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Operational and strategic supply model redesign for an optical chain company using digital simulation

Roman Buil¹, Miquel Angel Piera¹ and Toni Laserna²

Abstract
Decision making inside a company is usually performed by means of decision support tools at three different levels (strategic, tactical and operational) according to the working horizon. Unfortunately, the consequences of any decision at the strategic level are propagated to the tactical and even the operational levels. In order to support highly efficient flexibility while avoiding infrastructure over-sizing, resource saturation and poor coordination of activities and resources, it is important to consider the cause–effect interaction of strategic decisions with operational ones. In this paper, a discrete-event system simulation approach to evaluate the influence of the internal interactions among material, people, information and financial resources on the success of a Spanish optician supply chain is introduced. The emergent dynamics are analyzed and a redesign of the business and distribution network is proposed to foster synergy among supply chain actors.

Keywords
discrete event simulation, logistics, business model

1. Introduction
The customer products field is characterized by constant changes and new developments, innovative products with their related services expansion and improvements, new market scopes, higher points of sale coverage, new logistics infrastructure and others, to satisfy customer demands. These changes imply that decisions must be made at all levels (strategic, tactical and operational) to maintain competitiveness.

From the logistical point of view, manufacturers attempt to devise a goods creation and distribution system that creates greater value than its costs. Improvements in the efficiency of the global supply chain are essential for an increase of the overall levels of demand for just-in-time (JIT) logistics services. Although logistics costs today still make up around 10% of the total price of goods delivered to the consumer, ongoing progress in reducing cycle times is removing more costs and enabling more price competition by retailers. So logistics efficiency gains, openly shared between business partners, drive new consumer demand by shrinking the transportation costs element and by enabling more rapid re-supply and delivery fulfillment.

The influence of globalization on established companies forces them to find new and innovative business models in order for them to be smarter in their decisions than the growing competition. Business models usually define the business logic of a company at the strategic level; however, strategic decisions usually lead to high inefficiencies when operational aspects have not been properly considered. In contrast, when a new supply chain operational model is designed without considering strategic changes, inactivity, due to

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infrastructure over-sizing or unacceptable delivery delays due to resource saturation, appear quite often.\textsuperscript{1-3}

When addressing the transport problem in isolation from production, the object is to obtain the lowest total costs of transportation. Thinking of production and distribution as a linked system, the optimization goal should be a balance between production and transport costs, considering the minimization of the total distribution costs (TDC) instead of considering only the minimization of the transport costs. Thus, costs related to inventory (i.e. depreciation, spoilage, obsolescence, goods insurance, bay hiring costs, etc.) play an important role when designing the supply chain architecture.

There is a need to integrate the business specification with operational models to create an optimal coordination of transport, production, material, people, information and financial resources that will contribute to cost reductions without affecting the company’s quality factors.

Optical companies are one type of company which need new and innovative business and operational models to remain competitive. The optical field in any country is a really crowded market characterized by a highly diverse mix of local opticians with just one store (family businesses), small optical retailers with five to ten points of sale, and no more than five big optical retailers with more than 50 points of sale. This opticians’ network structure is common in most of the European countries due to high-quality service factors.

The opticians’ competitiveness depends on the economies of scale principles; thus, optical retailers can offer a wide variety of products, setting fashion trends and spending huge amounts of money for publicity using mass media communication (TV, press and radio). Even though they do not sell in foreign markets, they are considered as multinational companies because their basic components’ (frames) suppliers are located in different countries.

In this paper, the supply chain redesign of a European optical retailer, which decided to use advanced digital simulation and optimization techniques to integrate the definition of a new business model and the redesign of the operational model (infrastructure, human resources, processes and procedures, physical and logical flow) of the company, is introduced.

The paper is focused mainly on the economics and business aspects of the supply chain project; however, some technical and operational aspects are introduced. In-depth technical details are presented in several papers by the authors.\textsuperscript{4-6}

The current system specifications of this optical retailer are presented in Section 2. Section 3 summarizes the initial flow-oriented scenario which shows the needs (regarding space and material flow) of the system. These needs are covered by the operational supply chain optimization scenario presented in Section 4; however, structural constraints drive the study to another scenario, in which the whole supply chain is fully redesigned. This is the infrastructure redesign scenario in Section 5. Section 6 presents logistics outsourcing which is common for all the scenarios, and both financial and executive boards to compare the possibilities. Finally, the conclusions are presented in Section 7.

