SUPPLIER SELECTION: SINGLE SOURCING VS. DUAL SOURCING WITH SUSTAINABILITY CONSIDERATIONS

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ABSTRACT

This paper presents an integrated approach to supplier selection, which takes into account sustainability considerations and allows for the analysis of single sourcing vs. dual sourcing. A set of criteria and sub-criteria are identified from the literature and used for the evaluation of the suppliers. In line with the purpose of taking into account sustainability considerations, social sustainability and environmental sustainability criteria are included in the analysis, together with service criteria which reflect the traditional criteria used to evaluate and rank suppliers.

The model starts with the analysis of the single-sourcing strategy, where a single vendor (*supplier #1*) is available for a given supply. On the basis of the selection criteria, as well as of a fuzzy logic controller model, a score is computed for supplier #1. Such a score can be compared with the performance of *supplier #2*, who is taken into account when the dual sourcing strategy is pondered.

The proposed model is applied to the case of an Italian company, to show its usefulness in practical cases.

1. INTRODUCTION

In an increasingly competitive and interconnected market, companies need to strengthen their relationships with all the supply chain players, from the suppliers to the final consumers (Moqri, Moshref Javadi, & Yazdian, 2011). Market and demand are changing continuously and diversification of the needs and demands necessarily leads to an increase in the operating costs of a company and, consequently, to a decrease in profits. Purchasing decisions thus become strategically crucial to ensure the profitability and the long-term survival on the market.

Companies often forget that suppliers are actually a part of their supply chain and, as such, relationships with them have the potential to affect the costs and profitability of an enterprise. In many industries, the purchase volume, i.e. the total amount of money that a company spends in the purchase of parts, materials, components and services from external resources, is estimated to account for approx. 60% of the company's income (Monczka, Trent and Handfield, 2005; Weele, 2000). Right purchasing decisions allow these costs to be reduced and the final consumers to be satisfied, responding to their needs and expectations (Dulmin & Mininno, 2003; Xia & Wu, 2007; Figuera, Greco, & Ehrogott, 2005).

Supplier selection is currently recognized as one of the key decision-making processes of a company for gaining competitive advantage. Suppliers can be considered as a part of the company's asset. Indeed, choosing the "right" supplier enhances the quality of the incoming material, resulting in better quality of the finished product. At the same time, it also reduces the internal management costs, because of the lower need to run checks on the purchased items and lower purchasing cost that can result from increase in the purchasing volume.

Typically, companies can choose from a large number of potential suppliers. Accordingly, supplier selection strategies are distinguishable between single sourcing, dual sourcing and multiple sourcing. As the name suggests, in the single sourcing strategy a company selects only one source, from a set of available suppliers that can provide the purchased item. Conversely, in the multiple sourcing strategy, more suppliers will be selected for the provision of the same product or service. Obviously, in this context, several providers are available for the provision of the same product or service. At the same time, these providers can have different characteristics in terms of market coverage, price, reliability and sustainability (Tomlin and Wang, 2005). Finally, in the case of dual sourcing, the company will select exactly two providers for a given supply.

Several techniques are available in literature to help decision-making processes in supplier selection. These techniques can be either deterministic or stochastic, linear or non-linear, mono-criteria or multi-criteria. Nonetheless, typically supplier selection has been approached as a multi-criteria decision-making (MCDM) problem (Sahraeian, Tafti, & Nobar, 2010).

In this case, the decision-maker will identify a set of criteria and sub-criteria to evaluate and rank different candidate suppliers to reach a defined target. MCDM methodologies provide solutions that can help decision-makers in manipulating complex data to identify the best supplier. In addition, MCDM techniques are effective in those situations where the number of alternatives involved and decision criteria is relatively high.

Recently, supplier selection issues are gradually embracing the concepts of sustainability. Indeed because of the growing knowledge about sustainability in enterprise, sustainable supplier selection would be the central component in the management of a sustainable supply chain (Amindoust et al. 2012). For this purpose, appropriate criteria and sub-criteria should be included in the supplier selection process, to ensure that the ranking of the suppliers will take into account sustainability considerations.

