7th IFAC Conference on Manufacturing Modelling, Management,
and Control
International Federation of Automatic Control
June 19-21, 2013. Saint Petersburg, Russia

Dynamic Models for Green Logistic Networks Design

C. Serrano*,W. Aggoune-Mtalaa, N. Sauer*****

**Laboratoire de Génie Industriel et Production de Metz, ENIM, France (e-mail: chiristian.serrano@hotmail.fr).*
***Centre de Recherche Public Henri Tudor (e-mail: wassila.mtalaa@tudor.lu.)*
**** Laboratoire de Génie Industriel et Production de Metz, Université de Lorraine,*
France (e-mail: nathalie.sauer@univ-metz.fr)

Abstract: Nowadays, the relationship industry-environment plays a significant role in business and supply chain management. Due to legislation pressures, consumer awareness and economic interest in used products, the concept of Green Supply Chain Management was born, with Reverse Logistics as principal driver. Designing a green logistic network consists in integrating environmental aspects in strategic decision making towards the location of logistic facilities. In this work mixed integer linear programming models are proposed for the design of a reverse logistic network. The innovative aspects of this study are: the assumption of a dynamic, multi-product environment and the uncertainty of used products returns. CPLEX software is used to formulate and solve the models. A results analysis is presented as well as possible research avenues.

*Keywords:*Reverse logistics, Green logistic network design, Dynamic models, Product recovery, Uncertainty, MILP.

1. INTRODUCTION

Traditionally the main objective of manufacturers is to offer new products and services to the market. They are heavily involved in adding value throughout the supply chain, from suppliers to final customers. The return of products was first considered as an activity primarily annoying and unprofitable, in consequence reverse supply chains were originally designed to minimize cost and effort (Schuh et al., 2011). However, in the past decades there has been a growing interest in studying the design of such networks. The main reasons are: First, governments around the world have reacted to the progressive shortage of natural resources and the result is some environmental laws that restrict every-day business operations. One of them is the emissions of greenhouse gases due to transport. This constraint will be included in the model proposed in this paper. Secondly, at the same time, consumers are increasingly aware of this problem and their purchasing criteria are oriented towards "green" products. Last, companies have noticed the economic potential of returned products, as well as the possibility of generating a competitive advantage through reverse logistics.

2. RELATED WORK

Rogers and Tibben-Lembke (1999) define reverse logistics as the process of planning, executing and monitoring, in an efficient and cost effective way, all flows of raw materials, stocks, products and information from the point of consumption to point of origin in order to regain value or proper disposal. Several research studies classify reverse logistics activities in two groups: product return and product recovery (Fleischmann et al., 1997; Srivastava, 2007 and Schuh et al., 2011). Each group of activities is conducted in specific facilities, namely: collection centres for returns and reprocessing sites for recovery (Mtalaa et al., 2010). Figure 1 summarizes the activities within direct and reverse supply chains, and shows the relationships that may exist between the two of them.

One of the most delicate activities in reverse logistics is the green network design: Indeed the great degree of uncertainty that accompanies the product return must be taken into account, in terms of quantity and quality. Moreover, these product returns can take place at different times of the year. In addition, markets for these products are not always well known, this fact causes problems of capacity planning and location of collection centres and remanufacturing sites. Finally, several types of products must be collected and processed at a time, to improve transportation and ensure optimal performance of remanufacturing centres. These aspects are generally ignored in a reverse context (Pokharel and Mutha, 2009). Even in the forward supply chain design domain, they are not treated all together but rather separately as in the work of (Hinojosa et al., 2008) or (Gourdin and Klopfenstein, 2008) where dynamic models with capacity issues are proposed. In our model we include all relevant aspects of reverse logistics to better reflect what happens in reality.

We propose a dynamic model to solve a two-level facility location problem with capacity constraints for the design of green logistic networks, covering several types of products at a time. The environmental costs of transport in terms of greenhouse gases emissions are included in the model. The problem is formulated using mixed integer linear programming considering the reverse flow of several types of products at the end of their lifecycle. To solve the problem, an approach based on the simplex and Branch and Bound methods is chosen. CPLEX software will be used for the resolution.

