International Journal of Supply and Operations Management

IJSOM

August 2016, Volume 3, Issue 2, pp. 1253-1266
ISSN-Print: 2383-1359
ISSN-Online: 2383-2525
www.ijsom.com

A Supply Chain Design Problem, Integrated Facility Unavailability Management

Fouad Maliki[a,*], Mustapha Anwar Brahami[a], Mohammed Dahane[b], Zaki Sari[c]

[a]*Preparatory school on sciences and techniques, MELT Laboratory, Tlemcen, Algeria*
[b]*Ecole Nationale d'Ingénieurs de Metz (ENIM), Laboratoire de Génie Industriel et de Production de Metz (LGIPM), Metz, France*
[c]*Abou Bekr Belkaid University, MELT Laboratory, Tlemcen, Algeria*

Abstract

A supply chain is a set of facilities connected together in order to provide products to customers. The supply chain is subject to random failures caused by different factors which cause the unavailability of some sites. Given the current economic context, the management of these unavailability is becoming a strategic choice to ensure the desired reliability and availability levels of the different supply chain facilities. In this work, we treat two problems related to the field of supply chain, namely the design and unavailability management of logistics facilities. Specifically, we consider a stochastic distribution network with consideration of suppliers' selection; distribution centers location (DCs) decisions and DCs' unavailability management. Two resolution approaches are proposed. The first one called non-integrated approach consists of defining the optimal supply chain structure using an optimization approach based on genetic algorithms (GA), then to simulate the supply chain performance in the presence of DCs failures. The second approach called integrated approach is to consider the design of the supply chain problem and unavailability management of DCs in the same model. Note that, we replace each unavailable DC by performing a reallocation using GA in the two approaches. The obtained results of the approaches are detailed and compared to show their effectiveness.

Keywords: Supply chain Management; Location-allocation; Suppliers selection; Genetic Algorithms.

Corresponding author email address: f.maliki@epst-tlemcen.dz

1. Introduction

A supply chain is a network of facilities and distribution options that performs the functions of materials procurement, transforming those materials into intermediate and finished products, and finished products distribution to customers. As technological complexity has increased, logistics and supply chains have become more complex and dynamic. Companies need to increase their flexibility in order to remain competitive and be able to respond to rapidly changing markets (Ding H. et al., 2008). Today's customers demand products of a higher quality at a lower price, on-time delivery, and excellent after-sale services. From companies' point of view, customers prove to be increasingly influential in terms of purchasing and negotiating power. Hence, companies have to co-operate or coordinate with suppliers to maximize the productivity at the lowest cost while satisfying customer requirements. The supply chain design requires the consideration of different decisions divided -according to their temporal influences- to three levels: strategic, tactical and operational decisions.

The location and the choices related to different entities (suppliers, factories, inventory, and distribution facilities) and the different used transportation modes are some of strategic decisions that companies look to optimize first. This optimization approach which traditionally focuses on costs has become difficult due to the introduction of new decision criteria such as customer satisfaction (delivery time, product and / or service quality, ...), and the explicit consideration of different risks (social, environmental and economic). These decisions can become increasingly complex and difficult to manage due to uncertain events. The uncertainty affecting the system can significantly impact the supply chain performances.

Various risks and uncertainties that could affect the network are usually neglected in many distribution networks design problems. These risks can cause the unavailability of a site (distribution center (DC), suppliers, etc..) it also can be the result of an external event such as a natural disaster (tsunami), epidemic, war (military invasion) or an internal problem such as a conflagration. The unavailability of one or more logistics sites have disastrous effects on the system and leads to losses related to customer demands or transportation modes and other losses such as lack of raw materials. For this, it is necessary to take these risks and uncertainties into account in modeling and solving supply chain design problems in order to approach reality as possible (Tanonkou G. A., 2007).

