The influence of Corporate Social Responsibility on economic performance within supply chain planning

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Abstract This work aims to study the economic impact of incorporating corporate social responsibility issues on supply chain design and planning. A mathematical programming model that allows the optimal design and planning of supply chains is developed. A social benefit indicator is established where the regional development of less developed regions is intended. The supply chain is optimized under two different objective functions: economic and social. The model is applied to a case-study developed in collaboration with a Portuguese company, leader in battery production.

Keywords: Supply chain, Planning, Corporate social responsibility.

1 Introduction

There is a growing concern from customers on sustainability issues and governments are pressuring companies to become more sustainable and achieve a sustainable development, so that they can contribute towards the society goal of meeting the needs of the present without compromising the ability of future generations to

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meet their own needs, as defined by the Brundland Commission (1987). If previously the concept of sustainability was more environmentally focused, currently the concept of the triple bottom line is well established and sustainability is considered to be supported by three main pillars: economic, environmental and social sustainability (Elkington, 2004). However, while significant literature exists regarding the economic and environmental pillars, the social aspect of sustainability remains unaccounted for (Seuring, 2013).

New legislation and standards are being introduced as an attempt to fill this gap in industry. ISO 26000:2010 for example, provides guidance to all types of organizations, and is intended to encourage them to go beyond legal compliance in the field of social responsibility. The European Commission itself has demonstrated concerns on this matter and has recently released the agenda for the 2014-2020 funding period, where the main objective is funding projects that contribute to regional development and job creation (European Commission, 2010). All of these aspects are leading companies to look for ways to move towards a more sustainable state. Hence, there is a clear need for research in this field and tools to evaluate the impacts such strategies would have on the company's performance.

This work takes a step forward in this direction and aims to provide a methodology for companies to study how they could in fact go beyond legal compliance, namely towards the contribution to regional development, and what would be the economic impact of such actions. A mathematical programming model is developed for the design and planning of supply chains, along with a social benefit indicator that promotes the economic growth of the less developed regions. The model is applied to a case study where the supply chain of a Portuguese battery producer and distributor is optimized under different objective functions: an economic and a social one.

This paper is structured as follows. In section 2 the problem is defined and the developed model is characterized. Section 3 describes the case study and the results obtained. Section 4 presents conclusions and future work.

2 Problem definition

The problem here addressed aims at determining the supply chain structure and the planning decisions that minimize costs and the ones that maximize social benefit. The problem is modeled through a Mixed Integer Linear Programming (MILP) that uses a graph approach for the design and planning of closed loop supply chains. The decisions at the design level are taken for a given time horizon (e.g. 5 years). This time horizon is divided in time periods (e.g. months) in which demand and return values must be satisfied. Detailed planning on attaining this satisfaction is given by the model. The economic performance of the supply chain is measured through the costs involved, as described in equation (1).

$$minCost = \sum_{i \in I_a} cf_i Y_i + \sum_{mij:(m,i,j) \in F_s} \sum_{t \in T} CS_{mit} X_{miit} + \sum_{ij:(i,j) \in A_{own}} \sum_{t \in T} ct_{ij} d_{ij} Z_{ijt} + \sum_{mij:(m,i,j) \in F_{out}} \sum_{t \in T} ct_{ij} d_{ij} X_{mijt} + \sum_{mi:(m,i) \in V_c} cp_{mi} (\sum_{j \in I_a} \sum_{t \in T} X_{mijt}) + \sum_{i \in I_a} chr_i Y_i \quad (1)$$

