations and competitive advantage. In fact, they can be designed in order to respond to industry characteristics and organization specific requirements. Productivity, accuracy, standardization, data collection and decision making processes are improved when the ICT system installed in the organization is specifically

designed to represent its business operations. If not, it might undermine rather than support the business.

The decision of the company to recently buy an ERP solution was due to the inefficiencies it identified in adopting a decentralized system.

Focusing on logistics and inventory operations, processes were managed through two different application software.
The first software was used to record goods purchasing into a fictional "central warehouse". When new stock was needed to accomplish customer demand, the software transferred the goods to the "inventory". Hence, the "inventory" reported the quantities the company introduced in the production chain. Given that those products are not sold to final customers but they are used to supply services, recording their financial value as "inventory" would not allow the company to take into consideration products useful life. Therefore, the application was managing as well fixed assets value and depreciation recording over time. Lastly, the software was employed for maintenance expenses registration. However, even though the system was able to account for surgical instruments, linen and garments maintenance costs, no inventory transaction was generated when items were either sent to suppliers or moved to perform these activities. Therefore, it was not possible to properly account for stock availability.
A second software was used to collect soiled garments and linen counting data performed by other applications. Thus, it was registering products receipts from customers and even accounts receivable. However, the application was not designed to perform a detailed inventory control since no warehouses or logistic platforms were modelled into the system.

Figure 2.3 The previously installed ICT system.

No information exchange occurred between the software, leading to a completely decentralized system that caused many disadvantages. Indeed, not only data export and import usually led to data leakage, but they also were time consuming tasks to accomplish. Waiting times and loss of information became primary causes of lack of accuracy and reliability in data collection. Data processing to extract information and support the decision making process was affected as well.

2.5 IMPLEMENTED SOLUTION

It was roughly two years ago that the company decided to opt for the installation of an ERP solution in order to make up to the inefficiencies of its ICT system. Even though the current solution is extended to all the business areas of the company, from financial reporting to HR management, for the purpose of this project the logistics and inventory functionalities are analysed.

2.5.1 Business Processes Analysis

Business processes analysis must be performed in order to understand the company operations and it works as starting point to design and implement the solution.

Six major organizational entities are involved in the logistics and inventory operations:

- new stock warehouse;
- plant;
- logistic platform;
- coatroom;
- sterilization plant;
- maintenance provision.

A well-structured inventory management system is currently performed only in one of the company warehouses, where new stock is received and, when

needed, introduced in the production chain by send it either to plants or to customers[2].

Figure 2.2 is a map showing the interaction between the six organizational entities during inventory and logistics operations (a specific chart could be used to map all the activities related to specific products).

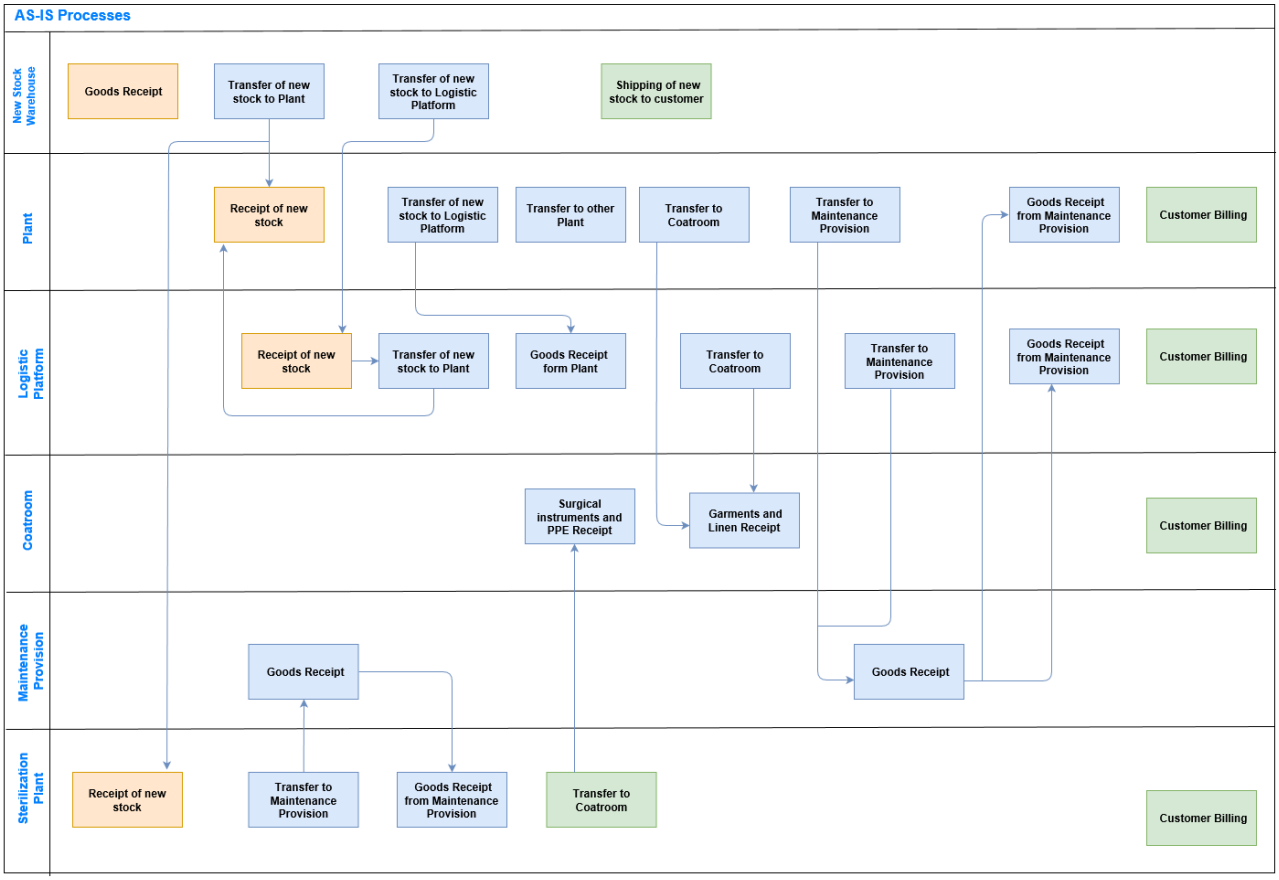


Figure 2.4 AS-IS Processes.

At present, the company does not exploit the RFID technology neither the barcode to register products entry and exit from the different location. This information is recorded into the system by entering the data reported on the documents attached to products. Therefore, no match is performed between the entered information and real quantities.

[2] This represents one of the main reasons why the implementation of a properly functioning inventory management module on the current ERP System has not been achieved yet. In fact, either the company has not started adopting traceability technologies, either processes streamline and formalization has not been performed, while instead, it is key to systems development.

2.5.2 Business Requirements

By analysing the company processes the business requirements that the implemented solutions needed to satisfy were defined. Items grouping and classification, products traceability and warehouses structure are the main features that would have allowed to achieve a complete view of goods handlings and manage stock levels.

2.5.2.1 Items Grouping and Classification

The company processes around 11.000 different products. Because many of them share similar characteristics, *item groups* were created in order to group similar products. This provide access to clearer information and more general data collection.

More specifically, 9 item groups were modelled into the system:

- Linen
- Garments
- Surgical equipment
- Single-use items
- Technical textiles
- Raw material
- Equipment
- Rags
- Services

Moreover, the association of each product to an item group is required by the system to automatically generate accounting entries whenever product transactions are registered.

Each product (or service) processed by the company is defined into the system as a *released product*. Many are the elements that can be defined for each released product in order to provide, whenever required, all the details that would ease business operations and data collection.

Each product has primarily been defined by a *product number*, *name*, *description* and the item group it belongs to. Additional information has been provided by filling in further fields such as:

- *Product variants*, which allow to manage variants of the same product number (such as colour, size and style) thus avoiding duplication of records into the database;
- *Storage dimension group*, which is used to register where products are physically located; at present, whenever product transactions are generated it is mandatory to define the *site* where the product is going to be stored; information on warehouses is not mandatory even though most of the time users account for this data as well.
- Unit, which can be differently defined for purchase, sale processes and storage areas.

Therefore, the system allows the company to have a clear view of the items it processes and collect data on specific products or aggregate the information according to different parameters (such as item group, product variants, site, etc.).

ITEM GROUP	*RELEASED PRODUCT*	*PRODUCT VARIANT*
Linen	Bedspread	-
	Pillowcase	-
	…	
Garments	Polo T-shirt	Blue – S Blue – M Blue – L White – S White – M White – L …
	…	

Figure 2.5 Items Classification.

2.5.2.2 Warehouses Structure

To manage stock levels and properly record data on goods handling it was necessary to represent into the system all the physical places where goods can

be stored and the transit areas. By analysing business processes, it has been decided to include in the logistic structure of the company

- 6 plants;
- 14 sterilization plants;
- 2 logistics platforms;
- N coatrooms (which must be included into the system since they can be used as storage place by the customer).

The system allows to define a hierarchical structure made up by sites, warehouses and locations and the entities that are created can be used in the queries to extract information at different degree of details.

A *site* is used to represent a set of warehouses belonging to the same plant. *Warehouses*, either physical or logical, are used to represent specific processes or product category. Lastly, *locations* are used to define warehouses layout and represent the lowest level of information. They are used to track where the on-hand inventory is stored and picked in a warehouse.

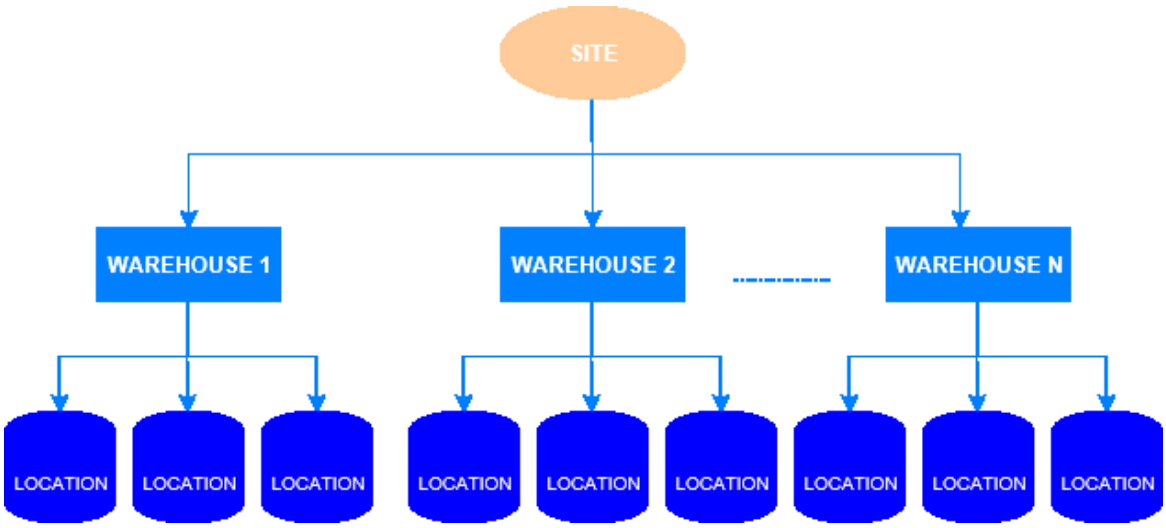


Figure 2.6 Hierarchical Warehouse Structure.

Given the specific needs of the company, locations have not been implemented into the system. In fact, it is hard to perform counting operations and inventory management activities given the nature of services the company supplies. Moreover, the integration of bar code and RFID

technologies in the company operations have not occurred yet. Thus, even though they would allow to collect data on quantities at locations level, when the company will start adopting the two technologies the current ERP solution can be integrated to include locations in the logistic structure.

To satisfy the customer requirements, a personalization was required when implementing the logistic structure into the system. In fact, products are not sold to customers but they are rented through different typologies of services *(see paragraph 2.3)*. Therefore, products enter and exit warehouses multiple times and the company must account for their useful life. Thus, it is required to account for fixed assets rather than inventory from an accounting perspective. However, for managing stock levels it also necessary to record available quantities.

The software standard functioning enables the user to decide whether to register product entries as inventory or fixed assets. If the inventory option is selected, the system provides information on stored quantities. Instead, when product entry is registered as fixed assets the system accounts for products financial value, applies depreciation rules but does not provide information on quantities.

The personalization implemented for the customer enables to simultaneously register and account for products financial value and manage quantities. More specifically, for each warehouse that needed to be represented into the system (for clarity, lets identify them as all the warehouses whose name ends with *21D) an additional one was initialized (all the ones whose name ends with *20D). The connection between the two warehouses is the following:

*Transactions as purchase orders which involve new products entries occur in the *20D. When the user needs to register products receipt it selects the fixed asset options and therefore it deprives the *20D warehouse of the acquired items. However, when the registration occurs the system automatically generate an inventory adjustment journal that accounts for these items to be stored in the *21D. By registering the journal, the user is able to display the acquired product in the *21D warehouse. Thus, the personalization is based on couples of linked warehouses (*20D and *21D)*

which allow to simultaneously account for fixed assets value and product quantities despite the standard functioning of the software.

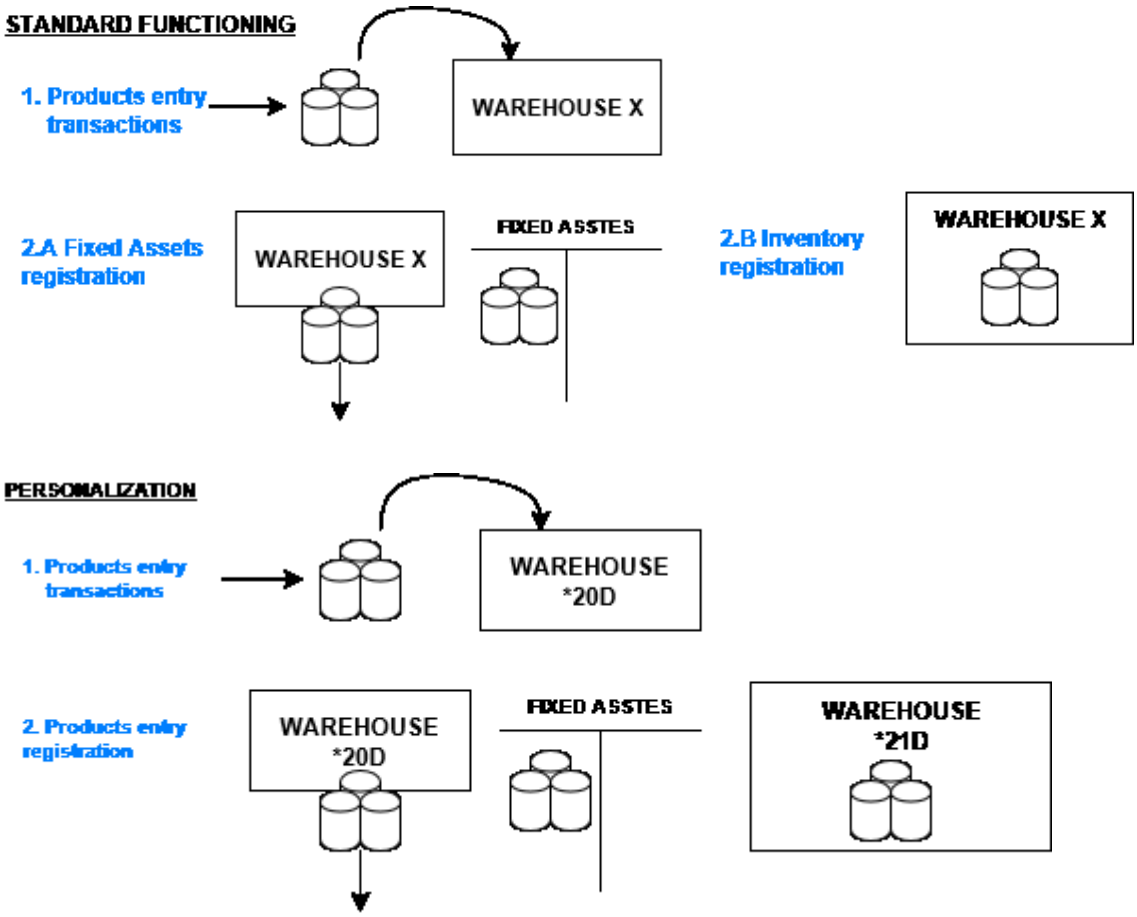


Figure 2.7 Product Entry Registration: Standard functioning vs. Personalization.

