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Technical Paper

Integration of AHP-TOPSIS method for prioritizing the solutions of reverse logistics adoption to overcome its barriers under fuzzy environment

Chandra Prakash*, M.K. Barua

Department of Management Studies, IIT Roorkee, India

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ABSTRACT

Reverse logistics practices are gaining attention due to industrial ecology, enforced legislation and corporate citizenship but presence of barriers make reverse logistics (RL) implementation difficult and hence reduce the success rate. To increase RL adoption, robust and flexible strategies are required to overcome its barriers. This study focuses on identification and ranking the solutions of reverse logistics adoption in electronics industry to overcome its barriers. It aids firms to ponder on high rank solutions and develop strategies to implement them on priority. This paper proposes a methodology based on fuzzy analytical hierarchy process (AHP) and fuzzy technique for order performance by similarity to ideal solution (TOPSIS) to identify and rank the solutions of RL adoption to overcome its barriers. Fuzzy AHP is applied to get weights of the barriers as criteria by pairwise comparison and final ranking of the solutions of RL adoption is obtained through fuzzy TOPSIS. The empirical case of Indian electronics industry is shown to illustrate the use of the proposed method. This proposed method offers a more precise, efficient and effective decision support tool for stepwise implementation of the solutions due to consideration of fuzzy environment. Finally sensitivity analysis is performed to illustrate the robustness of the method.

1. Introduction

Reverse logistics (RL) practices are gaining momentum among various industries including electronics industry because of growing environmental concern, enforce legislation, industrial ecology, corporate citizenship, sustainability, intense global competition, profitability issues and increased products returns due to product recalls, warranty returns, service returns and so on [52]. Sustainable development is an essential concept for twenty first century organization and that could be managed by implementing reverse logistics operations in its supply chain [42]. RL practices can provide efficient resource utilization and prevention from pollution by minimizing the environmental burden of end-of-life (EoL) at its source [16,20,61]. The stringent law on Waste Electrical and Electronic Equipment (WEEE) enforced electronics manufacturers to work efficiently in return management and proper disposal of the products [33]. Moreover it is not the issue what are the factors, which are affecting successful implementation of RL, but one should clearly understand the opportunities embedded in reverse logistics supply chain in improvement of customer satisfaction and loyalty. There are multiple reasons which are influencing organizations to adopt RL practices but presence of barriers make RL implementation difficult and effect of these barriers cannot be overcome at the same time. Even a same barrier may needs different treatment and priority for same type of organizations due to varied nature of resources, capabilities and strategies. And hence it is desirable to adopt RL practices efficiently; factual, flexible and feasible solutions must be projected and ranked to overcome these barriers on priority basis. Previous studies suggested that little attention have been given on the barriers and drivers of RL practices implementation on developing countries [29,35,38,47,48,55,69]. However barriers analysis of electronics industry in Indian context is remain unexplored. The research done by Jindal and Sangwan [29] on RL adoption barriers in India was based on government, organizational and market related barriers those were not related to any particular industry/sector in India. An exponential growth due to industrialization, modernization, urbanization and existence of 20% of the world population in India has led to huge production and consumption, which required massive resource consumption and causes environmental pollution. Indian electronics and durables market in rural and semi-urban areas account for about 40% of the overall market and is growing approx. 30% compound annual growth rate (CAGR).

* Corresponding author. Tel.: +91 9548141866.
E-mail addresses: cpgarg86@gmail.com (C. Prakash), baruafdm@iitr.ac.in (M.K. Barua).

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The Indian electronics industry has emerged as a fast growing sector in terms of production, internal consumption and export. The growth of PC ownership per capita between 1993 and 2000 was 604%, whereas the world average increase was 181% during the same period [12,13]. That led to generate more e-waste. The report "Recycling – from E-Waste to Resources" [53] forecasted that e-waste production from old computers will increase by 500% in India from 2007 to 2020. The amount of e-waste from discarded mobile phones will be approximately 18 times higher from 2007 to 2020. By 2020, e-waste from televisions will be 1.5–2 times higher, and e-waste from discarded refrigerators will be twofold or threefold [62].

This inspired us to deal with the issues related to RL implementation, specifically to identify the barriers in Indian electronics industry and suggesting realistic solutions/strategies to overcome these barriers. The goal of this study is to identify and evaluate the barriers of RL adoption and suggest and rank the solutions to overcome these barriers. It is significant to rank these solutions so that organizations may develop appropriate strategies to execute these solutions on priority basis to overcome the barriers. These strategies can be applied in Indian electronics industry to attain and improve strategic competitive position. Moreover organizations can employ adoptive and responsive return management practices to achieve business success.