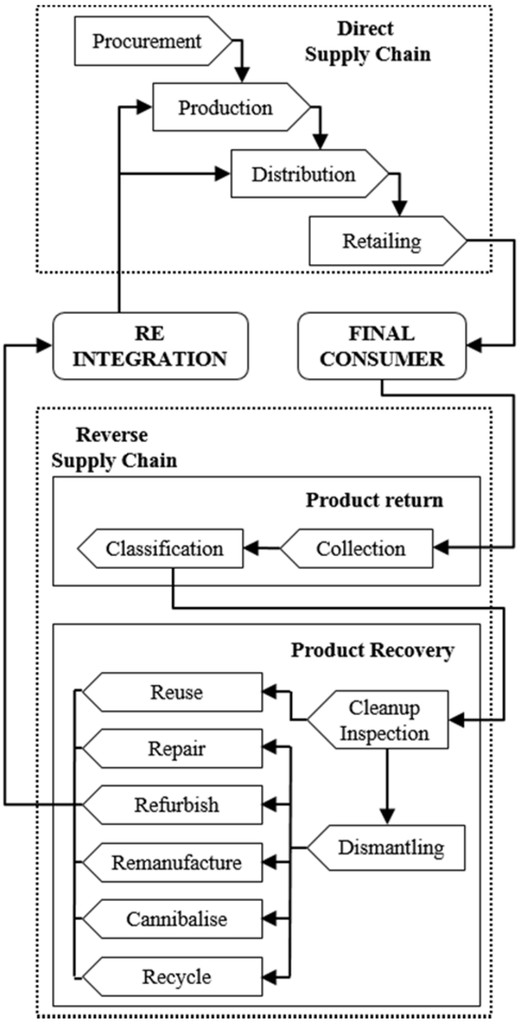

Fig. 1. Direct and reverse supply chains' activities.

3. FIRST MODEL

Figure 2 shows the logistic networktreated in this paper. Used products are returned by consumers to collection points; this may be, for example, supermarkets. Besides classifying products by type, no other activity is performed at this stage. Afterwards, products are shipped to treatment centres. After a cleanup and an inspection, they are classified according to their quality level. From these treatment centres, products may be shipped to remanufacturing facilities, subcontractors, to secondary markets or to recycling centres.

3.1 Hypothesis

In this work, the following assumptions are made:

- Product returns are supposed to be normally-distributed. Means and standard deviations are known and are input data. These values are different for each collection point.
- Each collection point is assigned to only one treatment centre. All the returned products belonging to this collection point will be therefore transported to this centre.
- A percentage of used products have a sufficiently good quality level to be sold in the secondary market.On the other hand, a percentage of used products must be shipped to recycling centres, given their poor quality level.
- Demand for subcontractors and secondary market are known, as well as products' selling prices to subcontractors, secondary market and remanufacturing facilities.
- In treatment centres, processing time is roughly the same for all types of products. In addition, the maximum capacity of these facilities is given in number of products per period.
- For remanufacturing facilities, subcontractors and recycling centres the processing time for each product type is known. Accordingly, the maximum capacities are given in hours per period.
- Transportation costs include those corresponding to emissions of greenhouse gases. They are computed using the same approach as in (Boudahri et al., 2013).

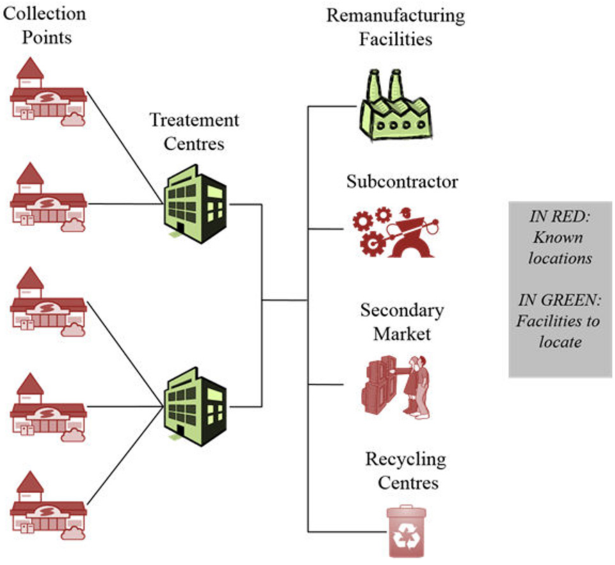

Fig. 2. Logistic network diagram.

