IMPROVING THE DISTRIBUTION PLANNING PROCESS IN THE FOOD&BEVERAGE INDUSTRY: AN EMPIRICAL CASE STUDY

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ABSTRACT

The distribution planning process is one of the phases of the broader logistics and production planning process for almost every company, and plays a pivotal role in the overall performances (Lee and Kim, 2002; Bard and Nananukul, 2008).
According to Chandra and Fisher (1994), companies can treat this stage in a dual approach. In the first one the overall planning process is considered as an indivisible entity: according to this way several researchers (Glover et al., 1979; Cohen et al., 1988) proposed models in order to coordinate production and distribution activities. In the second approach, the company considers the distribution policy as an independent stage of the entire planning process (for details, see Thomas and Griffin, 1996). Such an approach is more frequently adopted in industry (Chandra and Fisher, 1994).
According to the "independent approach", this paper illustrates the results of an empirical study involving a relevant food company operating in Italy. The aim of the study is to investigate the distribution planning process, in order to identify the main parameters that govern it, to analyse their impact on the company's performances and, finally, to propose some improvements, in terms of costs reduction.
According to these objectives, the study addressed, through an intensive case study, two main aspects: (i) the analysis of the company as-is context, encompassing the order process management and the supply chain structure, and (ii) the development of a simulation model that replicates the as-is context and proposes alternative scenarios (to-be), following some *ad-hoc* optimization rules.
Thanks to the simulations, we carried out an optimal configuration for the process parameters, which guarantee, along with the standardization of the order process management, significant economics savings and increased effectiveness for the overall distribution planning process.

INTRODUCTION

In our paper we provide the description of the results of an intensive case study involving one of the most representative food company operating in Italy (Company, in the remainder of the paper). It is the Italian subsidiary of a German Group, which employs about 9.000 people with 2.000 million € of revenue. The Company manages three different product categories, encompassing dry references (from ingredients of pastry prepared for cakes), cold references (puddings, panna cotta and yogurt) and frozen references (including 19 tastes of frozen pizza). The categories described above detain a different weight for the Company. The dry category includes more than 70% of total references, correspondingly to 55% of total volume streams; the cold products encompass almost 15% of the references (20% of total annual volumes) and the frozen references represent the remaining 15% of the Company's list (25% of total annual volumes).
The case study deals with the analysis & re-design of the distribution and delivery activities. In particular, the aims of the study are: to investigate the actual distribution planning process, in order to identify the main parameters that govern it, to analyse their impact on the company's performances and, finally, to propose some improvements, in terms of costs reduction.
In the next section, the problem is outlined and we described the reasons why we adopted a specific analysis methodology. The As-Is Company context, along with the main criticalities, is shown in the third section. In section 4 is depicted the adopted case study methodology; in section 5 are discussed the main elements of the simulation model developed and are reported the simulation results and the achieved benefits. Concluding remarks are drawn in section 6.

PROBLEM STATEMENT AND BOUNDARIES

The scope of the study deals with a specific stage of the planning process, the distribution planning process, one

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of the phases in the context of the broader logistics and production planning process, depicted in Figure 1. The company aims to manage in a better way the distribution and delivery process for the frozen pizza, which represents a growing relevant market in the Italian economy.

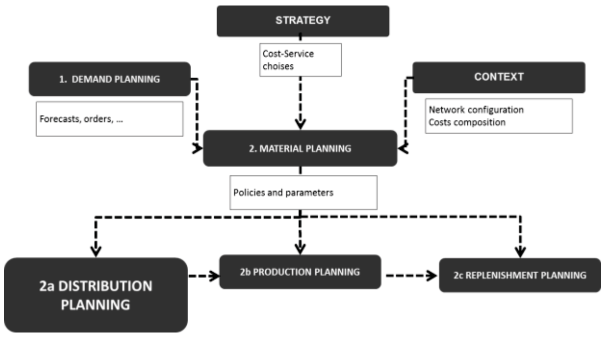

Figure 1: Planning Process Scheme

The integration of production and distribution decisions presents a challenging problem for manufacturers trying to optimize their supply chain (Bard and Nananukul, 2008). The literature provides several research streams for the optimization of the overall planning process. The main findings highlight the differences between an integrated approach, that guarantees a coordinated production and distribution policies, compared to the decoupled approach, where the production and distribution optimization are made separately (Bard and Nananukul, 2008).

