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A Logistics Reference Model for Mass Customization

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1. Introduction

The chapter introduces a reference model for the analysis, configuration and implementation of logistics networks with a dedicated focus on Mass Customization.

Logistics management is often considered as a support process but it can significantly contribute to reach core-business targets of companies because of its relevant impact on costs and performances. As Mass Customization asks organizations to radically change their production processes, logistics should be able to handle small quantities, personalized products and variable demand rates, keeping at the same time the desired service levels.

An accurate configuration of distribution and information networks is thus one of the most aggressive competitive leverages, as confirmed by many market-leader companies that continue to invest in this area to increase profits by strong improvements of efficiency. The markets where modern companies are operating have specific characteristics that don't allow a static attitude. Globalization creates important opportunities of improvement that need an harmonic growth of the whole organization, where a new generation of IT systems (for example RFID) plays a main role in managing different flows of goods.

The simple rationalization of production systems is no more sufficient, while an attention to new perspectives and opportunities in non-core processes can affirm the position of a company towards its competitors. In this scenario, logistics is a strong driver of competitiveness, enabling the sustainability of customization. While many studies already focused on inbound logistics (handling of goods during their production stages) as a key factor to address customization processes, outbound logistics still needs to be deeply analyzed as a strategic issue to maintain and control the level of customization.

A logistics framework for Mass Customization needs a clear definition of the objectives and an accurate analysis of the factors that can influence the performances of distribution networks, to support decisional processes and guide managers throughout the choices of the correct elements to reengineer, both in the case of an existing or in the design of a new network.

2. Literature review and objectives of the chapter

The importance of logistics on Mass Customization is not a novelty as it can, at the same time, limit and enhance Mass Customization. Logistics can be recognized as one of the main drivers of Mass Customization as it can push towards new and unrestricted markets, focusing manufactures on the creation of value for different clusters of customers defined by their location (Svensson & Barford, 2002).

A case analysis on 13 international companies (Moser, 2007) and many other researches (Verbraeck & Versteegt 2001, Cochran and Lewis 2002, Biswas & Narahari 2004, Lu & Storch 2004) identified logistics as a dominant competency for Mass Customization and a key element to customize the supply chain (Browning & Eppinger 2002). Study of application of Mass Customization in specific fields (as for the automotive, one of the most investigated) showed that improvements in the production process aren't sufficient to satisfy the required lead times without dedicated actions on logistics (Holweg & Miemczyk, 2002, 2003).

On the other side, the implementation of Mass Customization processes affects logistics performances, mainly due to the increase in the varieties of products, as the logics of scheduling and delivery of components to assembly tend to increase the level of inventories in order to prevent stock-outs (Aigbedo, 2007). Furthermore, some authors identified the need of a strong direct-to-customer logistics system as one of the limits of Mass Customization (Zipkin, 2001), in particular where e-commerce could open unexploited markets.

The Mass Customization manufacturing system, starting from a wide portfolio of different orders, forces companies to accurately organize workflows (Lu et al., 2003). But, at the same time, while Mass Customization needs an appropriate configuration of the logistics network, business needs and management rules tend to push towards conflicting solutions. For example, Just in Time philosophy, focusing more on managing material flows and reducing inventory than on the flexibility of the whole organizational system (Waller et al., 2000), affects performances of logistics and distribution system (among many: Pine, 1993; Kotha, 1995). Furthermore, outsourcing of manufacturing in low-cost countries or overseas suppliers leads to longer delivery times and bigger batches (Broekhuizen & Alsem, 2002).

The target of Mass Customization ("building of products to customer specifications using modular components to achieve economies of scale", Duray et al., 2000) can so be inherited in logistics where *postponement* can be recognized as the main and most suitable approach to these emerging problems, as showed by Fogliatto & Da Silveira (2011).

Postponement in logistics is the strategy to delay (in time and location) the increase of product's variety, value, volumes and weight to save on inventory, reducing carrying, holding, stock-out and obsolescence costs (Yang et al., 2004). After a first introduction of its general principles by Zinn & Bowersox (1988), Lee (1996) focused the theme on logistics to identify savings coming from the delayed distribution of semi-finished or finished products. Other researches proposed frameworks to assess the possibility of postponement in logistics, evaluating the opportunities on stocking (Pagh & Cooper, 1998), benefits of an alignment with production postponement (Rabinovich & Evers, 2003) and the implications on the whole supply chain (Yang & Burns, 2003). An extended review of postponement in logistics can be found in Yang et al. (2004), to identify challenges of implementation, and in Boone et al. (2007), to notice the slow rate of diffusion of this strategy.

Although the impact of logistics on Mass Customization is clearly visible, few studies offer a guide to the process of redesigning the distribution network to accomplish the target of customization. This is a recent issue (Chow et al., 2005) that needs more investigation (Nambiar, 2009) that was still not present in the 2011 review by Fogliatto & da Silveira as today it only shows specific applications without an overall view on the problem.

The need for an integrated model, as illustrated in this chapter, deals with the actual business environment that pushes organizations to move from a conventional logistics to a direct-to-customer distribution (Zipkin, 2003). In this scenario, as proved by various experiences in literature (Miller et al., 2010), logistics planners look for Decision Support System (DSS) to maintain distinctive advantages of competitiveness in evolving markets (Davenport et al., 1996). Those systems provide specific points of view to support network configuration, for example to select the best supplier of services, to identify the level of data sharing through the logistics processes, to choose the transportation mode or to quicken shipments and deliveries. Anyway, methodologies to design outbound logistics taking in consideration, at the same time, strategic, tactic and operational decision are still missing. The requirement assumes a greater significance if combined with the large investments in infrastructures needed to coordinate transportations and deliveries of materials and products on short notice, trying to contain costs. This leads most organizations to offer built-to-order customized products, using direct deliveries made by external logistics providers, with a relevant effect on the final price to the customers (Broekhuizen & Alsem, 2002).

3. The process of logistics design for customization

The definition of an integrated vision on the logistics network configuration first needs an accurate description of:

- the targets of the distribution processes;
- the factors that can affect decisions of logistics managers;
- the elements of the network that have to be defined.

All these issues that drive logistics performances have to be considered with specific reference to the high level of flexibility required by Mass Customization.

3.1 The targets of the network

The starting point to drive the changes of the outbound logistics is the right definition of the targets of the configuration process that can help to evaluate different alternatives. Two are the main dimensions of analysis that express the mission of a logistics network (Chopra & Sodhi, 2004):

- the satisfaction of customer needing;
- the total cost to fit these requirements.

