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WHITEPAPER
#003

ROI on footprint and warehouse design for inventory optimization along the Supply Chain

Inventory management is the system of keeping tabs on the goods available and sold, so that one is never out of materials required. Inventory management is a complex and time consuming process and the attention paid to it varies among industries, it is usually the top priority for retail decision makers, and it translates into the service commitment of any company. Unless one has a very specific and slim product mix, there is a high chance that one might end up spending a lot of time simply tracking inventory. This is of course a very important process and once finished, it can become the strength of a business.

If one takes a closer look, for example, at the automotive industry, it can be seen that inventory management has become very challenging task nowadays. Car manufacturers are now forced to offer a large range of vehicle models and options. This increase in product portfolio was driven by globalization and increasing customer requirements. From “one model fits all” (“You can have any color as long as it’s black”, Henry Ford), to the current days where a single model series of a premium German automobile brand can now reach up to 1,017 possible automobile variations!

The enormous product variety-induced complexity makes it more challenging to ensure efficient logistics. It is not only the production facilities that should be properly supplied with pieces but other parts of the business as well. The prompt supply of spare parts is very important for an efficient after-sales service; this is an essential aspect of customer satisfaction. For example, in the aftersales service in the automotive industry, the variety of parts and components to be kept in stock is extremely large, not only because of the vast range of car models and individual configuration options but also given the model variations along the years. Replacement parts must be available for car owners for a long time – some German car companies can actually supply original spare parts for historic cars that are well over 30 years old. The variety of parts puts immense pressure on replenishment policies around the supply chain.

As e-commerce increases its penetration into the market, it is very important for a retailer not to delay the product availability. If a customer does not find what he needs, he will simply move to another retailer. Inventory helps manage delivery time by always having a stock of products ready.

The buying trends may vary throughout the year. Festivals and holidays will see a boom in purchases; whereas; at the end of a financial year will show lower sale volumes. Retailers may want to hold back goods during a price or stock revision to increase demand or offer discounts. Those consumer patterns have to be fulfilled whereas the production rate might be a different one and the inventory will be used as a buffer for this mismatch.
If a more general view is taken across all industries, most probably some inventory is kept along the supply chain. Sometimes, those supply chains can be very complex. Therefore, it is not uncommon to see globalized companies holding inventory in multi echelons along the supply chain. After executing various projects in the last years, we suggested that there are 4 key levers while addressing the management of supply chain:

Supply Chain Segmentation & Strategy

- Customer identification & supply chain segmentation.
- Stock strategy by segment.
- Collaboration schemes with customers (when possible).
- Collaboration schemes with suppliers (when valuable).

Warehouse organization and Intelligence in Stock Policies Definition

- Product segmentation & criticality matrix.
- Footprint design and multi-echelon stock optimization.
- Defining the adequate layout, storage methods and MHE.
- Pick and order preparation layout, resources and procedures.
- Stock audit and obsolescence management.

Integrated Supply Chain Planning Model

- Stock-related processes integrated in Supply Chain Planning model at all levels:
    - Strategic
    - Tactical
    - Operational
- Data management and systematically update.

Demand Planning & Forecasting

- Demand planning and supply chain planning (including stock management) objectives aligned at all levels.

Warehousing is where the action takes place. It is where all the product fulfillment strategy will happen. The company's strategy and planning model will be transformed into action to deliver up to customer expectation (the moment of truth for the company's strategy). As the warehouse grows together with the company, it is important to keep verifying that it has evolved along with its products and products strategy. Therefore the company has to know what it owns and why it owns such an SKU. The company has to keep a lively and updated product segmentation & criticality matrix for the current portfolio that is in line with current sales levels and customer expectation. It is also significant, especially as the company grows how complex the multi- echelon layers of the company's supply chain becomes, and that the replenishment criteria along them remains consistent.

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Five real cases

ALG has been supporting clients in conciliating the ever growing pressure for product customization with the necessity to keep the number of SKU as low as possible along the supply chain. We believe the best way to explain how this can be achieved is through real examples where results were achieved.

Five real cases are presented that analyzes the issues in different industries from different angles. The aim is to provide an overview of the many opportunities for cost improvement and better services that lie behind a warehouse door.

Case 1: Improvements in the open yard warehousing of a steel manufacturing plant

The client requested ALG to revisit and analyze the warehousing of two Rolling Mills, a part of its cost improvement efforts along the supply chain. The project had to address the warehousing processes, picking, MHE and truck flows on the yard.

Rod and Bar Mill

The management of the Rod and Bar Mill were looking into a broad warehousing and dispatch operations improvement and the project had to achieve an enhanced service level to client, reduce the order preparation and pick up time, enhance order completion and reduce truck residence time on the yard.

Areas that had to be covered:

- Organization
- Capacity and storage efficiency
- Stock management processes and policies
- Dispatching capacity
- Internal truck flow management and control
- Safety and environmental compliance

Section Mill

This part of the project focused on a strong set of objectives, these are as follows:

- Double the dispatch capacity of finished goods trucks entering the yard and simultaneously the long waiting time duration for loading had to be improved from initial conditions.
- Increase storage capacity at the same yard and comply with the requirements of the production line evacuation.
- The layout had to work efficiently in a normal set up of production, and order preparation and comply with safety and environmental requirements.

The complete layout of rod and bar mill warehouse was reviewed; product mix, product location and location type were studied.