In this work, we treat two problems related to the field of supply chain, namely the design and unavailability management of logistics facilities. Two resolution approaches are proposed. The first approach called non-integrated consists of defining the optimal supply chain structure using an optimization approach based on genetic algorithms (GA), then to simulate the supply chain performance with the presence of DCs failures. The second approach called integrated approach is to consider the design of the supply chain problem and unavailability management of DCs in the same model. Note that, we replace each unavailable DC by performing a reallocation using GA in the two approaches.

The rest of the paper is organized as follows: section 2 presents some research works dedicated to location-allocation, supplier's selection and facility reliability problems. Section 3 describes the problem under consideration. Section 4 illustrates the proposed optimization and simulation approach. Section 5 shows the obtained results and their analysis. Section 6 concludes the paper with some directions for future research works.

2. State of the art

The problem addressed in this paper originates mainly from three research areas: suppliers selection, facility location problems and facility reliability problems that have been widely addressed. However, few of the existing works consider these three decisions simultaneously. The interactions of suppliers selection, facility location, and reliability have not been considered previously. This section summarizes briefly the proposed approaches and the obtained results in the literature for the three problems mentioned above.

Meixell and Gargeya (Meixell M. J. and Gargeya V. B., 2005) reviewed the model-based literature for the global supply chain design problem by using dimensions related to ongoing and emerging issues in supply chain globalization. Overall, they realized that although the research community has tackled some of the most difficult global supply chain issues, few models comprehensively address outsourcing, integration, and strategic alignments in global supply chain design. They concluded that 'global supply chain models need to address the composite supply chain design problem by extending models to include both internal manufacturing and external supplier locations', 'global supply chain models need broader emphasis on multiple production and distribution tiers in the supply chain', 'the performance measures used in global supply chain models need to be broadened in definition to address alternative objectives', and 'more industry settings need to be investigated in the context of global supply design'.

In (Bischoff M. and Kerstin D., 2009), the authors consider a general class of location-allocation problems with n candidate sites. A mixed integer multidimensional optimization problem is presented; the authors compare several methods for solving this problem such as neighborhood search, tabu search and evolutionary algorithms.

Stochastic versions of the joint inventory-location model are firstly presented in (Shen Z. J. M. et al., 2003) and (Daskin M. S., et al., 2006). Tanonkou et al. treat a stochastic distribution network design problem where decisions of suppliers' selection, DCs location and the assignment of customers to DCs are integrated into a single optimization model (Tanonkou G. A., et al., 2007). The studied network is composed of multiple suppliers supplying with random delays, a set of DCs to locate which meet demands (of a specific type of products) from different demand areas/customers. By hypothesis, each supplier is connected to each potential DC by a single transport connection. The objective is to choose the best suppliers, best locations for DCs, and the best assignments of customers to DCs in order to minimize a nonlinear cost function. The authors propose a lagrangian relaxation based method to solve the problem. This problem is addressed by Maliki and Sari (] Maliki F. and Sari Z., 2013) which propose a multicriteria genetic algorithm for its resolution in order to optimize the transport time and an oriented cost function. The same authors studied this problem by using different inventory management policies at the DCs to see the considered policies impact on the supply chain structure (Maliki F. and Sari Z., 2012).

Maliki et al. (Maliki F. et al., 2011) considered the problem treated in (Maliki F. and Sari Z., 2013) and presented a sensitivity analysis of some parameters on the obtained supply chain structure. More specifically, the authors studied the impact of transportation costs, inventory management costs and customer demand and supply lead time variances on the supply chain structure. The authors concluded that the number of opened DCs increases by the increment of transportation and inventory management costs and decreases when customer demand and supply lead time variances increase.

Motivated by uncertainty reduction and customer service improvement, many companies are interested in multiple sourcing, i.e. to engage with more than one supplier at the same time. In the design of any supply chain, finding a method/approach for suppliers selection problem is crucial. According to De Boer et al. (De Boer L. et al., 2001) the suppliers' selection goes through four steps: problem definition, selection criteria for evaluating suppliers, suppliers pre-qualification and final suppliers' selection. In this work the authors present some methods solving the suppliers selection problem, discuss different works related to this problem and classify the works based on the four presented steps.