Customer satisfaction presents many components that have to be accurately balanced, in particular when the level of the demand and its specialization tend to explode. In terms of logistics processes, customer satisfaction can be represented by a mix of (Figure 1):

- variety of products;
- lead time;
- availability of products;
- customer experience;
- traceability of orders;
- possibility of return.

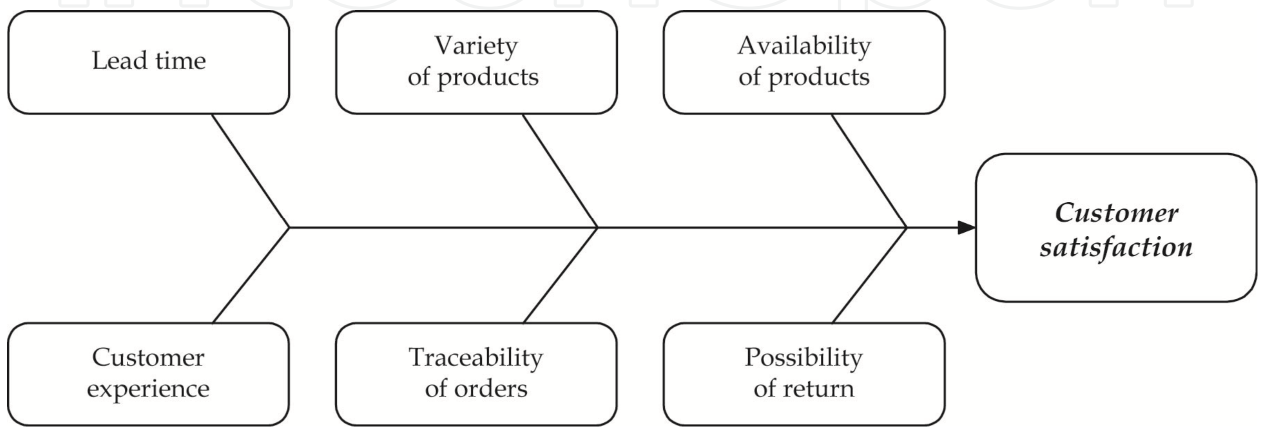

Fig. 1. Components of customer satisfaction

The *variety of products* is the main theme of the chapter and is the main assumption of the approach. Logistics is one of the strategic areas that have to be involved to guarantee that the increase in customization and flexibility can be perceived by the customers. Logistics assets and processes allow the capability of the network to effectively offer a wide range of products, making customers aware of its real possibilities.

Lead time between order (purchasing or production) and delivery is a critical parameter that has to be strictly controlled, in particular when the high level of differentiation is combined with zero-inventory approaches. In the modern environment, where products can be highly substitutable in terms of technical specifications, quicker companies prevail as time to market is one of the most tangible leverage of competitive advantage.

Once defined the portfolio of products to offer, their real *availability* at the retailer stage is a further indication of the service level. After a process of selection in catalogues, internet or other mass media, customers that go to shops and can't find products tend to become a missed opportunity. Low inventory at the production stage has so to be balanced with the right inventory at the distribution stage.

Customer experience is related to the easiness of purchasing, the possibility of having a support during ordering and shipment or, more in general, to the ability of a company to make simple and pleasant any contact with its customers. Mass Customization not always can be accompanied by a high specialization of workforce on the entire range of products, in particular if costs are not covered by the value generated. Setting up internet orders and outsourcing to logistics providers risk to let companies lose their control on this issue.

Traceability of orders is a very common service associated to logistics processes, where consignor and consignee can have real-time information on the position of products in the network so to follow their routes and allow fast and dedicated interventions in case of any problem.

Possibility of return is related to any situation where customers are protected by dedicated reverse logistics channels in cases of defective or unsatisfying products. For example, many e-business companies, realizing that a website can't give the same feeling of a physical shop, developed fast and effective processes of return with pre-paid labels and simple online procedures to solve complaints.

3.2 Factors of influence

Logistics managers have to take their decisions facing the environment where the network has to work, considering that any process of redesign is limited and, at the same time, addressed by the specific context of operations. Three groups of factors can so be identified:

- organizational and market factors;
- technological factors;
- environmental factors.

3.2.1 Organizational and market factors

Among these factors, able to significantly influence logistics choices, it's possible to identify two categories:

- characteristics of the company of the network;
- characteristics of the market where the network acts.

Cultural approach to logistics management is a key theme as many companies still consider logistics only as a service to the production systems even if it can generate significant performances of quality and costs. Furthermore, logistics is strongly influenced by the choices of markets to reach, the investments in infrastructures, the policies of efficiency, the level of relationships to have with the customers, etc. Product customization requires a fully developed logistics, with high competences, skills and a mature organization, not to limit the advantages of Mass Customization.

3.2.2 Technological factors

Customization and technology rates go along together. Advanced information and automation systems (e.g. identification, coding and accounting systems for goods) are factors that have to be considered to enable all the best practice and the alternative configurations. It is necessary to have a complete knowledge of the available technologies to extend the range of possible implementations, identifying (according to budget) the most adequate to manage picking, handling and transportation processes of products, different in terms of quantity, size, weight, packaging or shipment. Furthermore, technologies (e.g. Radio Frequency Identification) have to tune the processes of coordination and collaboration of companies, where interfaces among systems can increase (or reduce) lead times of information sharing and material flows.

3.2.3 Environmental factors

Push towards Mass Customization directly comes from the internationalization of markets where logistics have to face an extension of the coverage of geographical areas. Characteristics of the environment where to invest or operate have to be accurately investigated so to get all the information to understand opportunities and identify criticalities and uncertainties that could affect performances.

Environmental factors include all those specific elements of a certain area that have an influence on the installation of facilities and on the operations of a production-distribution network.

Macroeconomics and industrial maturity of markets are the main feature to assess local contexts. These parameters can't be considered constant and invariant in time but have to be analyzed in terms of possible developments as the network should be able to select the best areas to transit, stock or ship.

Four categories of environmental factors can be identified:

- political and cultural factors, as for stability of countries and respect of legality;
- exchange rates and uncertainty of demand, as a high differentiation of customers should reduce risks but have a significant and transversal impact on the value of stocks;
- taxes, duties and incentives;
- availability of transportation and stocking facilities.

3.3 Elements of the network

Once established the target service level and identified the factors that could influence the network, the decision process should determine the elements to configure and implement to enable the flows of products and information.

The elements that constitute a logistics network are various and generate a wide set of possible alternatives and solutions to all the specific problems, in particular for Mass Customization. At a strategic level, the main results to achieve are:

- the definition of the number of echelons;
- the definition of the number of knots;
- the localization of each knot;
- the assignment of customers to knots and definition of standard paths.