2.5.2.3 Products Traceability

Implementing products traceability will enable the company to extract detailed information on specific items. In fact, by tracking a product and registering the related transactions the system would be able to provide information on:

- Product location (for example, it has been shipped to the customer or it is currently subject to phase X of the production process);
- Product availability, which will be useful to determine whether a purchase order is required to accomplish customer demand or stock levels are sufficient to do so;

- Product remaining useful life; in fact, if the useful life of a product is determined by the number of washings it is subject to, product tracking will be able to account for how many times the process has already occurred and thus how long the product will still be available for rent.

The software provides many ways to perform items identification and traceability and integrate the data collected by the exploitation of other technologies. Bar codes, serial numbers, tags are all features that can be associated to items in order to uniquely identify them.

At present, products traceability has not been implemented yet into the system. If items would be uniquely identified, the system would prove its greatest efficiency by integrating it with external technologies such as bar code and RFID. In fact, it would be able to acquire data from external devices with no need for the users to manually insert them.

However, given that the company is not exploiting yet the benefits deriving from the integration of the two technologies in its business processes and the amount of goods handled in the day to day operations is considerable, unique item identification would currently slow down the company activities. In fact, it would force users to enter transactions for the specific item. Taking the registration of a transfer order from a warehouse to another as an example, the user would have to create a line for each item being moved. Instead, if the technologies are integrated into the system, this transaction would automatically be registered into the system.

2.6 IMPLEMENTED SOLUTION: STRENGTHS AND WEAKNESSES

As it usually occurs during software development projects, the initial requirements agreed between the customer and software engineers are subject to revaluation as the project progresses.

Focusing on logistics and inventory functionalities, the current solution is not able to provide an advanced inventory management system. *Lack of items traceability can be identified as the major cause which affects the system*

capabilities. In fact, manually inserting product transactions into the system based on documents attached to products is likely to lead to inaccurate information.

Furthermore, even though the system has been personalized in order to simultaneously account for fixed assets value and depreciation recording and products quantity registration, data on stock level might not always be reliable. In fact, when product entry is registered in the *20D warehouses, they are emptied out and inventory adjustment journals are automatically created to register quantities in the *21D. However, quantities will not be displayed into the warehouses until the user register the journals.

The personalization entails as well that to access information on available quantities, either items stored in warehouses and the one already ordered, the user must query different warehouses and then aggregate the data.

The information extracted from the system on stock levels is generally used to support the decision making process and ease the day to day operations. This is way the system should be implemented in order to guarantee data accuracy and integrity and ease business operations. However, it has not been the priority so far. In fact, given the complexity of developing an ERP solution which is extended to all the business areas, other issues were considered of major importance than advancing functionalities in warehouse management and provide more accurate data.

The solution supplied provides evident advantages compared to the decentralized system the company was adopting in the past. In fact, besides the weaknesses in advanced logistics and inventory functionalities, the system enables the customer to manage a well-structured and classified range of products, implement the logistic structure into the software, integrate data of sale, purchase and inventory processes and extract stock information at different degrees of detail. Last, but not least, the ERP solution is flexible and therefore new functionalities and/or corrective actions can be implemented in order to adapt the system to new requirements.

3 ADVANCED WAREHOUSING MODEL

ERP systems can somehow be considered the evolution of MRP systems. In fact, not only does Material Requirement Planning (MRP) serve as inventory control system, but it also provides the company the ability to meet customers demand. Since ERP system are management software that tight together, in a single database and user interface, all the business processes of an organization, procurement and resources planning operations can be managed as well. Actually, the information organizations could generate by integrating these activities into their ERP solutions could achieve high level of accuracy since all modules, and therefore data, are integrated.

In fact, the main outcome of MRP are either planned production/transfer or purchase orders. The data the system requires to generate the information are:

- customer demand
- products BOM (bill of material)
- inventory status, which includes both on-hand quantities and scheduled receipts

and all of them can be recorded into the system.

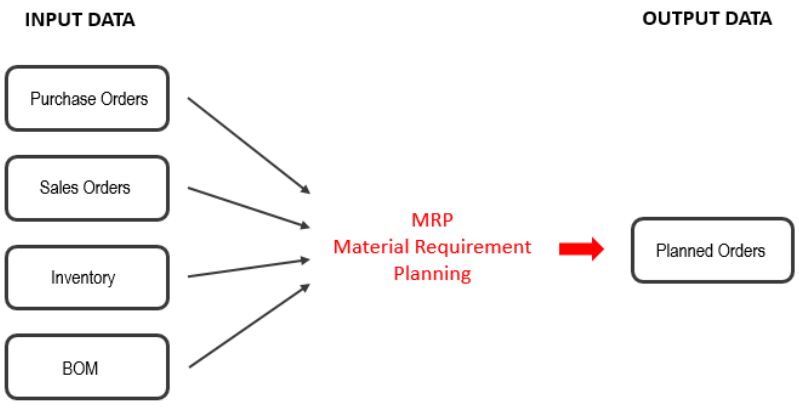


Figure 3.1 MRP System.

Flexibility is one of the main advantages that the company has achieved when opting for an ERP solution. In fact, as many other management systems, functioning and scope of Microsoft Dynamics 365 can be redefined at any

time. More specifically, modules can be progressively activated and settings edited in order to respond to changes in users and business requirements. Implementing the MRP process for the company is the aim of this project and it requires to activate a new module which is called *Master Planning*. However, settings will be discussed more into the details in the next chapter since for the correct functioning of the module it is necessary that the system is able to generate the data input.

Therefore, a model has been built for demonstrating how the company could implement these functionalities and thus achieve improvements in supply chain management.

3.1 WAREHOUSE REQUIREMENTS ANALYSIS

Microsoft Dynamics 365 provides the possibility to implement functionalities for advanced warehousing. However, even though many are the advantages that the customer has gained with the adoption of the new the system, the current solution is not providing an advanced inventory management. The functionalities that have been implemented enables the company to manage:

- Items grouping and classification;
- Logistic structure representation;
- Warehouses layout definition;
- Stock availability, even though actual quantities might differ from the ones registered into the system.

In fact, while business operations and goods handling can be properly replicated into the system thanks to a complete representation of item characteristics and logistic nodes, lack of traceability technologies application and integration with the system reduce the reliability of data recording and collection regarding stock quantities.

To provide advanced warehousing management, it is necessary that:

- the customer starts adopting bar-code and RFID technologies to track goods handling;

- the technologies are integrated with the ERP solution so that transactions are automatically generated into the system and real quantities are more likely to be recorded.

Items traceability implementation would allow the company to achieve item univocal representation, product lifecycle management and stock levels monitoring and management. Moreover, it would lay the foundation to the implementation of the company MRP system from which many are the advantages the company would achieve.

3.2 Model Implementation

At present, the company is willing to test the effects of the implementation of items traceability throughout the garments supply process. In fact, even though the overall value of garments amount to about a half the one of linen (24.5 million compared to 47.5), items of clothing represent a higher expense for the company[3]. The average unit purchase price for items belonging to the linen category is 8,067 € while instead garments reaches an average unit costs of 20,152 €.

	GARMENTS	LINEN
MINIMUM UNIT COST	0,02 €	0,02 €
MAXIMUM UNIT COST	240,00 €	57,75 €
AVG UNIT COST	20,152 €	8,067 €

Table 4 Garments and linen data on unit costs.

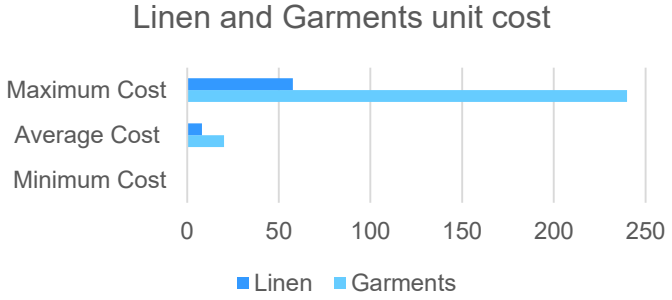


Figure 3.2 Garments and Linen unit cost.

[3] The difference in value is due the volumes of products of each category the company processes. However, speaking in terms of unit cost, garments represents a major investment for the company.

Indeed, the willingness of testing traceability technology for the garments supply process is due to the need of preventing and reducing losses and thefts of valuable assets.

The major prerequisite is given by the adoption of bar code and RFID in the company processes for scanning products during inbound and outbound operations. Then, new functionalities must be implemented into the system in order to enable automatic transactions recording and provide more accurate information on stock levels.

It has been agreed that before implementing the new functionalities into the customer system it would have been useful to realize a model which is able to replicate the business operations and demonstrate how the result can be achieved.

Therefore, the first step for determining the requirements is given by the analysis of the garments supply process. A flow chart has been built to show the interaction between the different entities and the sequence of activities which make up the whole process.

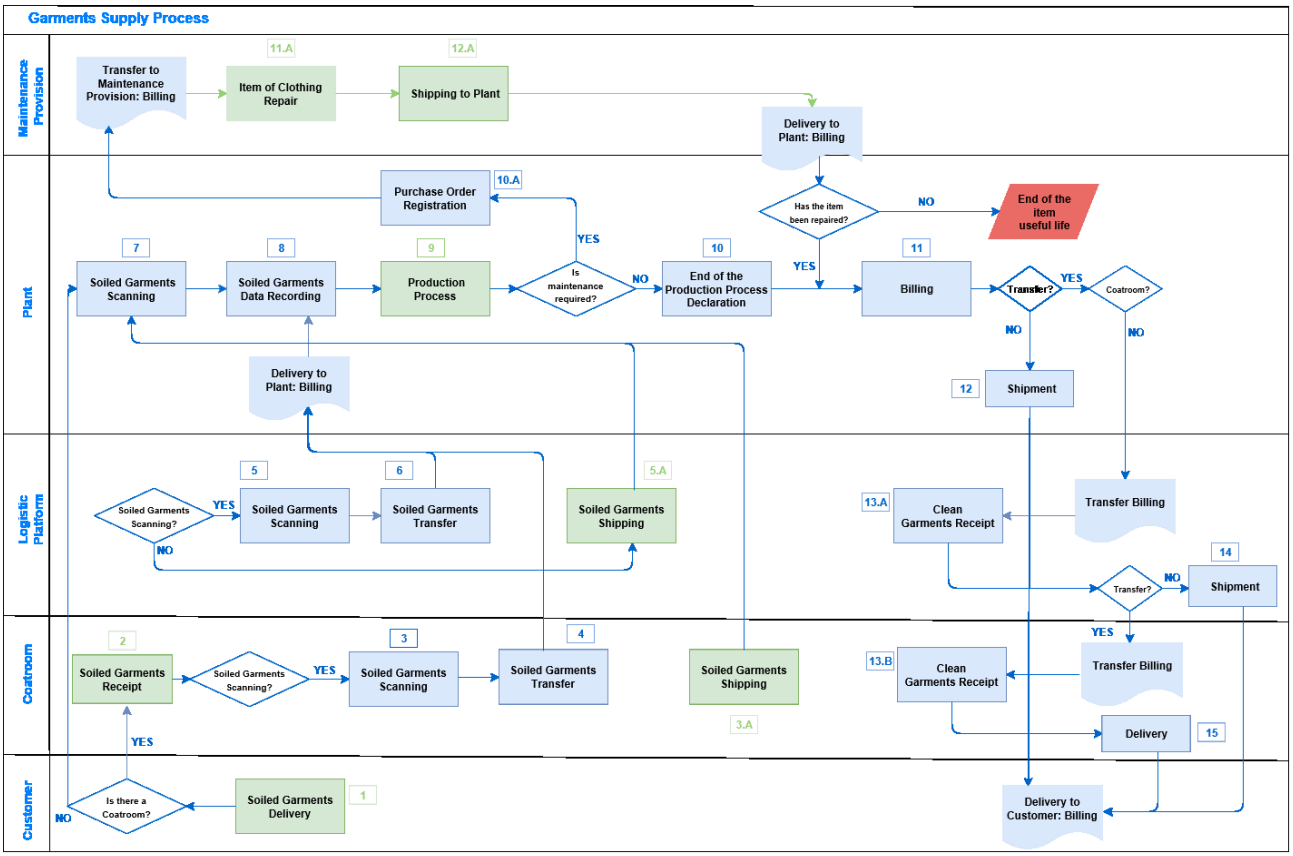


Figure 3.3 The Garments Supply Process.

Legend:

Inventory and logistic process managed by Dynamics 365

Operating process not managed in Microsoft Dynamics 365

External process

ENTITY	ACTIVITY ID	ACTIVITY	DESCRIPTION
Customer	1	Soiled Garments Delivery	The customer delivers soiled garments to the coatroom (if there exists one) or to the company plant.
Coatroom	2	Soiled Garments Receipt	Operators in the coatroom take delivery of soiled garments. They might proceed with scanning operations or not.
Coatroom	3	Soiled Garments Scanning	Operators proceed with soiled garments scanning operations by scanning bar code and/or RFID tags.
Coatroom	4	Soiled Garments Transfer	Operators transfer soiled garments to the customer plant. A transfer bill is attached to the delivery.
Coatroom	3.A	Soiled Garments Shipping	Operators ship soiled garments to the customer plant or to a logistic platform. No documentation is attached to the delivery.
Logistic Platform	5	Soiled Garments Scanning	If it has been arranged, the logistic platform operators proceed with soiled garments scanning operations.
Logistic Platform	6	Soiled Garments Transfer	Operators transfer soiled garments to the customer plant. A

			transfer bill is attached to the delivery.
Logistic Platform	5.A	Soiled Garments Shipping	Operators ship soiled garments to the customer plant or to a logistic platform. No documentation is attached to the delivery.
Plant	7	Soiled Garments Scanning	Operators proceed with soiled garments scanning operations by scanning bar code and/or RFID tags.
Plant	8	Soiled Garments Data Recording	Operators proceed with recording soiled garments data into the production buffer.
Plant	9	Production Process	Execution of the production process activities (washing, drying, ironing and packing).
Plant	10	End of the Production Process Declaration	At the end of the production process, if items meets quality requirements, operators proceed with scanning them to register data on available quantities.
Plant	11	Billing	Operators ship garments either to the customer or to other logistic nodes. Scanning operations are performed.
Plant	12	Shipment	Delivery notes are prepared in order to attached the document to the delivery.
Logistic Platform	13.A	Clean Garments Receipt	Operators register the receipt of clean garments by scanning item tags.
Logistic Platform	14	Shipment	Operators in the logistic platform record the delivery bill and ship items to the customer.
Coatroom	13.B	Clean Garments Receipt	Operators register the receipt of clean garments (either from the plant or the logistic

			platform) by scanning items.
Coatroom	15	Delivery	Operators in the coatroom record data of items delivered to the customer by scanning items.
Plant	10.A	Purchase Order Registration	When the washing process is completed, if items are damaged they are transferred to maintenance provision. To record the transaction into the system, a purchase order is created so that the clean garments warehouse is emptied, maintenance expenses are recorded and available quantity is updated.
Maintenance Provision	11.A	Item of Clothing Repair	The suppliers takes delivery of the damaged items and repairs them.
Maintenance Provision	12.A	Shipping to Plant	The supplier ships items to the plant and the related bill is attached to the delivery. When items are received, those that have been repaired are recorded into the clean garments warehouse. Instead, the ones which are permanently damaged are recorded into the rags warehouse. Data acquisition occurs through scanning operations.

Table 5 Garments supply process activities.

The flow chart displays six organizational entities involved in the garments supply process. Different decisions have been taken in order to represent all of them according to the system functioning:

- Maintenance provision has been modelled by inserting suppliers into the system; in fact, it simplifies accounting transactions recording for maintenance expenses;
- Plants, logistic platforms and coatrooms represents storage system for the customer. Therefore, these entities have been included into the model through the definition of a hierarchal logistic structure which enables as well the representation of the different stages of the product lifecycle;
- Opting for Customer accounts, as well as suppliers, ease purchase orders processing and revenues recording.