The first term gives the fixed costs of each entity (cf_i) controlled by the binary variable Y_i which equals 1 when entity i is opened. The second term corresponds to the costs of raw materials where cs_{mit} represents the unit cost of product m acquired in entity i for period t, and X_{mijt} is a continuous variable for the amount of product m served by entity i to entity j at time t. The third term concerns the costs of transportation which is performed by the company's fleet, and depends on parameters such as vehicle consumption, fuel price and vehicle maintenance. The fourth term is related to outsourced transportation, which varies with contracted costs (per kg.km), the amount of units transported and the kilometres travelled. The fifth term represents the costs of product recovery (cp_{mi}). The final term concerns the costs with human resources (chr_i) that result from opening a given entity. Regarding the social component, a social benefit indicator was developed that when maximized favors entities to be located in less developed regions, as described in equation (2) where u_i represents a regional factor attributing a higher score to less developed regions (measured through regional statistics of population density), and w_i is the number of jobs created at region i. Additionally to the objective functions a set of constraints are defined which describe structure and tactical decisions that need to be accounted to satisfy certain market levels.

$$SB = \sum_{i \in I} u_i w_i Y_i \quad (2)$$

Overall, and shortly, given: a) a possible superstructure for the location of the supply chain entities, the associated investment costs as well as involved processes; b) inventory, return and transportation policies and associated costs; c) human resources costs and the social benefit associated to each facility; and d) costumers demands; the goal is to determine 1) the network structure, 2) the production and storage levels, and 3) the flow amounts; so as to minimize the total supply chain cost from one side, and maximize the social benefit from the other.

3 Case study

The model was applied to a case study of a Portuguese lead battery manufacturer and distributor. This supply chain is composed by a factory in Oeiras (which is not to be relocated) and 12 rented warehouses in continental Portugal, serving around 2300 customers. The factory also has a storage function. Given the strategic nature of this work, customers were clustered in 237 groups, according to their municipality. 237 possible warehouses locations are then considered. A maximum number of 13 warehouses was imposed, according to the company's strategy. The company has a recycling strategy implemented for end-of-life batteries and thus there are both forward and reverse flows. Regarding distribution, the inbound transportation is outsourced, while the outbound transportation is performed by the company's fleet. All demand is to be fully satisfied. Three different scenarios were studied. Figure 1 shows the network obtained for each of the considered scenarios: the base case (A), the minimum cost solution (B) and the maximum social benefit solution (C). Scenario A shows the 13 warehouses that form the current supply chain of the company. Scenario B shows that only 7 warehouses are necessary to achieve the minimum cost solution. In scenario C, 13 warehouses are opened and located in the less populated regions (darker regions indicate higher population density). These results are supported by the cost distribution of each scenario, represented in Figure 2 (on the left), where we see that when minimizing cost (scenario B) the model returns a solution with a cost reduction of 21.5%. This is obtained by reducing the number of warehouses, compensated by the increase in transportation. With scenario C the cost increases 44% (compared to scenario B), where an increase in both the number of warehouses and in transportation is verified. The transportation costs for each scenario, represented in Figure 2 (on the right), are proportional to the increase in the secondary distribution.

When looking with detail into the supply planning obtained for each of the scenarios it can be seen that, in scenario A (results not shown), Lisboa supplies 19% of the products, followed by Setúbal (16%) and Porto (12%). In fact the clients with higher demand are located around these exact regions. In the minimum cost scenario (Figure 3) it can be seen that the warehouse in Lisboa is responsible for the major share of supply (more than 40%), since it is closer to the higher demand customers