3.2 Index and abbreviations

In what follows the following indexes and notations will be used:

$i \in I$	Index of collection points.
$j \in J$	Index of possible locations for treatment centres.
$k \in K$	Index of possible locations for remanufacturing facilities.

b ∈ B	Index of other actors. Secondary market (1), subcontractors (2) and recycling centres (3).

CP:	Collection Points
TC:	Treatment Centres
RE:	Remanufacturing Facility
SM:	Secondary Market
ST:	Subcontractor
RC:	Recycling Centres
u.p.:	Unit of product

3.3 *Model parameters*

The set of parameters used in the model are listed below:

Transport costs [€/ton.km]

ct_{ij}	Transport costs between CP i and TC j.
ct_{jk}	Transport costs between TC j and RE k.
ct_{jb}	Transport costs between TC j and$b$.

Opening costs and fixed operational costs [€]

co_j	Opening costs of a TC at location j.
co_k	Opening costs of a RE at location k.
cf_j	Fixed operational costs of TC j.
cf_k	Fixed operational costs of RE k.

Variable costs [€/p.u.]

cv_{pj}	Treatment cost of product p at TC j.
cv_{pk}	Treatment cost of product p at RE k.
cvm_p	Repackaging cost of product p at SM.
cvs_p	Treatment cost of product $p$at ST.
cvd_p	Treatment cost of product p at RC.
pe_p	Penalty for shipping a product p to RC.

Treatment times [min/p.u.]

tRE_p	Processing time of a product p at RE.
tRC_p	Processing time of a product p at RC.

Capacities

$capa_j$	Maximum capacity of TC j, per period. **[#Products]**
$capa_k$	Maximum capacity of RE k, per period. **[Hours]**
$capaRC$	Maximum capacity of RC, per period. **[Hours]**

Distances [km]

d_{ij}	Distance between CP i and TC j.
d_{jk}	Distance between TC j and RE k.
d_{jb}	Distance between TC j and b.

Returns and demands

r_{pit}	Quantity of products p returned to CP i, at period t.
dST_p	Demand of products $p$at ST, per period.
dSM_p	Demand of products $p$at SM, per period.

Selling prices [€]

$spSM_p$	Selling price of product p at SM.
$spST_p$	Selling price of product p at ST.
$spRE_p$	Selling price of a remanufactured product p.

Other parameters

w_p	Weight of a product p. **[Ton]**
$MaxR$	Maximum number of RE opened in a period.
aSM_p	Percentage of products$p$ that might be sold at SM, per period.
aRC_p	Percentage of products$p$ that must be shipped to RC, per period.

3.4 *Decision Variables*

The decision variables are listed below. The first five are binary variables. Y_{jt} and Y_{kt} indicate, respectively, which TC and RE are open at period of time$t$. Y_{kt} is the variable which allocates a CP to a TC. Z_j and Z_k (opening variables) guarantee one unique payment for opening a TC and a RE, respectively. The following three variables represent the quantities of goods transported throughout the logistic network.

Y_{jt}	1 if a CP is opened or reopened at location j, in period t ; 0 otherwise.
Y_{kt}	1 if a RE is opened or reopened at location k, in period t ; 0 otherwise.
Y_{ijt}	1 if CP i is assigned to TC j, in period t ; 0 otherwise.
Z_j	1 if TC j has been opened at least one time; 0 otherwise.
Z_k	1 if RE k has been opened at least one time; 0 otherwise.
X_{pijt}	Quantity of products$p$ shipped from CP i to TC j, in period t.
X_{pjkt}	Quantity of products$p$ shipped from TC j to RE k, in period t.
X_{pjbt}	Quantity of products$p$ shipped from TC j to b, in period t.