On the basis of the premises above, this paper presents an integrated approach to supplier selection, which takes into account simultaneously both sustainability considerations and the evaluation of single sourcing vs. dual sourcing strategies. Because sustainability considerations are often difficult to be translated into quantitative performance, the model is supported by a fuzzy logic controller (FLC), which is used to gather all the performance into a set of linguistic values, to derive a synthetic judgment. The model is tested on the case of a real company, which typically adopts a dual sourcing strategy, to evaluate its practical usefulness.

The remainder of the paper is organized as follows. Section 2 details the steps of the decision model developed. Section 3 shows the application of the model to the real case company. Section 4 concludes by describing the main pros/cons of the proposed model, as well as the key implications of the study, and by outlining future research steps.

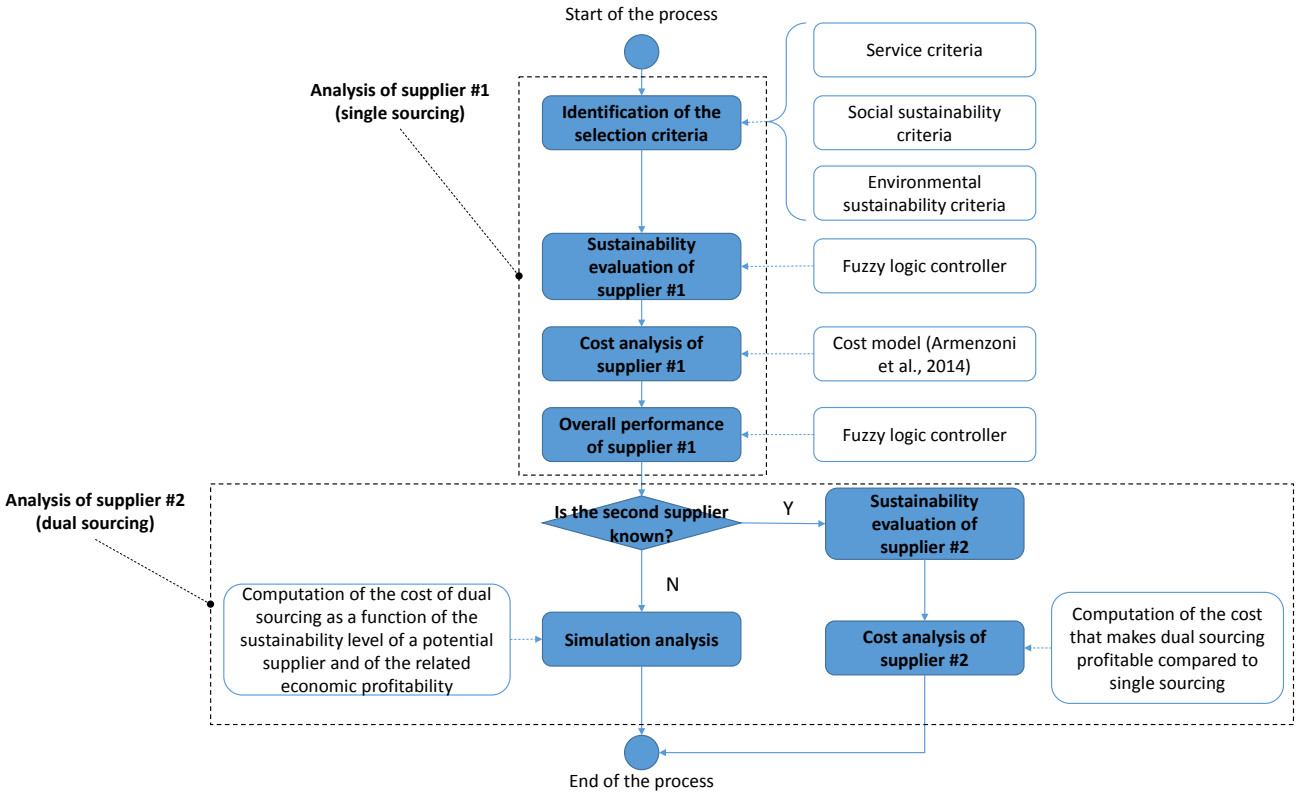

Figure 1: scheme of the approach proposed.