2. System specifications

The optical retailer consists of 200 points of sale distributed throughout Spain. Some of them have their own production and/or repair workshop, however, most of them depend on the production and repair workshop centralized in Barcelona city.

2.1. Infrastructure

The company center includes the production line together with the productive material warehouse, where they centralize the customer orders, both located at the same premises. Non-productive material, which is understood as products to be sold directly without requiring any further processing (i.e. glasses cleaning materials) are stored in an external warehouse. Workshop floor areas are:

- Production line: $Ps = 720 \text{ m}^2$.
- Warehouse: $Ws = 1,300 \text{ m}^2$.
- External warehouse: $NPs = 2,455 \text{ m}^2$.

Expedition operations are outsourced to an external logistics operator which distributes customer demands to all of the points of sale.

To perform the company expansion satisfying both a new business model together with a highly constrained quality factor (i.e. a 24-hour window of delivery of any order to any point of sale), new layout and operational procedures should be designed to satisfy supply chain policies’ targets.

Furthermore, a performance driven approach should require a deep knowledge of each particular capacity constraint (i.e. production, warehouse and distribution) to integrate a macro model (business specifications) with a micro model (operational aspects) in a simulation model.

2.2. Operational model

In Figure 1 the current operational flow model is sketched. The material flow and its operative policies or procedures are important aspects of the system and they must be fully modeled and analyzed.
2.2.1. Selling policy. Each point of sale (POS) has its own frame stock, ideally one frame of each type/style (reference), with two different selling procedures, one for sunglasses and another one for prescription sunglasses and glasses.

Sunglasses selling procedure. The POS could have one or more units of a sunglasses reference in stock.

- The final customer chooses the sunglasses and gets them immediately. It can be seen that the warehouse operates as a stock distributor.
- In case the sold frame was the last unit, a POS order is launched for new units of the same reference, which is served immediately (24 hours delivery time) if there is stock at the warehouse.
- The system supports movement of frames between POS to avoid stock outages.

Prescription sunglasses and glasses selling procedure. The POS has just one unit of each reference and the customer delivery time is two business days. The selling procedure is as follows:

- The final customer selects a frame and the prescription lens at the POS.
- The POS sends the frame and the prescription lens order to the production center.
- If there is stock, the warehouse sends, as soon as possible (24 hours delivery time), a new unit of that frame to the POS, and the production line makes the prescription lens order.
- Once the production line has the frame and the prescription lens, the prescription sunglasses or glasses are processed and sent back to the POS.

2.2.2. Supply policy. The sold frames of each POS must be restocked within a time frame of 24 hours. Thus, the supply procedure is as follows:

- Each POS sends a request of the sold frames to the warehouse department.
- Frames are packed in boxes, and boxes are put into transportation containers, one for each POS.
- Transportation containers are picked up by a logistics operator every day at 4 p.m. to be able to deliver them to the POS the next day.

2.2.3. Picking policy. A key process in the supply procedure is the picking process. The operator to product policy (see Figure 2) is used for this process. The warehouse operators get one list for each POS and they have to walk all over the warehouse to pick up the frames specified in one list and put them into the POS box.

Tray warehouse replenishment. Due to the critical nature of picking when feeding the production line with frames, SKUs (storage keeping units) master boxes are placed to optimize the picking operators productivity. Optimal SKUs master boxes placements reduce the operators’ travel time when replenishing empty or almost empty trays found during the picking process.

2.3. Expansion plan

The business model expects an increase in the number of POS from 200 to 350 distributed over the country. This expansion implies changes in the production line and in the warehouse, including operational supply chain policies.
The expansion plan also includes the centralization of all the production and the repair services; therefore, the operational model should consider the transport volume increase due to this extra workload.

3. Flow oriented scenario

A lean supply approach policy has been developed to design a flow oriented scenario that can cope with the business model objectives at a very high level.

Using conventional statistical techniques, a macro model evaluates an expected scenario considering square meters, the number of SKUs and the number of units to be transported via different expedition flows.