To rank the solutions of RL adoption is a hybrid decision making approach and involvement of human opinions through linguistic variables makes difficult to evaluate it by precise/certain numerical values. Hence fuzzy approach [67] is required to deal such problems characterized by vagueness and uncertainty. This study presents hybrid fuzzy Analytical hierarchy process (AHP) and fuzzy technique for order performance by similarity to ideal solution (TOPSIS) method to rank the solutions of RL adoption. AHP is multi criteria decision making method used to determine the relative importance/priority/ranking of the criteria and sub-criteria through pair-wise comparison and consider qualitative and quantitative variables/attributes; fuzzy AHP allows uncertainty and fuzziness in decision making. It has been used in many real world applications. This paper proposes fuzzy AHP to obtain relative weights of the barriers and fuzzy TOPSIS to prioritize the solutions. TOPSIS method is simple, easy to use and has many real world applications like Fuzzy AHP. It is based on ideal solution and considers the best alternative has the least distance from positive ideal solution and the longest distance from negative ideal solution. It allows cost, qualitative and quantitative variables/attributes and fuzzy TOPSIS consider uncertainty and vagueness in decision making. Lastly, an empirical case of Indian electronic industry is illustrated to exhibit the application of proposed approach.

The remainder of this paper is as follows. Section 2 concisely reviews the literature on barriers and solutions of RL adoption. The Fuzzy AHP and fuzzy TOPSIS approach are given in Section 3. The proposed approach for ranking the solutions of RL adoption is presented in Section 4. The results & discussions of empirical case with sensitivity analysis and managerial implications are shown in Section 5. Finally, the conclusion is given in Section 6.

2. Literature review

2.1. Barriers of RL practices implementation

It have been seen RL practices in developed countries derived by enforce legislation on manufacturers to take extended responsibility for recovery and disposal of end-of-life products. However it is in initial stage in developing countries including India [58]. The RL implementation is difficult in developing economies like India because of the lack of societal pressure, environmental issues, and price sensitive market. In India return management activities are often viewed as a cost of doing business and are generally processed through unorganized way and practiced traditionally by hawkers, peddlers and vendors [29]. The successful RL implementation needs economic and financial support from government along with coordination & cooperation from supply chain partners. Decision makers can fruitfully utilized information in their planning, obtained by a critical analysis of the RL barriers [46]. In order to implement RL practices effectively, some supported studies have provided several barriers of RL practices adoption (see Table 1). In this study we classify these barriers from the Indian manufacturers' point of view into seven criteria along with their sub-criteria. To explore the barriers classified into those criteria have discussed below-

2.1.1. Management barriers

Management barriers includes lack of management support, lack of awareness, less planning and effort on integrating the business process, lack change management practices, less focus on extended responsibility and drafting policies. Luthra et al. [36], Zhou et al. [68] and Rogers and Tibben-Lembke [47] found that top management was unwilling and less interested about RL. Due to change in current business scenario, competitive priority, technological up-gradation, behaviors of customers and suppliers management has to made policies and strategic planning about RL [43,46,47,60]. Companies did not want to compromise with quality of products by using returned products, hence it hinder companies to become active in RL practices [1,29,40,66]. Studies identified barriers are given in Table 1.

2.1.2. Organizational barriers

Organizational barriers are lack of proper organizational structure, less shared practices, lack of personnel resources, less attention on training & education about RL and inappropriate performance metrics system [2,39,47]. Lack of personnel resources and proper training for new upgraded scientific recycling methods were desired in proper implementation of RL practices [29,40,60,66]. Appropriate performance metrics system should be needed to measure, manage and improve RL practices in work integrated manner. Lack of such system had less scope of success in implementation [8,44,46,68]. Studies identified barriers are given in Table 1.

2.1.3. Economic barriers

Economic barriers can be classified as less economic value recovered from EoL products, high associated cost, less return on investment and returns of scale [1,24,29,60]. Lau and Wang [35] proposed that in developing countries manufacturers are still not able to recapture value and recover assets from recycling, probably due to low volume of returns. So, lack volume of EoL products is one of the greatest threats to industry [23]. Customers could make money to sell their used appliances so why they would show interest in paying for recycling and disposal [60]. Huge amount of initial capital and finance would require in implementing RL [42]. Transportation, Information and processing system required high capital investment that hinders companies to execute RL practices [47]. Timing, quality and quantity of return products were uncertain that reduce to achieve returns of scale. Studies identified barriers are given in Table 1.

2.1.4. Legal barriers

Legal barriers are lack of enforces legislation for end-of life products, lack of Govt. supportive policies, less green practices/environment concern and informal waste practices [1,5,8,18,24,29,31,38,45–47,68]. Wath et al. [64] stated that India