2. THE DECISION MODEL

The detailed scheme of the approach is proposed in Figure 1.

The starting point of the decision model is the analysis of a single supplier (*supplier #1*), i.e. of the single sourcing strategy. For this analysis, the first step is to identify the criteria and sub-criteria useful to the process of supplier evaluation. The selection criteria can be shared into three sets, i.e.: (1) service criteria; (2) social sustainability criteria; (3) environmental sustainability criteria.

More precisely, social sustainability and environmental sustainability criteria are recommended to be included in the analysis in line with the purpose of taking into account sustainability considerations when evaluating potential suppliers. Conversely, service criteria reflects the traditional criteria used to evaluate and rank suppliers. Obviously, these criteria cannot be defined in general terms, but rather the relevant factors should be identified on the basis of the specific context in exam. Scientific literature can provide useful guidelines for the identification of the selection criteria.

On the basis of the supplier's performance against the whole set of criteria, a preliminary evaluation of supplier #1 can be made. The supplier's performance are likely to be expressed with different measurement units, e.g. in terms of cost for the economic sustainability criteria or in qualitative terms for the social sustainability criteria. To gather the performance values into a synthetic index, a FLC is used to support the evaluation, and in particular to transform the different evaluations into the same linguistic scale (Amindoust et al. 2012). This leads to a synthetic judgment of the social and environmental sustainability of supplier #1. To complete the evaluation, the economic perspective of the triple bottom line approach to sustainability (Elkington, 1997) should be evaluated. This means that the cost of single sourcing at supplier #1 should be assessed. To this purpose, we adapt the model by Armenzoni et al. (2014), who have proposed a tool for the analysis of the cost of single sourcing vs. dual sourcing as a function of the reliability level of supplier #1. This completes the evaluation of supplier #1.

The second part of the model considers the analysis of *supplier #2*, which reflects the case of dual sourcing. The aim is to compare the cost of this latter strategy with that of the single sourcing, to assess the corresponding economic profitability. To carry out the analysis, it is paramount to know whether a second supplier is actually available for the given supply and therefore its performance can be evaluated and compared to that of supplier #1. In the case the company knows supplier #2, the sustainability analysis is repeated on that supplier, applying the same criteria used for the evaluation of supplier #1 (for consistency). Similarly, the cost analysis of supplier #2 can be easily carried out. Under that circumstance, the company will own the complete set of information useful to assess the profitability of the sourcing strategies (i.e., single sourcing vs. dual sourcing). In the case supplier #2 exists, but its performance is not known to the company, some simulation analyses can be carried out exploiting both the fuzzy logic model and the cost model by Armenzoni et al. (2014). More precisely, the total cost of the dual sourcing strategy can be estimated as a function of the sustainability level, to assess the economic profitability of that strategy compared to single sourcing.

3. APPLICATION EXAMPLE

The proposed model is applied to the case of a real Italian company, *Franchi S.r.l. Società unipersonale*, which was experiencing a problem of supplier selection on some critical provisions. Franchi S.r.l. operates as a manufacturer of home and office furniture. We consider the provision of chipboards, which are one of the critical raw materials used by Franchi S.r.l for manufacturing. For this provision, Franchi S.r.l. can exploit two suppliers. Supplier #1 is a local supplier, quite sensitive to sustainability practices; conversely, supplier #2 is a big company, headquarted in Austria and operating worldwide. Franchi S.r.l. has already worked with both vendors, therefore it knows the second supplier and the related performance.

To apply the model to the problem under examination, we start by analyzing supplier #1. The relevant criteria identified for the evaluation of the suppliers are:

(1) Service criteria: delivery reliability; quality; delivery lead time; delivery flexibility;
(2) Environmental sustainability criteria: emissions from the production of chipboards; use of eco-design practices; availability of an environmental management system; use of raw materials and resources;
(3) Social sustainability criteria: employment practices; health and safety at the workplace; stakeholders influence; employee's rights.