Once the entire logistics area was reviewed, the main improvement areas that were in need for investments were listed:

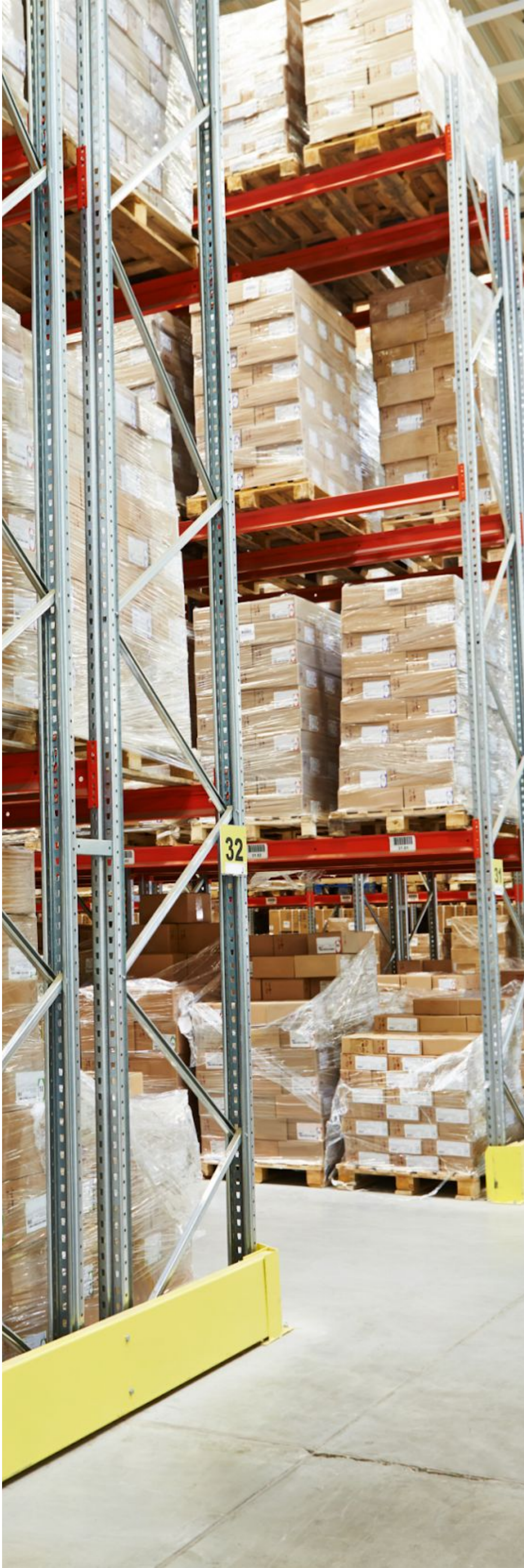
- Extension of **pen posts**:
  - New locations in the bar warehouse.
  - External protection fence for the *New Extension*.
  - Bar locations at the North of the exterior warehouse.
- Paving/concreting of the **South Yard** and of the **railway crossings.**
- **Signage** of locations (painting on in-plant floors and walls).

- Horizontal and vertical signage of truck itineraries and loading points (traffic signs, boards and painted signage).

The savings were identified and quantified per year. The company was focused in OPEX reduction in a yearly basis.

A new layout of the section mill was developed, and new stock-keeping locations were designed to maximize capacity and tracking possibilities.

- Part of the truck routes and railway tracks were eliminated to free up space.
- **Efficient use of the cranes' dead areas** by using pen posts.
- **Pen posts** on the sides of the plants and rectangular and square stacks at the center.
- Introduction of new **location criteria** based on product **turnover** (high, medium or low).
- The internal logistics for order pick-up was optimized, new flows were designed and a new signage was developed.
  - **Circular flow**: 3 entries and one exit way. Direct access to the gate where it will be loaded.
  - **Loading points**: two loading points were defined for each plant (total of 6).
  - Capacity for more than **30 trucks** on standby or loading.
  - Ongoing load capacity for more than 4 trucks/hour and up **6 trucks/hour** during peak time.
  - **Control** over the truck flow depending on their picking list.



- ○ The figure of the **Traffic Controller** was introduced.

The main investments went to pen posts and the refurbishment of plants A, B and C.

- **Adaptation of the new truck route**:
    - ○ Opening of a cross corridor between plants A, B and C.
    - ○ Widening of the access road to 3 lanes.
    - ○ Horizontal and vertical signage of the routes and loading points.
- Installation of **a booth** for the **Traffic Controller.**
- **Signage** of in-plant locations according to the new layout.
- **Refurbishing of the warehouse area** inside plants:
    - ○ Sheltering of railway tracks in 3 points: in plant B before and after the transfer table and in plant A.
    - ○ Surface levelling at the sides of three specific loading areas.
- Installation of **pen posts** at the sides of plants A, B and C, according to the layout.

Those investments allowed to double the dispatch capacity and enabled an extra 20% storage capacity in the yard:

1. **Increase in the loading capacity of trucks:** From 3trucks/h to 5-6 trucks/h.
2. **Increase in warehousing capacity:** 20% increase (due to a more efficient use of the area and increased area allocated to storage and the best use of them).

The fact that both projects were developed at the same time allowed that both mill’s storage facilities benefited from each other and the improvements and knowledge generated were shared among them.

Case 2: Definition of alternative warehouse designs for a leading retailing company

In order to evaluate the options for each of the two warehouses under the study the following methodology was used:

Alternative warehouse scenarios

In comparison to the existing layout, the proposed scenario provides a number of improvements:

Current layout:

Storage

- Single deep racking system with same SKU in multiple locations.
- Storage of furniture in mezzanine and on the floor.

Operations

- Location system in place based on experience.
- No dedicated area for management of returned items.