The suppliers selection decision is complicated because several qualitative and quantitative criteria should be considered. For more details on the existing research for this subject the reader may consult the reference (Jain V. et al., 2009) wherein the authors present a complete state of the art about suppliers selection problem, and describe the various steps taken into consideration in the suppliers selection cycle and the different criteria used for evaluating suppliers performances. In addition, the authors present the characteristics of this problem and the available methods in the literature to solve it.

Our objective is to integrate location-allocation and suppliers selection decisions in the same model while taking into account facilities unavailability. Note that few works integrate these decisions in the same model and address reliability problem in the supply chains design.

In (Simchi-Levi D. et al., 2002), the authors present convincing arguments that supply chains are particularly vulnerable to intentional or accidental disruptions and propose possible approaches to reduce these disruptions. However, the authors don't present quantitative models to solve these problems.

Snyder (Snyder L. V., 2006) presents a detailed state of the art on robust and stochastic facility location problems; the author illustrates the optimization approaches variety under uncertainty existing in the literature and their application to facility location problems.

Snyder and Daskin (Snyder L. V. and Daskin M. S., 2003) present location-allocation models based on the P-median and incapacitated facility location problem (UFLP). The objective is to minimize transportation costs, taking into account transportation costs generated in the case of facilities unavailability. The authors present a Lagrangian relaxation for solving these problems.

Maliki et al. (Maliki F. et al., 2013) consider the same distribution network studied in the reference (Maliki F. and Sari Z., 2013) with DCs maintenance inclusion. The authors propose a simple genetic algorithm in order to obtain the optimal supply chain structure. Then a simulation of the supply chain performance in the presence of possible DCs failures is performed. Two simulation strategies are developed, one incorporating a maintenance policy and the other without maintenance policy. The authors present and compare the obtained results of both strategies demonstrating the benefits and performance of the incorporating maintenance policy.

Tanonkou et al. address the unreliable facilities distribution network design problem (Tanonkou G. A., 2007). The author proposes two different design models with Monte Carlo optimization combined Lagrangian relaxation resolution method. The first model concerns a single supplier / single product distribution network with unreliable DCs (Tanonkou G. et al., 2006) and the second model is a multi-supplier / single product distribution network with unreliable suppliers (Tanonkou G.et al., 2013). In their works, the author considers that unavailable facilities are lost permanently; this is not the case of our problem in which we suppose that DCs are unavailable for a specific period of time and become operational after that period.

In (Brahami M. A. et al., 2014) consider a stochastic distribution network with suppliers selection and distribution centres location (DCs) decisions and DCs' unavailability management. The proposed resolution approach consists of firstly on defining the optimal supply chain structure using an optimization approach based on genetic algorithms (GA), then to simulate the supply chain performance in the presence of DCs failures. Two simulation strategies are performed; one by replacing each unavailable DC with the closest DC and the other consists of performing a reallocation using genetic algorithm.

3. Problem and mathematical formulation

3.1. General problem definition and hypothesis

The studied problem in this work is based on a supply chain that consists of a set of potential suppliers connected to a set of retailers, every retailer is identified by his/her location zone (town or region) and every zone represents a potential zone of DC location. Located DCs satisfy the random single commodity demands generated by retailers. To manage inventory in DCs, the economic order quantity (EOQ) policy is used by each DC, and a safety stock level is kept to ensure a given retailer service level is going to be protected against the possibility of stockouts during the supply lead-time. The supply lead-time for deliveries from the suppliers to the DCs is random. Figure 1 illustrates the considered supply chain structure.