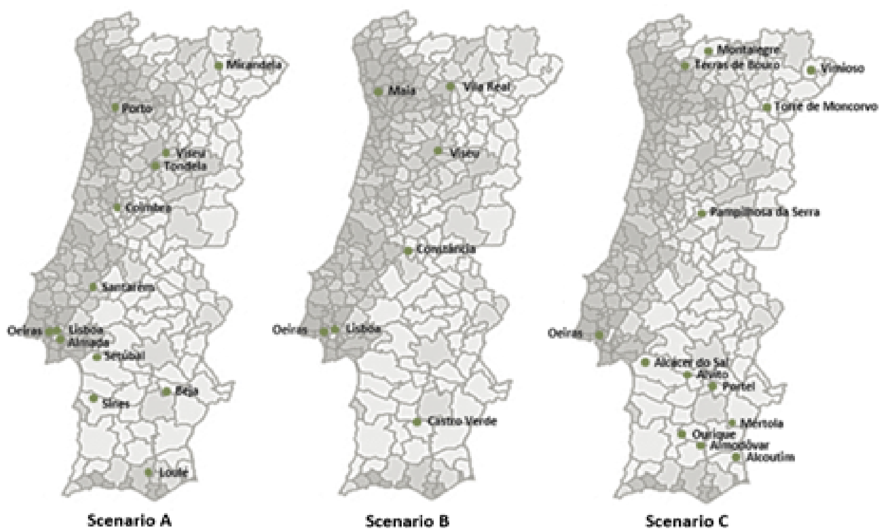
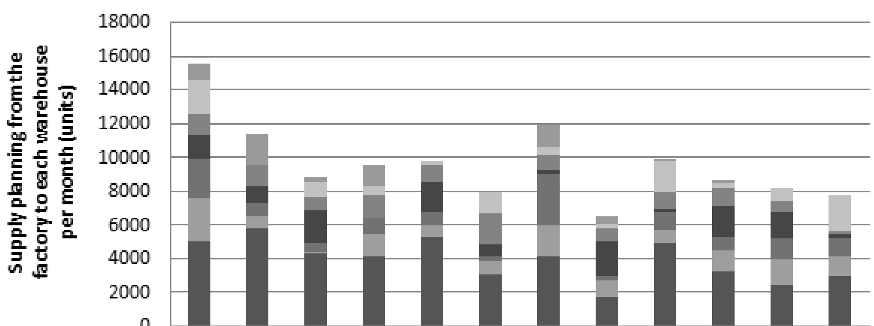


Fig. 1 Location of warehouses for each scenario: a) base case, b) minimizing cost, and c) maximizing social benefit. Darker regions indicate higher population density.

in Setúbal. It is interesting to see that the model preferably uses this warehouse, even though having the warehouse in Oeiras available with no costs of primary transport. Viseu and Maia supply the North, and Castro Verde supplies the southern municipalities. Oeiras, Constância and Vila Real play a more secondary role, complementing the mentioned warehouses.

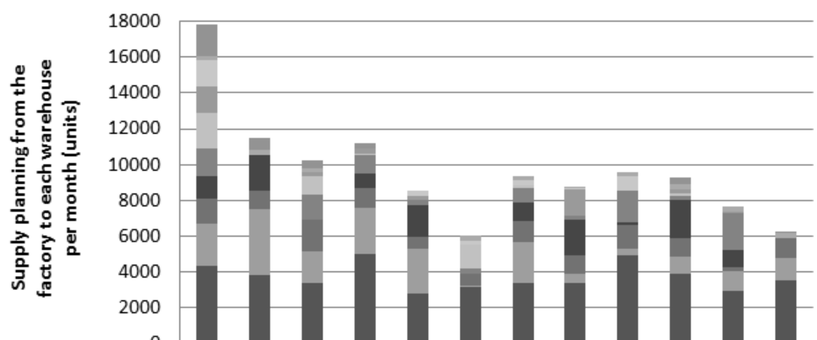
Finally, and having in mind the objective of maximizing the social benefit as a goal to pursue within a corporate social responsibility perspective, the optimal warehouse locations determined for maximum social benefit (scenario C) are assumed. Such network is then studied so as to determine the minimum cost supply planning. Figure 4 shows the results obtained. Lisboa and Porto are very densely populated regions. Therefore, when looking to the results of scenario C we see that these warehouses are replaced and the corresponding demand reallocated. In this case the importance of Oeiras, the warehouse within the factory, is increased when compared to the minimum cost solution. Since the warehouses are so distant from the main clients, the model mostly uses the warehouse in Oeiras (38% of the supply) to minimize the costs of primary distribution. Alcácer do Sal supports Oeiras supplying the region of Lisboa and Setúbal. Terras de Bouro, Torre de Moncorvo and Montalegre replace Maia and Vila Real in the supply of the northern clients. Pampilhosa da Serra covers the central regions. Having the satisfaction of the demand as a defined strategic goal – forward flow, it is important to look at how the obtained networks perform on the reverse flows (results not shown). Whereas in scenario A, Lisboa collects 19% of the total end-of-life products, followed by Setúbal (16%)