3.1. Material volume and space growth estimation

The expansion plan implies an increase of material flow and the need to increase the operational capacity. The different aspects to be considered in the simulation model are:

- SKU: Due to the expansion plan the number of references (SKUs) will be increased by about 35%; thus, the warehouse will need more SKU locations.
- Supply frequency: Delivery frequency is difficult to predict due to the lack of control of international frame suppliers. Therefore, frame delivery delays must be considered with the consequent costs or penalties for the company.
- Reception area: Concerning delivery frequency, the amount of incoming raw material in each delivery is uncertain, because the suppliers try to fit as much raw material (frames) as possible into each delivery to reduce transportation costs. Therefore, the reception area needs to be big enough to store an unknown quantity of incoming raw material.
- Shipping to POS: There is a transportation container for each POS and it is used to hold glasses from the warehouse and from the production line. Thus, there is a need for a special area to locate these transportation containers and to coordinate their replenishment, since they must be delivered at a certain time every day, depending on the logistics operator.

By considering these aspects and analyzing historic behavior, a decrease in the supply frequency from Asian providers is expected, implying the consequent increase in the number of frames units in each shipment. Figure 3 shows a six months’ warehouse stock evolution according to the macro model using a 63% increase in sales volumes which represents one-quarter of the warehouse increase. This expected stock evolution is a key aspect to be considered in the warehouse scenario design in terms of square meters required for the different areas.

As well as the increase in material flow and warehouse area implied by the expansion plan, there is also an implied increase in production and the consequent increase in the production area layout. The evaluated macro model concludes with a requirement of space for the new production line of around 1,758 m² instead of the current 720 m². This increase appears due to the introduction of new machines to guarantee production rates.

Current warehouse occupation rates of around 42% should be preserved as an initial estimation for the projected warehouse. Thus, besides the increase in the production line space, there would also be about a 40% increase of area for the warehouse.

3.2. Staff growth estimation

Company staff is distributed in different sections; however, in this paper only two different groups of employees are considered, those at the productive material warehouse, and those at the external warehouse (non-productive material).

The macro model expectation is to increase the number of employees at both warehouses. The external warehouse would see an increase in the number of employees from the current 23 to only 26; however, due to the volume increase, the warehouse operational staff needs to rise by 25% to deal with higher operational work demands, which corresponds to an increase in the number of employees at the productive material warehouse from 24 to 35. Thus, the total expected warehouse staff projection would increase from 47 to 61 employees.
3.3. Operational model conclusions

Operational flexibility is constrained by tactical and strategic decisions leading sometimes to inefficient scenarios. The scenario design for this particular optician supply chain case study shows that there are no operational policies that could fit the expected material volume into the warehouse designed under strategic and tactical policies. Therefore, due to fierce cost competition, strategic policies should be integrated with tactical and operational policies to create a good performance based and cost effective policy. A discrete event methodology\(^9\) has been used to specify, in the model, all the possible target interactions for an efficient coordination of the different business and operational aspects. Discrete event system simulation models have been developed using colored Petri net (CPN), and the integration of business aspects with operational aspects, to study technical solutions and new procedures. Two new scenarios were considered: an operational supply chain optimization scenario (SC-Op scenario), and an infrastructure redesign scenario (IR scenario), presented in Sections 4 and 5, respectively.

3.4. Frames flow model

Figure 4, Table 1 and Table 2 illustrate a simplified high-level CPN model of the frames flow, from their arrival (transitions T1 and T2) to their dispatch (transitions T7 and T10), either to POS or to suppliers (old frames). Colors and arc expressions have not been included; however, the resulting Petri net is perfectly understandable.

There are different general flows (new collection frames, replenishment frames, frames from POS and old frames to return). The majority of new collection frames are distributed directly to POS (T3–P10) as samples for display, the rest are stored at the storage area (T3–P5). Replenishment frames and returned frames are directly stored at the storage area (T4 and T8 respectively). Sunglasses and frames, in general, age because of fashion; then they are returned to the suppliers (T7). The other frames at the storage area can be carried to the production line to obtain prescription sunglasses or glasses (T5), and then carried to the dispatch area (T9) at the end of the process; or they can be directly carried to the dispatch area (T6) if they are sunglasses. Products at the dispatch area are sent to POS (T10) every day.

Qualitative information, such as flow volume, warehouse limitations, picking and replenishment performance, can be obtained by firing events under certain rates (quantitative analysis).