Chandra and Fisher (1994) described the benefits and the disadvantages of these two approaches. The first approach deems the overall planning process as an indivisible entity: several researchers (Glover et al., 1979; Cohen et al., 1988; Chien et al., 1989; Thomas and Griffin, 1996) in past years have proposed computational studies to validate models and algorithms in order to coordinate products' production and distribution activities. This approach considers the correlations and the dependencies between production, inventories and distribution stages, ensuring a more coordinated and integrated design and control of these activities, that lead to an increased service level and low cost for the companies (Thomas and Griffin, 1996). Addressing production, inventory and distribution components in a single framework offers an holistic view of the logistics network and provides a good starting point for the full integration of the supply chain (Bard and Nananukul, 2008).

According to the second approach described by Chandra and Fisher (1994), in this study we consider the distribution policy as an independent stage of the entire planning process of the company: we treated company strategy (cost-service choices), company demand planning & forecasting process, production planning and replenishment planning activities as a facts of the context, exogenous to our analysis. Such an approach is more frequently used in industry: first, the company defines the costs policies and determines a production schedule that minimizes setup and inventory holding costs, and then the distribution policy is developed to satisfy customers' need. In this way, production scheduling and distribution planning are considered as separated problems, which can be solved separately (Chen and Smith, 2010).

There are at least three main reasons why we adopt the independent approach to develop our case study:

1. The production of the frozen products is made in the German plants, that are under the headquarters control. So, the production stage cannot be managed by the Company and therefore could be treated as an independent stage;
2. The decoupled approach works well if there is sufficient finished goods inventory to buffer the production and distribution operations from each other (Chandra and Fisher, 1994). As described in the next section, the inventory level is not a constraint, because the German plants realize the frozen products for all the European country, and the stored references are always available.
3. Finally, the frozen references have a long lifespan and shelf life, reducing the Company's needs to react very quickly to the production phase (Chen and Smith, 2010).

So, we do provide neither solutions nor changes related to the supply chain configuration (number of levels and number of nodes at each level) or stock level: the main goal of the project is to determine which products, how and when will be delivered and transported from the factory (or warehouses) to customers, with the aim to minimize the total cost of the process, ensuring the same service level agreement and respecting the existent constraints.

Obviously, we aware that the results represent just a local optimum for the distribution process, not a global optimum for the overall Company planning process.

THE AS-IS COMPANY CONTEXT

In order to describe in depth the initial situation (As-Is), we analyse two different elements: the supply chain structure and the evaluation order process followed by the logistics employees to fulfil the customers' orders.

The supply chain through which products are delivered in Italy is composed as follows:

1. Two German plants that realize 19 references (different flavours of pizza), stored into two different warehouses even in Germany (closed to the production plants). These sites can be considered the first supply chain level.
2. The second level of the supply chain encompasses two different Italian warehouses, one located in the north and the other in the middle of the peninsula. The company does not own these nodes.
3. At the third level, we find the customers, represented by several (almost 200) stores of the mass retail channel operators.

Due to the supply chain configuration, there are two possible delivery channels:

- Direct way: when a customer order fulfils a series of parameters (see Table 1), the required customers' quantity can be replenished directly from the German warehouse to the retail store. Depending on customer location, it could be replenished both in one day (north clients) and two days (middle and south clients). Trucks starting from German warehouses must be at full load. According to this constraint, we identify two different direct delivery ways:
  - One step direct delivery: when customer requires exactly 33 pallets or multiples (fully loaded), the delivery provides only one unloading of goods at the retail store;
  - Two steps direct delivery: when customer does not require a full load, the Company has to saturate the truck with other references. In this case, in addition to the customer unload, there will be planned an unload to the Italian warehouses for these added references.
- Indirect way: whenever even one of the parameters of the evaluating flow chart is not respected, the order has to be replenished through the Italian warehouses (depending on the customer location). Every customer could be replenished in one day.

The supply chain structure and the delivery ways are depicted in Figure 2.