The following paragraphs are aimed at describing the main settings and activities that have been performed to build the model into the system. Therefore, the focus is on three modules that allow to manage inventory and logistic operations in Microsoft Dynamics 365:

1. Warehouse Management Module;
2. Inventory Management Module;
3. Product Information Management Module.

Additional settings in the general ledger, accounts payable and accounts receivable modules were necessary either for the system functioning and for the model implementation. However, since most of them are standard operations which must be performed, no description is provided.

3.2.1 Warehouse Management Module

The warehouse management module allows to manage warehouse processes and configure the company logistic structure. The functionalities are fully integrated with the ones provided by other modules of Microsoft Dynamics 365 as accounts payable and receivable, inventory management, master planning.

Event thought the module enables to manage activities as packing and containerization, cycle counting, locations replenishment and many others, its main contribution to the model is given by the possibility to implement the

company logistic structure. As it has been described in the previous chapter, Microsoft Dynamics 365 allow to build hierarchical structures made up by sites, warehouses and locations (*see paragraph 2.2.2.2*).

The *plant*, *logistic structure* and *coatroom* entities must be represented when defining the company logistic structure. For each of them, a *site* has been created into the system. Then, a different number of warehouses have been associated to the different sites, according to the information that must be represented (that is, item availability and lifecycle). More specifically:

- The main processes that occur in the plant are:
  - Receipt and storage of *new* products and raw material;
  - Receipt and storage of products that have been introduced in the production chain;
  - Soiled garments processing;
  - Rags storage;

Therefore, five warehouses have been implemented, respectively representing:

- **New Stock warehouse**, where all the new items of clothing purchased by the company are recorded;
- **Raw Material warehouse**, in order to distinguish between products and raw material stored quantities;
- **Stock warehouse**, which is used to record all the items that have been introduced in the production chain and cannot be classified as "new stock" anymore;
- **Production process warehouse**, in order to account for all those products that are temporarily unavailable since they first need to be processed;
- **Rags warehouse**, where all the items that cannot be supplied anymore, either because they have reached the end of their useful life or because they have been damaged, are stored.

Since site and warehouse are parameters that can be specified when extracting data from the system, this configuration allows to collect more accurate data on quantities filtering the information for items status and availability.

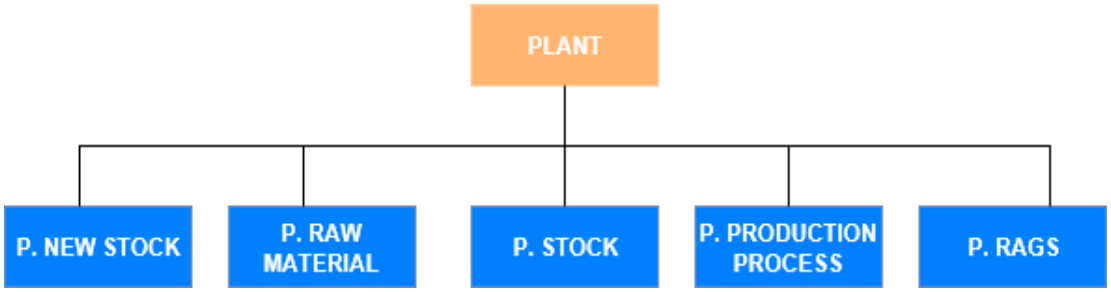


Figure 3.4 Plant: hierarchical structure representation.

The same logic has been applied when defining the structure of the logistic platform and the coatroom. Therefore, in order to aggregate data according to items status and availability, two warehouses have been associated to the sites:

- the **Coatroom/Logistic Platform IN** warehouses are used to record data on clean garments received by the sites (activities 13.A and 13.B in the flowchart);
- the **Coatroom/Logistic Platform OUT** warehouses instead are used to register soiled garments quantity that will be than delivered to the plant (activities 3.A, 4 and 5.A in the flowchart).

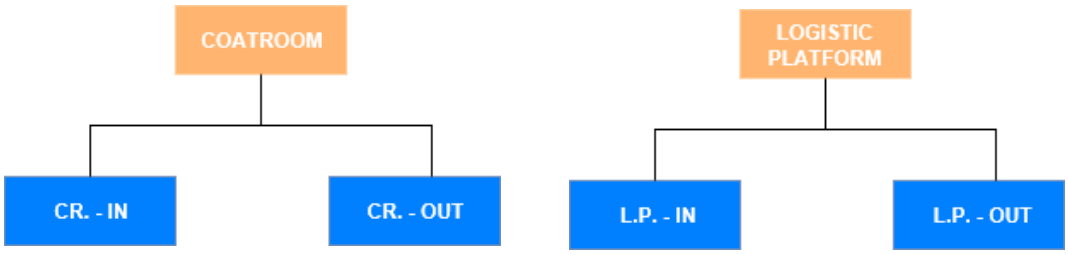


Figure 3.5 Coatroom and Logistic Platform: hierarchical structure representation.

3.2.1.1 Sites Creation

To implement the logistic structure in Microsoft Dynamics 365 it is necessary to firstly create the three sites. Therefore, by accessing the *Sites* form under *Warehouse management > Setup > Warehouse > Sites* the entities have been initialized. When creating a site, it is required to specify a code and the name.

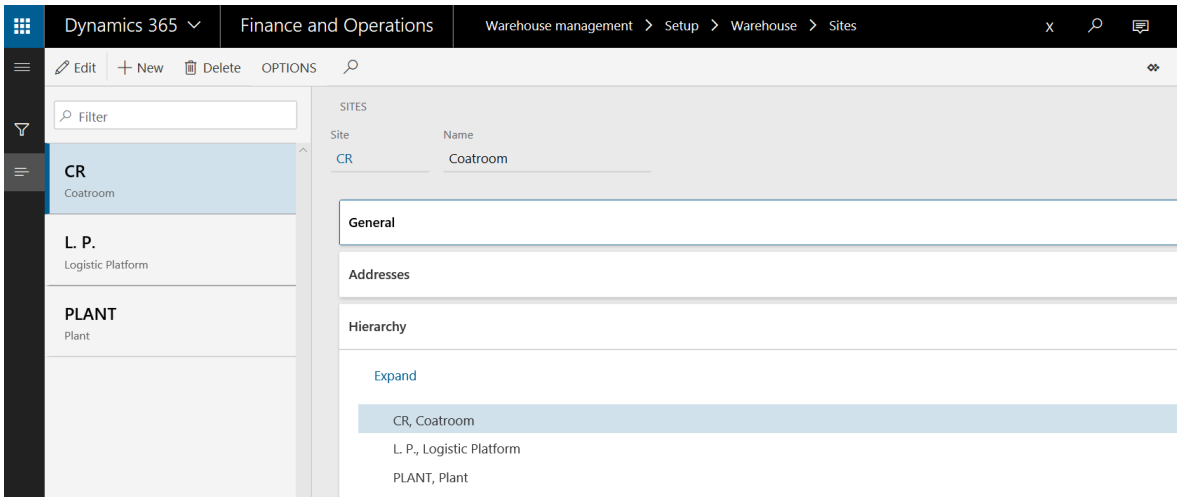


Figure 3.6 Microsoft Dynamics 365: sites creation.

As soon as warehouses are created and associated to the related site, they are shown in the *Hierarchy* tab. The site address can be inserted as well.

3.2.1.2 Warehouses Creation

Microsoft Dynamics 365 allows to define 3 types of warehouses:

- Default warehouses are physical warehouses used to store and pick up products;
- Quarantine warehouses are physical warehouses used to store products that are subject to quality control;
- Transfer warehouses are virtual warehouses that the system requires to process transfer orders; in fact, when items are moved from a warehouse to another, to take into consideration that these products are available the system temporarily register them into transfer warehouses.

When creating a warehouse, the following information must be entered:

- Warehouse code;
- Warehouse name;
- The site the warehouse belongs to;
- Warehouse type:
    - If default is selected, the system allows to specify the related quarantine and transfer warehouses; if transfer or either quarantine is selected, these option is not provided.
- Physical and Financial negative inventory;
    - If the checkbox is selected the system allows to issue an item even though stock is not available into inventory (it might be the case of items that have been purchased but product entry has not been registered yet; if a sale order is issued, the system allows to sell these items even though they are not physically stored into the company warehouses);
- Default inventory status ID (see paragraph 3.2.1.3)

The warehouses shown in figures 3.2 and 3.3 have been created into the system; additionally, a transfer warehouse for each site has been modelled in order to enable inventory transactions into the system.

When entering the Warehouses module, the hierarchy of the implemented logistic structure is shown as well.

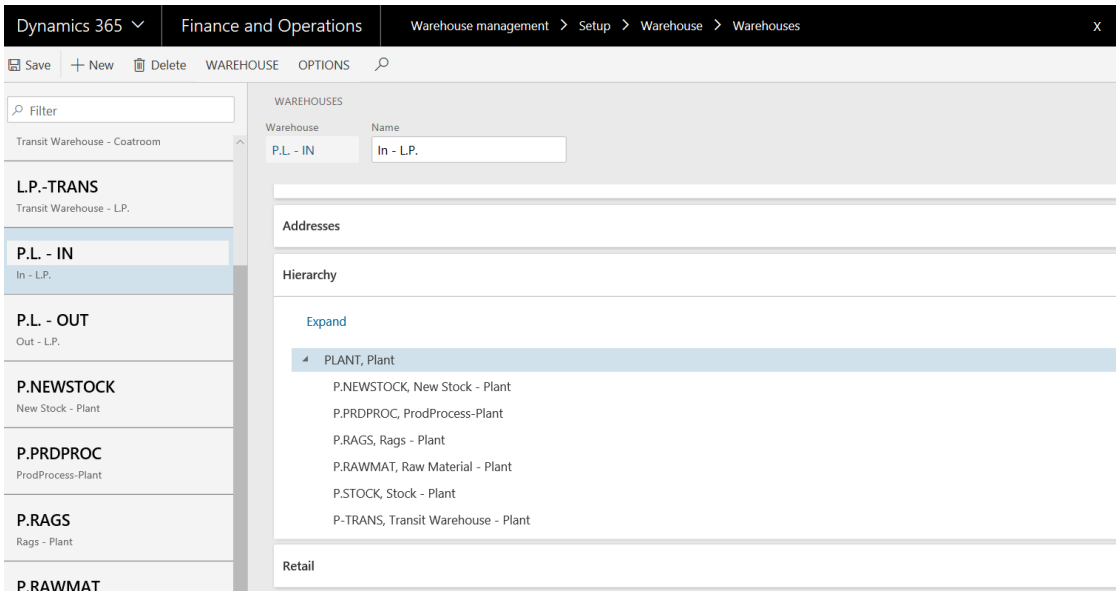


Figure 3.7 Microsoft Dynamics 365: Warehouses creation and logistic structure hierarchy .

3.2.1.3 Inventory Statuses

Inventory statuses can be implemented in Dynamics 365 to categorize inventory. In fact, it is possible to associate a default inventory status to a warehouse so that the statutes of the stock stored in it is known in advanced.

For the purpose of this project, four inventory statuses have been created into the system:

- AVA – Available Stock;
- NEW – New Stock;
- PROD – Processing, Soon Available Stock;
- UNAV – Unavailable Stock, Rags.

An available status (AVA) has been associated to all the items that can immediately be used to supply services to customers; PROD and UNAV statuses have been created to identify the items which are not available, that is, either they are being processed either they are soiled items that must be transferred to the plant in order to be processed, either they have reached the end of their useful life, therefore they can be classified as rags. Finally, the NEW status is used to identify new products.

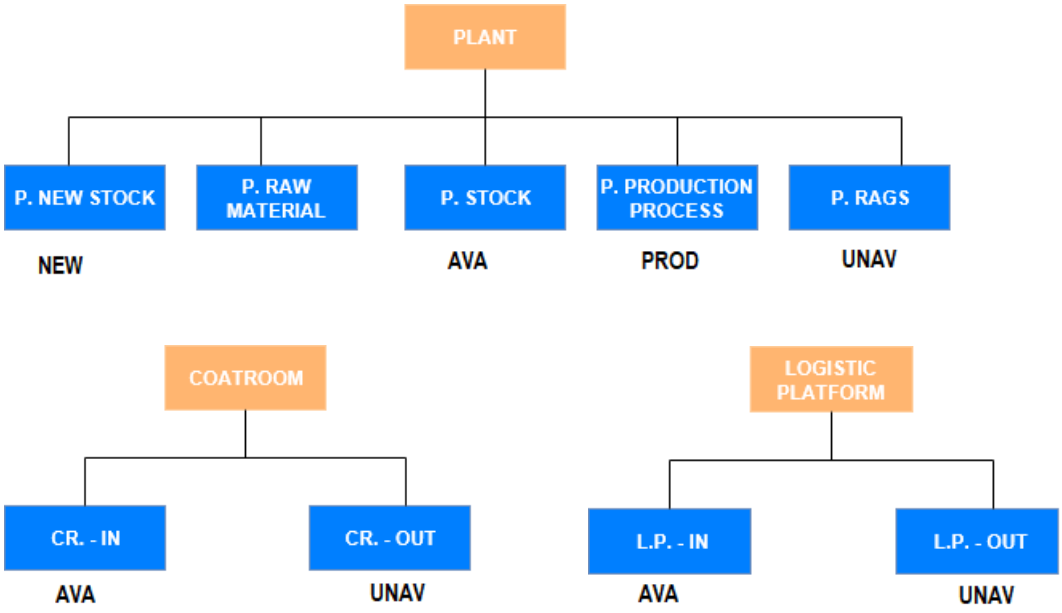


Figure 3.8 Dynamics 365: Inventory Statuses and Warehouses.

3.2.2 Inventory Management Module

The inventory management module provides the functionalities for managing inbound and outbound operations and inventory control (as calculate, adjust and close inventory).

Settings that have been done for the purpose of the projects are related to:

- inventory journals;
- item groups;
- tracking number groups;
- general inventory and warehouse management parameters.

3.2.2.1 Inventory Journals

Inventory journals can be used to record into the system inventory transactions. Different types of journal can be created:

- Movement and inventory adjustment journals are used to record inventory costs in general ledger accounts;
- Transfer journals can be used to transfer items from a location to another. It is in fact necessary to specify from and to where are products being transferred in order for the system to accordingly update quantities. Differently from transfer orders, where in-transit inventory is tracked, transfer journals are used to reflect immediate movements of goods.

  Both transfer journals and transfer orders are needed to replicate the garments supply process activities shown in figure 3.1. In fact, while transfer orders would be used to transfer goods between different entities which are geographically located in different areas (and therefore it would not be correct to consider it an immediate transfer), transfer journals could be used, for example, to record the transfer from coatrooms to customers.
- Counting journals are created when there is the need to correct and therefore update items quantity. It is the case of manually performed counting operations that reveals different data from the ones registered into the system.

Counting journals could therefore be used for registering into the system counting operations performed through bar code scanning.

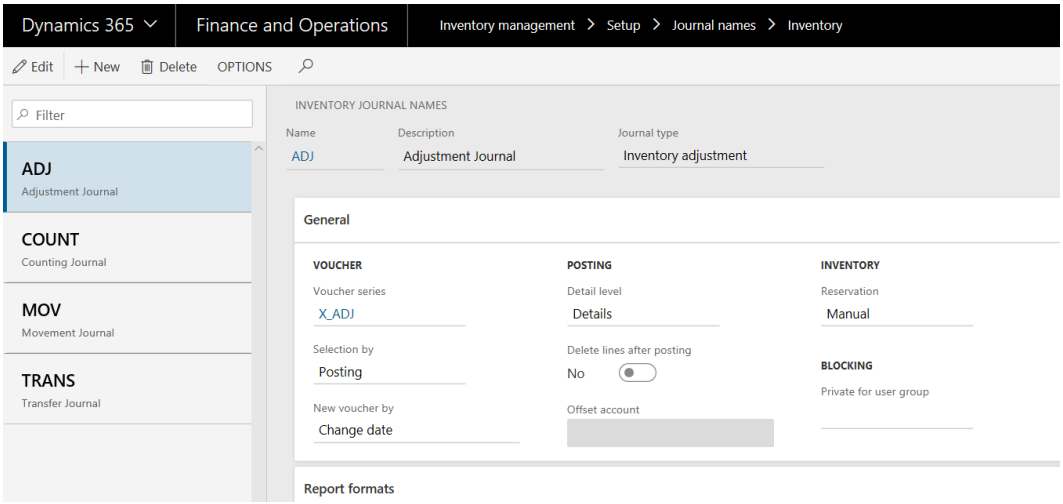


Figure 3.9 Dynamics 365: Inventory Journals creation.