4. Operational supply chain optimization scenario

The SC-Op scenario maintains the current infrastructure, only requiring a new room of 650 m\(^2\) at the company center building. Some hypotheses and constraints on distribution and operations are analyzed to fix boundary conditions to focus the simulation models on both the redesign of the productive material warehouse to be allocated to this new room, and the design of new operational policies in order to deal with an incremental growth of the number of POS, from the current 200 to the expected 350, in 5 years.

4.1. Constraints

Constraints based on the knowledge of the infrastructure and the material flow are imposed by the company. These constraints are presented in the following sections.

4.1.1. Automation. One of the most important hypotheses is the automation of two sections, the production line and the filled-up transportation container section. For the project scope, there are just two important consequences which result from this automation. The first is the production capacity, which should be 4,500 work orders per day; the second is the buffer capacity to feed the production line which should allocate the necessary number of frames to feed the production line work for 2 hours. These two characteristics should be evaluated to optimize the picking process cycle.

4.1.2. Productive requirements. A minimum productive operative must be implemented into the company center warehouse. This productive minimum includes the following:

- Warehousing and picking of glasses frames and prescription sunglasses frames.
Reception of suppliers frames to allocate into the warehouse.

Additional shelves to allocate surplus stock when it is needed.

Small sections to manage the frames flow to and from the POS.

Therefore, these four sections must be allocated into the new warehouse design.

4.1.3. Radio frequency. Radio frequency (RF) should be introduced for a stricter control over all of the material and its location. RF would also support an automated picking order, a better tray replenishment policy, and a complete shelf occupation by allocating master boxes at different depth levels, one behind the other.

4.1.4. Selling policy. The selling policy described in Section 2.2 has been analyzed. The sunglasses selling procedure can be considered efficient; however, the prescription sunglasses and glasses selling procedure can be considered inefficient due to the following facts:

- Logistics costs due to the manipulation of the product (frames transportation) made by an external logistics operator.
- Stock costs due to the non-centralized stock which implies stock control faults, product duplicity, obsolete products, etc.
- Poor response time. This fact is solved in part by associated workshops located near the POS. These workshops work as the production line and they help some POS to reduce the response time. The company has more than 15 of these workshops over all metropolitan areas in Spain and, even though they help the response time reduction, they increase production costs too much.

Therefore, it is necessary to redesign new selling procedures to decrease the material flow, which implies the introduction of more information flow. The picking policy must be also redesigned and, operator to product and product to operator policies have to be used within

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<tr>
<th>Table 2. Transitions specification</th>
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<tr>
<td>Transitions definition</td>
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<tr>
<td>T1 Arrival of new collection frames at reception area</td>
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<td>T2 Arrival of replenishment frames at reception area</td>
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<tr>
<td>T3 Distributing new collection frames</td>
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<tr>
<td>T4 Distributing replenishment frames</td>
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<tr>
<td>T5 Carrying frames to production line</td>
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<tr>
<td>T6 Carrying sunglasses to dispatching area</td>
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<tr>
<td>T7 Returning old frames to suppliers</td>
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<tr>
<td>T8 Distributing returned frames from POS</td>
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<tr>
<td>T9 Carrying prescription sunglasses and glasses to dispatch area</td>
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<td>T10 Sending products at dispatch area to POS</td>
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<th>Table 1. Places specification</th>
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<tr>
<td>Places definition</td>
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<tr>
<td>P1 Supplier frames for new collection</td>
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<td>P2 Supplier frames for trays replenishment</td>
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<tr>
<td>P3 New collection frames at the supplier reception area</td>
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<td>P4 Replenishment frames at the supplier reception area</td>
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<tr>
<td>P5 Warehouse storage area</td>
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<tr>
<td>P6 Returned frames from POS</td>
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<tr>
<td>P7 Prescription sunglasses or glasses ‘on demand’ frames</td>
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<td>P8 ‘On demand’ sunglasses</td>
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<td>P9 Production line</td>
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<td>P10 Dispatch area</td>
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</table>

- Reception of suppliers frames to allocate into the warehouse.
- Additional shelves to allocate surplus stock when it is needed.
- Small sections to manage the frames flow to and from the POS.
the same warehouse. The new procedures and policies are presented in Section 4.3.