The definition of the *number of echelons*, that is to say the number of levels (e.g. warehouse, distribution and retail) between the production site and the customers, is the first output of the decisional process (Figure 2).

According to the portfolio of products and its possible customization, the number of echelons increases to meet specific requirements and enable postponement strategies in dedicated facilities (e.g. merge centers). On the other side, the introduction of new echelons requires multiple activities of loading, stocking, transfer and unloading of products to ship, facing costs of facilities, infrastructures and management.

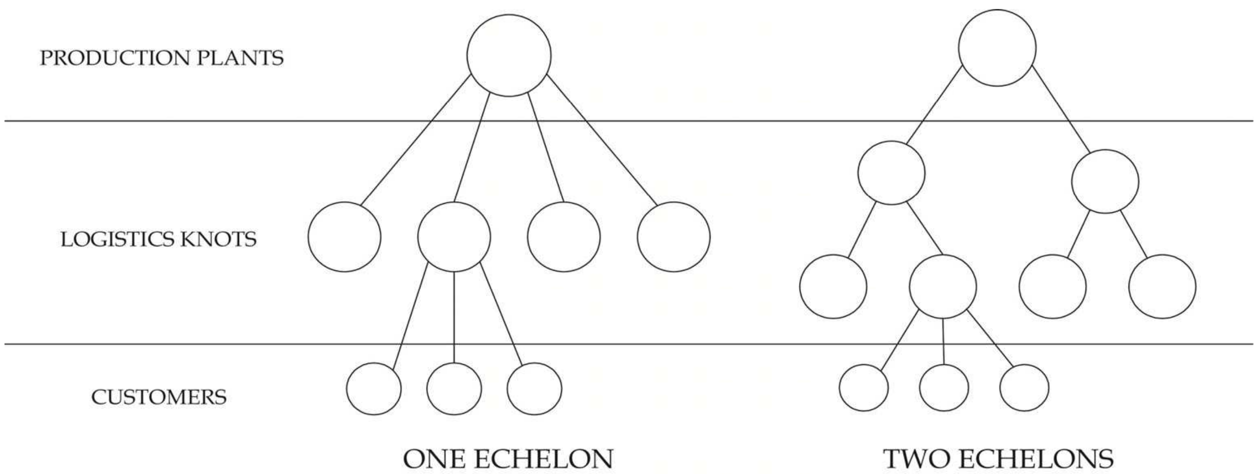

Fig. 2. Logistics network configuration: different number of echelons

At the same time, the *number of knots* with the same operations, to activate in each echelon, allows to better approach customers, hear their voice and reduce delivery times, recovering lead times of customization and make-to-order policies (Figure 3 and Figure 4).

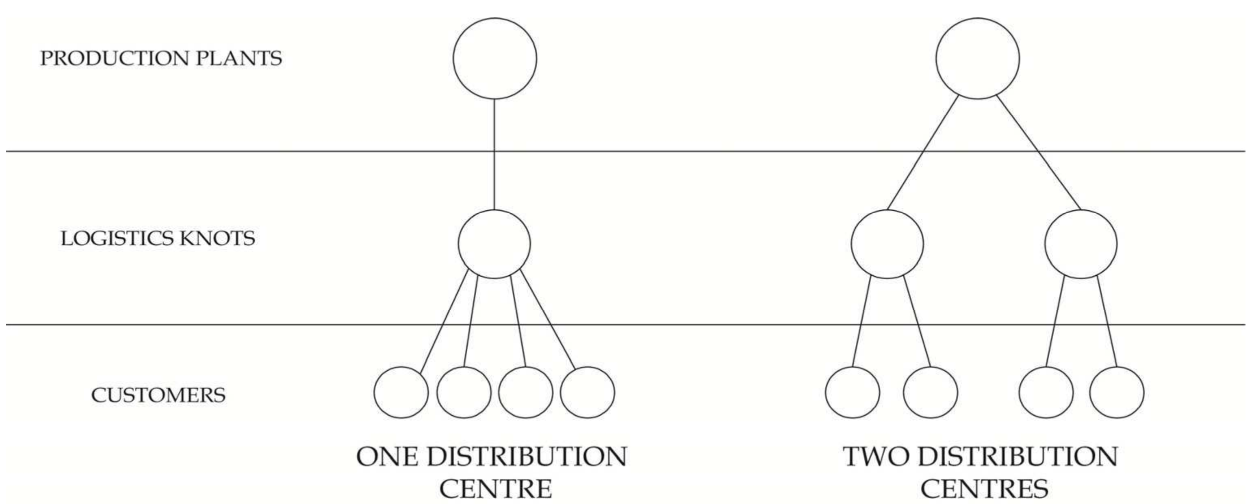

Fig. 3. Logistics network configuration: different number of knots (same number of echelons)

According to the availability of potential sites and resources to invest, the *localization of each knot* of the network is the next step of configuration (Figure 5). The assessment has to consider many different criteria, e.g. the proximity to the main transportation routes and infrastructures (motorways, railways, ports, airports), the location of markets and production sites, the strategies of development and expansion.

The last stage is to *define standard paths* and sequences to deliver products from production sites to cluster of customers, passing through the different echelons and knots of the network (Figure 6). This issue is particularly significant in Mass Customization because low volumes always present significant costs due to Less Than Truckload (LTL) transportations. The optimization of Vehicle Routing Problems can help to find static or dynamic solutions to assign knots and customers to delivery paths, considering the direction of the shipment (delivery or return) and the availability of agents for collection.