Proposed layout:

Space efficiency

- 45% increase in floor space utilization for using a VNA racking system.
- 30% increase in floor space utilization for using a double deep racking system.
- 35% reduction in space requirement when using cantilever racking over mezzanine.
- No more floor stacking for large items when using cantilever racking.

Operational efficiency

- Improved pallet picking operation through the implementation of a location system (ABC location system).
- Elimination of double handling when it comes to binning and picking of furniture.

    - 50% reduction in manpower requirements when using cantilever racking (only require one forklift operator).
    - 50% faster operation for binning and picking of furniture.
- Dedicated workstation for management of returned items.

For the second warehouse, the following options were evaluated:

Current layout:

- Majority of warehouse space occupied by racking systems.
- Buffer stock stored in locations far away from picking locations.
- Location system in place based on experience.
- No dedicated area for management of return items.
- No fixed schedules.

Proposed layout:

Space efficiency

- Increased floor space available for fashion products.
- 400% increase in floor space as mezzanines used across the entire warehouse for storage of products.
- Buffer stock is stored in the same area as picking locations leading to drastically reduced replenishment times (no need for forklifts).

Operational efficiency

- Improved picking operation for all brands by implementing a location system based on ABC analysis.
- Dedicated work station for management of returned items, so there is no need to interfere with operations within the reception/expedition area.

- Fixed schedules can ensure higher operational efficiencies.

Due to the proposed new layout and operations of the warehouses, great storage and operational efficiencies were achieved:

- Implementation of optimal storage methods for the different product types.
- Improvements in floor space utilization:
    - 45% increase in utilization due to VNA.
    - 30% increase in utilization due to double deep racking.
    - 35% reduction in space requirements due to cantilever.
- All storage in Warehouse 2 on mezzanines.
- Optimization of space utilization by best locating the products in the most adequate warehouse.
- Location system based on ABC analysis of all brands – WMS included in the investment.
- Operational improvements:
    - No cross-docking items remaining in expedition area for over 2 days.
    - Expedition area only to be used for same day deliveries.

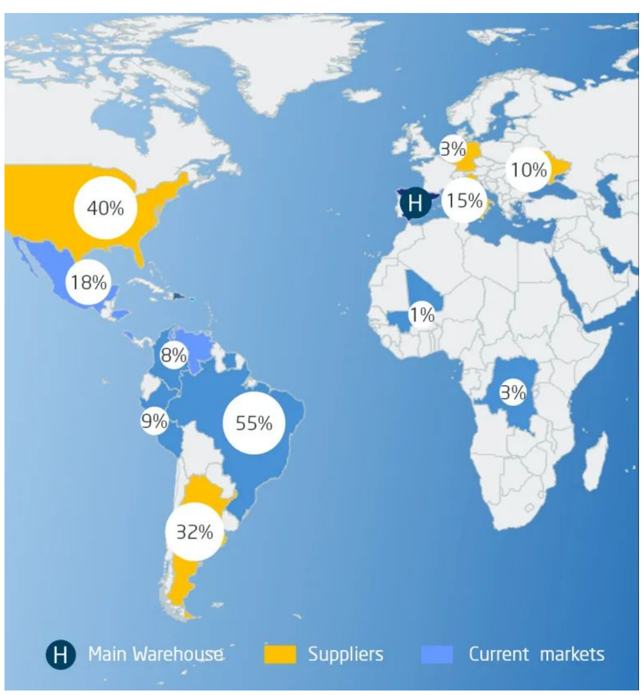
The results were:

- Increase of both warehouses' areas – approx. 8,000 sqm.
- Reduction of construction investments required by 50% – approx. 40 Mio AED.
- Reduction of manpower requirements by 15% due to operational improvements.
- Reduction of equipment requirements – approx. 20% of reduction.
- Optimization of picking operations for all brands – less movements due to ABC layout.

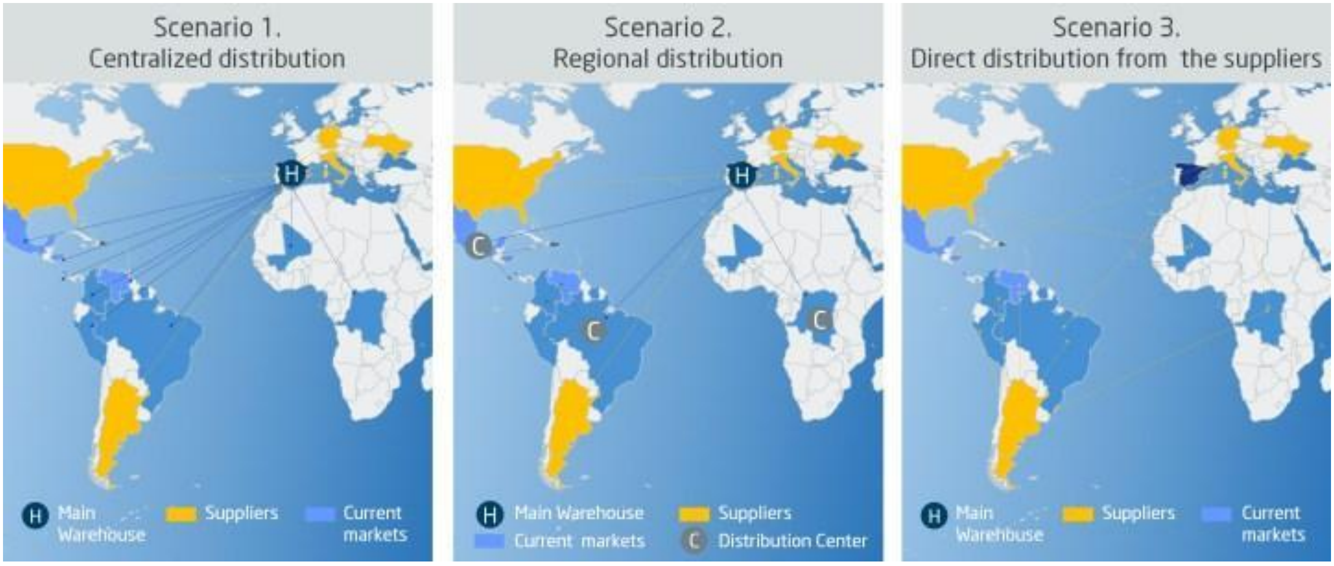
Case 3: Footprint definition and multi echelon replenishment polices for global supplier of equipment for windmill power plant