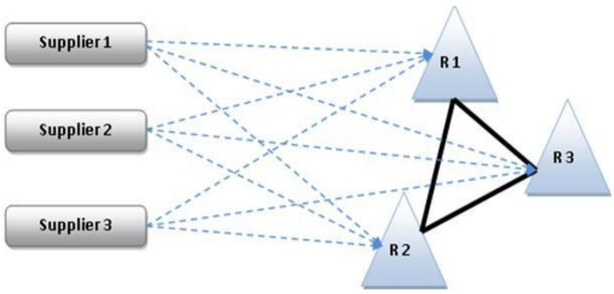

Figure 1. The studied supply chain structure

We assume that the considered supply chain copes with DCs failures that make them unavailable. The nature of these failures is of various origins: natural disasters, unavailability of transport road, workers strike and terrorism acts etc. However, the supply chain should be robust and in correct running every time a DC failure occurs.

Two resolution approaches are proposed, the first one (non-integrated approach) is divided into two distinct steps E1 and E2. The first step consists of finding the optimal structure of the supply chain by assuming that all DCs are operational. Contrariwise, in the second step one or more DCs may become unavailable; the objective of this step is to optimize the management of these unavailability. So, the resolution of this problem consists of solving the problem during the step E1 by taking three types of decisions that are: location of DCs, DCs to retailers allocation and selection of suppliers. This problem is solved by using a genetic algorithm (Maliki F. and Sari Z., 2013) and (Maliki F. et al., 2013). This algorithm provides the optimal structure of our distribution network.

Based on the supply chain structure obtained in the first step, the second step consists of simulating the supply chain performance while taking into account possible failures of one or more DCs. We assume that the DCs cannot be simultaneously unavailable. The objective of this step is to optimize the unavailability management of DCs in order to minimize the total generated cost (Brahami, M.A. et al., 2014).

The second approach (integrated approach) consists of defining the optimal supply chain structure and simulate its performance in the presence of DCs failures at the same time in order to minimize the total generated cost.

Note that for both approaches, at each unavailability of a DC, a reallocation by using a genetic algorithm optimization (AG) is used for the replacement. Reallocation is equivalent to running the GA considering only retailers affected by unavailability and operational DCs (Brahami, M.A. et al., 2015).

A comparative study between the two approaches is performed. It enables us to highlight the earnings generated by the integrated approach versus the non-integrated approach.

3.2. Used variables and notations

We use the following variables and notations for the mathematical formulation of the considered problem:

The used notations are:

I: Set of retailers indexed by i;
K: Set of suppliers indexed by k;
DC_j: DC located at retailer j;
μ_i: Global demand of retailer i;
D_j: Daily demand of DC_j;
σ_i^2: Global demand variance of retailer i;
f_j: Fixed annual cost of locating DC_j;
d_{ij}: Per-unit shipment cost from DC_j to retailer i;
h_j: Inventory holding cost per unit per year in DC_j;
F_{jk}: Fixed order cost (including transport fixed cost) placed by DC_j at the supplier k;
a_{jk} : Per-unit shipment cost (purchase and transport costs) from supplier k to DC_j;
L_{jk} : Mean lead-time in days from supplier k to DC_j;
λ_{jk}^2 : Variance of lead-time from supplier k to DC_j;
α : Desired service level at DCs;
Z_α : Standard normal variate such that $P(Z \leq z_\alpha)$;
$C_{unav\ j}$: Total cost of DC_j unavailability;
$\Phi_j(E_2)$: Number of DC_j unavailability during step E_2;
$M_{unav\ j}$: Mean cost of DC_j unavailability;
$C(E_1)$: Global generated cost in the step E_1;
$CGI(I)$: Unavailability management cost of the integrated approach;
$CGI(NI)$: Unavailability management cost of the non-integrated approach.