3.5 *Objective function*

The goal of the model is to maximize the profit of the logistic network, taking into account all periods. The objective function is divided in four terms. The first one is the benefit. It is obtained by multiplying the quantities shipped to RE, SM and ST with the respective selling prices. The following costs will be subtracted from benefit: fixed costs (opening and operation of TC and RE), variable costs (for TC, RE, SM, ST and RC) and transportation costs throughout the logistic network. These expressions are defined below.

$$Max\, Z = BENE - \ (CFIX + CVAR + \ CTRA) \quad (1)$$

Where:

$$BENE = \sum_{p\in\mathrm{P}}\sum_{j\in\mathrm{J}}\sum_{k\in\mathrm{K}}\sum_{t\in\mathrm{T}} X_{pjkt} * \ spRE_p + \sum_{p\in\mathrm{P}}\sum_{j\in\mathrm{J}}\sum_{t\in\mathrm{T}} X_{pjb_1t} * \ spSM_p + \sum_{p\in\mathrm{P}}\sum_{j\in\mathrm{J}}\sum_{t\in\mathrm{T}} X_{pjb_2t} * \ spST_p \quad (2)$$

$$CFIX = \sum_{t\in\mathrm{T}}\sum_{j\in\mathrm{J}} cf * Y_{jt} + \sum_{t\in\mathrm{T}}\sum_{k\in\mathrm{K}} cf_k * Y_{kt} +$$

$$\sum_{t \in T} \sum_{j \in J} co_j * Z_j + \sum_{t \in T} \sum_{k \in K} co_k * Z_k \qquad (3)$$

$$CVAR = \sum_{t \in T} \sum_{k \in K} \sum_{j \in J} \sum_{p \in P} X_{pjkt} * \left(cv_{pj} + cv_{pk}\right) +$$

$$\sum_{t \in T} \sum_{p \in P} \sum_{j \in J} X_{pjb_1t} * (cv_{pj} + cvm_p) + \sum_{t \in T} \sum_{p \in P} \sum_{j \in J} X_{pj2t} * (cv_{pj} +$$

$$cvs_p) + \sum_{t \in T} \sum_{p \in P} \sum_{j \in J} X_{pjb_3t} * (cv_{pj} + cvd_p + pe_p) \ (4)$$

$$CTRA = \sum_{t \in T} \sum_{p \in P} \sum_{i \in I} \sum_{j \in J} X_{pijt} * d_{ij} * ct_{ij} * w_p +$$

$$\sum_{t \in T} \sum_{p \in P} \sum_{j \in J} \sum_{k \in K} X_{pjkt} * d_{jk} * ct_{jk} * w_p +$$

$$\sum_{t \in T} \sum_{p \in P} \sum_{j \in J} \sum_{b=1}^{3} X_{pjbt} * d_{jb} * ct_{jb} * w_p (5)$$

3.6 Model constraints

$$\sum_{i \in I} Y_{ijt} \geq Y_{jt} \ \forall j \in J, \forall t \in T \qquad (6)$$

$$\sum_{j \in J} Y_{ijt} = 1 \quad \forall j \in J, \forall t \in T \qquad (7)$$

$$X_{pijt} = Y_{ijt} * r_{pit} \forall p \in P, \forall i \in I, \forall j \in J, \forall t \in T \qquad (8)$$

$$\sum_{k \in K} X_{pjkt} + \sum_{b=1}^{3} X_{pjbt} = \sum_{i \in I} X_{pijt} \ \forall p \in P, \forall j \in J, \forall t \in T \quad (9)$$

$$\sum_{j \in J} \sum_{p \in P} X_{pijt} \leq capa_j * Y_{jt} \forall j \in J, \forall t \in T \qquad (10)$$

$$\sum_{j \in J} \sum_{p \in P} X_{pjkt} * tRE_p \leq capa_k * 60 * \ Y_{kt} \forall k \in K, \forall t \in T \quad (11)$$

$$\sum_{j \in J} \sum_{p \in P} X_{pjb_3t} * tRC_p \geq capaRC * 60 \quad \forall t \in T \qquad (12)$$

$$\sum_{t \in T} Y_{jt} - M * Z_j \leq 0 \quad \forall j \in J (13)$$

$$\sum_{t \in T} Y_{kt} - M * Z_k \leq 0 \quad \forall k \in K (14)$$

$$X_{pjb_1t} \leq aSM_p * \sum_{i \in I} X_{pijt} \ \forall p \in P, \forall j \in J, \forall t \in T \qquad (15)$$

$$\sum_{j \in J} X_{pjb_1t} \leq dSM_p \forall p \in P, \forall j \in J, \forall t \in T \qquad (16)$$