	1	2	3	4	5	6	7	8	9	10	11	12
Vila Real	996	1898	256	1280			1280	512	106	256		
Constância	2048		911	512	256	1280	512	256	1878	256	768	2106
Oeiras	1231	1224	765	1303	1000	1805	844	765	918	1071	680	153
Castro Verde	1383	989	1928		1770	768	256	2048	256	1792	1536	306
Maia	2304	768	574	1024	768	256	3072	256	1024	816	1226	1055
Viseu	2584	768	82.5	1280	768	768	1809	1024	768	1280	1536	1135
Lisboa	5007	5764	4284	4131	5253	3060	4131	1683	4953	3213	2448	2995

Fig. 2 Supply planning, from the factory to each warehouse, per month, for the minimum cost scenario (B).

and Porto (12%), in scenario B Lisboa collects 41% of the total end-of-life products and the warehouse co-located with the factory (Oeiras) collects around 12%. In scenario C this warehouse gains importance once again and is responsible for about 52% of battery recovery. One aspect that stands out in scenario C is why in several months, some warehouses are idle. This happens because the structure obtained in this case does not support a profitable planning as the demand is located far away from these warehouses. This result opens way to further research on how to improve this result, achieving a less expensive solution while still increasing the social benefit. Also worth mentioning is that very few units are supplied in some months from certain warehouses. This happens due to the constraint of having all demand satisfied, even if only one unit is to be supplied. In conclusion, although the pursue of a social benefit under a corporate social responsibility perspective should be targeted, it is important to have in mind if this can be applied in real terms in the organization. In the present case the analysis shows that further studies are required and call for a multiobjetive approach to find a compromise solution amongst the three pillars of sustainability.



	1	2	3	4	5	6	7	8	9	10	11	12
4 remaining warehouses	1727	695	404	256						367		4
Ourique	256	256	256	63		256	256	59	256	256	256	256
Alvito	1447				256	256	256	85	768			
Almodôvar	1487		212	256	256			1462		256	125	
Montalegre	2000		1018	61		1353	196			118		
Torre de Moncorvo	1558		1441	1029	256	256	768	256	1792	256	2048	24
Pampilhosa da Serra	1245	2000		837	1748		1055	1984	159	2092	914	
Terras de Bouro	1405	1049	1707	1136	679	675	1176	1024	1280	1024	256	1073
Alcácer do Sal	2326	3683	1803	2560	2560	42	2304	512	425	1024	1082	1280
Oeiras	4354	3825	3380	4996	2754	3193	3366	3366	4896	3866	2958	3521

Fig. 3 Supply planning, from the factory to each warehouse, per month, for the maximum social benefit scenario (C).

4 Conclusions and future work

This work proposes a mathematical optimization model for the design and planning of closed loop supply chains that serves as a tool to study the economic impact of incorporating corporate social responsibility issues in the company strategy. The model is applied to a case study where the promotion of regional development is intended. The results show that this strategy alteration translates in a quite different supply planning, accompanied by a compromise of the economic performance. However, room for improvement is identified. As future work, the social benefit indicator should be further refined to incorporate other regional development measures such as unemployment rate or GDP, and the model further optimized to minimize results with idle warehouses in the planning horizon. Also, as mentioned above, a multiobjetive approach should be explored to find a compromise solution within a sustainable development.

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