The first step to define a new logistic footprint is the analysis of the current situation of material sourcing/production and sales distribution. In order to understand the current flow the following data was analyzed:

- Analysis **of the current suppliers'** situation:
  - Suppliers location
  - Suppliers flow analysis
  - Volume of material shipped
- **O/D spare part matrix** definition:
  - Flows
  - Volume sent
  - Transportation mode
  - Average value per shipping
- **Current costs estimation:**
  - Transportation costs
  - Customs costs
  - Working capital costs
  - Person and infrastructure costs
- **Lead times** analysis per O/D and mode of transport.
- Not considering **Exceptional situations** that can lead unreliable results:
  - Stocks breaking
  - Urgencies



Once the current situation has been outlined, the different scenarios were defined in order to enable the evaluation of each of them.



Definition of scenarios for benchmarking.

Once all scenarios were studied the following results were achieved upon selecting the best option.

Initiatives	OPEX (per year)	CAPEX	Lead time reduction	Working capital reduction
Logistics footprint methodology				
LatAm logistics footprint	70			400
Logistics and Repair alignment		60	2 months	5.100
Preventive maintenance		500*		
Suppliers material requirements plan	120	500*	1 month	
Stock balance		500*		6.200
Recommended spare parts list for wind farms				2.700
Stock accuracy and shipping tracking		10		
Spare parts master data	15	20	5 days	
Registrations/withdrawals and duplicities		20		400
Agile replenishment process			3 days	
Logistics planning department	-105			
Sizing for Logistics	75	30		
KPI dashboard				
Targets				1.200
TOTAL	**175**	**620**		**16.000***

Impact estimation of identified initiatives (k€)

Some initiatives have an impact in reducing the Working Capital, those initiatives will need some time to produce the expected effect as excess inventory will be reduced in the mid-range run, and the first noticeable impact is a decrease of purchasing needs.

The overstock will be reduced in the mid to long term, hopefully by the consumption of the part over the following months. In some cases a long time has to pass until overstock components will finally get broken, obsolete, and eventually written off. One should always keep in mind the obsolescence risk while defining/reviewing stocking policies; it is much more real that many people think it is.

It was considered 500 k€ to be invested in a SPP planning software to enable initiatives 4, 5, 6, 10, 14 to take place. This would be a long run increase in efficiency that will be a byproduct of this effort. Normally lean supply chain must be powered by the right systems and information that will strengthen the competitive position of the company undertaking such effort. In many situations inventory is replaced by information and flexible systems to produce/source more efficiently which pieces are exactly required instead of keeping large inventory and running the risk of obsolescence.

The definition of a new stock policy to reduce inventory and improve service to clients was built around the following steps:

1. CRO functionality modification: CROs are no longer regulator warehouses, are just warehouses that provide support for urgencies and ease distribution operations (X-dock).

2. Large Components: stock depending on agreements with the customer.

3. Critical spare parts stock:

- Wind farms: apply correctly recommended spare parts list supplied from PMP
- CRO: only stock to supply in case of emergency.
- Transform some CROs into wind farm warehouses with centralized stock for some wind farms (*i.e.* Ixtepec México), with high value and low use frequency in order to reduce storage units.
- PMP: apply recommended spare parts list.

4. Non critical spare parts stock (the unavailability of these components do NOT cause machine stopping):

- High-value and low-frequency products will be stored in Spain.
- High-value and high-frequency products stored in Spain depending on its consuming prediction, when it is sent, will it be sent to a wind farm and to CRO, from the CRO is it sent to the wind farms, and once it has been used is it sent again to wind farms and CRO.

- Low-cost and high-frequency products will be stored in wind farms based on consumption predictions, when the inventory is exhausted, it is requested to suppliers in Spain and sent again to the wind farms.
- Low-cost and low-frequency products will only be stored in Spain based on the set recommended spare parts list.

5. In case of abundance stock, the critical references will be stored in the CROs, based on the consumption frequency.

6. In case of lack of stock (Critical pieces), distribute available stock to CROs based on frequency and use.

As it was previously mentioned it was necessary to implement a tool for the inventory management and replenishment management and for the calculations of consumption forecasts.

Those polices delivered an extra reduction according to the following points:

- 20% reduction of the selected Non critical stock (ALG experience) representing a decreasing of 5 M€ in working capital.
- 15% reduction of the selected Critical stock (assuming less risk than in the non-critical stock) resulting in 1,2 M€ in working capital.