$$\sum_{j \in J} X_{pjb_2t} \leq dST_p \forall p \in P, \forall j \in J, \forall t \in T \qquad (17)$$

$$X_{pjb_3t} \geq aRC_p * \sum_{i \in I} X_{pijt} \ \forall p \in P, \forall j \in J, \forall t \in T (18)$$

$$\sum_{i \in I} Y_{kt} \leq MaxR \forall t \in T \qquad (19)$$

$$X_{pijt} \geq 0, X_{pjkt} \geq 0, X_{pjbt} \geq 0$$
$$b \in B, \forall i \in I, \forall j \in J, \forall k \in K, \forall p \in P, \forall t \in T \qquad (20)$$

$$Y_{jt}, Y_{kt}, Y_{ijt}, Z_j, Z_k \in \{0,1\} \forall j \in J, \forall k \in K, \forall t \in T \qquad (21)$$

The first three expressions are allocation constraints. Constraint (6) ensures that at least one CP is assigned to the TC j (if open). Constraint (7) ensures that each CP is assigned to one unique TC. Constraint (8) gives the quantities transported between the set of CP and TC open. Constraint (9) guarantees an equilibrated flow of products: all goods arriving to each CT must be shipped somewhere. The three following expressions (constraints (10), (11) and (12)) are capacity constraints for TC, RE and RC, respectively. Constraints (13) and (14) assign the value to opening variables (Z_j and Z_k). Constraints (15) and (16) refer to the quantity of products sent to the SM while the percentage and demand must be respected. Constraint (17) states that the total amount of products sent to ST has to be less or equal than its demand. Constraint (18) states that the total amount of products sent to RC is at least equal to a percentage of returned products. Constraint (19) restricts the number of RE that remain open. The expressions (20) and (21) are non-negativity constraints and binary constraints, respectively.

4. MODEL TESTING

The described model was tested several times in a computer with 4GB of RAM and an Intel Core i3-2350M CPU @ 2.30GHz processor. To start, the main parameters were set, as shown in Table 1. Data was randomly generated using Microsoft Excel. Moreover, several macros were programmed to allow an automatic selection of data in the spreadsheet, based on the main parameters setting. This file is used by CPLEX to integrate the data into the model and run the different tests. Charts in Tables 2 and 3summarize the tests results obtained for different number of time periods. For Problem 1 tests an optimal solution is found fairly quickly. In Problem 2 tests, the number of CP is increased from 10 to 15. The computation time increases slightly, but optimal solutions are found. For the third series of tests (Problem 3), the number of possible locations for TC and RE is set to 10, keeping 15 CP. This makes the problem more complex and optimal solutions are obtained for problems from 3 to 9 periods, in an acceptable computing time. On the other hand, from 11 periods and more the computing time increase significantly and for some problems an optimal solution cannot be found. For these cases, the GAP after 30 minutes is given in the results table (instead of the optimal solution). A final group of tests were conducted with four types of products. The simplest test (3-period horizon) is solved optimally. For others, the optimal solution is not reached. As for Problem 3, the GAP appears in the chart. In fact, it was observed that for tests for which no optimal solution is obtained, the number of nodes remaining to evaluate explodes and even leaving the program running over an hour, the optimal solution is not found.

MAIN PARAMETERS	PROBLEM					
	1	2	3	4	5	6
Number of CP	10	**15**	**15**	10	10	**15**
Locations for TC	7	7	**10**	7	7	7
Locations for RE	7	7	**10**	7	7	7
Types of products	3	3	3	**4**	3	3
Max of RE open	2	2	2	2	2	**3**

Table 1. Main parameters for model testing.

		Problem 1		Problem 2	
t	Test	Optimal Solution (€)	Test Time (s)	Optimal Solution (€)	Test Time (s)
3	1	6 213 023	3,76	6 070 271	2,73
	2	6 223 526	3,18	6 070 132	3,40
5	1	10 483 483	4,49	10 236 685	7,08
	2	10 479 456	5,65	10 246 223	4,49
7	1	14 747 534	5,90	14 436 249	6,66
	2	14 788 544	5,96	14 432 586	7,33
9	1	19 016 352	9,53	18 574 358	7,44
	2	19 027 975	9,06	18 603 099	6,83
11	1	23 305 296	10,14	22 777 045	12,17
	2	23 336 414	10,44	22 742 055	10,69
13	1	27 568 797	10,45	26 916 223	27,68
	2	27 548 296	15,60	26 954 939	12,84
15	1	31 834 597	7,04	31 103 712	55,47
	2	31 836 454	15,07	31 152 174	43,13

Table 2. Results for Problems 1 and 2, initial model.