Once created, in order to complete the setup, it is necessary to associate the journals in the general inventory and warehouse management parameters.

3.2.2.2 Item Groups

Item groups can be implemented in the inventory management module. The main purpose of creating item groups is to allow the system to automatically record various types of transactions into general ledger accounts.
However, they allow as well to divide items into logical groups and provide the user a further filter parameter when extracting information from the system. As explained in paragraph 2.5.2.1, each released product must be assigned to an item group. The structure built for items grouping into the current ERP solution delivered to the company would not need to be revised for the implementation of the project. However, since the purpose it to show how the master planning module can be activated and meet customer requirements, there is no need to add much information into the model. Therefore, two main item groups have been created:

- Garments;
- Linen.

For each groups, the general ledger accounts where transactions must be recorded have been defined.

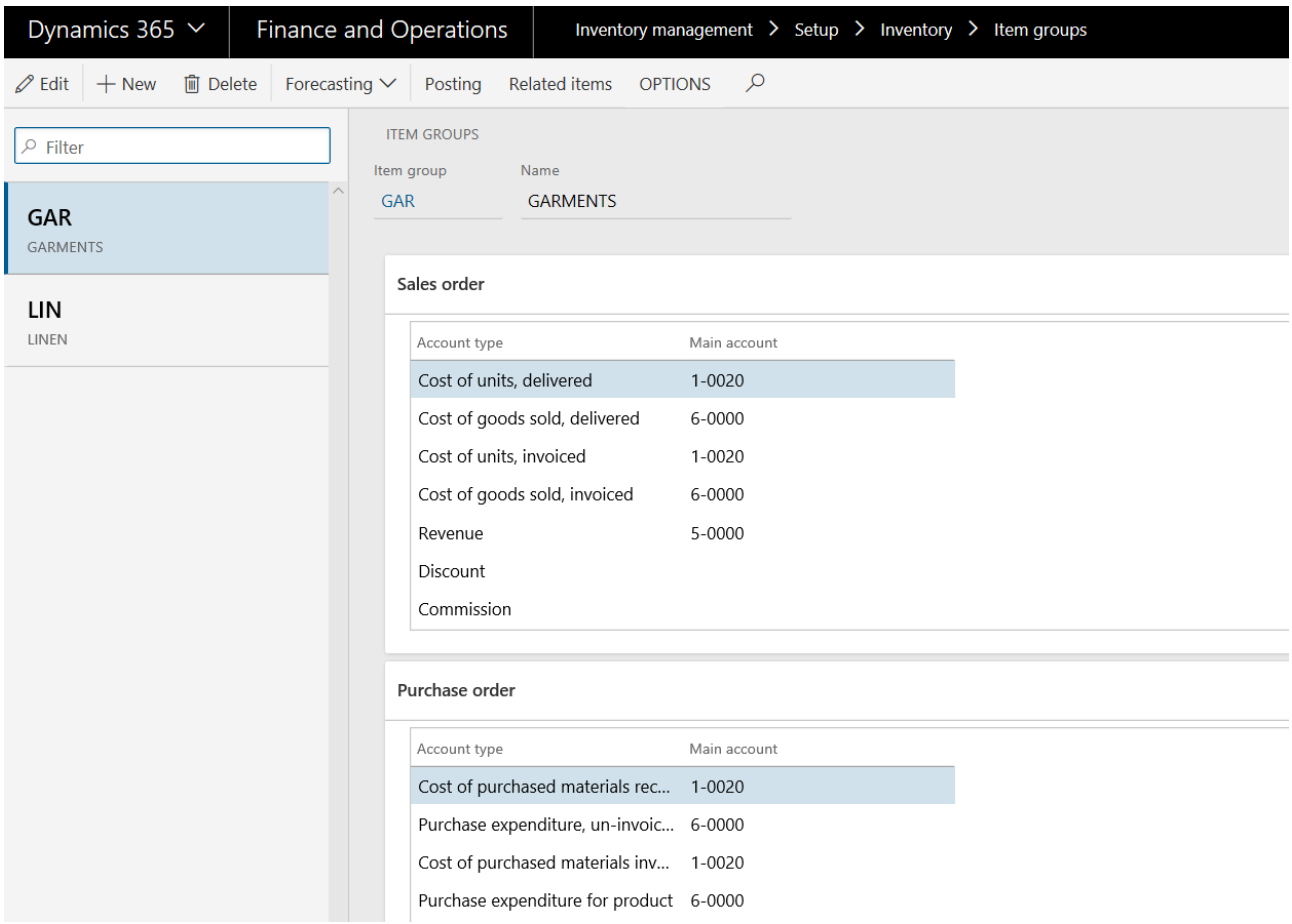


Figure 3.10 Dynamics 365: Item Groups creation.

3.2.2.3 Tracking Number Groups

Tracking number groups are the third element of interest in the inventory management module. They are strictly related to product dimension groups that will be analysed later on in this chapter (since the settings are available in the product information management module).

For product traceability it is necessary to uniquely identify each item. Dynamics 365 provides several ways for item identification. Bar code settings have not been implemented since the implementation would make sense once mobile devices are integrated into the system. However, there is a specific set of features that enable to attach bar code label to each item registered into the system. Instead, the serial number tracking dimension have been

implemented into the system. This functionality entails that a serial number is assigned to an item once it is acquired. Products acquisition is realized through purchase orders, therefore, the system generates a unique code any time the product entry is recorded. However, since there are items already stored into warehouses at the moment in which the solution is delivered to the customer, to replicate the requirement of serial number association settings have been implement even for generation of codes during inventory management operation.

The serial number is reflecting the RFID tag that is attached to items when the technology is integrated into the company operations (see paragraph 2.4.1).

Tracking number groups are a prerequisite to tracking number dimension. Two tracking number groups have been initialized for the purpose of automating serial number generation during purchase and inventory management activities. One is used to generate serial number for garments (in the format G-######) and the other one is related to items belonging to the linen group (in the format L-######).

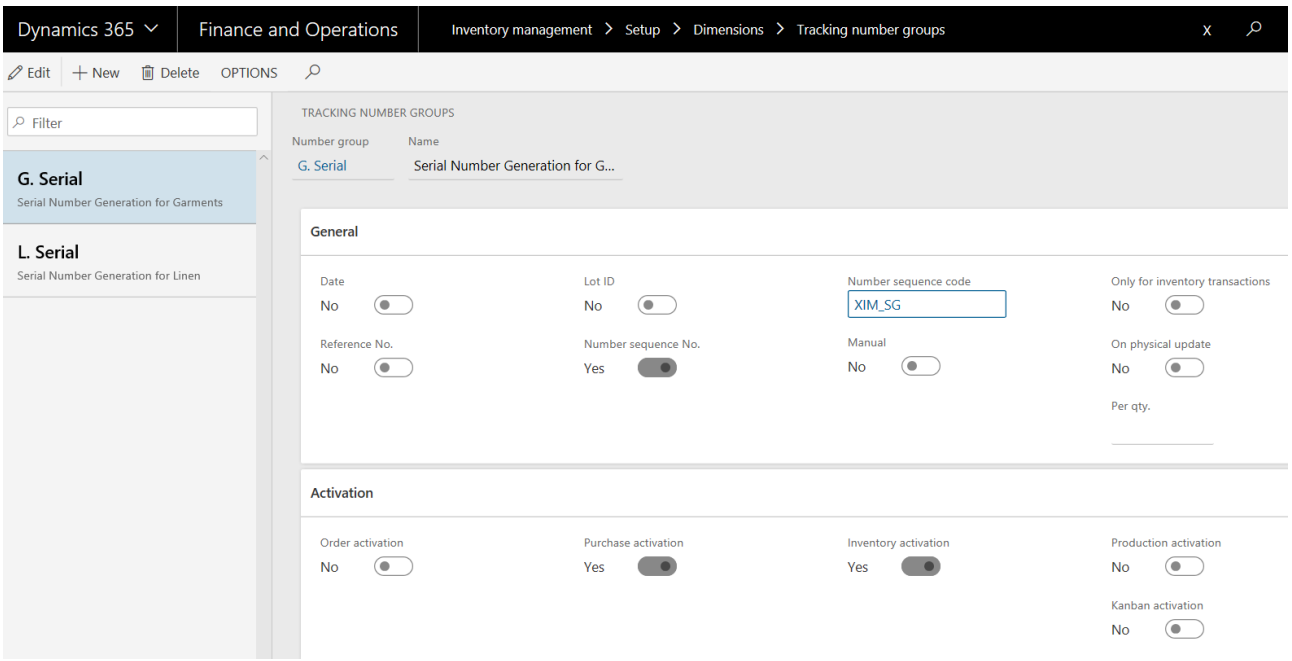


Figure 3.11 Dynamics 365: Tracking Number Groups creation.

3.2.2.4 On-hand Inventory

The inventory management module enables the user to extract information on on-hand inventory. This functionality has been used several times when testing the model.

The on-hand inventory functionality allows to query the system on stock availability and many filters can be applied to extract the data. Both the on-hand inventory and the physical on-hand inventory will be displayed. The difference lays on whether products have already been received, or they have been purchased but product entry has not occurred yet. The use of this functionality is shown in chapter 4 when the functioning of the master planning module is described.

3.2.3 Product Information Management Module

For a software application to effectively manage supply chain information on products are essential. The product information management module of Dynamics 365 is thought to manage and record information on the products the company processes.

Definition of products has already been described in paragraph 2.5.2.1 when discussing the implementation on the current solution of items grouping and classification.

In addition to product definition, the module is used to define:

- tracking dimension groups;
- storage dimension groups.

3.2.3.1 Tracking Dimension Groups

To accomplish items traceability into the system tracking dimension groups must be defined.

Tracking dimension groups are associated to *released products* and define which tracking dimension must be specified whenever transactions are recorded into the system.

The SerialN tracking dimension group has been created which entails that:

- any time there are transaction involving physical inventory, serial numbers must be associated to items;
- the same serial number cannot be associated to more than an item.
  The flag on serial number control avoid duplication of serial number into the system. However, inventory movements must have a quantity of one. Therefore, whenever creating purchase orders, inventory journals, sales orders and so on, for each item a line must be created. Even though it might look a time consuming process, the integration of the data collection process with the RFID technology should allow documents lines automated creation.

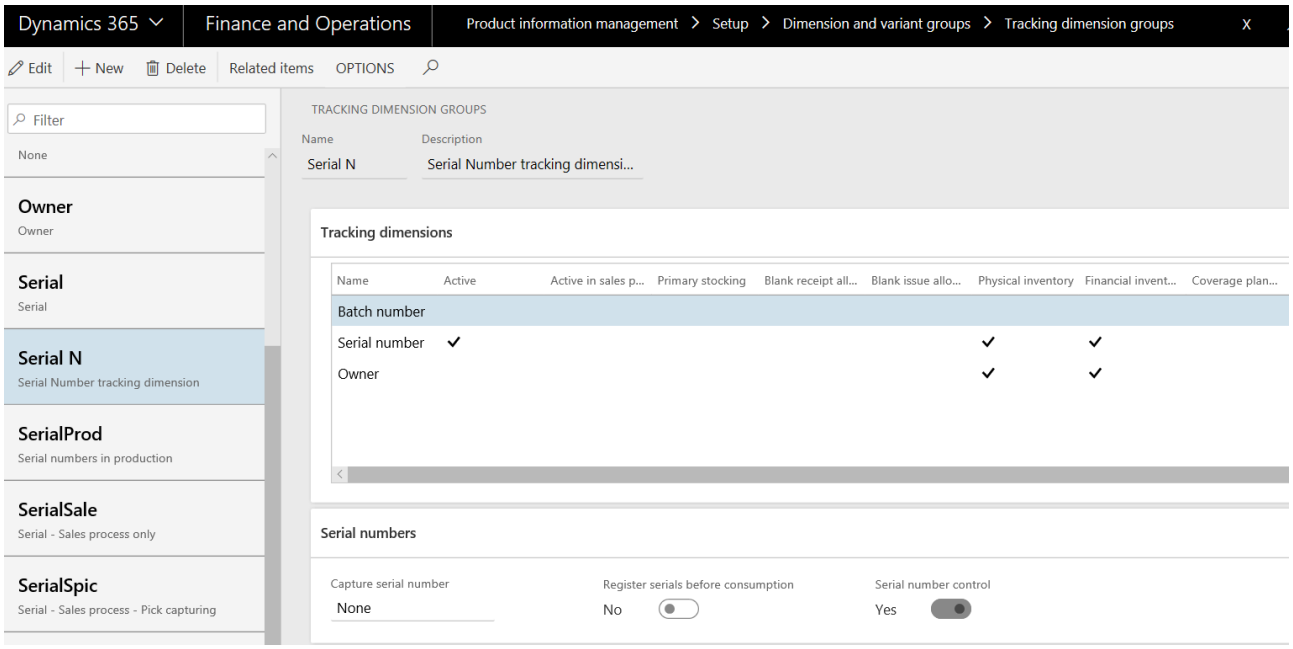


Figure 3.12 Dynamics 365: Tracking Dimension Groups creation.

3.2.3.2 Storage Dimension Groups

Storage dimension groups as well are associated to released products. As the name suggests, they are aimed at defining which storage dimensions must the user define whenever transactions are recorded into the system.

Given the logistic structure that has been implemented for the model (see paragraph 3.2.1) the SiteWH storage dimension group has been created. It implies that for each item that is involved in transactions, the site and warehouse where it stored (or it is going to be) must been specified.

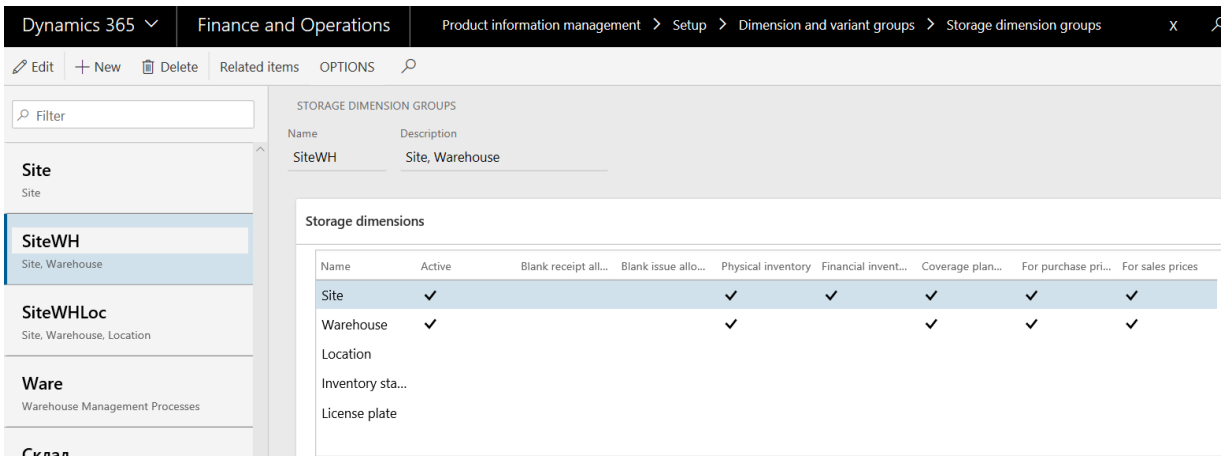


Figure 3.13 Dynamics 365: Storage Dimension Groups creation.

3.2.3.3 Product Definition

A more detailed description of how is product definition implemented into Dynamics 365 can be found in paragraph 2.5.2.

For the purpose of the project, since it has been implemented referring to the garments supply process, few items belonging to the garments category have been created into the system. In addition to *name, description* and *item groups*, for each released product the *tracking and storage dimension groups* have been defined.