Case 4: Global inventory optimization after a major acquisition in the Oil Sector

A major European Oil company acquired an important Oil Company operating in the Americas. Following a merger, there was a necessity to harmonize the materials along the supply chain to create a new global chain for the new company. Most of the cost synergy and reasoning of this acquisition was powered by the expected improvement in scale. The new and more efficient supply chain had to play a key role in materializing the expected savings. This was a massive project that involved the optimization and harmonization of the stock polices and materials across the globe. This project was undertaken by the consultants and the internal team of 24 Supply Chain Managers from 24 counties in a 12-week effort.

The objectives of this massive optimization were:

1. Cash recovery, applied to most of the countries.
2. Sharing project surplus material, where it were not restricted by BU depending on contract agreements (JoAs) and local governments.
3. Production inventory optimization applied when there are operated wells and JoA.

From the total of 24 countries in the study there were some with special considerations:

- **Countries with restrictions.** Not included in the business case

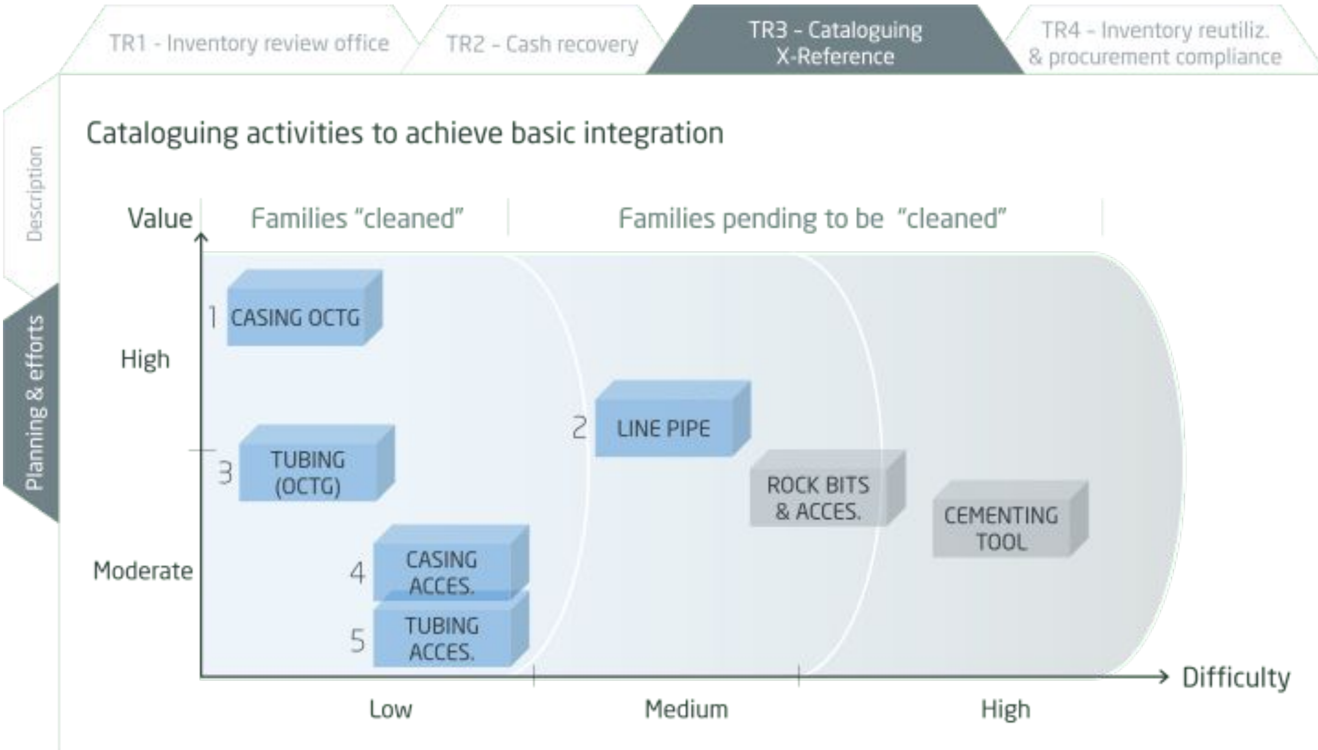
1) & 2) Cash recovery & Project inventory reutilization: countries with legal / JoA restrictions.

3) Production inventory optimization: we have not been able to quantify target inventory for the American Company countries without movement data to calculate coverages.

- **Countries with some risk to materialize business case.** Included in total business case but marked as "Risk Countries":

1) & 2) cash recovery & projects: countries with JoA Partner with some challenges to manage.

The joint company recognizes that stock management has to reach a new optimal level of inventory and therefore the first massive effort was harmonization of all SKU across the two companies. This exercise was developed in waves as shown in the following figure:

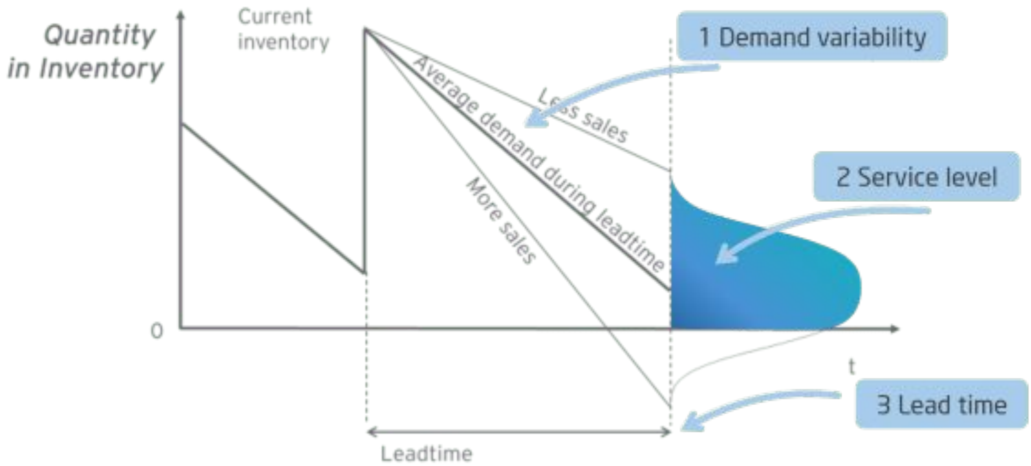


Understanding a properly classifying the SKU.