The decision variables are:

X_j = {1 if DC_j is located; 0 otherwise};
Y_{ij} = {1 if retailer i is served by DC_j; 0 otherwise};
Z_{jk} = {1 if supplier k is selected to supply DC_j; 0 otherwise};

3.3. Mathematical formulation

Based on the reference (Tanonkou G. A. et al., 2007), in this section we present our problem‘s mathematical formulation. The resolution of the problem allows us to determine the decision variables X_j, Y_{ij} and Z_{jk} and therefore our supply chain structure (Maliki F. and Sari Z., 2012). The mathematical formulation of the problem is as follows:

$$(MF)\ J^* = \min_{X,Y,Z} J(X,Y,Z)$$

With $J(X,Y,Z)$ defined by

$$J(X,Y,Z) = \sum_{j\in I} f_j X_j + \sum_{j\in I}\sum_{i\in I} \mu_i d_{ij} Y_{ij} + \sum_{j\in I}\sum_{i\in I}\sum_{k\in K} \mu_i a_{jk} Y_{ij} Z_{jk} + \sum_{j\in I}\sum_{k\in K} \sqrt{2h_j F_{jk} \sum_{i\in I} \mu_i Y_{ij}}\, Z_{jk} + \sum_{j\in I}\sum_{k\in K} Z_\alpha h_j \sqrt{L_{jk} \sum_{i\in I} \sigma_i^2 Y_{ij} + \lambda_{jk}^2 D_j^2}\, Z_{jk} \quad (1)$$

Subject to

$$\sum_{j\in I} Y_{ij} = 1 \qquad \forall i \in I \quad (2)$$

$$\sum_{k\in K} Z_{jk} = X_j \qquad \forall j \in I \quad (3)$$

$$Y_{ij} \le X_j \qquad \forall i, j \in I \quad (4)$$

$$X_j, Y_{ij}, Z_{jk} \in \{0,1\} \qquad \forall i, j \in I, \forall k \in K \quad (5)$$

The objective function (1) minimizees the sum of the following costs: fixed cost of locating facilities, shipment plus transportation costs from DCs to retailers and from suppliers to DCs, the third term represents the total inventory costs at the DCs (assuming that each DC uses an EOQ policy) and the last term represent the costs of holding safety stock at the DCs to maintain a service level α. Constraint (2) ensures that each retailer is assigned to one located DC. Constraint (3) assumes that each open DC is supplied by a single supplier. Constraint (4) states that retailers can be only assigned $(Y_{ij} = 1)$ to opened DCs$(X_j = 1)$. Constraints (5) are standard integrity constraints.

4. Resolution approach

4.1. Non-integrated approach

In this approach, we divide our study in two st ages. To solve the problem (MF) during the first stage E1, a genetic algorithm is used to determine the optimal supply chain structure. In our case, a candidate solution is composed of binary values 0 or 1, where each chromosome is composed of three parts. The first part represents the DCs location, the second part shows the allocation of retailers to DCs and the third part represents the assignment of DCs to suppliers. We calculate the fitness of each candidate solution using equation (1) to obtain the total generated cost (see section 3.3).

Therefore, a chromosome represents a supply chain structure; it is composed of three parts corresponding to the three decision variables Xj, Yij and Zjk (see section 3.3). Thus, a representation in integers is used where each gene can have the value 0 or 1. An example of chromosome corresponding to a problem with 4 retailers (we have 4 candidates DCs since DCs are located in the same regions as retailers) and 3 potential suppliers is shown in Figure 2.

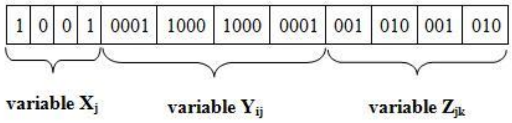

Figure 2. A chromosome example

The GA used steps are as follows:

- **Step 1.** Generate the initial population P of size N randomly.
- **Step 2.** Evaluate all solutions of P by calculating their fitness.
- **Step 3.** Select two parents using the « binary tournament selection ». It consists of selecting two solutions of the population P randomly and choosing the lowest fitness solution.
- **Step 4.** Generate two children solutions by crossing the two parents using single point crossover with probability$0.25 \leq Pc \leq 0.95$.
- **Step 5.** Execute the mutation operator using deterministic mutation with probability $0.05 \leq Pm \leq 0.1$ for the two generated children.
- **Step 6.** A correction procedure is executed if the obtained solution is infeasible*.
- **Step 7.** Add both children in the next population G.
- **Step 8.** Repeat steps 3 to 7 until having N solutions in G.
- **Step 9.** Repeat steps 2 to 8 until the stopping conditions are satisfied (The number of iterations NI_{max}=20).

