Reverse Logistics Network Design Literature Review

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INTRODUCTION

The forces such as regulation pressure, profit advantage, the necessity of strengthening green image and social responsibility make firms develop strategies on sustainability and integrate necessary systems to their own production systems in order to make consumers return used and damaged products. Process of product return is disciplined by a management approach named as Reverse Logistics (RL). One of the most frequently used definition of RL is suggested by The European Working Group on Reverse Logistics (REVLOG) as the following (De Brito & Dekker, 2004); "The process of planning, implementing and controlling backward flows of raw materials, in process inventory, packaging and finished goods, from a manufacturing, distribution or use point, to a point of recovery or point of proper disposal." It is noticeable to say that in different approaches, the grouping types of recovery options may differ, but fundamentally they mostly include the same operations and all of them are performed for the same reasons: in order to decrease waste, grow profits, utilize resources efficiently and increase green corporate image.

Studies regarding RL have been conducted in different aspects which range from strategic decisions to tactical and operational decisions. In this study, one of the most important topics: reverse logistics network design (RLND) is taken into account. It is aimed to execute a literature review of RLND studies relate to the period 1988-2011.

In view of attracting attention to RL, many important literature review articles have been conducted on that field (Fleischmann et al., 1997; Prahinski & Kocabasoglu, 2006; Srivastava, 2007; Rubio et al., 2008; Akçalı et al., 2009; Pokharel & Mutha, 2009; Subramoniam et al., 2009). To our search, in publications available at scientific databases, there is not literature review study considering nearly all exact solution based RL studies including indexed proceedings directly related to RLND. Also, we note that although these papers give different classifications on RL literature, they do not provide comprehensive overview on structure of RL model and network, and implementation environment. In order to fill this gap, we have investigated RLND by reviewing literature in many aspects, classifying articles, and providing results and further directions which may give some ideas to the researchers who want to study on this topic.

The goals of this paper can be summarized as: (1) to contribute to a better understanding of directions related with RLND by classifying articles, (2) to provide a focused and comprehensible literature review in exact solution based RLND studies, and (3) to determine a plan by considering lack of specific issues in RL studies for further research. In the view of these goals, first of all the research methodology that is divided into three subcategories: identification, evaluation and interpretation (findings), is described. Then, limitations of the study are discussed. Finally, the work is concluded with the directions for future research and conclusion. We hope that the recom-

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mendations will help researchers easily understand the conceptual content of the field and guide to the development of new study development.

BACKGROUND

Because sustainability is one of the most important strategies in today's competitive business environment, RL as a process increasing sustainability has been recognized by organizations incrementally. This study helps to researchers who want to study on the specific issue of this field, and managers who want to improve their business processes, by two ways:

1. Introducing and comparing past and current characteristics and trends of RLND studies, and
2. Providing which parameters and variables should be taken into consideration when modeling their business processes in RL network with respect to expected requirements.

This study differs from literature reviews conducted in the past in that it focuses on RLND studies from a comprehensible perspective. Literature review methodology is chosen because as Hart and Bond (1998) mention, "Without literature review, you will not acquire an understanding of topic, of what has already been done on it, how it has been researched, and what the key issues are."

This analysis focuses upon journals, academic notes and conference proceedings that are searched via Web search engines of Istanbul Technical University and Otto von Guericke University Magdeburg. In order to find related studies, a structured keyword search was conducted. The most important keywords are ''reverse logistics," "reverse logistics network design," "reverse logistics network modeling," "green supply chain design," "product recovery," "reverse supply chain" and "closed loop supply chain design." To establish a time span, there was no starting point set. The analysis is started with Gottinger (1988), one of the basic studies on this field, and ended with the papers published in 2011.

The steps of literature review methodology can be summarized as the following:

1. Conducting a structured keyword search in order to gather RLND publications published in journals, academic notes and conference proceedings.
2. Categorizing the publications into two groups: "Model and Network Structure" and "Implementation Environment," and evaluation of publications by analyzing them in more details in terms of:
    - Modeling type, objectives of models, parameters of models, product quantity and capacity limits for "Model and Network Structure" and
    - Characteristics of illustrative examples for "Implementation Environment."
3. Interpreting the findings in order to highlight changings, drawbacks and trends in RLND studies in order to easily understand the conceptual content of that field.
4. Proposing further directions.

Identification and Evaluation of Publications

Identification of the taxonomy is launched by conducting descriptive analysis that lists all papers published since 1988 in different scientific journals/academic notes and international conference proceedings published in the areas of operations research, production, manufacturing, logistics, waste management, recycling, and operations research.

This study develops review on RLND optimization problems which are exact solution method based. Rardin (1997) defines the exact optimal solution as: "a feasible solution to an optimization model that is probably as good as any other in objective function value" and states that this kind of methods give feasible results under a particular