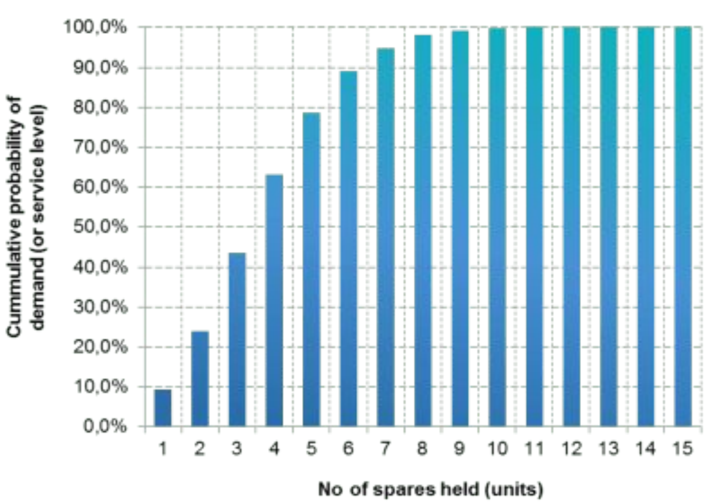
Once the SKUs were homogenized, it was possible to merge the inventories and optimal level of inventory had to be calculated. In the oil and gas industry, there are two major reasons to carry inventory:

- The maintenance of current infrastructure: This in turn have two components:
  - Preventive maintenance.
  - Corrective maintenance.
- To build new installations (projects): Those materials come from the BOM of a specific project that will be undertaken. It has to comply with the overall SKU denomination to avoid creating a new SKU, enabling the usage of leftovers in the post construction phase. It keeps the purchase complexity lower and increase the overall buying per SKU.

For **preventive maintenance** parts calculation of Safety Stocks is based on Service Level, Demand and Lead Time variability using **Normal distribution**



For **corrective maintenance** parts calculation of Safety Stocks is based on Service Level, Demand and Lead Time using **Poisson distribution**

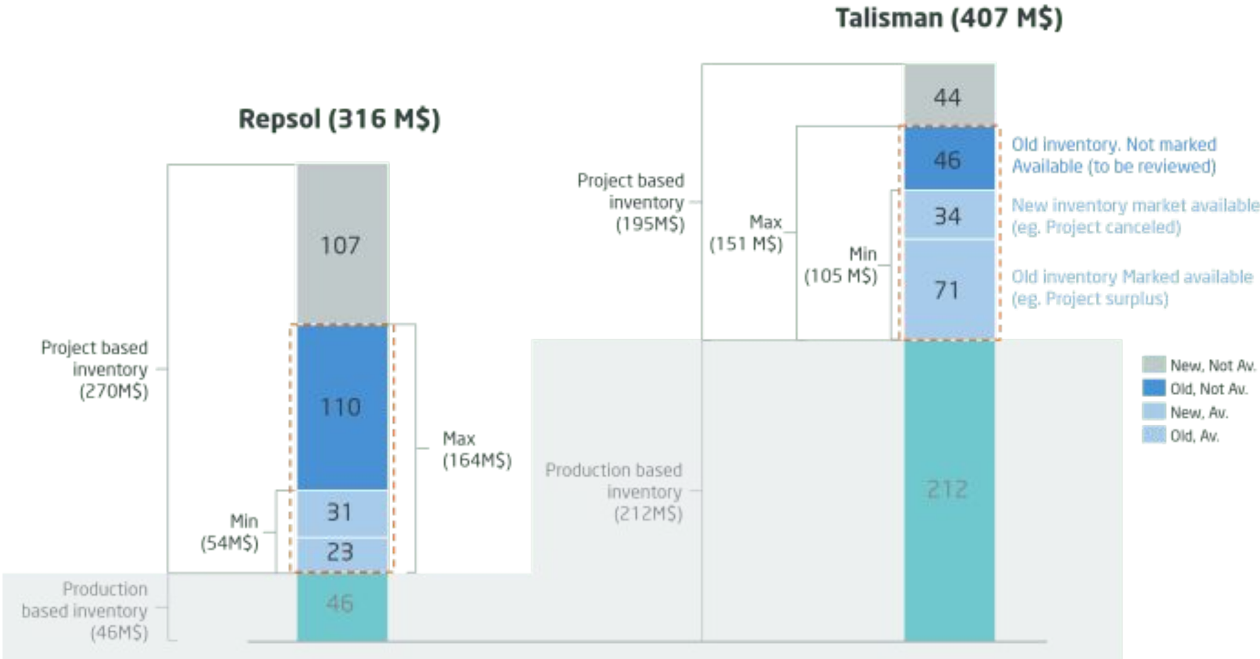


Example:

- Electric motor, Supply lead time 30 days.
- Expected demand over the supply lead time 4 units
- 99,9% service level is achieved by holding 11 items.
- Holding more than 14 does not reduce risk: it only increases costs.

Understanding a properly classifying the SKU.