4.2. Technical solutions

4.2.1. Traceability Solutions. As the authors have already presented there is a lack of information technology which implies that the storage policy, necessary for absolute traceability, is poor. These poor storage policies are one of the reasons for the low occupation rate. The authors also presented the use of RF to ensure a high traceability of the products and to use as much available space as possible at the warehouse to increase the occupation rate to 80–85%. The introduction of RF is an assumable investment to add to the product costs. However, there are two other complementary solutions which are rejected due to the higher investment compared with the benefits they can contribute: radio frequency identification (RFID) and pick-to-light.

4.2.2. Storage solution. Several solutions have been analyzed, the first one was to introduce an automatic warehouse which ensures a high occupation rate. However, this option was rejected due to the following facts:

- The volume occupied by the carousels is large compared to the number of frames that can be allocated.
- The required investment is too high, for both carousels and their accessories.
- The carousels would not provide good productivity due to the interaction between picking by product and picking by POS.

As an alternative, once the automatic warehouse was rejected, new shelf and tray solutions to find the most appropriated configuration for the warehouse size (in the SC-Op scenario) and for the new procedures were modeled and fully analyzed. Thus, the solution proposed required small modifications to the current trays and shelves to support a better picking performance. Therefore, just a small investment was needed to obtain remarkable benefits, increasing the current warehouse capacity by increasing the density of frames in the warehouse.

4.2.3. Transportation solution. The frames transportation from the warehouse to the beginning of the production line is another aspect to take into account, specially for the SC-Op scenario.

One of the possibilities could be to introduce conveyors; however, the required investment is too high for the benefits they give for the SC-Op scenario. Different alternatives were simulated before making the decision and the most suitable of the studied alternatives is the use of trolleys with special trays. Thus, new trays were designed to make the picking process and the transportation easier. An explanation of their use can be found in Sections 4.3.2 and 4.3.4.

4.3. New procedures and policies

Processes and procedures have been redefined by means of simulation. Thus, the number of employees for each job and the timetables can be fully analyzed. These processes and policies were defined by thinking about the different constraints that the SC-Op scenario presents.

New policies and procedures for the different processes have been defined to maximize the occupation rate of the warehouse and to minimize the picking time per unit, improving the tray replenishment process and frames transportation to the production line (routing policy). Detailed explanations can be found; however, let us introduce here the most relevant characteristics. Notice that these policies are based on the structural characteristics of the warehouse for the SC-Op scenario.

4.3.1. Storage policy. Since RF will be introduced, master boxes can be allocated randomly all over the shelves, even using different depth levels, improving the occupation rate to 80–85%.

4.3.2. Picking process policy. The picking operators (pickers) will be dedicated operators to increase their performance. The picking process involve two different picking procedures which will coexist in time but not in the work area: product to operator approximation (see Figure 5) to feed the production line, and operator to product for the products which do not have to go through the production line (for example, non-graduated sunglasses).

Product to operator approximation. Due to the advantages of an automatic warehouse regarding picking productivity, shelves and trays were redesigned (low investment) to allow the picking operator to behave in a similar way as working with an automatic warehouse, which would require a high investment. The new design, which basically consists of flat and deep trays with enough volume to support 40 frames (the maximum historically registered picked frames of the same reference in one day), increases the number of SKUs per lineal meter, in such a way that the pickers will work in front of as many references as possible to minimize their travel time between shelves (see Figure 6).

Using this new design, picking performance will be improved by defining a new procedure to feed the
production line. This procedure consists of ordering the picking lists by product instead of ordering them by POS as is currently done. This order must also be in line with the order of the SKUs along the shelves to effectively minimize the pickers’ travel time.

**Operator to product.** Even though picking to feed the production line is proposed to be ‘by product’, a picking process by POS (see operator to product policy in Figure 2) must be kept due to the products which do not have to go through the production line, for example non-graduated sunglasses.

### 4.3.3. Tray replenishment policy

The current tray replenishment policy is very expensive in terms of profitability. This work is currently done by the picking operators during the picking process, when they find empty or almost empty trays. The new replenishment process is an independent task carried out by a dedicated operator; thus, picking and replenishment processes are carried out separately. Because of RF it is possible to determine which trays must be replenished every day and which master boxes should be used. This approach reduces the travel time of the operators increasing their performance.