For all the criteria listed above, a performance judgement is assigned to supplier #1, using a 1-10 linguistic scale (1 = very low; 10 = very high). Performance judgements are listed in Table

Table 1: Performance of supplier#1 against the service, environmental sustainability and social sustainability criteria

Criterion	Sub-criterion	Performance (1-10)
Service	delivery reliability	6
	quality	8
	delivery lead time	2
	delivery flexibility	8
Environmental sustainability	emissions from the production of chipboards	8
	use of eco-design practices	6
	availability of an environmental management system	9
	use of raw materials and resources	7
Social sustainability	employment practices	10
	health and safety at the workplace	10
	stakeholders influence	5
	employee's rights	10

By processing these performance by means of the FLC, developed *ad hoc* under Microsoft Excel™, we got scores of 8.71, 8.50 and 7.50 respectively for the service, economic sustainability and social sustainability of supplier #1 (aggregated score: 8.64).

With respect to the cost analysis, the model by Armenzoni et al. (2014) requires the following input data: order cost [€/order]; inventory holding cost [€/pallet/day]; stock-out cost [€/pallet]; reliability level of supplier #1 [%]. These data were computed for

supplier #1 (see Table 2) and led, overall, to a total cost of the single sourcing strategy of 2,210.60 €/day.

Table 2: cost components for supplier #1

Parameter	Numerical value	Measurement unit
Order cost	152.21	€/order
number of orders	1	order/year
inventory holding cost	314.80	€/pallet/day
stock-out cost	3365.04	€/pallet
reliability	0.70	-

By aggregating the economic and sustainability performance of supplier #1, once again exploiting the FLC model, we got an aggregated performance of 6.00 (on a scale from 1 to 10).
The same analysis, carried out on supplier #2, led to scores of 8.50, 8.71 and 8.50 respectively for service, economic sustainability and social sustainability (aggregated score: 8.50). The total cost of the dual sourcing strategy, computed again exploiting the model by Armenzoni et al. (2014), is estimated to account for 3.313,18 €/day. As both the performance and the total cost of supplier #1 outperform that of supplier #2, it is suggested that Franchi S.r.l. exploits a single sourcing strategy (supplier #1) for the supply under examination.

4. DISCUSSION AND CONCLUSIONS

This paper has presented an integrated approach to the supplier selection problem, which takes into account sustainability considerations and allows for the analysis of single sourcing vs. dual sourcing strategies.
The proposed approach has some strong points. First, it considers simultaneously the three main sustainability pillars during the supplier selection process, i.e. the environmental, social and economic points of view. To be more precise, the first two pillars are evaluated by means of a specific set of criteria and sub-criteria, which can be defined by the decision maker depending on the specific problem in exam (with possible suggestions from the literature). The economic pillar, instead, is evaluated by means of a detailed model, adapted from Armenzoni et al. (2014). Moreover, the proposed approach takes into account the traditional evaluation criteria for suppliers (service criteria). Overall, the resulting supplier selection process complements the traditional ones, which typically consider only the service criteria and the economic performance of the supplier, by including several sustainability considerations.
The methodological approach is new as well, since it grounds on the use of a fuzzy logic controller (FLC), which is useful to gather a set of performance, with different measurement units, into a synthetic performance index of the supplier.
Finally, the model allows for the comparison of different sourcing strategies, and in particular of the single sourcing strategy and the dual sourcing one. From the use of the model, therefore, a company can also identify the most appropriate sourcing strategy.
The application of the model to the case study company considered allows deriving some practical considerations. The first one is that the successful application of the model requires a wide set of input data, including the definition of the relevant criteria and sub-criteria for the evaluation of the supplier, the supplier performance against these criteria, as well as some economic parameters (e.g., order cost, inventory holding cost or stock-out cost). All these input data cannot be defined in general terms, but rather should be identified on the basis of the specific company and vendor selection problem. This means that the use of the model should be supported by some company's representatives. Apart from this shortcoming, the use of the model allows a company to derive several interesting outcomes about its suppliers, namely three performance parameters (service, environmental sustainability and social sustainability) and the total cost of the sourcing strategy, thus enabling a very detailed evaluation and ranking of its suppliers.
Future research activities could address the comparison of the model with more traditional supplier selection procedures (where sustainability considerations are not made) or the extension of the model to the case of multiple sourcing.

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