*A solution is called infeasible if it does not respond to problem constraints. Thus, a chromosome modification procedure is executed after mutation to verify the following constraints:

- A candidate solution is correct if at least one DC is located;
- Each retailer is served by one DC;
- Each open DC is supplied by one supplier;
- If a DC serves a retailer, it must be located.

For the step E2, one or more DCs may become unavailable. This step consist of performing for each DC unavailability a new allocation for retailers affected by the unavailability, this means running the same GA as the first period with considering operational DCs and retailers affected by the unavailability. During this step, the unavailability management cost $CGI(NI)$ is equal to the sum of delivery costs, shipment costs, inventory and maintain safety stock costs and DCs unavailabilities costs. None location cost (investment cost) will be generated during the second step, since there will not be new DCs locations (Brahami M. A. et al., 2014).

For each DC the unavailability cost is calculated as follows:

$$C_{unav\ i} = \Phi_i(E_2)M_{unav\ j} \tag{6}$$

Where,

$C_{unav\ i}$: DC_i Unavailability total cost;
$\Phi_i(E_2)$: DC_i Unavailability number during step E_2;
$M_{unav\ i}$: Per DC_i unavailability mean cost.

4.2. Integrated approach

In this approach, we use the above genetic algorithm with the same chromosome representation, except that one or more DCs may become unavailable during the determination of the supply chain structure. In this case, at each unavailability of a DC, a reallocation by using a genetic algorithm optimization is used for the replacement. Reallocation is equivalent to running the GA considering only retailers affected by unavailability and operational DCs. The total generated cost is calculated using equations (1) and (6).

In Order to compare the effectiveness of the two approaches, we calculate the unavailability management cost after obtaining the supply chain structure using the same scenarios like the non-integrated approach in the step E2. This cost $CGI(I)$ is equal to the sum of delivery costs, shipment costs, inventory and maintain safety stock costs and DCs unavailability costs.

5. Obtained results and analysis

This section evaluates the performance of our proposed approaches; we studied different supply chains instances of different sizes. The instances are obtained by varying the number of retailers who represent the candidate DCs number and the number of suppliers. We considered five different scenarios for each instance depending on DCs unavailability (numbers, times and duration of unavailability). The numerical experiments are performed using a Pentium core 2 Duo 2.20 GHZ and 2 GB of RAM. Note that the simulation programs of the two steps are implemented in "VBA" language. The used parameters are presented as follows:

- **The number of retailer's location (#RL):** we have considered problems with 10, 15, 20, 30, 40 and 60 retailers (each retailer location can be selected to host a DC).

- **The number of suppliers (#F):** we have considered problems with 4, 6, 8, 12, 15 et 18 suppliers.

- **Retailer demands:** for each retailer, the mean demand μ_i is discretized through time t, it is randomly generated with $\mu_i(t) \sim U\,[100,\ 1600]$.

- **Supply lead times:** for each potential location, the average supply lead time is randomly generated with $L_{ik} \sim U\,[10,\ 30]$.

- **The standard deviations of demand and supply lead time:** are randomly generated with $\sigma_i \sim U[50,\ 100]$ and $\lambda_j \sim U[5,\ 10]$.

- **Fixed facility location cost** (f_j)**, transportation cost** (a_{jk}) **and shipment cost** (d_{ij})**:** are randomly generated with respect to $f_j \sim U[4500,\ 10000]$, $a_{jk} \sim U[2,\ 10]$ and $d_{ij} \sim U[1,5]$.

- **Desired service level:** $\alpha = 97.5\%$ for $Z\alpha = 1.96$ for all studied problems.

- **Inventory holding costs** (h_j)**:** constant value for all DCs equal to 25.

- **Fixed ordering costs** (F_j)**:** constant value for all DCs equal to 50.