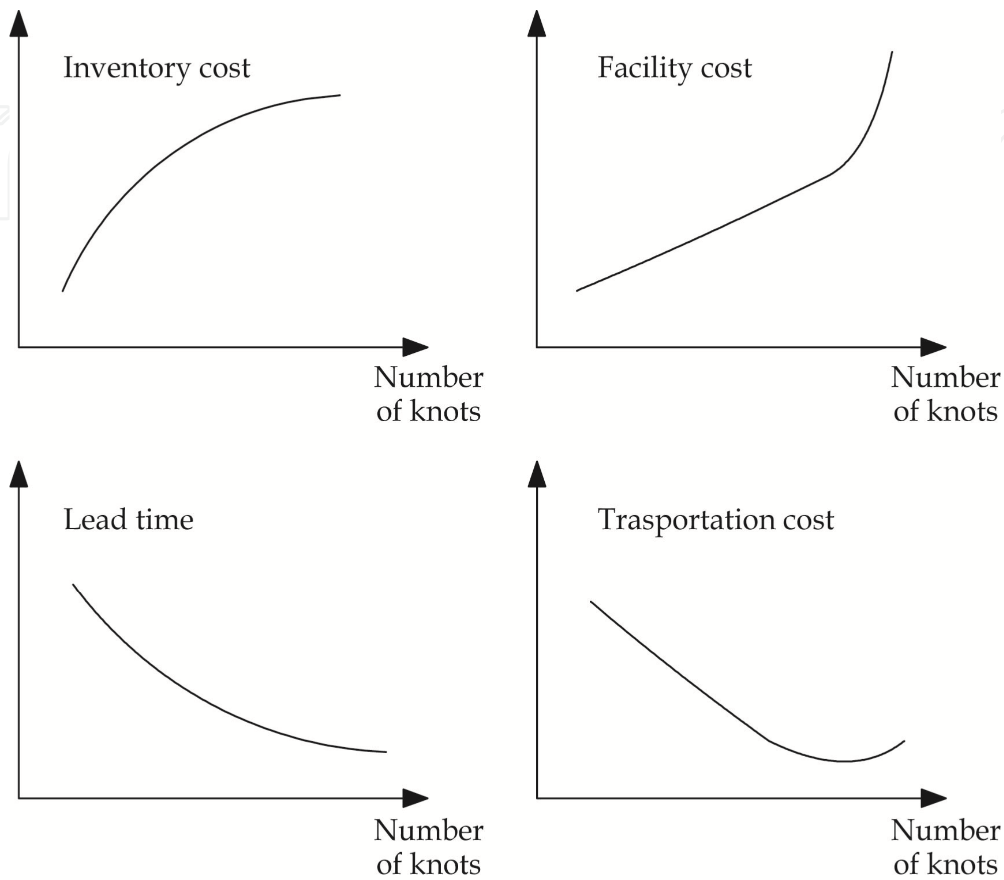

Fig. 4. Number of knots–Performance analysis

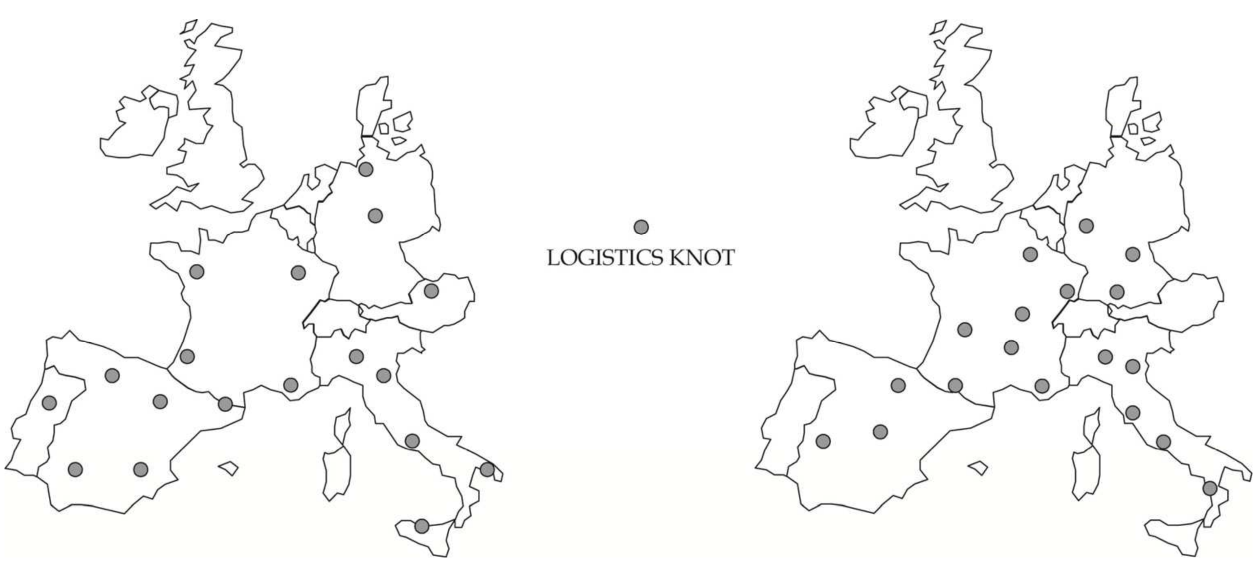

Fig. 5. Logistics network configuration: different localization of knots (same number of knots)

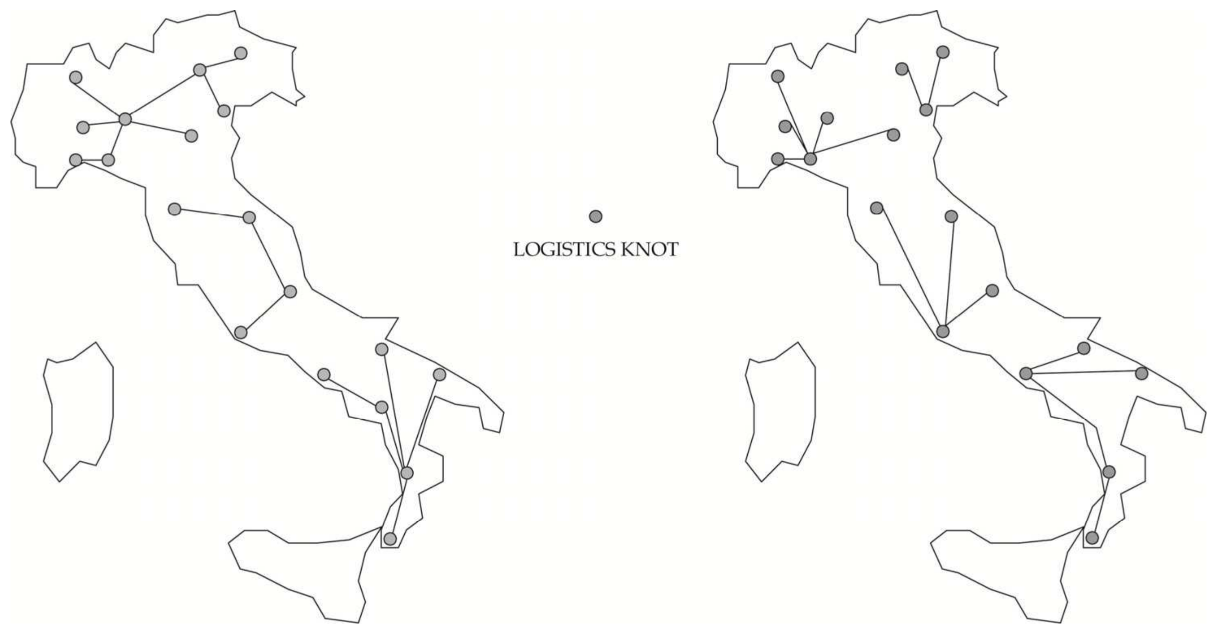

Fig. 6. Logistics network configuration: different standard delivery paths (same number of knots)

4. The levels of the decision process

The design or redesign of logistics network for Mass Customization is not a simple sequential process but needs and integrated vision that has to take in consideration the interdependences and cross impacts among the elements of the network. In literature, the decision process is generally divided into strategic, tactic and operational levels (Ballou, 1992) according to the time extension that the alternatives need to be implemented, achieve targets and compare results (Figure 7).