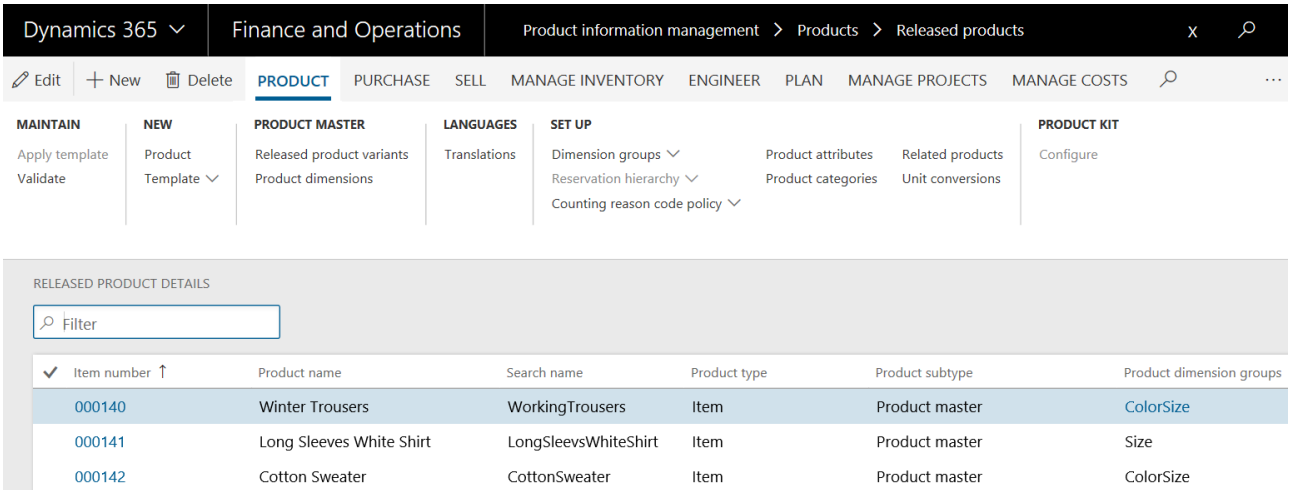


Figure 3.14 Dynamics 365: Released Products creation.

For some products *configurations* have been implemented, such as combinations of size and colour.

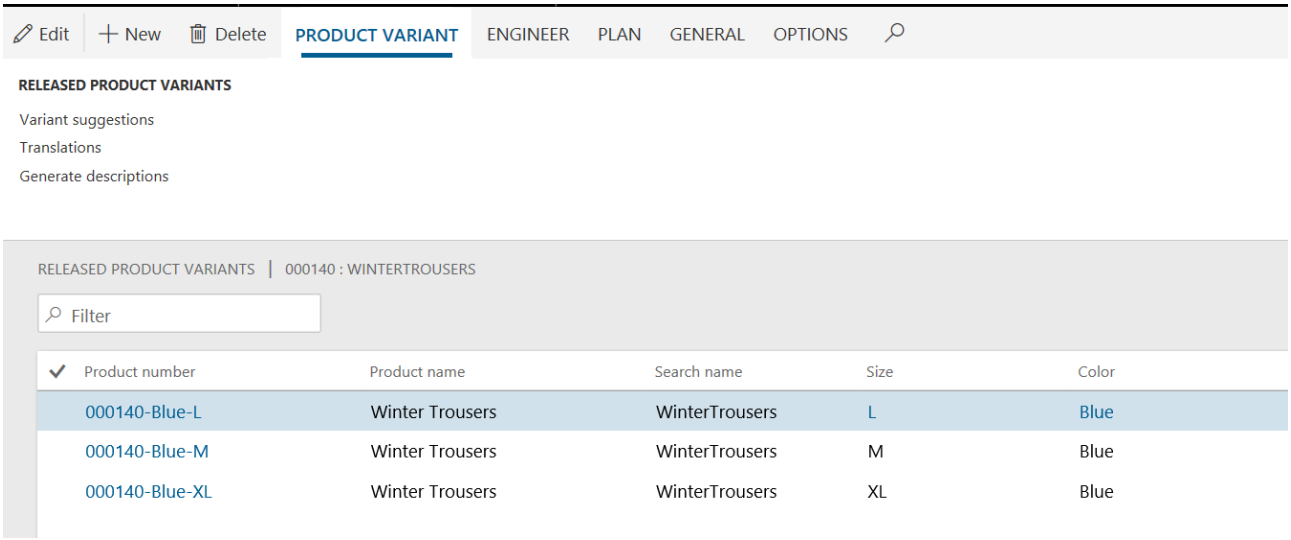


Figure 3.15 Dynamics 365: Product Variants creation.

By accessing the default order settings tab, it is possible to define:

- *purchase lead time*.
- *minimum and maximum order quantities*;
- *multiple requirement*.

This information is taken into consideration when running master planning. In fact, planned purchase orders are going to be scheduled for the latest order date. Moreover, when computing requirement and therefore suggesting purchase orders, constraints on quantities are going to be considered. Dynamics 365 enable users to override this information when creating purchase order.

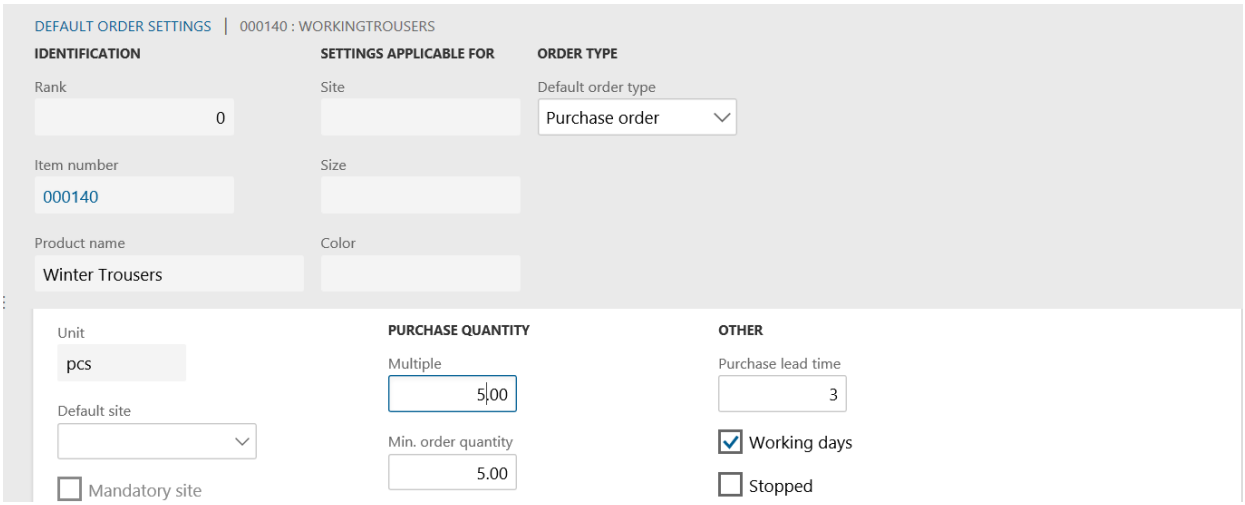


Figure 3.16 Dynamics 365: Default Order Settings.

Further settings in product definition are going to be performed when activating the master planning module. In fact, for the system to calculate requirements it is necessary to create item coverage groups which are used for stock levels definition. Once created, it is necessary to associate them to items and therefore settings are analysed in the next chapter when more detailed description on functioning and purpose are provided.

4 MASTER PLANNING

The master planning module represents the heart of this project. In fact, not only the functionalities have not been implemented in the current solution adopted by the customer, but they also represent the last actions that must be performed for the implementation of the company MRP system.

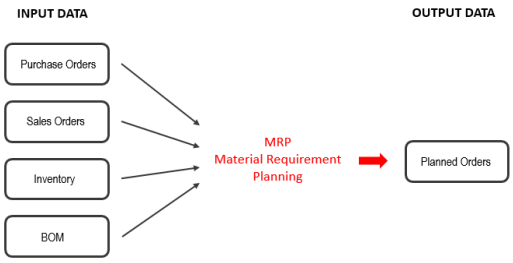
The following paragraphs analyse the module functioning and provide a description of the sequence of settings that have been performed in order to obtain planned orders.

4.1 REQUIRED DATA INPUT

The settings that have been done so far were aimed at enabling the correct functioning of the master planning module. In fact, in order to allow the system to generate planned orders, the correct information must be generated since it will provide the required data input to the management software.

As it is shown in figure 3.1, the data input required for planning requirement is:

- ✓ purchase orders;
- ✓ sales orders;
- ✓ inventory levels;
- ✓ BOM.



Sales orders define the net demand the company must meet. Forecasting methodologies could be applied as well in order to provide further information to the system. Anyway, data on customer demand is stored into the system whenever sales orders are recorded.

Purchase orders, together with inventory, provide the overall picture on the company stock levels. In fact, MRP takes into consideration both physical on-hand inventory as well as ordered quantities when evaluating whether new items must be acquired to meet demand. Dynamics 365 provides many ways to query stock level. More specifically, two of them are particularly useful for

the purpose of the project and both are accessible through the inventory management module:

1. **On-hand inventory**: this functionality provides information on the on-hand quantity. That is, the data includes both physical inventory and ordered one. When running master planning procedures for defining items requirements, not only does the system considers physically available quantities, but it take into account purchase orders and lead times as well.

   The logic behind considering ordered quantities is the following:

   A sale order has been confirmed, however, at present, the physically stored quantities are not enough to fulfil the requirement. If items have been purchased already and product entry is scheduled for a day which is prior to the delivery requested date + sales lead time, then no purchase order is suggested by the system. If instead, product entry is scheduled later that the requested date + sales lead time, according to the system settings, either delays are considered either a new purchase order is planned.

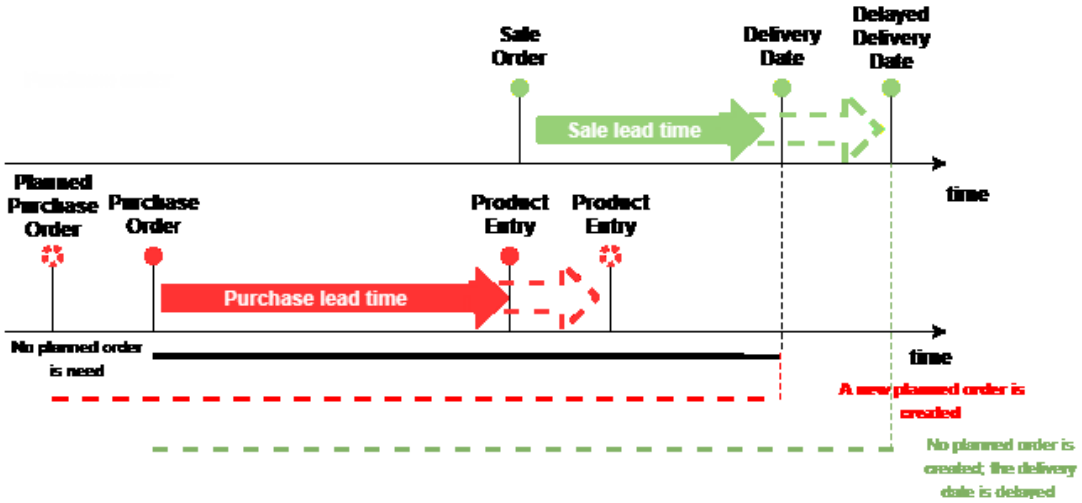


Figure 4.1 Ordered quantities and system functioning.

2. **Physical inventory by inventory dimension:** this functionality instead provides a picture on the physical quantities stored into the company warehouses. Many filters can be applied when extracting data, according to the information the user wishes to extract.

Even though MRP systems are extremely useful for managing operations in complex manufacturing processes taking into consideration BOMs, production times and acquisition lead times of the different components, this information is not required by the model. In fact, in the linen and garments supply industry:

- products are not made up by components, therefore there are no BOMs that the system must consider when generating planned orders;
- production processes as washing, sterilization and ironing are simple activities that require short times to be performed.

Therefore, there are no sequences of activities neither hierarchies of components that must be carefully organized, while instead item quantities represent the real challenge. In fact, as it has been already described many times in the previous chapters:

  - items are continuously transferred from a logistic node to another throughout their lifecycle;
  - constant flow of clean linen and working clothes must be supplied to customers (for many of them a daily frequency is required);
  - given product size, use and particular hygienic standards that must be met, losses and thefts are likely to occur.

4.2 MASTER PLANNING MODULE: FUNCTIONALITIES

The master planning module of Dynamics 365 is used by organizations to determine and balance the company future needs. Three main planning processes are available in order to enable companies to determine different types of output:

1. **Master planning** is used to compute net requirements based on physical inventory and ordered quantities. Inventory is controlled on a short term, day to day basis.
2. **Forecasting planning**, which is not at the core of this project, is instead used for long term planning and the system uses data on future projections;

3. **Intercompany planning** computes and balances requirements across different legal entities.

Most of the data recorded into the system feeds into master planning.

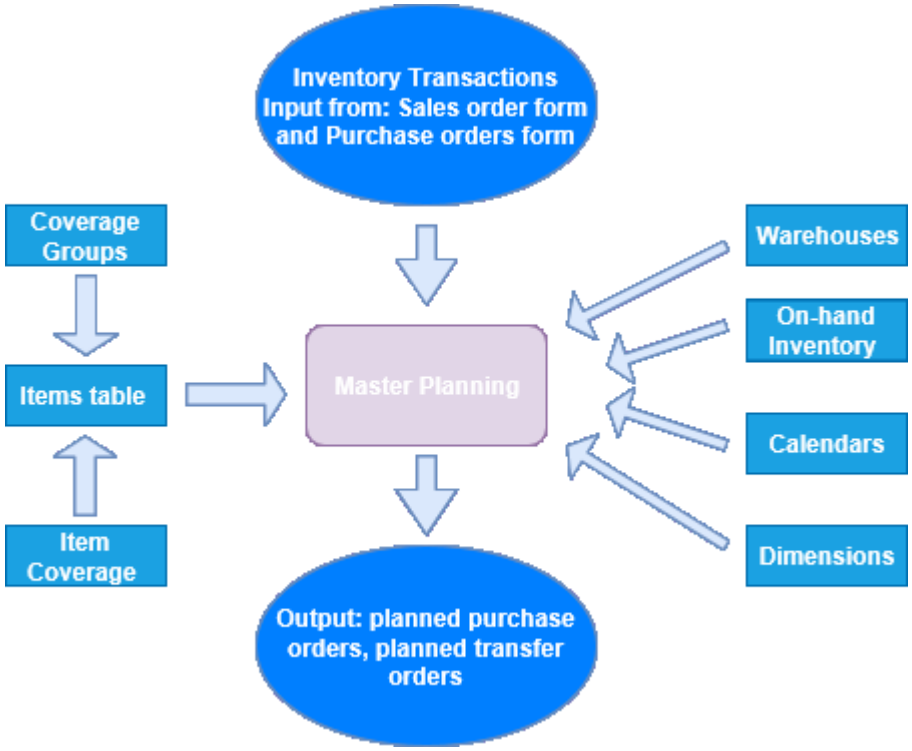


Figure 4.2 Dynamics 365: Master planning flow of information.

For enabling master planning two main settings must be performed that refer to:

- master plans;
- coverage groups.

The general parameters of the module must be defined as well, since this is the primary requirement for the activation of each module of Dynamics 365.

4.3 Master Planning Module: Setup

The following paragraphs describe into the details the available options provided by the software for the definition of plans and coverage groups and justify the choices according to the company requirement.

4.3.1 Master Plans

At least one master plan must be implemented into the system in order to enable Dynamics 365 to compute requirement. However, according to the customer needs, different master plans can be created:

- a **static plan** is used to calculate the net requirement based on current data. The plan remains unchanged until the next time the master plan is run and it can be used by different BUs to perform activities such as procurement or production management and analysis;
- a **dynamic plan** instead uses both the current data and the ones generated by the last static plan to modify planned orders where necessary. It can be used to manage day to day operations and monitor changes in items availability.