The optimal level of inventory was calculated for each SKU. Then a complete audit of existing inventory was done, also per SKU, and identified as “addressable inventory” for reutilization or cash recovery. The inventory was classified by age: old inventory (+ 2 years) and new (< 2 years) and by availability according to BU declarations (Available to be sold or reused, and Not available assigned to project or production MRO). The following figure shows the results:



Post-merger inventory audit by purpose.

The final result of this effort was that the total inventory may be reduced by more than 50% by three main levers to materialize inventory benefits as represented by the following figure:

Total stock	Potential inventory obsoletes	Project inventory surplus	Production inventory excess
723 M$	249 - 410 M$	22- 36 M$	36- 37 M$
Three main levers for inventory benefits	**1. Cash Recovery:** Savings cash recovered selling obsoletes (savings estimation according to a real previous examples of recovery rates)	**2. Reusing project inventory surplus:** Savings avoiding to buy (estimation according to ex-post simulation 4 yrs. history, driller estimations and real transfers)	**3. Optimizing production inventory:** Savings avoiding to buy (target according to advance inventory statistics techniques applies to Ecuador sample data)

One off savings	**1. Cash recovery 2. Reuse inventory 3. Optimize production**	62 - 98 M$
Recurrent yearly savings	**4. Inventory carrying cost**	18 - 42 M$

The Return on an Inventory optimization after a major acquisition in Oil and Gas.

Case 5: Data analytics to improve warehousing performance in a vehicle storage facility for a leading European car manufacturer

Our client was the importer of vehicles to the Iberian Peninsula market. It wanted to better manage the time once the car arrives in the country until it is delivered to the dealership. The objective of this project was the creation of a forecast model to identify early problems in the warehousing performance and to establish a course of action to resolve them as early as possible. Such a model had to be embedded into a management tool that would monitor the dates in which the cars are moved along the car silo. The tool should inform more precise dates for the processes of customization and when each vehicle would be ready for delivery to the dealership. It should send alerts in case any of the various processes was not handled within the expected timeframe. Moreover it should support the identification of the main root cause leading to the observed delay or problem.

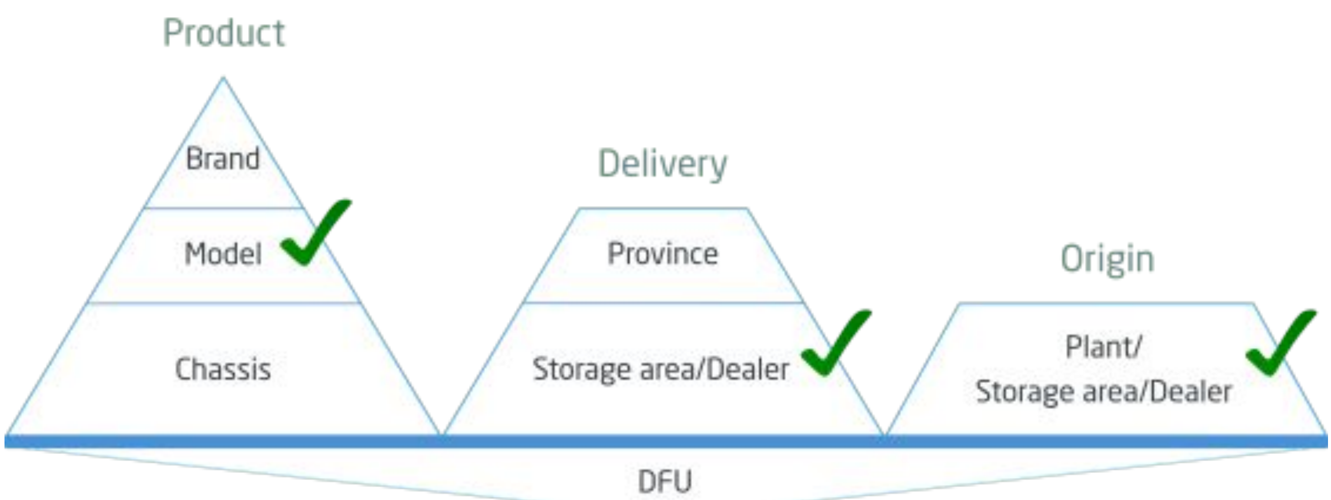
The final forecast algorithm identifies potential problems, enables action taking and calculates the timing for each of the processes that a vehicle (chassis) passes through the logistics chain. This allows:

- Greater control over the location of a vehicle at national and planning by the dealer.
- Reduction of errors through greater control of transport and management of stock in transit.
- Reliable delivery forecast, contributing to the improvement of customer satisfaction.
- Reduction of delivery times to the customer.
- Cost reduction through the earlier sharing of information, allowing carriers to better plan the location of their fleets.
- Improved cash flow, through the reduction in delivery and collection times.

In order to understand all the processes that occur with each vehicles the entire logistics chain starting on the production facility going all the way to the delivery on the dealership was defined. The following lead times per each process phase was defined.

Demand Forecasting Unit (DFU).

The following characteristics have to be built into the model while defining the forecasting model.



The model was constructed with capabilities for early identification of future problems and enabling action taking in order to reduce lead time and improve fulfillment rates.

During the pilot implementation of the model, a substantial reduction in the delivery times was obtained and on top of that, the variance in the total lead time was reduced leading to a lower mode value on the overall delivery time. The before and after results were as follows:

- Initial delivery times: 77 – 103 days.
- During the pilot ran the new delivery time: 70 – 90 (74 days mode).