### 4.3.4. Routing policy

Since the picking process is done by a dedicated operator, there is a need for another operator for the frames transportation to the production line. This task specialization improves the performance of all the operators in the warehouse. New trolleys and transportation trays together with the warehouse distribution allow the transportation operators to work without disturbing the picking operators.

### 4.3.5. New selling policy

Besides the changes and improvements of procedures, policies and infrastructure, the current supply chain system deals with a high final stock, with some penalties due to obsolete products, high logistics costs (transport between company center or workshops and POS) and production staff overstocking due to the different workshops.

To overcome the main drawbacks of the current supply chain system, a new selling procedure was defined, designing a new material and information flow:

- Each POS will have just one unit of each prescription sunglasses and glasses frame reference. Regarding sunglasses, a POS will be allowed to stock a certain security stock level according to the proximity of another POS.
- The final customer will choose the frame at the POS.
- This POS will place the order by a computer system which includes all the company information.
- If there is stock, the warehouse will send the frame to the production line, otherwise, the POS will send its frame to the production line.

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**Figure 5.** Product to operator.

**Figure 6.** Product to operator approximation.
The production line will process the glasses and they will be sent back to the POS through the logistics operator.

Production orders are grouped by product (frame reference) to improve the picking performance, thus, the production line outputs should be reordered by POS to distribute them throughout the corresponding transportation containers.

This new policy contributes multiple economic benefits if the following aspects are considered:

- The company must implement an information system to fully integrate the factory and POS. A SAP ERP (enterprise resource planning) system is under consideration.
- Part of the material flow is substituted by information flow.
- The logistics operator must accept the changes presented above and guarantee 24-hour nationwide delivery from the moment they get the POS container at the company center until the delivery to the POS.

5. Infrastructure redesign scenario (IR)

A new factory would allow the company to design a lean oriented layout improving material flow and operational policies due to a better distribution. Lower warehouse and production costs could be achieved by removing non-productive operations which usually occur due to structural constraints.

5.1. Constraints

Besides the constraints presented in Section 4.1, there are some other constraints to take into account for the IR scenario.

5.1.1. Infrastructure distribution. Only two possible subscenarios were evaluated:

First Subscenario: To concentrate all of the activities of the company in a new center but keeping the external warehouse they are currently using.

Second Subscenario: To eliminate the external warehouse and, thus, to concentrate all of the activities at a new and unique center.

5.2. Location

There are different aspects to consider when relocating an entire company. One of these aspects is the geographic location of the building. The employees have some rights and one of them is the possibility of not accepting relocation depending on how far the new center is from the old one, and they can also claim for indemnification if they exercise this right. Another right is to accept the relocation in return for a salary increase. Therefore, the company can try to minimize these costs by offering one of two alternatives:

- Relocation of the new center within the same city.
- Relocation of the new center to the metropolitan area (between 30 and 50 kilometers away from the old one).

With these geographic constraints they can fix the maximum costs for the relocation of the company center.

5.3. Technical solutions

Section 4.2 presents the technical solutions introduced for the SC-Op scenario, and they are divided into three groups: traceability, storage and transportation solutions. The same traceability solutions would be kept for this scenario; however, other alternatives have been considered for storage and transportation.

5.3.1. Storage solutions. An automatic warehouse was also rejected for this scenario due to the same facts presented in Section 4.2.2 for the SC-Op scenario.

Besides the design of similar current trays and shelves, other alternatives were studied for this project:

(a) Dynamic shelves using the suppliers’ master boxes as storage trays.
(b) Dynamic shelves with boxes to store frames in their own cases.
(c) Dynamic shelves with trays to store frames in their own cases.
(d) Dynamic shelves to store frames in bulk, without boxes or trays.

By using a meta model\textsuperscript{10,11} in which all costs were considered (material, operators, etc.), a multicriterion regression line was constructed to identify the best option for the IR scenario. Option b) provided excellent results because it is possible to reduce the total warehouse space (productive and non-productive material) because empty space in the cases will now be occupied by the frames, which does not increase the process time during picking or replenishment activities.

5.3.2. Transportation solutions. The new design of the factory was created to support conveyors. The idea was to design the material flow in such a way that the operators minimize their travel time due to the use of a conveyor system.
5.4. New procedures and policies

Small changes were made to the procedures and policies of the SC-Op scenario due to the different configuration of the shelves (using the gravity fall technique), the introduction of conveyors and the storage policy.