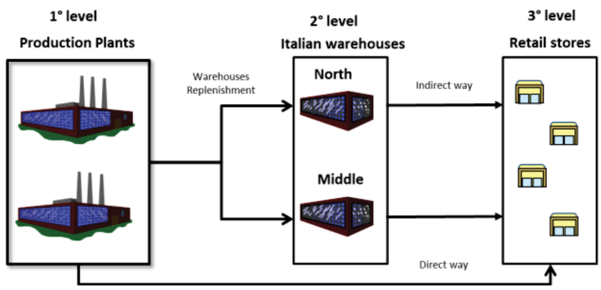

Figure 2: Supply Chain Structure & Delivery Ways

The As-Is evaluation order process, exploited by logistic employees to identify one of the two possible ways to replenish the customers, counts 7 major assessment stages: for every one of these, the logistics operators have to evaluate a specific parameter, and only if it satisfies the threshold value, the evaluation process will continue. At the end of the process (to repeat for each order), if all the 7 checks are positive, the order will be replenished through a direct delivery; otherwise the order will follow the indirect way. In Table 1 are summarized the evaluation phases, with the description of the value parameters, namely the thresholds that permit to discriminate among direct or indirect delivery.

Table 1: Order Evaluation Steps with As-Is Values / Thresholds

Evaluation phase	**Parameter**	**Value / Threshold**
1	Order quantity	> 10 pallets
2	Delivery lead time	>= 5 days from the order date
3	Full pallet	*Each reference is required in full pallet*
4	Geographic localization	< > from islands (Sicily and Sardinia)
5	Available German stock	>= reference order quantity
6	Date of delivery	< > Tuesday
7	Available truck	10 per day: each truck can replenish only one customer (are not allowed cross docking or multi-drop strategies)

In this scenario the Company manifests at least three relevant criticalities:

- the process is not adequately monitored and controlled, and the set of KPIs is quite weak. The Company gathers and monitors only few relevant KPIs (i.e. inventory days in German warehouses), but does not calculate neither the total cost of the process, nor the basic elements cost;
- the evaluating process followed by the Company employees, is not well formalized and standardized (different employee could follow a diverse step sequence to analyse the customer order);
- the values of the parameters that govern the process don't result from empirical analysis, but come from past experience of the Company managers.

OBJECTIVES AND METHODOLOGY

According to the organizational and methodological lacks described above, the main objectives of the project can be summarized as follows:

1. Mapping the order process, drawing all the activities involved in the order fulfilment process, thanks to which standardize the process and identify levers for improvements;
2. Analysis of the supply chain structure, in order to assess which parameters can be considered as constraints or which can be treated as process variables;
3. Designing and developing a simulation model that replicates the As-is scenario, identifying the optimal value of the parameters (described in Table 1) that can be treated and considered as variables endogenous to the Company;

4. Evaluating the benefits among the as-is and to-be scenarios, showing to company the time benefits and the economic savings occurred thanks to the changes implemented in the process.

The project follows a case study approach, which allows the investigation of the phenomenon in its natural setting (Voss et al., 2002; Meredith, 1998). Furthermore, the case study methodology allows the questions of why, what and how, to be answered with a relatively full understanding of the nature and complexity of the complete phenomenon.

As case study approach recommend when dealing with complex systems, such as engineering development projects, researchers were "insider" and "participatory" to research (Gosling et al., 2011; Ottoson and Bjork, 2004), to capture depth, nuance, and complex data during the project.

In Figure 3 is drawn the project protocol adopted, described hereafter.

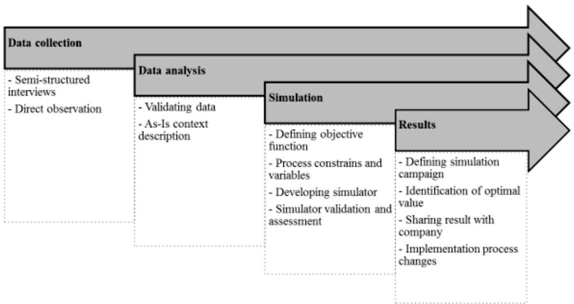

Figure 3: Project Methodology

The first stage consists of gathering data and information about distribution process. Upon the completion of the interviews in which researchers and practitioners collected information involving the Company logistics operators, the researchers analysed and validated the gathered data, assessing the As-is context, from both organizational and methodological standpoints.