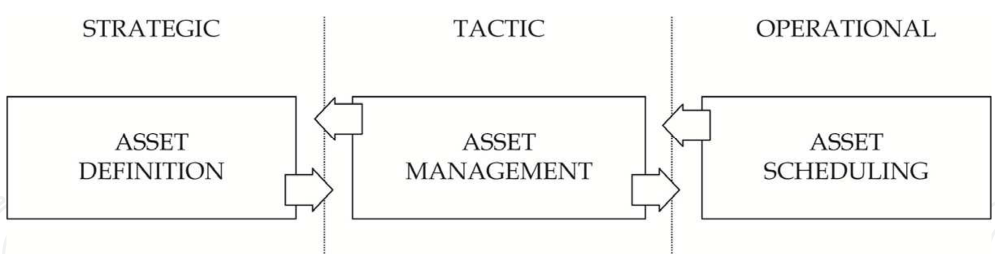

Fig. 7. Levels of the logistics network configuration process

4.1 Strategic level

The strategic level regards all those alternatives of network configuration that present an impact in the long term, over two years, or that need the same time to be realized or modified. This level refers, for example, to the acquisition or installation of infrastructures, selection of transportation means, implementation of information and management systems. All these themes can be summed up in the general problem of the *asset definition*.

Specific choices for Mass Customization are related to the opening or closing of echelons and knots, according to the requirements of agility and time compression. At the same time, it is to consider that high variety and low volumes are subject to uncertainty, causing unpredictable situations that affect the achievement of the desired performances (Bhattacharya et al., 1996). Risk Pooling logics could help to face variability of events, sharing facilities among organizations and aggregating their assets, with a trade-off between the reduction of inventories and an increase of delivery times.

Strategic decisions have to be taken also in terms of insourcing or outsourcing of processes through the evaluation of a cost-benefit profile, balancing the loss of the logistics intelligence and its transfer to specialized agents with the possibility of standardizing programs and generating economies of scale.

4.2 Tactic level

The tactic level regards the definition of the *asset management* rules of the network to reach best performances in terms of production, inventory and transportation. Mass Customization requires a specific focus on lot-sizing of deliveries, standardization of minimum and maximum load units, assignment of inventories areas and levels for each product, definition of material handling processes. As for the strategic level, where the aggregation of assets creates benefits and opportunities, also at a tactic level it is possible to identify methodologies of integrated management able to increase efficiency and effectiveness of logistics so to contain times and costs.

The configuration process starts from the definition of all the management rules that have to be stated from upstream to downstream of the network, trying to correctly implement them into the different knots, avoiding wastes and loss of values and reducing at most organizational constraints.

4.3 Operational level

Logistics operations have to be day by day planned and executed. The operational level regards *asset scheduling*, the programming and control of short term process of orders, deliveries and human resources along the network.

Only at this level the targets defined in the other levels can be realized, according to the information that flows along the network. Increasing the complexity of the configuration (players, business relationships and products) carries a strong need of coordination and alignment techniques to fit customers' requirements.

A detailed definition of the process map of the entire network is so the main tool to address operational choices (Qiao et al., 2004), considering all the logistics activities that each knot has to perform (Logistics Model, 2005).

5. A case study of application

An application of the logistics configuration process for Mass Customization is presented on a specific case study with the following characteristics:

- make-to-order production;
- high differentiation of products;

- variable amounts of products in any order;
- highly distributed market.

The research is centered on a web portal of regional products (mainly food and beverage) from Valtellina (http://www.storevaltellina.it), an Italian territory where the quality of production is guaranteed by local protection Consortia, which keep watch over the quality of typical products and delicatessen. By this e-commerce solution, a group of about 40 local organizations is now able to show off their products and sell them in orders that are totally customizable by customers, from a high quantity of a single product to any selection of products in different quantities.

Once the portal started its online activity, the number of orders increased constantly. The traditional portfolio of customers evolved from local consumers to buyers, brokers, distributors, retailers and merchants, like restaurants, hotels and food shops that finally found through the B2B solution a way to get Valtellina tradition. The geographic area of interest increased as well as the need of a logistics coverage.

At a first stage, the logistics strategy didn't change and some negative effects suddenly occurred. High costs of delivery, outsourced from every producer to express freight companies, were not rewarded due to the disappointing perception of customers that received different shipments for a single order (only certain groups of products travelled together), facing extended lead times due to the consolidation of orders (sometimes caused by the stock-out of a single product) and damages from poor packaging.

Therefore, a redesign of the logistics configuration, according to the presented model on its strategic, tactic and operational levels, defined new elements of the network to answer the following questions:

- how is it possible to reduce lead times and avoid wastes?
- how is it possible to avoid partial shipments and always ensure complete orders?
- is it useful to open a distribution center to stock a certain amount of products and apply postponement strategies?
- is it possible to coordinate flows of materials and information to standardize processes and service levels?
- how is it possible to have a strong relation with the customers to correctly understand feedbacks?

Different opportunities of improvement in this Mass Customization context were assessed in terms of cost-benefit, focusing on a set of possible alternatives that present different combinations of strategies for:

- distributing or concentrating warehouses (*Risk Pooling*);
- potential aggregation of different products in a single shipment (*Merge-in-Transit*);
- organization of vectors on standard delivery paths (*Vehicle Routing*).

5.1 Risk Pooling

Risk Pooling is the advantage that can be realized through a large scale analysis and aggregate forecasting of particular products (e.g. reduction of number and typology of components thanks to standardization): a Risk Pooling strategy can affect the choice of aggregating production systems of different products on different sites (from Production Plant Network to Process Plant Network – Figure 8).