- **Per unavailability mean cost** $(M_{unav\ j})$**:** this cost is generated randomly for each DC with $M_{unav\ j} \sim U[1000,\ 5000]$.

- **Mean time between unavailability (MTBU) and unavailability mean time (UMT):** are randomly generated for each DC with $\sim U[100,\ 250]$ **and** $UMT \sim U[15,\ 30]$.

- **Simulation time** (E_1, E_2)**:** we have considered 1250 working days (5 years) for each step.

The Table 1 shows the obtained results for each instance of our problem. These results represent the supply chain structure (located DCs and selected suppliers) and the unavailability management cost for the two proposed approaches ($CGI(NI)$ and $CGI(I)$) obtained for five different scenarios simulation.

Table 1. The obtained results

Instances		Non-integrated approach			Integrated approach			Comparison
#RL	*#F*	*#DC*	*#S*	*CGI(NI)*	*#DC*	*#S*	*CGI(I)*	Earnings
10	4	*6*	*3*	*664.502*	*3*	*2*	*214.695*	67.69 %
15	6	*6*	*3*	*441.115*	*5*	*4*	*258.839*	41.32 %
20	8	*10*	*5*	*828.525*	*7*	*5*	*304.989*	63.18 %
30	12	*17*	*9*	*842.781*	*11*	*6*	*618.232*	26.64 %
40	15	*15*	*11*	*1195.127*	*15*	*10*	*666.352*	44.24 %
60	18	*26*	*13*	*1455.509*	*19*	*11*	*1200.487*	17.52 %

- *#DC*: Number of located DCs;

- *#S*: Number of selected suppliers;
- $CGI(I)$ *:* unavailability management cost of the integrated approach ;
- $CGI(NI)$ *:* unavailability management cost of the non-integrated approach.
- *Earnings*: Earnings in unavailability management cost by comparing strategies;
- The costs are in millions money unit.

From Table 1, we see that the unavailability management cost increases by the increment of the number of located DCs and selected suppliers. It is also clear that the unavailability management cost obtained by the integrated approach are lower than those obtained by the non-integrated approach during the second step, with winnings percentages between 17% and 67%. The obtained results clearly show that unavailability management optimization using an integrated approach leads in better results.

6. Conclusion and Perspectives

In this article, we studied location -allocation integrated suppliers selection problem with DCs unavailability. Firstly, we used a non-integrated approach which consists of using a genetic algorithms based optimization to solve a stochastic distribution network problem design where the strategic decisions of suppliers selection, DCs location and retailers allocation are integrated in the same model. Then, a simulation of the considered supply chain was performed with the presence of possible DCs unavailability wherein we replace each unavailable DC by performing a reallocation using GA. The second approach consists of using an integrated approach wherein we consider the same stochastic distribution network problem with unavailability management i.e. one or more DCs may become unavailable during the determination of the supply chain structure. We used the same genetic algorithm to solve this problem. After obtaining the supply chain structure for both approaches, we calculate the unavailability management cost for the same scenarios. The comparison between the two strategies through generated earnings has shown that the integrated approach strategy provides better performances in the DCs unavailability management.

This work has identified several future directions research. The most immediate area is to consider other meta-heuristics for structuring supply chain optimization; it is also possible to extend the problem to a maintenance integrated approach. In this direction a DCs maintenance policy can be considered to reduce failures number and improve the DCs unavailabiliies management.

References

Bischoff M. and Kerstin D., 2009. Allocation search methods for a generalized class of location–allocation problems, European Journal of Operational Research, Vol. 192, pp. 793-807.

Brahami M. A., Maliki F., Dahane M. and Sari Z., 2014. Conception et gestion des indisponibilités des sites dans les chaînes logistiques, 10 ème Conférence Francophone de Modélisation, Optimisation et Simulation- MOSIM'14 – 5 au 7 novembre 2014, Nancy, France.

Brahami, M.A., Maliki, F., Dahane, M. & Sari, Z., 2014. Gestion des indisponibilités des sites dans le problème de localisation et sélection des fournisseurs, Proceedings of the 7ème édition du Colloque International de la logistique et du Supply chain Management (LOGISTIQUA 2014), Fès, Maroc.