Then, the researchers design, develop and validate the process simulations, with the aim of assessing an objective function depending on several parameters and constraints. Company employees and managers were asked to review and validate the simulation model carried out in terms of correctness and completeness. The final version of the simulation model was amended according to the feedbacks received.

As a final stage, a simulation campaign is conducted, in order to investigate the optimal value of the selected parameters that minimize the objective function (described in section 5.1). The evaluation of the intermediate and final results is conducted through several specific workshops with the Company.

PROJECT RESULTS AND MAIN FINDINGS

The simulation model

The simulation model has been developed in ©MS Excel for two main reasons: first of all, the possibility to exploit the ©Visual Basic for Application programming language in order to reproduce the evaluation processes followed by logistic operator and the supply chain structure; then the general diffusion of the tool and its knowledge by anyone will permit further development and extension of the work by the Company itself.

Discrete event simulation has been used to test the impact of the selected variables and propose their optimal configuration basing on historical demand time series. The simulation model structure is depicted in Figure 4.

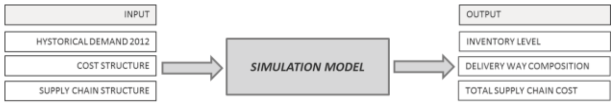

Figure 4: Simulation Model Structure

The direct inputs of the simulation are the order series of 2012, encompassing about 6.000 orders and 22.000 order lines, and the supply chain costs structure described hereafter.

The model reproduces the evaluation flow chart presented in section 3 followed by company employees. The fundamental logic can be described as follows:

1. The model examines the historical order of 2012 with a daily time bucket, assessing in which of these respect the parameters of the evaluation order process. As a consequence of this assessment process, the simulation model can decide which customers' orders can be replenished through direct or indirect delivery.
2. The model reproduces the material flow towards customers' retail store, identifying the correct German warehouses where the references (belonging to the considered order) must be taken.
3. After having evaluated the daily customers' orders, the model verifies if there is the need to replenish the Italian warehouses. Such a operation is possible analysing the state of the inventory days related both to the German and Italian warehouses. If there are available trucks and the inventory days in the German warehouses exceed 10, the model calculates the right quantity to send towards the Italian ones.

The objective function is composed of the following cost elements:

- Handling cost: it manifests when the products are moved out the Italian warehouses, and it is calculated as €/pallet;
- Distribution cost: it is function of the delivery way assigned to every order. For the direct way it is a fixed unitary cost (€/pallet). According to the first criticality described above, and the general lack of process knowledge and information, the evaluation of this parameter was a significant issue: the Company had only a singular cost element, in which were considered the distribution activities and many other activities related either to different

processes or product category (dry and cold). We disaggregated this cost element until the level of individual activities, and considered the average value as the unitary pallet distribution cost. Indeed, we did not distinguish the cost of delivery to different locations, considering that the customers in the centre and south of Italy are less than 23% and their orders only occasionally meet the requirements for a direct delivery (less than 1% of total deliveries). For the indirect delivery way it depends on the geographic location of the customers and the number of pallets required: a double-entry table is provided by the company;

- Transfer cost: this cost deals with the quantity needed to replenish the Italian warehouses from German plants. The method of calculation is the same as the direct way for the distribution cost;
- Holding cost: this cost deals with the physical occupation in the Italian warehouses by the company's references (the Italian warehouses are not owned by the company). The cost structure is €/pallet*day.

The output of the simulation campaign consists of a synthetic dashboard, developed in order to implement an appropriate performance measurement system that ensures that actions are aligned to strategies and objectives (Lynch and Cross, 1991; Kennerley and Neely, 2003). The set of KPIs encompasses: the total cost for the company (disaggregated into the four cost elements), the value of the inventory days for the German warehouses and the incidence of direct delivery compared to the total number of delivery.