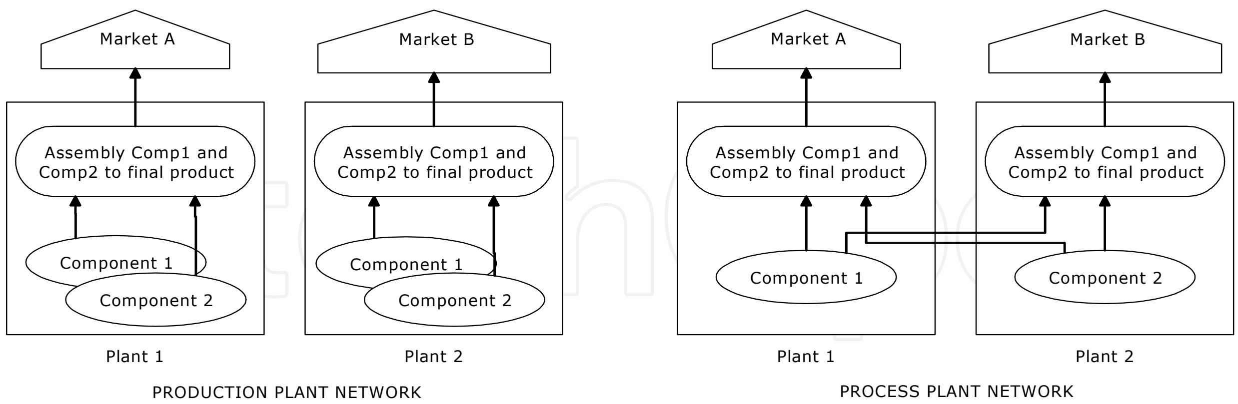

Fig. 8. Production network strategies

This behaviour, characteristic of the consolidation of distribution centers in a unique sorting point, was originally studied by Eppen (1979), the first to analyze effects in warehouse management. The study of Barahona & Jensen (1998) put the basis of the more recent analysis in operation research, for example Schrijver (2000) and Iwata et al. (2001), to solve problems with a huge number of knots in the network. Researchers proved that pooling or aggregating demands reduces the risks associated with forecasting errors and inventory mismanagement (Chopra & Sodhi, 2004) under appropriate conditions (Yang & Schrage, 2009).

Considering a distribution network, where a unique plant feeds regional depots to supply local retailers or customers, operations present two main costs: the first is directly related to an average value of goods transited, caused by stock and handling costs and order management costs; the second is related to safety stock of warehouses, depending on the value of the standard deviation of the customer's demand. Reducing the number of depots and aggregating demands smooth variations and allow lower safety stock levels while generating an increase in complexity of physical distribution. This is a typical opportunity for Mass Customization levels of inventory, where benefits are more consistent when verifying a non-correlation of the markets. The approach generates a reduction of the number of distribution centers and the correspondent pool of stocks among a determined set of markets.

5.2 Merge-in-Transit

Merge-in-Transit (MIT) consists in a logistics practice used where the product needs:

- an aggregation of different products from different sources in a single delivery;
- an aggregation of on-demand orders with components in stock.

This order management methodology was first introduced by Muller (1992), whose activity was enriched by the significant industrial experiences of Hewlett Packard, Dell, Cisco and Ikea. Many studies followed to build mathematical models of MIT (Ala-Risku et al., 2003; Croxton et al., 2003) and to analyze its technical and informative requirements (Kärkkäinen et al., 2002).

Merge-in-Transit is the substitution of direct shipments of a multi-product order with a single aggregated shipment. Instead of executing many direct deliveries, the different lines of order are converged with a direct transportation in a *merge center*. Here the products are placed in the same vector, if necessary after an operation of assembly or consolidation, and delivered to the customer, so to avoid the costs of specific warehouses. The advantage of Merge-in-Transit in Mass Customization is related both to a higher level of customer satisfaction and to a possible decrease of transportation and inventory costs (due to the elimination of warehouses) together with the possibility of increasing a larger range of products on catalogue.

5.3 Vehicle Routing Problem

Vehicle Routing Problem (VRP) has a well-known mathematical formulation where cost optimization is related to the number of shipments and sequencing of journeys, as for Laporte (2000). Many solution algorithms were presented in literature, exact ones (Fisher, 1994), heuristic ones (Shaw, 1998) and meta-heuristic ones (Vigo & Toth, 1998; Gambardella et al., 2005). For an extended review of the problem see Laporte (2009).

In this case, with the opportunity of a multi-level network, the models have to be concerned with the definition of standard routes for multi-knots deliveries to assign to clusters of customers. The total cost is the sum of activation and transportation costs, where the final customer routes (*last mile*) make the difference. The optimization process needs to evaluate every combination of assignment (of customers, vehicles and routes), defining the shortest path and the best configuration. This helps the organization to reach standard delivery times and easily manage shipments even when the freights quantities and typologies constantly change.

5.4 Framework application and results

The redesign of the logistics focused on the implementation of these three strategies (Risk Pooling, Merge-in-Transit and VRP) where the best results for each strategy generate constraints to the other two: for example, decisions about opening a set of distribution centres, obtained by a Risk Pooling analysis, expand or reduce the possible routes to establish with the VRP analysis. This means that the organization needs to define the best sequence of the optimization process, starting from the analysis with the highest impact but not moving too far from the best integrated and balanced solutions.

A three-stage modular architecture can be built to identify priorities and to take them into proper account in a step-optimization (Figure 9). Depending on the environment, infrastructures, products, company background and logistic network maturity, different cost issues can prevail. As a first step, the optimization analysis has to be effectuated on parallel branches to evaluate the impact of each perspective: this could be considered as the weight of non-optimized configurations on the item in focus. In the second step, a comparison among the three different approaches, evaluating the best and the worst cases for each strategy, assigns a greater importance to the perspective of optimization with the higher spread or (as a second criterion of priority) to the most significant in percentage.

Characterizing the models with a degree of their relative impact allows to proceed with a stratified resolution of the problem, from the most relevant effect (Highest Impact Model –

HIM) to the least one (Lowest Impact Model – LIM). Therefore, the optimization process considers the specific results obtained by the HIM, fixing elements of the most important solution, and then running the MIM (Middle Impact Model) with more constrains and less degrees of freedom. The new results create further constrains, input for the last optimization problem (LIM) that completes the network configuration. Figure 10 shows the six possible combinations of priorities, explaining for each stage the constrains generated by the step-optimization to the final logistics solution.