		Problem 3		Problem 4	
t	Test	Optimal Solution (€)	Test Time (s)	Optimal Solution (€)	Test Time (s)
3	1	6 267 771	3,76	8 210 233	15,88
	2	6 247 444	9,47	8 225 909	52,88
5	1	10 552 952	27,19	*0,01%*	*1800,0*
	2	10 545 045	34,12	11 034 698	325,65
7	1	14 835 375	19,81	*0,01%*	*1800,0*
	2	14 846 661	69,02	*0,01%*	*1800,0*
9	1	19 133 597	122,06	*0,02%*	*1800,0*
	2	19 149 206	46,29	*0,02%*	*1800,0*
11	1	23 443 067	112,34	-	-
	2	23 395 979	137,02	-	-
13	1	*0,03%*	*1800,0*	-	-
	2	27 764 351	106,05	-	-
15	1	*0,03%*	*1800,0*	-	-
	2	*0,03%*	*1800,0*	-	-

Table 3. Results for Problems 3 and 4, initial model.

5. ANALYSIS AND MODIFICATIONS

Based on the previous results, some modifications were made to the initial model. Since there were no constraints for the maximum number of products per type to be treated in the RE, the optimal solutions suggested treating only one type of product: the one that generates the greatest profit, which is logical but not exactly what the reverse supply chain is expected to achieve. Also, it was observed that the quantities sent to RC were a little too high. The reason for this fact is that changing the number of CP from 10 to 15 increases the number of returned products. Since the number of RE open was maintained, excess of products went to RC. From this results analysis, the model was modified as shown below:

- Instead of giving the capacity for TC in terms of number of products per period, it will be given in hours per period (as for RE). This seems more consistent with what happens in reality.
- The static demands were changed to dynamic demands for SM and ST.
- The number of products that can be processed in the RE, by product type is now limited.

Accordingly some parameters were modified, as described as follows:

$capa_j$	Maximum capacity for CT *j*, per period. **[Hours]**
tTC_p	Processing time for a product of type *p* at TC. **[Min/u.p.]**
QM_p	Maximum number of products of type *p* remanufactured per period.

Constraint (10) changed into the following one:

$$\sum_{j\in J}\sum_{p\in P} X_{pijt} * tTC_p \le capa_j * 60 * Y_{jt} \quad \forall j \in J, \forall t \in T \qquad (10)$$

Last, the following constraint that limits the number of products that can be processed in a RE was added:

$$\sum_{j\in J}\sum_{k\in K} X_{pjkt} \le QM_p \forall t \in T, \forall p \in P \qquad (22)$$

Two types of new problems were conducted with several tests for each one (Table 4). Since the number of returned products increases (up from 10 to 15 CP) in Problem 6, the number of RE open per period was augmented from 2 to 3. Accordingly, the maximum quantities of products that can be remanufactured have been increased too. This has a significant impact on the optimal solution for tests with the same number of periods (and different problems). For example, for test 1, Problem 5, with 9 periods, profits represent 15 millions, while for Problem 6 it reached almost 21 millions. This is because the solution of Problem 6 processes more products in the RE (since more RE are available) and less in the RC than the solution of Problem 5. Main parameters of Problems 3 and 4 were used also in this new model, but no optimal result was achieved. In general, most tests had the same behaviour: CPLEX finds, in less than 5 minutes, a solution with a GAP around 0,05%, but even after an hour, no optimal solution is found.