After having developed the simulation model, we carried out a validation step. A validated model adequately represents the behaviour of the system for the project objectives. Model validation is usually defined to mean "substantiation that a computerized model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model" (Schlesinger et al., 1979). If a system really exists, the validation step consists of the comparison between the outputs obtained from the simulator with the performance measured in the real system. A model is considered valid for a set of experimental conditions if the model's accuracy is within its acceptable range, which is the amount of accuracy required for the model's intended purpose (Schlesinger et al., 1979).

The total costs obtained running the simulation with all the parameters fixed to the real system values differ from the system performance only about 2%.

Table 2: Comparison Between Real System and Simulation Model

	TOTAL COST	INVENTORY DAYS PLANT 1	INVENTORY DAYS PLANT 2
System performance	€ 3.614.389	10,60	10,00
Simulation result	€ 3.544.452	9,94	10,09
Delta %	-2,0%	-6,2%	+0,9%

Simulation campaign

In order to design the simulation campaign, the evaluation order process parameters have been classified as to which are endogenous and which are exogenous to the company environment. The former are under Company control, so they could be modified and tested during the simulation; the latter are not manipulated by the Company, so in the simulation are treated as constraints.

The parameters classification is presented in Table 3.

Table 3: Process Parameters Classification

Evaluation phase	Parameter	Parameter classification
1	Order quantity	Endogenous
2	Delivery lead time	Headquarter limitation
3	Full pallet	Headquarter limitation
4	Geographic localization	Exogenous
5	Available German stock	Headquarter limitation
6	Date of delivery	Exogenous
7	Available truck	Headquarter limitation

Only one parameter has been classified endogenous: the order quantity respect to which an order can be delivered in direct way from Germany.

The other 6 parameters are not controllable by the Company: 4 of them for specific limitations imposed by the Group Headquarters, while the remaining 2 depend on customers' requirements. Therefore has been tested only the order quantity impact, maintaining others parameters fixed to their real value.

Case study results and insights

The analysis of the 4 cost elements structure, guarantees to identify the hypothetical costs trend moving the order quantity parameter. These evaluations support the empirical decision to carry out a simulation campaign that encompasses 10 simulations: starting from a minimum of 5 pallets to evaluate a direct delivery, till to 15 pallets (the actual value for the company is 10 pallets). The simulations outputs are summarized in Table 4 and Table 5 and described hereafter.

Table 4 provides the value of the tested parameter (order quantity), the percentage of direct delivery compared to the total shipment, the costs structure for the company, and finally the values of the main constraints for the company, imposed by German HQ to the Company.

All the simulations performed ensure to respect the constraints: the German plants limitations consist of 10 days of maximum inventory days.

Table 4: Simulation Campaign Results

VARIABLE	SHIPMENT COMPOSITION	COMPANY COSTS					MAIN CONSTRAINTS (avg ID < 10,00)	
Quantity order (pallet)	**% direct delivery**	**Handling Cost**	**Transfer Cost**	**Distribution Cost**	**Holding Cost**	**Total Cost**	**Inventory days plant 1**	**Inventory days plant 2**
5	6,4%	€ 159.425	€ 1.729.603	€ 1.242.298	€ 426.842	**€ 3.558.167**	9,88	10,00
6	5,9%	€ 156.890	€ 1.702.104	€ 1.259.766	€ 425.691	**€ 3.544.451**	9,97	9,97
7	4,9%	€ 157.599	€ 1.709.795	€ 1.255.122	€ 425.764	**€ 3.548.280**	9,96	10,02
8	4,4%	€ 157.951	€ 1.713.612	€ 1.252.690	€ 426.115	**€ 3.550.367**	10,03	10,03
9	3,9%	€ 158.675	€ 1.721.469	€ 1.248.854	€ 421.307	**€ 3.550.306**	9,97	9,90
10	3,7%	€ 159.833	€ 1.734.029	€ 1.240.736	€ 424.624	**€ 3.559.222**	9,99	9,99
11	3,2%	€ 161.434	€ 1.751.403	€ 1.225.366	€ 426.076	**€ 3.564.279**	10,00	10,02
12	3,0%	€ 161.847	€ 1.755.884	€ 1.223.993	€ 425.032	**€ 3.566.757**	9,98	9,95
13	2,7%	€ 163.229	€ 1.770.879	€ 1.216.191	€ 425.100	**€ 3.575.400**	10,04	10,05
14	2,5%	€ 163.974	€ 1.778.957	€ 1.209.922	€ 426.219	**€ 3.579.071**	10,01	10,05
15	2,3%	€ 164.321	€ 1.782.720	€ 1.205.159	€ 425.978	**€ 3.578.178**	9,99	9,97