For the purpose of this project, both a static and dynamic plan have been created into the system. If the company industry is considered, customer demand can somehow be considered static. In fact, as it is show in the example provided in paragraph 2.2, once a new customer is acquired, the requirement is basically defined over a long-term horizon. Of course, any contract of this type usually includes clauses on the possibility of variations in the quantities supplied. Therefore, a static plan could potentially be enough to meet customer requirement and allow the procurement and sourcing area to control and guarantee inventory levels. In fact, the plan could be periodically run and anytime it regenerates the suggested planned orders updating quantities. However, once planned orders are suggested, the correct procedure would require operators to review the orders before firming them (in fact the function transforms a planned order into an actual one). Given the high number of items the company processes, the output of launching master plan could be made up by an extremely long list of planned orders that requires time to be reviewed. Here comes the utility of implementing a dynamic plan. In fact, if time has passed by the time the list of orders that the company wants to firm is completed, a dynamic plan could be run to check whether there have been transactions registered into the system that have caused changes in the suggested plan. In fact, a dynamic plan does not

regenerate orders but proposes changes to the existing ones based on the system current data.

4.3.1.1 Master Plans: settings

As for many other entities into Dynamics 365, when creating a master plan both an *identification code* and a *name* must be provided. In the general tab, two flags are used to define which data must the system consider when running master planning; both the on-hand inventory (see paragraph 4.1) and inventory transactions have been included. In fact, even transfer orders must be taken into consideration since there are activities in the garments supply process shown in figure 3.3 that are replicated into the system using transfers from and to logistic nodes.

A number sequence that generates planned orders numbers is associated to the plan. Therefore, each planned order generated by the system is going to follow the notation PPO#####.

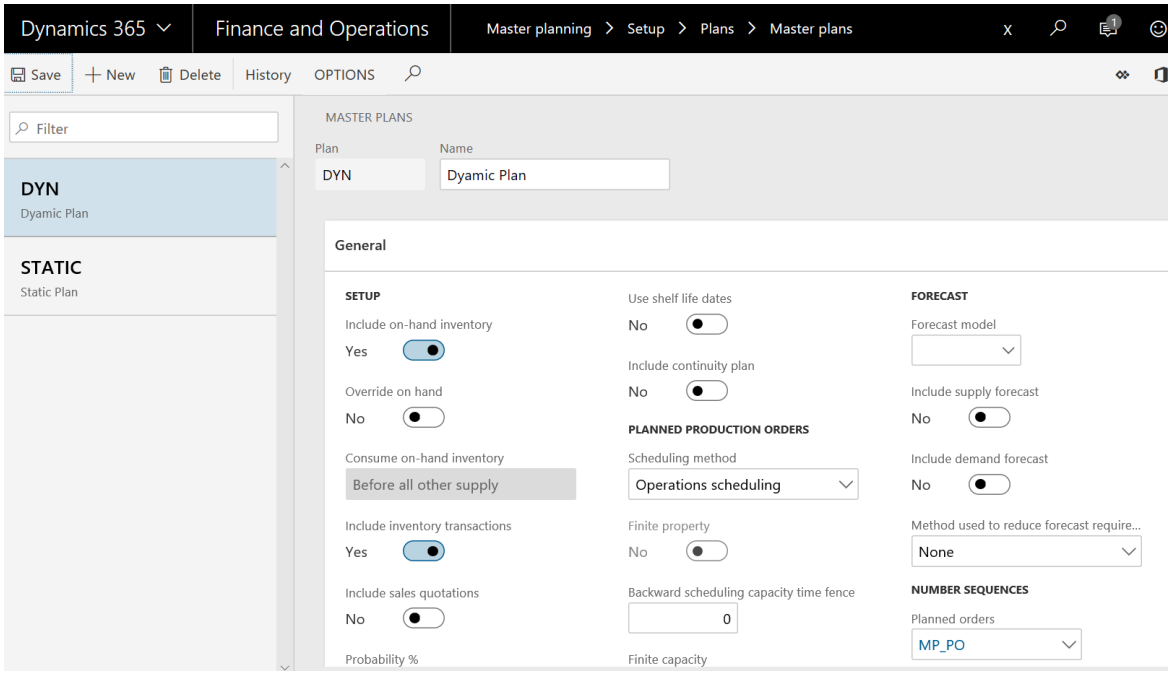


Figure 4.3 Dynamics 365: Master plans creation.

The time fences in days tab is used to define the time fences the plan considers when master plan is run. Time fences must be defined for many different activities such as:

- Coverage
- Freeze, that is no planned orders are generated neither existing ones can be changed;
- Firming, for planned orders approval;
- Action messages generation.

If no information is inserted in the tab, time fences the plan considers are the ones defined into the item coverage groups (see next paragraph). Indeed, only when the dynamic plan has been created, a shorter time fence for coverage has been defined.

The calculated delays tab is used to define whether or not master plan should compute delays when defining the requirement date of a transaction. This option has been selected for both the static and the dynamic plan. In fact, the requirement date is basically computed as the original requested date + safety margins. By flagging the delay options:

REQUIREMENT DATE = ORIGINAL REQUESTED DATE + SAFETY MARGINS

and

DELAY = DELIVERY DATE – REQUESTED DATE if DELAY > 0

so that the system provides the user information on potential negative inventory or inventory levels below safety margins.

Safety margins, that is the number of days that the system uses when computing the requirement date of a purchase order have not been defined into the plans. In fact, they can be inserted into the item coverage groups and if the information is present in both plans and groups, the system sums the days.

4.3.2 Coverage Groups

Master plans uses coverage settings to compute item requirements. In order to define the logic that Dynamics 365 follows when running master plans,

coverage groups must be created and then associated to products. The user has the ability to implement different coverage groups if items must follow different rules for requirement calculation.

Once a name and a description has been defined for the coverage group, a coverage code must be selected. Four different options are available:

1. **Period**

   When period is selected, Dynamics 365 bases requirements calculation on a length of time logic. All requirements not covered within this period are summarized in a single planned order. The date suggested by the system is the delivery date of the first requirement and the aim is to minimize the number of planned orders. However, this could cause an increase in inventory costs since items might be kept in inventory longer.

2. **Requirement**

   The requirement code type creates a planned order for each requirement that is not covered, that is for each requirement that would bring inventory below safety stock level or below zero. Therefore, requirement code is strongly suggested when there is the need to keep inventory costs at the minimum.

3. **Min/Max**

   The Min/Max code is used by organizations to keep inventory levels between a specified range. In fact, whenever there are requirements that would bring inventory levels below the minimum, a planned order is created in order to bring again inventory at the specified maximum.

4. **Manual**

   If manual is selected, master plan does not calculate requirement neither generate planned orders for items associated to this coverage group.

For items belonging to the garments group the Min/Max methodology is selected and therefore defined in the *Min/Max* group created into the system. A time fence of 100 days is set, that is, from the day master plan is launched, the system counts 100 days forward for calculating requirement.

When creating the dynamic plan, the time fence for coverage has been set to 15 days. In fact, the system computes requirement for the time fence specified into the coverage group unless a different information is specified for the specific plan (see paragraph 4.3.1.1). The aim of having different time fences defined for the plans is to allow the company to continuously monitor stock level and easily organize replenishment based on predetermined stock levels. In fact, stock availability and inventory costs represent the real challenges the company has to deal with.

Dynamics 365 enable the user to specify whether *late delivery for sales orders are allowed*. That is, when comparing the receipt date of a purchase order and the delivery date of a sales one (assuming that physical inventory is not enough to meet the requirement), according to the information inserted in the negative days field the system decide whether to generate a new planned order or not. In fact:

- if zero negative days are defined, no late delivery for sales are allowed and therefore, if products receipt is scheduled later than the delivery date a new planned order is created;
- instead, by defining a time interval for delay in delivery the result of launching master planning would be an action message rather than a new purchase order if

$$\text{DELIVERY DATE} - \text{RECEIPT DAY} \leq \text{NEGATIVE DAYS}$$

Given that the coverage group is being created for items belonging to the garments group and delivery to customers are not as frequent as the ones for linen, two days of negative inventory has been allowed[4].

The positive days field instead, is used to define the time interval during which a planned receipt that is due can be used to fulfil requirement. Since items the coverage group is being created for do not expire, there are no constraints on time and therefore the positive days field has been set to 100 as the coverage period.

[4] Coatrooms installed by customers serve as storage system for the organization mainly for items belonging to the linen category. In fact, linen is picked up from customers' facilities and delivered to the same on a daily basis, while instead garments usability is generally longer.

Finally, a safety margin of one day has been specified into the coverage group and it is going to be considered by master plan when computing the requirement date of a planned order (see paragraph 4.3.1.1).

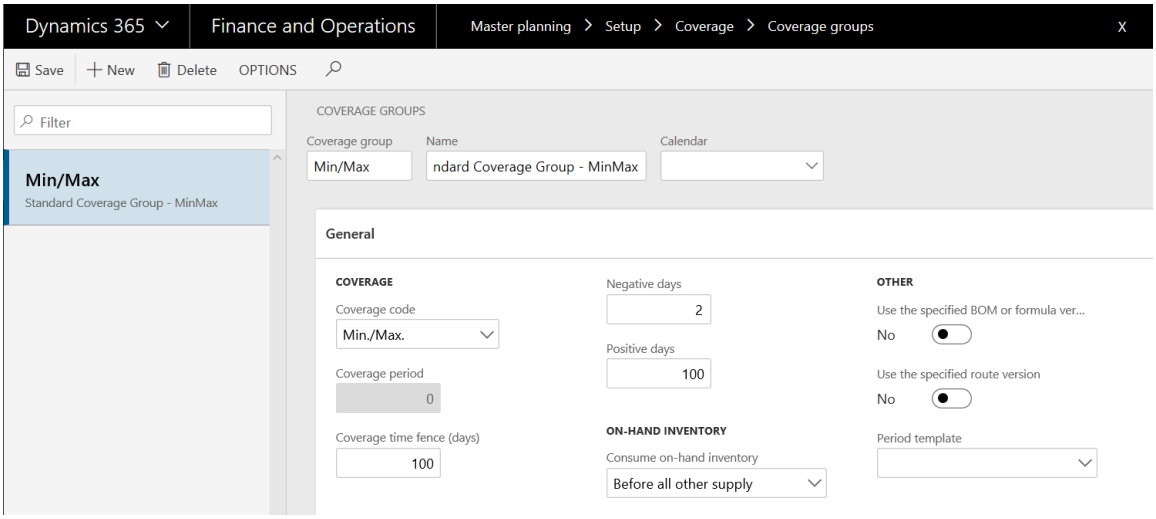


Figure 4.4 Dynamics 365: Coverage group creation.

The action message tab enables users to define action messages settings. In fact, when running master plans the system might associate action messages to purchase/sales/transfer orders in order to suggest users to take specified actions. These refer to:

- Advance orders;
- Postpone orders;
- Decrease or increase quantities.

Action messages on derived actions have not been activated since they are related to derived requirements arising from BOMs information.

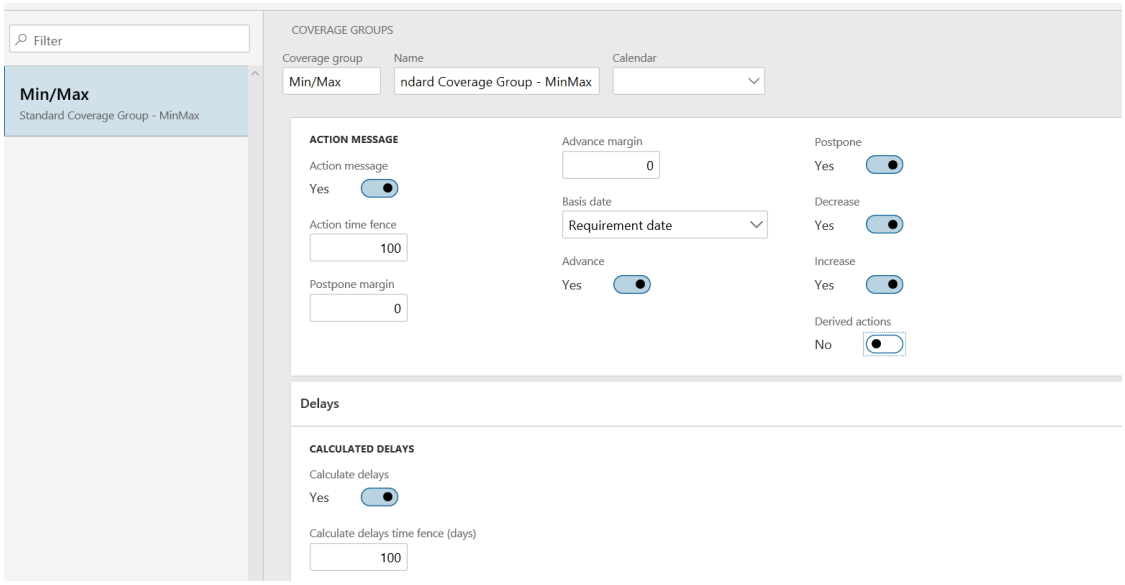


Figure 4.5 Dynamics 365: Coverage group creation, action messages and delays.

The last tab shown when creating a coverage groups refers to delays. The coverage group created for the model has been set so to take into consideration delays when computing the requirement date for a planned order.

4.3.2.1 Item Coverage

Once coverage groups have been created, in the general master planning parameters a default coverage group can be defined. By default, the system assigns this coverage group to all the released products.

However, Dynamics 365 enables users to define coverage settings at the level of:

- site or warehouse;
- item group;
- released product;
- product variants;
- any combination of these factors.

In fact, when accessing the form of a specific product, the user can either specify the coverage group either open the item coverage form and set more specific rules for coverage.

Given that the Min/Max methodology is being applied for requirement calculation, more specific settings must necessarily be defined at least to identify different values of minimum and maximum stock level for each product[5].

[5] Data on minimum and maximum quantities should be provided by the customer since the calculation derives from the application of the EOQ model (economic order quantity). Aimed at balancing the average fixed ordering cost and the average inventory holding cost, it is based on the assumption that demand occurs continuously and at a constant and known rate. Given the specific characteristic of the industry the company operates in the assumptions can be considered realistic (see example provided in chapter 2).

Just to provide an example on how the system takes into consideration specifications on stock levels, on the four released products created into the system different combinations of coverage settings have been implemented.

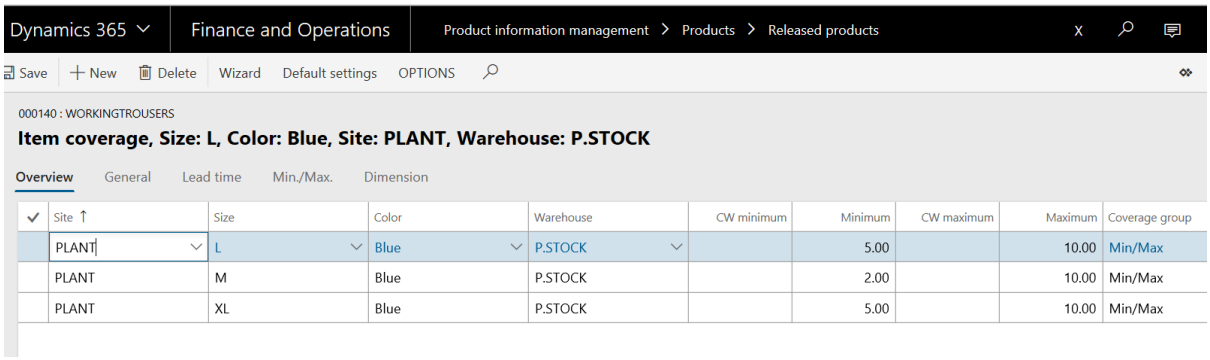


Figure 4.6 Dynamics 365: Item Coverage Settings.

4.4 THE RESULT

Planned orders, either purchase and transfer ones, are the expected outcome of the MRP system implemented for the customer.

Once master plans and coverage groups have been created and coverage settings defined for each released product, it is necessary to provide the system the required data input.

For initiating stock levels:

- purchase orders had first been created and then either confirmation either product entry was registered into system; that is, data on on-hand inventory had been recorded.
- transfer orders as well as purchase ones are supposed to be considered by master planning when computing requirement; therefore, quantities on warehouses have been initiated by exploiting this functionality as well. The inventory management module provides several ways to query on-hand inventory. More specifically, the function “on-hand list” can be called to display the on-hand inventory, which includes both physical available quantities and ordered ones.