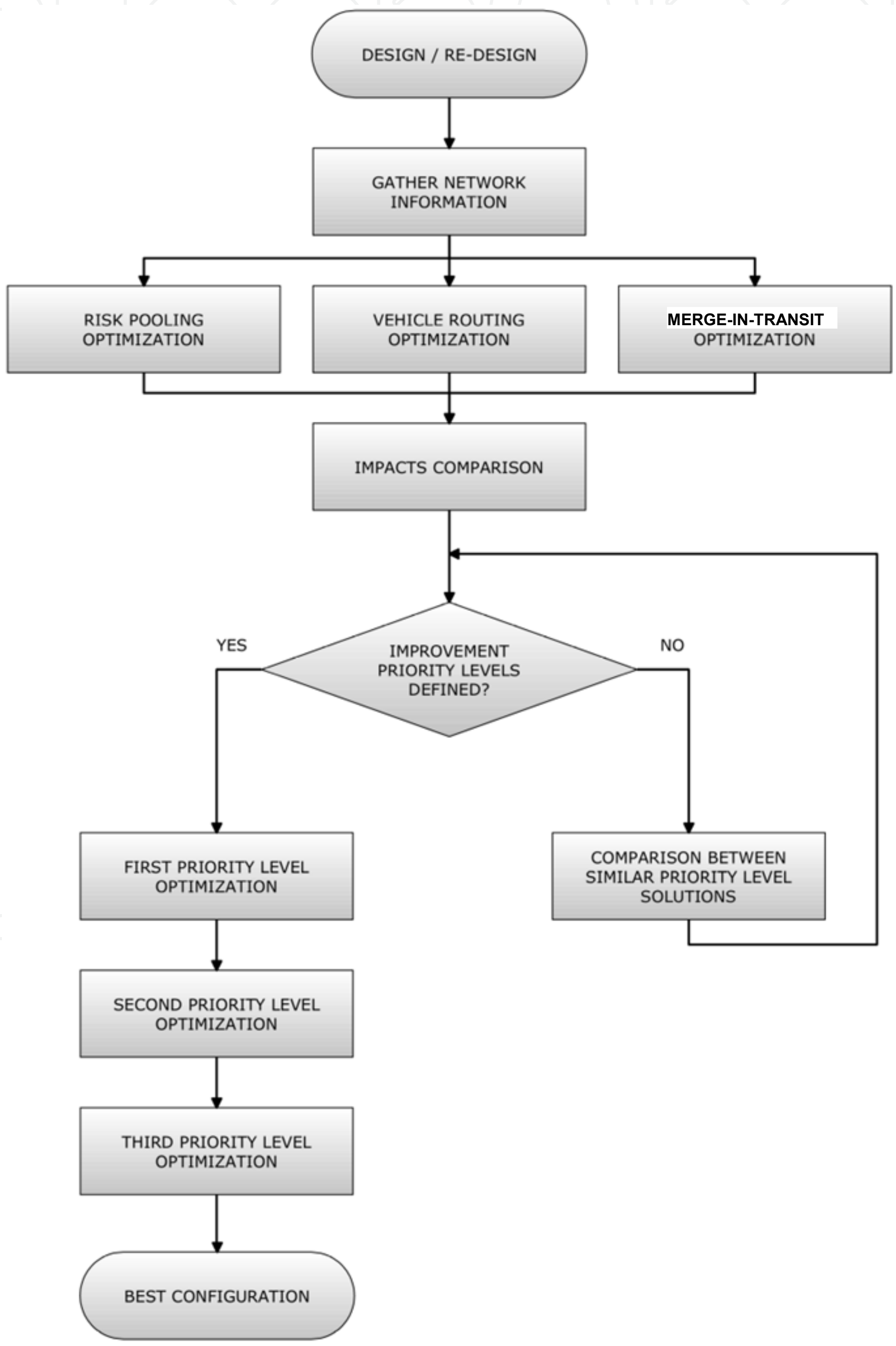

Fig. 9. Applied framework

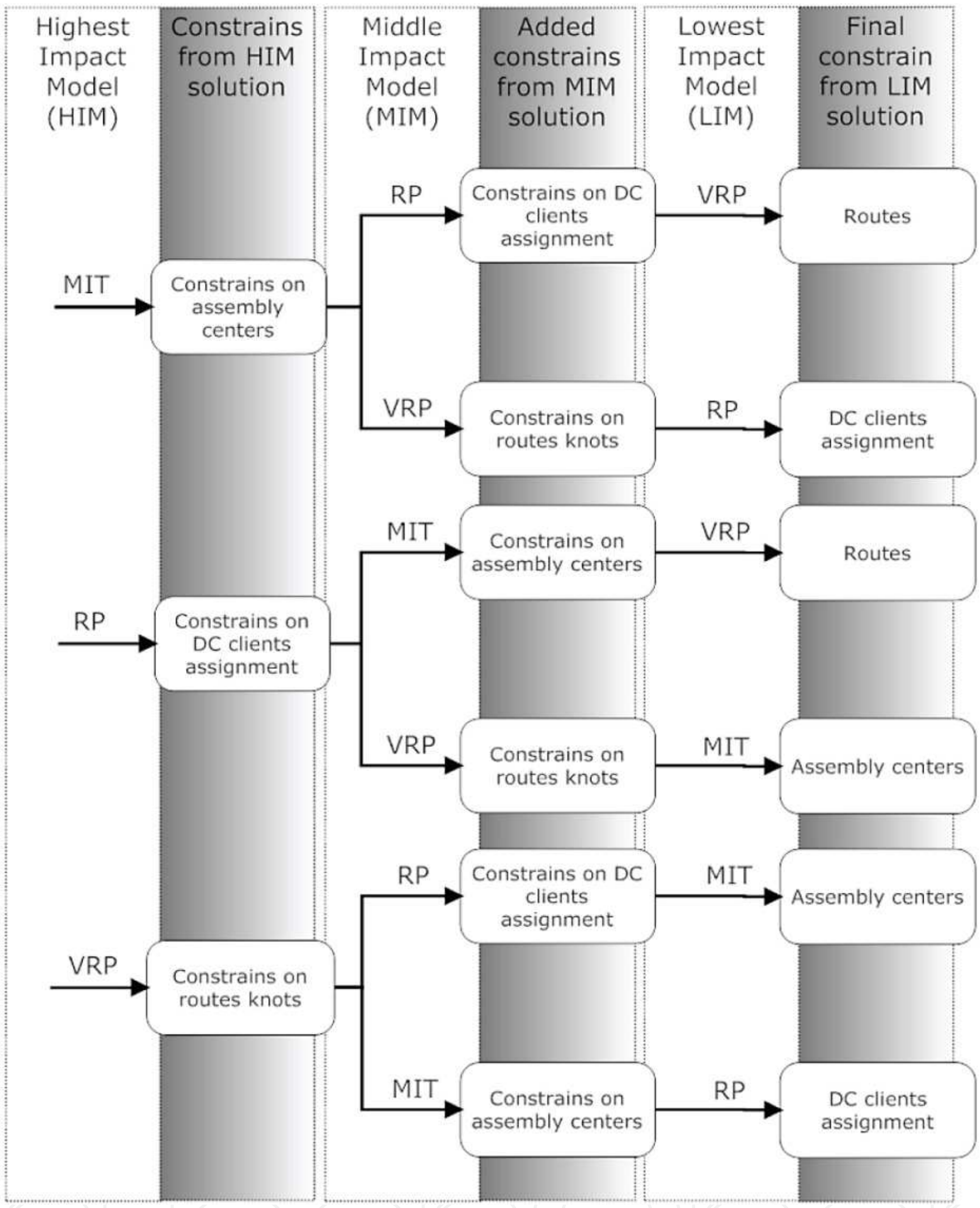

Fig. 10. Possible combinations of priorities

To avoid a classification priority where network characteristics don't allow to identify a sharp difference, a simple tool for measuring the range of impact can be developed, as shown in Table 1. Every model is compared on cost results, considering the best and the worst solution, that means the biggest possible loss for a non-appropriate configuration. Table inputs compare two perspectives a time, by rows with percentage difference between two solutions. The analysis, in terms of absolute variation and relative variation, considers the level of importance of the possible loss related to the total cost. The three pairwise comparisons express the correct priority ranking. When the result of the tool cannot identify a neat preference (values in table from 0.6 to 1) or gives a slight difference (from 0.3 to 0.6), the step-optimization has to be completely carried on for the two alternatives of sequences (in Figure 10) to compare the final cost and define the better path.

Δ_{ij}	80% - 100%	0.2	0.4	0.6	0.8	1
	60% - 80%	0.16	0.32	0.48	0.64	0.8
	40% - 60%	0.12	0.24	0.36	0.48	0.6
	20% - 40%	0.08	0.16	0.24	0.32	0.4
	0% - 20%	0.04	0.08	0.12	0.16	0.2
		0% - 20%	20% - 40%	40% - 60%	60% - 80%	80% - 100%
		$\Delta\%_{ij}$				

	High differentiation between impacts
	Medium differentiation between impacts
	Low differentiation between impacts
B_i	Best solution for the analysis *i*
W_i	Worst solution for the analysis *i*
$\Delta_i = B_i - W_i$	Weight (absolute) of non-optimization for the analysis *i*
$\Delta\%_i = 1 - B_i / W_i$	Weight (relative) of non-optimization for the analysis *i*
$\Delta_{ij} = \Delta_i / \Delta_j$	Percentage variation in the comparison between analysis i and j, calculated with absolute values
$\Delta\%_{ij} = \Delta\%_i / \Delta\%_j$	Percentage relative variation in the comparison between analysis i and j, calculated with relative values
i and j $\in$ [RP, MIT, VRP]	

Table 1. Prioritization rating

The test on the e-commerce portal ranked first MIT and then Risk Pooling and VRP. This sequence brought to a new logistics network with a merge center close to the producers, a fixed distribution center in the south of Milan and a network of drop-points on the territory, always available for deliveries of the shipper and for the pickup of the customers. The drop-points are assigned to standard routes, not to reconfigure with a day-by-day, stopping or not according to the destinations of orders.

The owners of the portal settled an agreement with producers and assigned all the traffic outbound the local area (from the merge center to the customers) to a single freight transportation supplier. This created a solid partnership that, after four months of activities, carried to the standardization of a small set of packages of standard size.

The new logistics brought a constant service level of less than five working days and a cost reduction of about 20% of the total logistics costs, considering the rent of the distribution center and the new fares agreed with the transportation supplier, chosen through a tendering process that assured the lowest available fees. Moreover, the number of complaints due to the shipping process strongly decreased, mainly because defects in quality are directly blocked at the pickup point without reaching the customers.

6. Conclusion