		Problem 5		Problem 6	
T	**Test**	**Optimal Solution (€)**	**Test Time (s)**	**Optimal Solution (€)**	**Test Time (s)**
3	1	4 936 769	12,48	6 800 383	9,48
	2	4 927 890	4,43	6 818 393	22,39
5	1	8 319 055	17,83	11 475 867	21,05
	2	8 279 508	25,13	11 439 791	26,41
7	1	11 777 287	18,60	*0,01%*	*1800,0*
	2	11 742 919	17,72	16 208 767	57,72
9	1	15 071 859	50,16	20 888 575	27,75
	2	15 078 281	270,91	*0,01%*	*1800,0*
11	1	18 513 046	78,56	*0,01%*	*1800,0*
	2	18 502 874	29,72	*0,01%*	*1800,0*
13	1	21 852 667	128,6	*0,02%*	*1800,0*
	2	*0,01%*	*1800,0*	*0,01%*	*1800,0*
15	1	*0,02%*	*1800,0*	-	-
	2	*0,01%*	*1800,0*	-	-

Table 4. Main parameters and results for Problems 5 and 6, modified model.

6. CONCLUSIONS

Integration of environmental objectives in supply chain management is no longer a secondary aspect. At first, due to legislative requirements and consumer demand, a general concern was started around recycling and waste treatment. Nowadays companies are going much further. They realized that the green supply chains represent a major opportunity to generate revenues through used products. Collection activities, distribution and reprocessing of returned products must be integrated into the traditional supply chain in order to obtain benefits.

The main objective of this work is to propose a model for the design of a reverse logistic network, taking into account aspects which are generally neglected in existing literature. A mixed integer linear programming model was formulated and solved using CPLEX software. It is a dynamic, multi-product model, which takes into account the uncertainty associated with product returns. Remanufacturing activities, waste disposal, subcontractors and sales in the secondary market are included in the network. The model establishes all the flows of products transported throughout the network and determines which facilities must be open in each period in order to maximize profits. The initial version of the model allows the design of a reverse logistic network with up to 15 collection points, 10 possible locations for treatment centre and remanufacturing facilities, 3 types of products and 15 periods. Modifications made to the initial version result in a more robust model, which allows achieving optimal solutions to large-scale problems, with more logical results.

Despite the attention made to the input data selection, refining the parameters such as the demand of remanufactured goods will improve the model. This could be the purpose of a future research work on a real-world reverse supply chain. One might also consider the storage of products for further enhancement of the reverse supply chain performance. A stochastic analysis of product returns will also be interesting to conduct.

REFERENCES

Boudahri F., Aggoune-Mtalaa W., Bennekrouf M., Sari Z., 2013. Applicationof a Clustering BasedLocation-Routing Model to a Real Agri-food Supply Chain Redesign*Adv. Methods for Comput. Collective Intelligence*, SCI 457: 323–331. DOI: 10.1007/978-3-642-34300-1 31.

Fleischmann M., Bloemhof-Ruwaard J. M., Dekker R., Van der Laan E., Van Nunen J., Van Wassenhove L. N., 1997. Quantitative models for reverse logistics: A review, European Journal of Operational Research, 103: 1-17.

Gourdin, E., and Klopfenstein, O., 2008. Multi-period Capacitated Location with Modular Equipments. Computers & Operations Research, 35 (3): 661-682.

Hinojosa,Y., Kalcsics, J., Nickel, S., Puerto, J., &Velten,.S., 2008, Dynamic supply chain design with inventory. Computers & Operations Research, 35(8): 373-391.

Mtalaa W., Aggoune R., 2010. Un modèle bi-objectif pour la conception de chaînes logistiques vertes [online], 8èmeConférence International de Modélisation et Simulation, Tunisie. Available from: http://www.enim.fr/mosim2010/articles/78.pdf [Accessed 2 February 2012].

Pokharel, S., and Mutha, A., 2009. Perspectives in reverse logistics: A review. Resources, Conservation and Recycling, 53: 175-182.

Rogers, D. and Tibben-Lembke, R.S., 1999. Going Backwards: Reverse Logistics Trends and Practices. Pittsburgh: RLEC Press.

Schuh G., Novoszel T. and Mass M., 2011. Rebound logistics: An integrative reverse supply chain for multiple usage products, Advances in Sustainable Manufacturing: Proceedings of the 8th Global Conference on Sustainable Manufacturing, 399-406.

Srivastava S. K., 2007. Green supply-chain management: A state-of-the-art literature review, International Journal of Management Reviews, 9(1): 53-80.