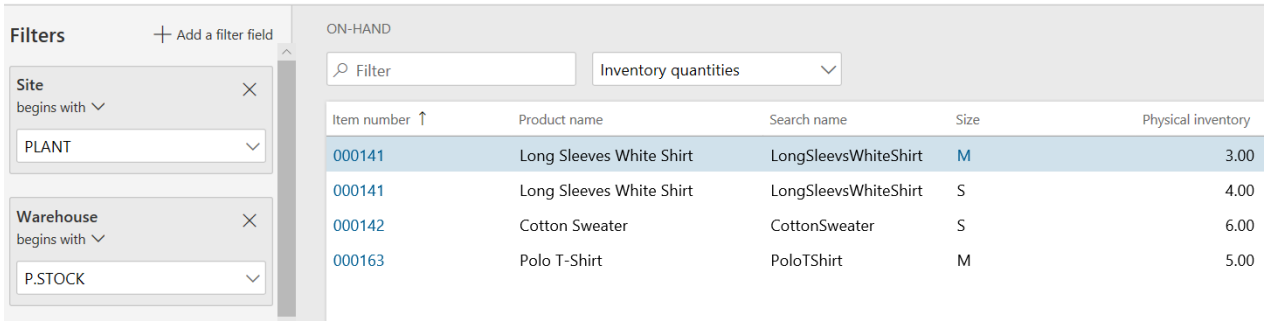


Figure 4.7 Dynamics 365: on-hand list in the stock warehouse.

In this specific case, given that the stock warehouse is being analysed, no ordered quantities are shown. In fact, as explained in paragraph 3.2.1, the stock warehouse is used to record all items that have been introduced in the production process and cannot be considered "new stock" anymore. Instead, ordered quantities are registered in the "new stock" warehouse, and therefore, filtering the on-hand list for this specific warehouse they are displayed.

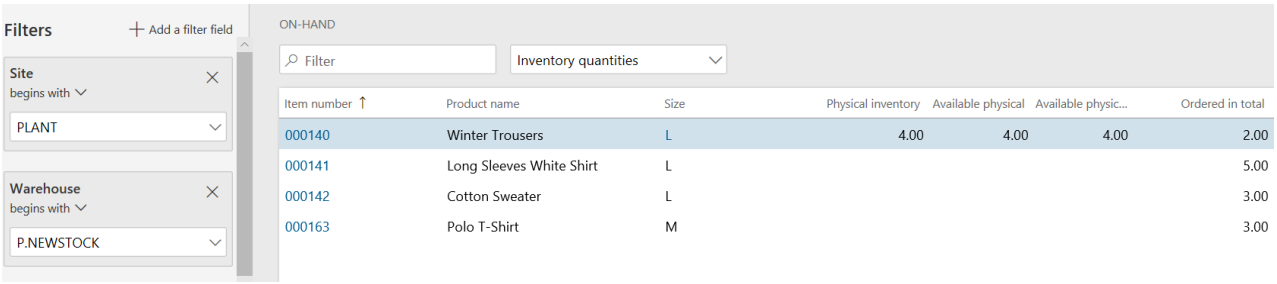


Figure 4.8 Dynamics 365: on-hand list in the new stock warehouse.

By querying the system, overall data on on-hand inventory had been extracted.

Item number	Product name	Size	Warehouse	Physical inventory	Ordered in total	Total available
000140	Winter Trousers	L	P.NEWSTOCK	4,00	2,00	6,00
000140	Winter Trousers	M	P.PRDPROC	10,00	0,00	10,00
000140	Winter Trousers	XL	P.PRDPROC	2,00	0,00	2,00
000141	Long Sleeves White Shirt	L	P.NEWSTOCK	0,00	5,00	5,00
000141	Long Sleeves White Shirt	M	P.STOCK	3,00	0,00	3,00
000141	Long Sleeves White Shirt	S	P.STOCK	4,00	0,00	4,00
000142	Cotton Sweater	L	P.NEWSTOCK	0,00	3,00	3,00
000142	Cotton Sweater	S	P.STOCK	6,00	0,00	6,00
000163	Polo T-Shirt	L	CR. - IN	6,00	0,00	6,00
000163	Polo T-Shirt	M	P.NEWSTOCK	0,00	3,00	3,00
000163	Polo T-Shirt	M	P.STOCK	5,00	0,00	5,00

Table 6 On-hand inventory.

When running master planning, the system computes requirements taking into consideration the following information:

- on-hand inventory, that is both physical and order quantity;
- the maximum stock level that has been defined while implementing coverage settings for items;
- quantity on sales orders;

The aim is to bring stock level to the maximum quantity whenever inventory goes below the safety stock level defined in the coverage settings (and all sales orders haven been covered).

Therefore

PLANNED QUANTITY = MAXIMUM QUANTIY – (ON-HAND QUANTITY – SOLD QUANTITY)[6].

Of course, as described in the previous paragraphs, master planning takes into consideration additional factors when computing requirements as:

- purchase orders delivery date and sales orders delivery date (see figure 4.1), in order to determine whether a new purchase order must be created to meet requirement;
- negative days settings, in order to determine whether late deliveries are allowed;
- potential constraints on ordered quantities, that is whether when purchasing the item there are constraints such as minimum, maximum or multiple quantities that must be met;
- purchase lead time and safety margins in order to properly compute the requirement date for planned orders.

All this information has already been inserted into the system. Therefore, before launching master planning, sales orders were created and confirmed, in order to provide the system additional data for computing requirement.

When the static plan is launched, the system displays the following planned order:

PLANNED ORDERS

Plan: STATIC

Filter

Number	Reference	Item number	Product name	Requirement quantity	Unit	Order date	Delivery date
PLO00028	Planned purchase orders	000140	Winter Trousers	10.00	pcs	2/19/2019	2/22/2019
PLO00029	Planned purchase orders	000140	Winter Trousers	8.00	pcs	2/25/2019	2/28/2019
PLO00030	Planned purchase orders	000140	Winter Trousers	10.00	pcs	2/19/2019	2/22/2019
PLO00031	Planned purchase orders	000140	Winter Trousers	10.00	pcs	2/19/2019	2/22/2019
PLO00032	Planned purchase orders	000141	Long Sleeves White Shirt	5.00	pcs	2/19/2019	3/1/2019
PLO00033	Planned purchase orders	000142	Cotton Sweater	5.00	pcs	2/19/2019	2/24/2019
PLO00034	Planned purchase orders	000142	Cotton Sweater	5.00	pcs	2/19/2019	2/24/2019
PLO00035	Planned purchase orders	000163	Polo T-Shirt	10.00	pcs	2/19/2019	2/19/2019
PLO00036	Planned purchase orders	000163	Polo T-Shirt	20.00	pcs	2/19/2019	2/19/2019

Figure 4.9 Dynamics 365: Planned Orders.

By opening the form of each order, more detailed information is shown, as for example action messages and delays.

[6] On-hand inventory is given by the sum of physical inventory and confirmed purchase orders. Sold quantity refers to sales orders that have been confirmed and have not been delivered yet.

Taking as example the item 000140, for the variant winter trousers size L colour blue, master plans creates two purchase orders, respectively PLO00028 and PLO00029.

The input data to system was:

Item Number	Size	Warehouse	Mix /Max	Physical quantity	Ordered in total	Confirmed sales
000140	L	P.NEWSTOCK	-	4	2	-
000140	L	P.STOCK	5 - 10	-	-	8

Table 7 Item 000140, size L colour Blue input data.

Both the planned purchase orders are programmed to be delivered to the STOCK warehouse. In fact, coverage settings had not been specified for the NEWSTOCK warehouse. Therefore, unless there is a negative on-hand quantity (because a sales order is confirmed on that warehouse), the system does not take any action for replenishment.

Instead, the STOCK warehouse does show a minimum and maximum level of stock that the system must meet.

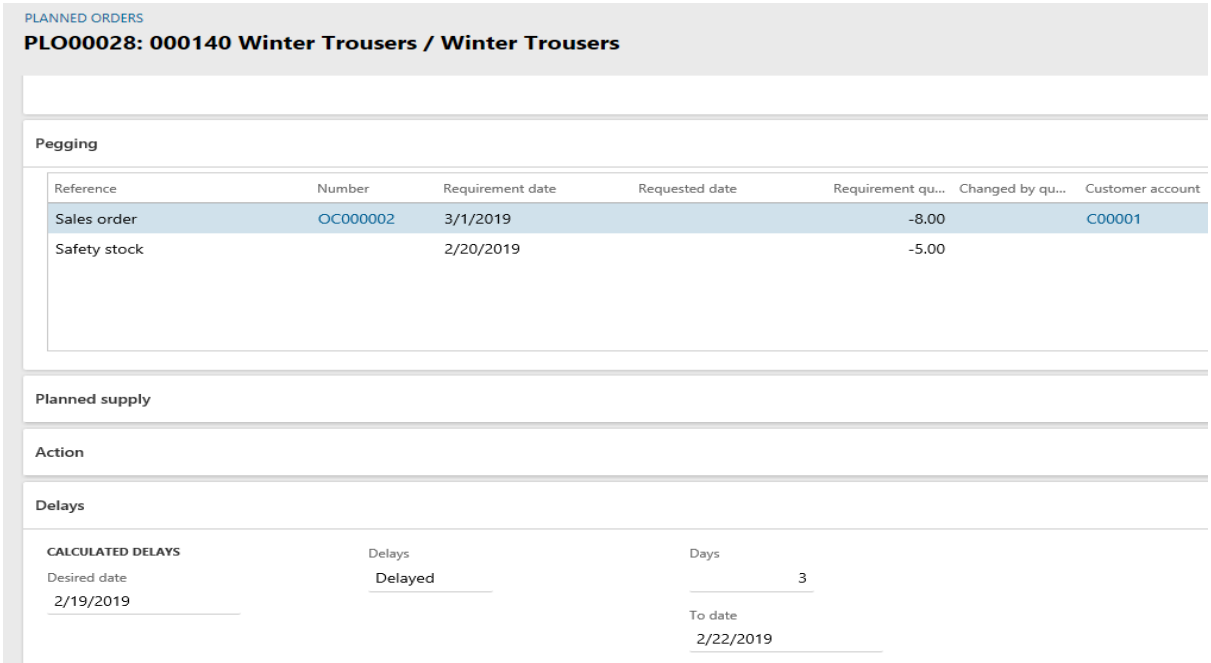


Figure 4.10 Dynamics 365: Planned purchase order PLO00028.

- The planned purchase order PLO00028 shows a purchase quantity of 10 to be ordered the current day (February the 19th). In fact, no stock

is registered into the STOCK warehouse, while instead at least 5 units are required. Being below the safety stock level, the system aims at bringing inventory to the maximum level defined, therefore 10 items should be purchased.

Moreover, in the delay tab, 3 days of delay are shown. In fact, the requirement day is as soon as possible, however 3 days of purchase lead time were defined in the item form. The data is used by master planning to compute delays with respect to requirements dates.

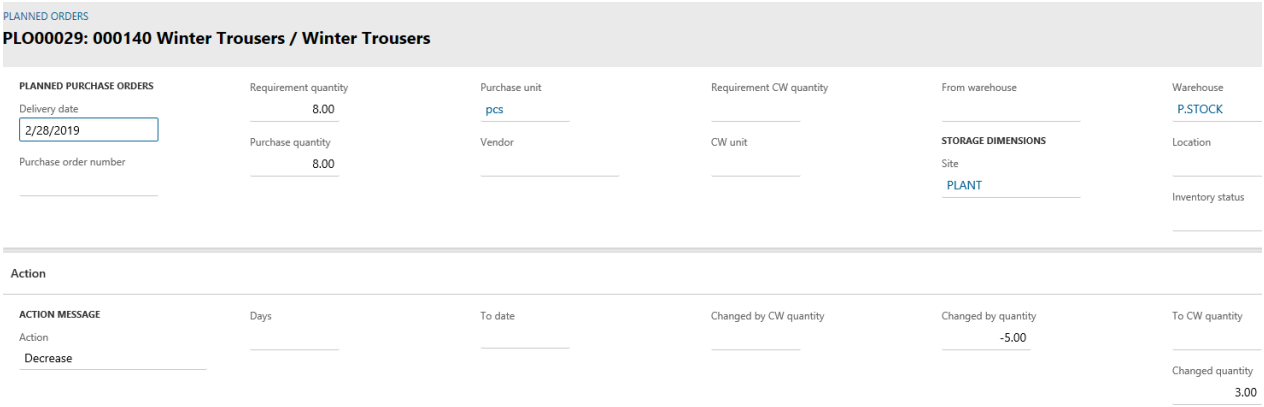


Figure 4.11 Dynamics 365: Planned purchase order PLO00029.

- The planned purchase order PLO00029 has an order date on February the 25th and it is scheduled to be delivered on February the 28th. The number of units to be ordered is 8. In fact, as it shown in table 7, a sales order was registered into the system for 8 units of the product and the delivery date was confirmed on the 29th of February. Therefore, by ordering 8 additional units the STOCK warehouse levels would be:

Figure 4.12 Dynamics 365: Stock level in the STOCK warehouse.

However, there is a decrease action message attached to the purchase order that suggest to decrease the ordered quantity by 5 units, so that just 3 units are ordered. In fact, as on the 29th of February:

Figure 4.13 Dynamics 365: Stock level in the STOCK warehouse (2).

In fact, given that inventory would not go below the safety stock level (5 units), the system planned a purchase order of 8 to keep inventory at the maximum, however, the action message suggests that if the user wishes just to meet requirement, then 3 units must be acquired. In fact, the STOCK warehouse would store 5 units and therefore be compliant with the coverage settings.

The system follows the same logic for all the released products registered into the system.

Planned orders are just suggested to the user. That is, the standard process entails that the user reviews the list generated by Dynamics AX and decide whether a specific planned order should become effective.

5 REQUIRED ACTIONS

Over the past years ICT has achieved a primary role in companies' competitive advantage. In fact, Information and Communication Technologies (ICTs) enables organizations to improve efficiency, effectiveness, reliability and performance in day-to-day operations and strategic management.

The term ICT refers to a wide range of technologies, including either hardware and software, that collect, storage, manipulate and transfer information. Each product or service by itself can be exploited to ease and perform a set of business activities. However, the greatest results are achieved whenever the computerized technologies adopted by companies are linked together, which is what nowadays an effective ICT system does. In fact, not only does integration reduce geographical distance and electronically transfer information from different locations, but it also provides updated and integrated data which could be manipulated through business intelligence (BI) applications and thus support the decision making process.

When considering the company's activities and the industry it operates in, that is the integrated laundry services industry, an effective ICT system could represent the most effective tool to deal with many of the challenges it faces in its day-to-day operations.

In fact, many are the benefits that can be achieved in supply chain management, inventory control, logistics and requirement planning by adopting and integrating today's technologies in business processes.

5.1 TECHNOLOGY INTEGRATION AND BUSINESS PROCESS REENGINEERING

From an organizational perspective, operational capability is of major importance for the company. In the specific context, business operations are made up by activities such as:

- picking up soiled garments and linen from customers' facilities;
- items processing;

- quality checks;
- products sorting and storage;
- items packaging and shipment to customers.

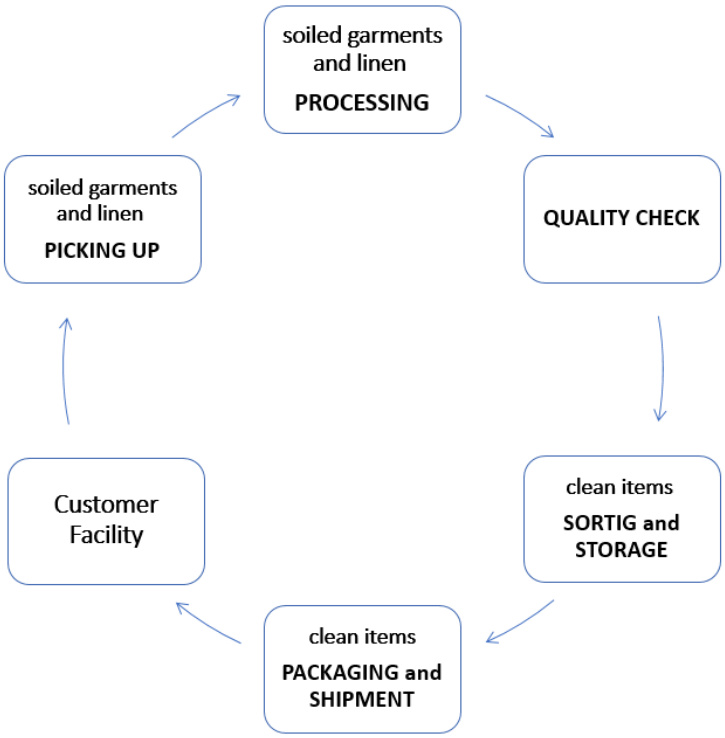


Figure 5.1 Linen and Garments supply: Sequence of Activities.