The study of the literature showed the importance of logistics in implementing Mass Customization strategies without paying this choice with a decrease of performances in terms of costs and service levels. Unfortunately, applications in logistics dedicated to this issue are still short in quantities and concentrated on single aspects (for example, on postponement solutions). This research is a first attempt to identify all the different aspects of the logistics design process to build a reference model for logistics managers that could take into account the requirements of shipping a great amount of small sized orders of highly personalized products.

The logistics network has to be designed considering the targets of the distribution processes, the factors that can affect decisions, the elements that have to be defined. Managers can so achieve new solutions, dedicated to customized production, through a multi-level decision process, assessing the impact of strategic, tactical and operative choices on the possible alternatives of configuration. A structured approach to model these logistics parameters is so presented to give a new perspective and support in defining the characteristics of the network.

The key result presented in the chapter is the reference model that embodies the actual state of the art with an innovative specific point of view on customization issues. The most significant outcomes can be summed up in the identification of a logical framework, applicable to different logistics problems, that integrate solutions moving from a traditional distribution network to a flexible logistics system, with no payoff on performances. The modular methodology, that has to be fed up with different mathematical models and solving algorithms to guarantee a higher speed of calculus, is dedicated to logistics so that a multi-criteria analysis can evaluate different alternatives of solution.

The actual limitations of the study open new directions of research. First, the model for logistics is general in its applicability and can be specialized on specific Mass Customization industry, such as to the distribution of automotive products, airplanes, boats, clothes, computing systems, etc. where every business has its implications, standard solutions and past experiences to develop. Secondly, the analysis defined a high-level reference model but it still needs to be accompanied in real cases with decision support systems, methodologies of improvement, optimization analysis and algorithms to face every single decision of network configurations. A deep research to classify best practices, available for this peculiar issues, could be useful to provide a complete handbook for logistics in Mass Customization.

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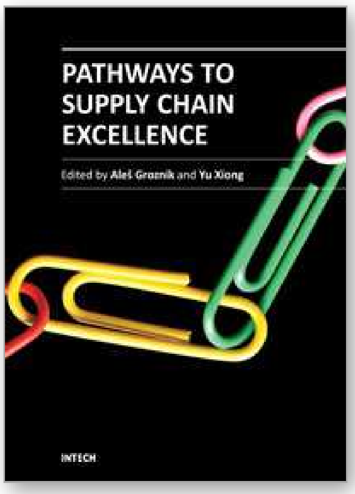

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Over the last decade, supply chain management has advanced from the warehouse and logistics to strategic management. Integrating theory and practices of supply chain management, this book incorporates hands-on literature on selected topics of Value Creation, Supply Chain Management Optimization and Mass-Customization. These topics represent key building blocks in management decisions and highlight the increasing importance of the supply chains supporting the global economy. The coverage focuses on how to build a competitive supply chain using viable management strategies, operational models, and information technology. It includes a core presentation on supply chain management, collaborative planning, advanced planning and budgeting system, risk management and new initiatives such as incorporating anthropometry into design of products.