Chapter 7
Reverse Logistics Network Design Using a Hybrid Genetic Algorithm and Simulated Annealing Methodology

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ABSTRACT
Reverse logistics network design (RLND) effectiveness has an important impact on the effectiveness of the whole supply network coordination. Considering that, in this study, the RLND problem is investigated and a hybrid genetic algorithms and simulated annealing (HGASA) methodology is proposed. This problem is applied to a preceding study which utilized genetic algorithms (GA) for the optimization. HGASA and GA results are tested with Wilcoxon rank-sum test for hundred runs and the results prove the difference between two approaches. Additionally, the averages and the standard deviations support that, the HGASA algorithm increases the probability of obtaining better solutions.

INTRODUCTION
Supply network coordination is an essential requirement in modern industry (Germain et al., 2007). According to Malone and Crowston, coordination is the concept of managing dependencies between activities (Malone and Crowston, 1994). Shared resources, producer/consumer relationships, simultaneous constraints, and tasks/subtasks can be identified as dependencies between activities in the supply network (Germain et al., 2007). Coordination is particularly problematic when considering supply networks, as
the scope of business processes exceeds the individual company’s boundaries (Danesa et al., 2004).

Considering the definition, Supply Chain Management (SCM) considers the holistic, process-oriented,
cross company management and coordination of processes regarding material and product flows as well
as complementary, initiating and accompanying information flows and the principles of SCM build on
logistics and its key issues (Fritz and Hausen, 2009). Literature on SCM emphasises the importance
of coordination and integration mechanisms to manage logistics processes successfully across supply
networks (Xu et al., 2009).

In terms of supply chain efficiency, the network’s ability to respond quickly and effectively to the
customer requirements is a key factor differentiating competing companies. Technological advancements
facilitate the way of meeting customer needs. Agility, quality, traceability, and service-ability depend on
collaborative logistics networks that can focus on enhancing their performance by cooperative processes.
Collaborative logistics networks are collections of supply chain partners designing and providing high
quality and customized products (Miranda et al., 2009). To this end, electronic environment provides
various important opportunities for the efficiency of supply networks. Communication over the internet,
Electronic Data Interchange (EDI), internet based business-to-business, business-to-customer applica-
tions, e-logistics, e-commerce applications, e-fulfilment applications are the examples of the opportunities
provided by electronic environment. Additionally, according to Daugherty et al. (2005), it is important
that the resources to be focused on developing information technology capabilities and this is also
reflective for the nature of the Reverse Logistics (RL). Information support-for authorizing, tracking,
and handling returns-can positively impact both economic and service-related performance (Daugherty
et al., 2005). It is important for companies to be able to physically handle returns-including activities
such as stock selection, transportation, centralized collection, data collection, sortation, refurbishing or
remanufacturing, and disposition. However, they must also develop data management capabilities, for
example they should be able to integrate manufacturer and retailer data, create invoices, generate store
credits, detail accounts receivable, and issue management reports. Finally, companies should also be
able to strategically apply the gathered information to streamline internal processes and support supply
chain-level planning (WERC Sheet, 2003; Daugherty et al., 2005).

As stated earlier, supporting processes of RL electronically is important; however, initial establish-
ment of the RL network (RLN) is also crucial. It can be said that, one of the important parameters of the
effectiveness of RL information systems is the design of RLN with the distances, possible connections
and transportations between the nodes. With the proposed approach, it is aimed to initialize a suitable
environment for the effective electronic SCM applications. Definition of return channels and destinations
with an effective and flexible way may provide opportunities for more flexible, reliable, fast electronic
SCM environments from the point of returns. Changes in the network inputs may be easily integrated
into the model and also results of the changes may be quickly and reliably obtained for the electronic
SCM environment with the help of proposed approach. Before explaining the proposed approach, it
would be better to first explain the RL concept and related literature.

Due to the severe environmental problems, environmental initiatives, which are enforced by govern-
ments, customers or companies themselves, have become an obligation. As a part of environmentally
conscious initiatives, reverse logistics has taken considerable attention both from academicians and
practitioners. Rogers and Tibben-Lembke (1998) defined reverse logistics (RL) as “the process of
planning, implementing and controlling the cost effective flow of raw materials, in-process inventory,
finished goods and related information from the point of origin for the purpose of recapturing value or
proper disposal”. Traditionally, the term of “logistics” is perceived only with the forward side of the