Services supplied include linen, garments, surgical and personal protective equipment renting to medium-large companies operating both in private and public sector (such as hospitals and hotels). Counting around 1200 customers and 11000 different items processed, volumes become hard to manage. Furthermore, customer demand is constant and no shortages or delays are allowed, particularly for certain categories of products (thinking of an hospital and the need of available clean linen and surgical instruments).

Thus, supply chain management turns to be as important as in manufacturing industries. In fact, not only would it provide the possibility to effectively monitor inventory levels and costs, but it would also enable the company to manage requirement planning so to always meet on time customer demand.

Two main advantages can be achieved by implementing todays technologies throughout the supply chain process:

- collecting real time business transaction data and improve visibility;
- synchronize customers and suppliers' information.

5.1.1 Real Time Data Collection

One of the main use of RFID is to track livestock movements thus enabling a tight inventory control. As introduced in chapter 2, *Radio Frequency Identification* enables contactless items identification using radio frequencies. Tags that are attached to products can store different types of information, such as colour, size, supplier, and so on, depending on the specific needs. Identification codes, such as serial numbers, enable to uniquely identify each item. Thanks to antennas, a reader is able to collect the information stored into tags and send it to a computer system (see figure 2.2).

Compared to bar code, which is probably still the most used technology for items identification[7] given the lower investment it requires, RFID allows massive and contactless items identification, which extremely reduces the time required for contacting the tag.

Volumes of items processed each day, hygienic standards that prevent to manually perform counting operations and goods handling (which have previously been described) are all activities that have led the company to get interested in the technology.

The technology integration in the organization business processes, however, requires many actions to be taken.

First of all, the RFID system design must be implemented. Many are the factors that the company must consider, and they include:

- **objects to be tagged**; tags can be attached at individual item level, package level and pallet level. The former is the most expensive and complex system to implement.

[7] Many are the challenges a company faces when deciding to integrate RFID technology in its business activities. These refer to:
- technical challenges, arising from lack of global standards for tags and the difficulty of integrating the data collected by readers with the organization computer system;
- financial challenges, in fact installation and maintenance costs would require a high investment (even though costs, especially the one of tags, have been decreasing over time);
- security and privacy issue, both from the side of competitors and final customers;

The application of RFID at individual item level is the system the company wants to implement. In fact, items trough which services are supplied also constitute part of the company assets. As explained in chapter 3.2, some of this items are worth the investment. More specifically in fact, items belonging to the garments category have an average unit cost of 20,152 € (compared to 8,067 € for linen) and therefore the company is willing to reduce the possibility of theft and losses and more tightly monitor some of its most valuable assets.

- **operating environment**; tags reading could be affected by environmental conditions as for example extreme temperature and moisture. Therefore, when designing the system, the company should carefully decide the phases of it business processes where RFID tags reading should be performed.

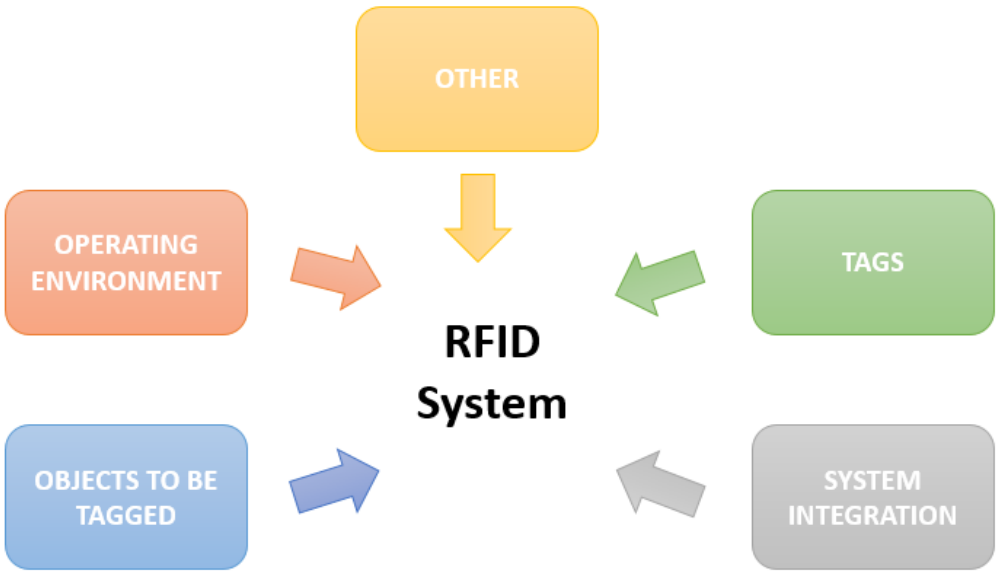


Figure 5.2 Factors to consider when building an RFID System.

- **Tags**; many types of tags exist to provides different performance in terms of data capacity, readability, volumes, etc. The type of tag the company decides to adopt affects the investment in the RFID technology;

  Given that the company wishes to apply RFID tagging at item-level, even though it is limited to certain categories of products, it should

find and accept trade-offs in order to find the suitable balance between cost and performance.

- **System integration**; since an RFID system is basically used to collect information on goods handling and inventory items, to get the most value from the technology the company must consider its integration with the other computer technologies adopted.

The latter factor is at the origin of this project. In fact, almost two years ago, the company has decided to buy and ERP solution in order to upgrade its ICT system. ERP systems provide the ability to integrate their database with data collected by other technologies. Applying the RFID technology for items traceability and then integrate the data collected with the management software would enable the company to extremely improve inventory monitoring. In fact, at present, data on product entry and exit are manually registered into the system and arises from:

- counting operations periodically performed in warehouses;
- documents attached to product delivery and receipt.

Human errors on documented quantities are likely to occur given product sizes, volumes and hygienic conditions which all together contribute to make counting operations hard to perform and time consuming if accurate data wants to be collected.

Instead, as explained in previous chapters, the integration with RFID would automate the data collection process by automatically creating lines on sales and purchase orders and inventory journals lines.

In order to get the most from the integration of RFID into its business processes, the company should first perform an accurate analysis of the process AS-IS in order to streamline activities and identify non-value added tasks. The analysis can be performed by carrying out interviews with operators and managers, mapping-out the process using a flow chart and accurately understand the meaning of each activity. Once the AS-IS process has been analysed, a phase of business process reengineering is likely to be required. In fact, by introducing RFID, the data collection phases of the process would differently be performed. Therefore:

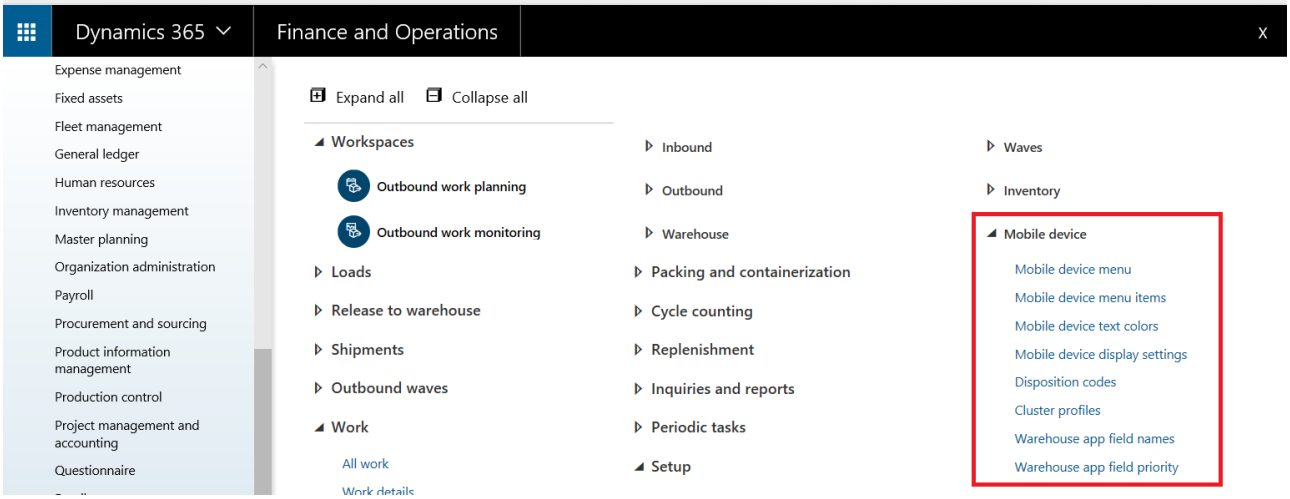
- the company must first of all determine which data are going to be collected;
- then, the company should identify the phases of the process where data collection should be performed (taking into consideration even environmental conditions that could undermine RFID tags readiness);
- finally, it would be strongly suggested to implement the new process with a view on the integration of the new technology with the ERP system adopted to manage business operations;
  Software have standard functionalities that at the occurrence can be customized to reflect specific needs; however, the more the customizations implemented, the higher the investment required and the time consultants and software engineers spend on designing and implementing the solution.
  The flow chart represented in chapter 3 (figure 3.3 – the garments supply process) is describing the TO-BE process including RFID for data collection activities. A deep analysis of the tasks making up the process was required for figuring out the Dynamics 365 functionalities and setting that would have allowed the system to replicate the whole process (see next paragraph). Thus, the subsequent step has been the implementation of the model not only for showing the achievable results in inventory monitoring, but also the possibility to activate a build the MRP system which would extremely increase the value the company could achieve from the investment already done to upgrade its ICT system.

Thus, it is clear that changes in day-to-day operations (for both employees and warehouses' operators) would be required when introducing and then integrating the RFID technology. However, the likelihood of success does not only depend on well performed BPR *(business process reengineering)* activities, but it is strongly affected by change management practices taking into consideration the social and organizational context as well (see paragraph 5.3).

5.2 ERP INTEGRATION AND EXTENDED FUNCTIONALITIES

In order to effectively implement the MRP system into the management software installed by the customer, changing in the current solution must be applied. Some of them have more deeply been analysed by the model build in chapter 3 and 4, while instead other features require more technical support and time.

For managing RFID data collection and bar code scanning, it is necessary to allow Dynamics 365 to interact with RFID readers and bar-code scanners. The latter would be easier to perform compared to the former. In fact, there are standard functionalities that enable to configure and connect mobile devices with the management software. A stand-alone component called Warehouse Mobile Devices Portal (WMDP) must be first downloaded and installed by navigating the Warehouse Management module. Then, configurations steps would allow the interaction of mobile devices with specific module of Dynamics 365 for Finance and Operations (allowing for example the registration of the receipt of items ordered via purchase orders).



Instead, there are no standard functionalities available in Dynamics 365 for integrating the RFID technology into the system. In fact, the activities to perform differ depending on factors as the RFID readers, the tag storage capacity, the information that must be collected and which modules of the management software should be involved. RF-SMART is a software for automated data collection (ADC) and it is a certified Microsoft Dynamics

solution. Therefore, for managing automated purchase/sale and transfer orders lines creation into the company ERP system, the solution should be acquired and configured to allow the RFID system to interact with the management software.

Chapter 3 and 4 have analysed all aspects related to:

- logistic structure implementation;
- items grouping and classification;
- master plans and coverage settings definition;

While there is no change that must be performed on the current solution for anything that concerns sites and warehouses structure and items definition, the master planning module has never been activated for the customer.

Therefore, the steps necessary for the activation of the module have been deeply described in chapter 4 and should be performed on the current solution in order to enable requirement planning.

However, the personalization that has been described in paragraph 2.5.2.2 for allowing the system to register the value of purchased products both as fixed assets and inventory entails that further actions must be taken with respect to the model that has been build.

In fact, as previously explained:

*(…) The personalization implemented for the customer enables to simultaneously register and account for products financial value and manage quantities. More specifically, for each warehouse that needed to be represented into the system (for clarity, lets identify them as all the warehouses whose name ends with *21D) an additional one was initialized (all the ones whose name ends with *20D). The connection between the two warehouses is the following:*

*Transactions as purchase orders which involve new products entries occur in the *20D. When the user needs to register products receipt it selects the fixed asset options and therefore it deprives the *20D warehouse of the acquired items. However, when the registration occurs the system automatically*

*generates an inventory adjustment journal that accounts for these items to be stored in the *21D. By registering the journal, the user is able to display the acquired product in the *21D warehouse. (...)*

Therefore:

- coverage settings for the *20D warehouses are going to be set to manual; that is, when running master planning, the system does not create planned orders for these warehouses. In fact, just ordered quantities are recorded into the *20Ds and thus the system would not properly account for items availability since no physical inventory is registered in there;
- coverage settings for the *21Ds are going to be defined on a Min-Max logic. However, the on-hand inventory registered in these warehouses refers just to physical available quantities since, until product entry is registered, ordered quantities are not displayed.

  Therefore, a customization must be implemented for modifying the logic trough which Dynamics 365 computes on-hand inventory in the 20Ds warehouses when running master planning. In fact, given that the system creates a planned order whenever inventory levels go below safety stock levels defined, when computing on-hand inventory it must be able to account as well for quantities ordered into the *21Ds. Otherwise, it might create planned purchase orders even when they are not required, that is if

  ON-HAND INVENTORY – SOLD QUANTITY[8] ≥ MAXIMUM LEVEL.

  For changing the logic applied by Dynamics 365, a customization is required.

[8] On-hand inventory is given by the sum of physical inventory and confirmed purchase orders. Sold quantity refers to sales orders that have been confirmed and have not been delivered yet.

5.3 THE SOCIAL AND ORGANIZATIONAL CONTEXT

Even though, over the past years, organizations have been investing in new technologies in order to build/upgrade their ICT system, many are the companies that fail to gain the business value arising from the investments.

When developing ICT projects, much emphasis is given to activities such as desirable goals identification, processes analysis, requirements and specifications definition. However, little focus is given on users' involvement with the new technology and the impact it would have in changing the company's routines. In fact, IT projects do not end as soon as the solution is delivered. Many companies today have employed IT experts in order to manage IT strategic decisions such as:

- finding the most suitable technology in line with business strategy;
- defining and accepting trade-offs among achievable results and IT spending;
- analysing and reengineering processes in order to integrate the new technologies.

However, users of the new technologies rarely are the ITs experts and this approach tends to give no focus on the social and organizational side of the project. The workforce that is going to interact with the new system must be considered in order to avoid resistance to change. In fact, when changes are imposed and employees are not involved in the design phase, they might be reluctant in learning new practices and thus little or no benefit would arise from the investment.

For increasing the value in IT investment, many actions could be undertaken:

1. once identified the operational units involved in the change, cross-functional teams could be created in order to analyse the current situation.

   That is: what is currently not working in the process? Are there any not-necessary tasks? Where is improvement required? Could the new technology make-up to the process inefficiencies?
2. the social system should be considered as well;

Is there a correct and sufficient flow of information among the units involved in the adoption of the new technology? Are roles well defined and identified? Is there any extent of flexibility between roles?

3. IT managers' role should be taken more into consideration and their responsibilities should be extended.
   Many organizations have developed a common understanding of IT managers as the ones supposed to design the new processes arising from the adoption of the new technologies. However, the role of IT managers should also be aimed at leading the behavioural change required for the organization to fully exploit the benefit arising from technology innovation. In fact, technical competences must be transferred to people involved in the change. It is an incremental process which requires individuals to learn new competences: that is, acquiring new knowledge trough experience.

It took time for the company employees to learn how to use the ERP system functionalities required to perform day-to-day operations. In fact, the average employee has few or no experience with technological tools (in the original decentralized system just few processes were managed through computerized technologies). Therefore, it has first of all been necessary to spread information on the advantages that the installation of the ERP system would have brought in the management of business processes and then training sessions were carried out to teach employees how to use the system. However, the process of communication and knowledge sharing must continue. In fact:

- the functionalities provided but the current solution are not fully exploited yet;
- if RFID and master planning are integrated in the company IT system, new competences must be developed, otherwise the company will not be able to gain the benefit of the investment.

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