Table 5: Simulation Campaign Results Compared to Actual Real System (Quantity order = 10) Performances

VARIABLE	SHIPMENT COMPOSITION	COMPANY COSTS					MAIN CONSTRAINTS	
Quantity order (pallet)	**% direct delivery**	**Handling Cost**	**Transfer cost**	**Distribution cost**	**Holding cost**	**Total cost**	**Inventory days plant 1**	**Inventory days plant 2**
5	74,6%	-0,3%	-0,3%	0,1%	0,5%	0,0%	-2,0%	-0,1%
6	59,6%	-1,8%	-1,8%	1,5%	0,3%	-0,4%	0,2%	-1,0%
7	34,5%	-1,4%	-1,4%	1,2%	0,3%	-0,3%	0,8%	-1,4%
8	19,1%	-1,2%	-1,2%	1,0%	0,4%	-0,2%	0,3%	-1,2%
9	6,9%	-0,7%	-0,7%	0,7%	-0,8%	-0,3%	0,4%	-0,7%
10	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
11	-13,2%	1,0%	1,0%	-1,2%	0,3%	0,1%	0,3%	-0,8%
12	-18,5%	1,3%	1,3%	-1,3%	0,1%	0,2%	-0,4%	-0,7%
13	-26,4%	2,1%	2,1%	-2,0%	0,1%	0,5%	0,6%	-1,4%
14	-32,1%	2,6%	2,6%	-2,5%	0,4%	0,6%	0,0%	0,3%
15	-38,2%	2,8%	2,8%	-2,9%	0,3%	0,5%	0,2%	0,0%

The behaviour of the total cost trend proves the empirical test range defined before (5-15 pallets) and provides an optimal objective function value in correspondence to the simulation performed with 6 pallets as minimum quantity to evaluate a direct delivery.
We can identify different trends for each cost element:

- Handling cost: it is related to the Italian warehouses activities, so when a major number of orders are replenished through the indirect delivery, it increases. Thus, as the order quantity threshold grows, a major number of orders have to be replenished with the indirect mode, so the products are shipped through the Italian warehouses, the ones where this cost manifests.
- Transfer cost: decreasing the number of direct deliveries as the order quantity threshold increase, the cost of this element increase because the cost of replenishing the Italian warehouses that have to supply a major number of orders grows.
- Distribution cost: this element is subjected to a dual effect. The former is related to the direct deliveries cost: as the order quantity threshold assumes higher values, the number of orders replenished this way decreases. The latter is related to the indirect deliveries cost: as the order quantity threshold grows, the cost of replenishing customers' stores through Italian warehouses increases. The latter effect is less than proportional to the former, so we assist a growth of the total transfer cost moving towards higher values of order quantity threshold.
- Holding cost: this element is characterized by non-specific trend. This is reasonable considering that in each simulated scenario the majority of the customers' orders are replenished through the Italian warehouses, and the number of stored pallets doesn't change significantly.

In Figure 5 are shown the cost differences between the optimal scenario (obtained with Quantity Order = 6 pallet) and the simulated As-Is, disaggregated into the 4 cost elements.
Compared to the As-is situation, just changing the order quantity value from 10 to 6 pallets allows Company to reduce the total cost about 2% (approximately 60.000 € per year). This saving, even if it seems low, is actually significant, considering that only one parameter is changed, and the modification does not imply any organizational changes and does not require any ICT integration. It is a real zero-cost modification for the Company.