Brahami, M.A., Maliki, F., Dahane, M. & Sari, Z, 2015. Supply chain design and unavailabilities management, Proceedings of The12th International Conference on Logistics and Sustainable Transport (ICLST),

Daskin M. S., Coullard C. and Shen Z. J. M., 2006. An inventory-Location Model: Formulation, Solution Algorithms and Computational results, Annals of Operations Research, 110, pp. 83-106.

De Boer L., Labro E. and Morlacchi P., 2001. A review of methods supporting supplier selection, European Journal of Purchasing and Supply Management, 7, pp. 75-89.

Ding H., Benyoucef L. and Xie X., 2008. Simulation-based evolutionary multi-objective optimization approach for integrated decision-making in supplier selection, International Journal of Computer Applications in Technology, 31(3/4) pp. 144-157.

Jain V., Benyoucef L. and Deshmukh S. G., 2009. Strategic supplier selection: some emerging issues and challenges, Int. J. Logistics Systems and Management, vol. 5, No. ½, pp. 61-88.

Maliki F. and Sari Z., 2013. Resolution of stochastic supply chain design problem by metaheuristic, The international conference Control, Decision and Information Technologies (CODIT'13), Hammamet, Tunisie, 06 - 08 Mai.

Maliki F. and Sari Z., 2012. Etude comparative des politiques de gestion de stock lors de la conception des chaînes logistiques, 9e conférence internationale de Modélisation, Optimisation et Simulation (MOSIM'12), Bordeaux, France, 06 – 08 Juin.

Maliki F., Benyoucef L. and Sari Z., 2011. Sensivity anlysis for a stochastic multi modal location-allocation integrated suppliers selection problem, the international conference on Industrial Engineering and System Management (IESM 2011), Metz, France, 25–27 May.

Maliki F., Brahami M. A. and Dahane M., 2013. Optimisation du problème de localisation et sélection des fournisseurs sous contrainte de maintenance, 8 éme Conférence internationale de Conception & Production Intégrées, Tlemcen, Algèrie, 21-23 octobre.

Meixell M. J. and Gargeya V. B., 2005. Global supply chain design: A literature review and critique, Transportation Research, Part E, 41pp, 531-550.

Shen Z. J. M., Coullard C. and Daskin M. S., 2003. A Joint Location-Inventory Model, Transportation Science, 37(1), pp. 40-55.

Simchi-Levi D., Snyder L. V. and Watson M., 2002. Strategies for Uncertainty times. Supply Chain management Review, Vol 6 N° 1, pp. 11-12.

Snyder L. V., 2006. Facility location under uncertainty: a review, IIE Transactions, 38:7, pp. 547-564.

Snyder L. V. and Daskin M. S., 2003. Reliability Models for Facility Location: the expected failure case, Presented at the INFORMS workshop on Managing Risk in an Uncertain World, Northwestern University, Evaston.

Tanonkou G. A., 2007. Une approche par relaxation lagrangienne pour l'optimisation d'un réseau de distribution : modèles stochastiques et fiables, Thèse de doctorat, université Paul Verlaine de Metz.

Tanonkou G. A., Benyoucef L. and Xie X., 2007. Joint Facility Location and Supplier Selection Decisions of distribution Networks with Random Supply Lead Time, International Conference on Industrial Engineering and Systems Management (IESM 2007), Pékin, Chine, pp. 1-10.

Tanonkou G. A., Benyoucef L. and Xie X., 2006. A Two-Period Stochastic programming Model for Distribution network Design, Proceedings of the 12th IFAC Symposium on Information Control Problems in Manufacturing, St Etienne, France, pp. 377-382, 17-19 Mai.

Tanonkou G. A., Benyoucef L. and Xie X., 2013. Supply chain network design with unreliable suppliers: a Lagrangian relaxation-based approach, International Journal of Production Research, 51:21, pp. 6435-6454.