A systematic review of multi-criteria decision-making applications in reverse logistics

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Abstract

Multi-criteria decision-making (MCDM) methods have been applied to various reverse logistics problems. In order to develop a reliable knowledge base through accumulating knowledge from previous studies, we conduct a systematic review of the applications of different MCDM methods to different reverse logistics problems. We found 80 relevant papers published in scientist journals, which are application of different MCDM methods to different reverse logistics problems. We classify the literature based on two dimensions problem context and methodology. The results show that recycling and AHP are the most researched problem and methodology respectively. We finally suggest some future research directions with respect to problem context and methodology.

1. Introduction

According to The Council of Supply Chain Management Professionals (CSCMP) "Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements". Although this definition contains both forward and reverse flows, when we are using 'logistics' we usually refer to the forward flow, while for reverse flow we use 'reverse logistics'.

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Drawing on the CSCMP definition we can define reverse logistics as "planning, implementing, and controlling the efficient and effective flow and storage of goods, services and related information between the point of consumption and the point of origin for economical or environmental purposes". It is important to note that although reverse logistics (RL) can greatly address some environmental concerns in logistics and supply chain management, it is different than 'green logistics' (GL). That is, although there are some activities to which we can apply both RL and GL, there are some activities which are unique to either reverse logistics or green logistics. Adopting from Rogers and Tibben-Lembke (2001), here we classify these activities to three classes:

- Only applied to GL: 'packaging reduction', 'air emission', 'noise emission', 'environmental impact of mode selection';
- Only applied to RL: 'product return', 'marketing return', 'secondary markets';
- Applied to both GL and RL: 'recycling', 'remanufacturing', 'reusable packaging', 'waste management', 'disassembly', 'design'.

So we consider the last two classes to draw the boundary of this paper.

In the context of RL there are different decision-makers such as governmental bodies, buying companies and suppliers that are responsible for several decisions. One approach to formulate complex decisions is multi-criteria decision-making where a (or a group of) decision-maker(s) should evaluate a number of alternatives with respect to a set of decision criteria in order to select the (or a number of) best alternative(s). The methods which are used for this kind of decision-making problems called multi-criteria decision-making (MCDM) methods. MCDM methods have been widely applied to many different areas. Here we refer to some of the review papers: in sustainable energy planning (Pohekar and Ramachandran 2004), in supplier evaluation and selection (Ho, Xu et al. 2010), in financial decision-making (Zopounidis and Doumpos 2002), in natural resource management (Mendoza and Martins 2006), and in construction (Jato-Espino, Castillo-Lopez et al. 2014). We did not find any review paper in the field of RL, however, we found two review papers which are close to one activity in RL: waste management (Achillas, Moussiopoulos et al. 2013, Soltani, Hewage et al. 2015). In this paper we conduct a systematic review of the applications of MCDM methods in the field of RL.

In the next section, the research methodology used for the systematic review is described. Section 3 reports the analysis and synthesis. The conclusion and future research directions are discussed in Section 4.

2. Research methodology

In this section, we describe the research methodology, a systematic review, we used in this paper. A systematic review is defined as "a specific methodology that locates existing studies, selects and evaluates contributions, analyses and synthesizes data, and reports the evidence in such a way that allows reasonably clear conclusions to be reached about what is and is not known" (Denyer 2009). In this paper we follow the five-step procedure proposed by (Denyer 2009) as follows.

Step 1. Question formulation: in this step, clear questions should be made to establish the focus of the study, and to frame the inclusion criteria. To formulate the questions we follow the CIMO-Logic proposed by (Denyer, Tranfield et al. 2008). CIMO is the acronym for Context, Intervention, Mechanisms, and Outcome. This logic is constructed as follows: "in this class of problematic Contexts, use this Intervention type to invoke these generative Mechanism(s), to deliver these Outcome(s)" (Denyer, Tranfield et al. 2008). Applying this logic to this study, we formulate the design proposition to identify the four main elements:

"*If a firm aims to make a decision about a reverse logistics problem characterized by multiple criteria and multiple alternatives (C), it should evaluate the alternatives using a multi-criteria decision-making method (I) based on one or more decision-makers (experts) opinion to identify the importance of different alternatives (M) in order to select the best one (O)*".

Step 2. Locating studies: in this step, we should locate, select and appraise the relevant studies as much as possible. To this end, we searched the literature via the scientific search engines Scopus and Web of Knowledge in a structured way. That is to say, we used 27 keywords and acronyms. We used search strings, simple operators, and Boolean logic to group the keywords to make the search more efficient. More specifically, we conducted the search