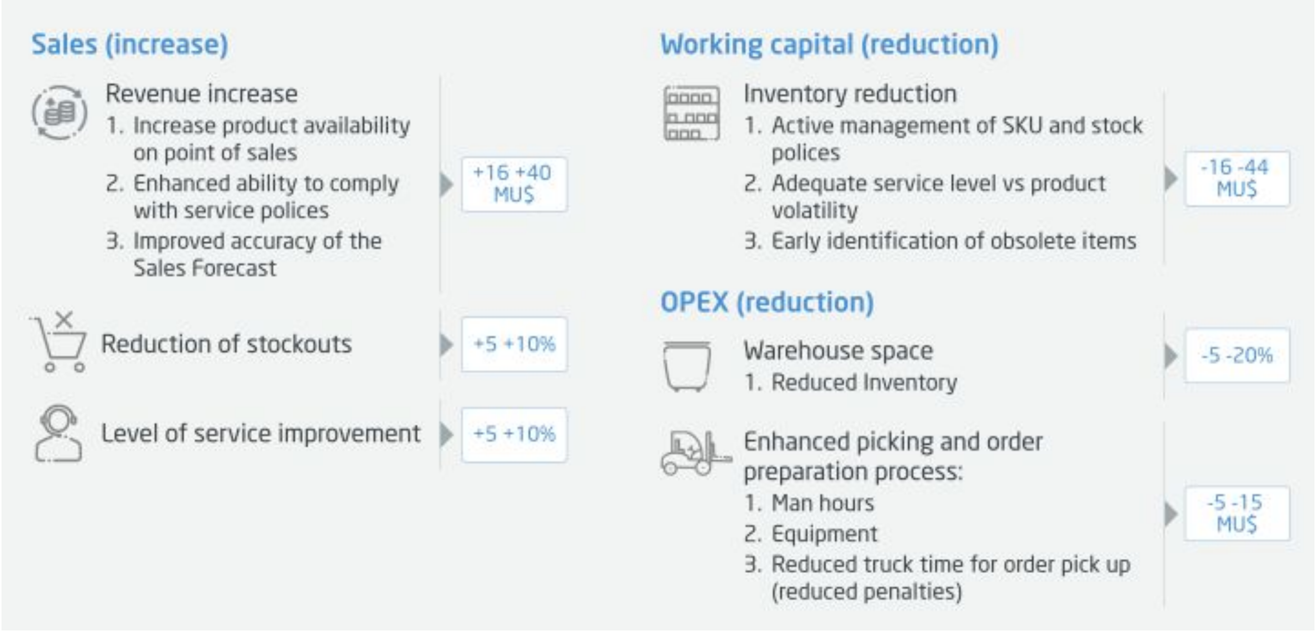
As a cascade effect in the supply chain, the following benefits were observed after the reduction in the LT spread:

- Increase in occupancy levels (increase 15%) of transportation resources, reduced fleet requirements.
- Increased customer satisfaction and meeting customer promises.
- Reduced bullwhip effect.

Closing words: The ROI on a typical project

After applying the suggested framework towards various projects aimed at improving the warehousing and inventory optimization across various industries, we are convinced that there are numerous opportunities for a strong return in such projects.

The following figure provides an overall view of the financial improvements and some qualitative aspects that a project aimed at optimizing the warehousing and streamlining the replenishment polices can delivers to a company.



Potential savings based on the financial results – Annualized.

In order to enable a quick estimation of the benefits that a company can expect from undertaking such optimization, the following example is presented.

Considering the following company metrics:
Yearly sales volume: 2.100 AED Mio
Gross Margin: 32.1%
Net income: 262.3 AED Mio
Inventories: 1.150 AED Mio

According to our framework for such company, the expected ROI on warehousing and stock optimization project could lead up to 260bps increase in gross margin and lead up to 6.9% increase in sales.

We believe that many companies neglect this opportunity when considering how to improve financial performance. ALG can run a warehouse and inventory audit that can quantify and qualify this opportunity upfront pinpointing the areas to be addressed attending to the specifics of a given company.

Supply chain in today's globalized world comprises of a long chain with inventory moving through multiple levels until it reaches the final consumption point. The following factors have to be considered while designing the chain:

- Multi-sourcing network
- Total lead times between locations (*)
- Lead time variability and schedules compliance
- Forecast and forecast accuracy
- Holding costs
- Production and distribution lot sizes
- Target service levels

Once all of these factors have been considered, the reorder point in each location and the safety stock in each location have to be calculated.

Upfront, it seems very complex; therefore, as it was mentioned earlier companies forego this opportunity. But, if one company decides to undertake such endeavor it will lead to companies fully recognizing the relevance of each of them and transform them into a competitive advantage.

In our view, the following key points are the most neglected ones while designing warehousing and replenishment policies:

- Properly differentiate customer segments and accordingly define adapted stock strategies for each segment, this will lead, normally to get heavy stock levels reduction.
- Segment products and assigning different target service levels to focus on more profitable and less volatile products. Properly address the proliferation of SKU number (optimize packaging options) to reduce complexity. Define the best postponement strategy.
- Define multi-echelon stock policies to reach service levels and optimize cost by considering all the interactions in the network.
- Integrate stock policies in supply chain planning model to standardize processes, review stock policies systematically and update data.
- Take care of forecast quality to update safety stocks and stock levels properly. Update data involved in stock policies calculation to maintain accurate stock policies and levels.
- Warehouse layout, review stock location strategy, yard storage vs covered areas, palletizing methods and materials, storage solutions and rack systems, pick and order processing to align with stock management polices.

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ROI on footprint and warehouse design for inventory optimization along the Supply Chain

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