5.4.1. Storage policy. Frames were put into their own cases and into boxes, which are distributed all along the shelves. Half of the frames are expected to arrive in cases from the suppliers; therefore, operators must put the other half into their cases before allocating them along the shelves.

The occupation rate of the warehouse can decrease a little; however, the total warehouse area (productive and non-productive material) is reduced, as is mentioned in Section 5.3.1.

5.4.2. Picking process policy. The picking process retains two different procedures: product to operator to feed the production line, and operator to product to directly feed the POS. The differences being in picking cases (with the frames inside) instead of picking frames, and placing them on the conveyor instead of supplying the transport operators.

5.5. Possible locations

The following factors should be fully analyzed to determine the placement of the new factory:

- Logistics costs due to the new location.
- Purchase or renting costs of buildings.
- Relocation expenses.
- Costs resulting from staff transfer.

Comparing the possibility of keeping the current external warehouse or of not including it, and after studying different possible locations for each alternative (0 km or 30–50 km), the best solution for each scenario was considered. See the summary table (Table 3).

6. General aspects

The financial board in Figure 7 shows the costs of the different scenarios depending also on the locations for the 1R scenario.

6.1. Logistics outsourcing

There is a need to outsource some logistics activities. Under an economic-financial point of view, to outsource all of the logistics activities (OPL level 4) would improve the ROE (Return on equity) and ROA (Return on assets) ratios, and therefore it would return better financial leverage for the company.

Currently, the company only outsources the transport of raw material and final product operations (OPL level 1). Thus, there is a need to find a logistics operator capable of carrying out all the logistics activities which are performed internally. Unfortunately, specialist logistics companies for opticians do not exist; therefore, different aspects should be properly considered:

- To select one of its current logistics operators and to push them to achieve accreditation at logistics operations equal to level 3.
- To identify other high level logistics operators in other fields which could be related to multinational opticians.
- To create its own logistics operator specializing in opticians for its own use and to service other companies in the field.

6.2. Business model

An executive board with the selected alternatives was developed from a technical point of view (see Figure 8). The decision about which is the best alternative (the more convenient project) was taken using the best value method (BVM) which compares the technical value of each alternative.

First, the factors to consider were identified, selected and ordered as quantitative and qualitative. Second, the company graded the importance of these factors. The next step was to assign a technical value for each factor considering that there is a difference between the quantitative factors value calculation and the qualitative factors value calculation.

- Quantitative factors technical value calculation: These calculations were made through the simulation model since it has been formulated considering all the resources available: space, physical equipment, logistics equipment, staff, facilities, etc.
- Qualitative factors technical value calculation: The relevance of each option and alternative was made according to the subjective valuation of the company.

Finally, all of the information/criteria obtained and the best value determine the option to choose and execute. Once this board has deliberated, the decision is in the company directors’ hands; however, a document with
evaluation conclusions is summarized according to the simulation results.

6.2.1. Evaluation conclusions. Annual recurrent costs (operational costs) of the IR scenario alternatives with a new operational center are 5% less than the SC-Op scenario alternative which keeps the operational center where it is now. This difference is due to the costs of the transportation between buildings and the costs of the building rents that the company must incur for the SC-Op scenario.

The investment (or one time costs) is obviously higher for the IR scenario alternatives. In fact, it is approximately double for the IR scenario than for the SC-Op scenario. However, the use of simulation techniques allows an efficient equipment sizing for the new center to save in annual costs.
operational costs as much as would be necessary to recoup the investment over two years.

Qualitative factors get best consideration for the IR scenario due to the free decision making in the distribution of all the elements of the operational center. The company can accommodate the center in the best way.

7. Final conclusions

Discrete event simulation models have been developed as an efficient benchmarking technique to minimize the risk in the decision making process when considering tactical and operational decisions. Despite that the best option found for the medium term is to design and build a new operational center; the redesign of the current facilities and its equipment, new processes and policies, new distribution and supply material logistics system and staff reorganization would make feasible the company growth to 300 POS whilst retaining the operational center. Different scenarios with variations on the project hypothesis have been simulated to minimize the risk.

The simulation results obtained have contributed drastically in minimizing the investment in new equipment and also the recurrent costs while maintaining customer service quality factors. All of the evaluated scenarios include innovative processes, which were never tested on the real system due to financial risks.

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References


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