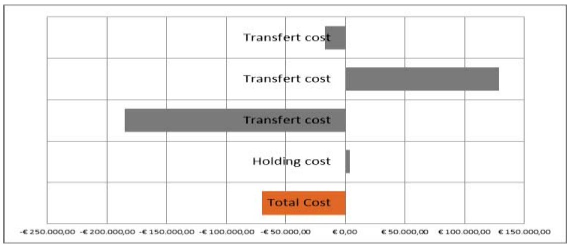

Figure 5: Cost Differences between Optimal Scenario and the As-Is Scenario

Process flow chart reviewing

Another relevant result of the case study has been the reviewing of the flow chart process, with the aim to developing an improved release of the framework, with an increased level of effectiveness. The same number of evaluation steps, but in a different sequence, characterizes the new version: these changes guarantee to the logistic operator to discriminate more quickly the delivery way for each order.
So, in the flow chart, are anticipated the nodes that filter the major number of orders, guaranteeing a more effectiveness evaluation process.
As the result of the simulation campaign proves, the value of order quantity parameter is adapted in the evaluation stage as described in the previous section. The new process sequence is shown in the second column of Table 6.

Table 6: To-Be vs. As-Is Order Evaluation Stages

Order phases As-Is	**Order phases To-Be**	**Parameter**
1	1	Order quantity (**threshold value: 6 pallets**)
2	2	Delivery lead time
3	**6**	Full pallet
4	**3**	Geographic localization
5	5	Available German stock
6	**4**	Date of delivery
7	7	Available truck

We carried out some empirical tests in order to quantify time benefits due to this new configuration of the evaluation order process. The assessment process is composed of three relevant time consuming activities: the first is required for each order, and the remaining two only for the direct deliveries. In order to estimate the economic saving, we considered the modification of incidence of direct delivery compared to the total number of delivery in the As-Is and To-Be scenarios. Table 7 shows that the total evaluation time per order is about 10,13 minutes in the As-Is situation, while in the To-Be scenario is about 5,59 minutes: with the modification of the order quantity threshold and with the new evaluation order process sequence, the overall Company process achieves an effectiveness 1,44 times higher.

Table 7: To-Be (vs. As-Is) Order Time Evaluation

Activity	**Minutes per order (As-Is)**	**Evaluated order (As-Is)**	**Minutes per order (To-Be)**	**Evaluated order (To-Be)**
Check input order list	10 min	100,0%	5 min	100,0%
Verify available HQ stock	5 min	1,3%	5 min	5,9%
Manage truck for direct delivery	5 min	1,3%	5 min	5,9%
Total time per order	10,13 min		5,59 min	

Due to this time reduction, and knowing the total number of orders (1.750 in 2012) and the average gross logistic operator cost (about 38 €/hour), it is possible to calculate the (second) economic savings, about 5.000 €/years.

CONCLUSION

Our paper aims to underline how distribution planning is a fundamental task for companies that deliver fast-moving consumer goods (FMCG), and its optimization through the use of simulation can lead to significant economics and time saving for the Company.

The case study underscores that is possible to achieve several benefits also considering only the distribution planning stage, separately from the other planning stages. Particularly when the considered products belong to the FMCG: the main characteristics of these references are short shelf life, long life cycle, low price and low added value. Due to these elements, there are relevant buffers and inventories that permit considering the replenishment, production and distribution stages as independent phases in the planning process. More in detail, the benefits achieved by this “independent approach” are related to:

- the simulations prove the benefits changing the order quantity to evaluate a direct way delivery, from 10 to 6 pallets. This modification implies savings about 60.000 € per year.
- the proposed new release of the flow chart aims at representing an initial model to better manage the required activities and leads to an increased efficiency about 1.44 times (savings of 5.000 € per year).

Further guidelines of improvement are required to analyse whether other constraints limit the company performances. The simulations may underline how constraints works, and explain the possible benefits for the Company and so for the Group whether the constraint value will be replaced to other optimal value. For example the inventory days threshold imposed by the German HQ could influence the total cost of the process. In order to prove to the Company how to use the simulation model to identify any further levers for improvement, we simulate the impact on inventory days constraints: moving from 10 days to 11 days, the total process cost decreases about 25.000 € per year.

A further element to analyse could be the delivery lead time, equal to five days in the As-Is context. Reducing this value from 5 to 4 days, thanks to organizational changes related to the order fulfilment, the Company could increase the number of potential direct deliveries about 1.300 units. It should be analysed the impact of this modification, verifying which cost elements increase and which decrease, assessing the total cost variation.

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