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# Development of a Performance Measurement System for International Reverse Supply Chains

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**Abstract**

In times of globally connected production networks, supply chain management is a key discipline of modern living. Due to increasing commodity prizes and a greater awareness of resource efficiency, the relevance of international reverse supply chains is increasing. Unfortunately, there is a lack of knowledge when it comes to the assessment of international reverse supply chains. To close this lack, scientists from Bayreuth defined a performance measurement system to assess international reverse supply chains. The aim of this paper is to support the Circular Economy and the remanufacturing industry with an approach to optimize international reverse supply chains and thus to become more sustainable.


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*Keywords:* Reverse Supply Chain; Reverse Logistics; Supply Chain Management; Performance Measurement; Performance Measurement System

## 1. Introduction

The awareness of topics as *reverse logistics* and *reverse supply chain* are steadily increasing in the last years.

According to Asdecker, the retour rate of fashion products is up to 55.65 per cent [1]. According to the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, 127,577 tons of old products were reused or recycled within the electro and electronic sector in 2013 [2].

Both examples emphasize the necessity of efficient reverse logistics respectively reverse supply chains. Besides the above-mentioned sectors, reverse logistics is an important topic in other industry sectors as well, for example the automotive industry sector [3].

In 1989, Sink and Tuttle pointed out, that the management and thus the efficient operation is not possible without being able to measure the performance [4]. Therefore, also the efficient management of reverse supply chains is not possible without assessing its performance. Janse et al. [5] and Shaik [6] pointed out, that there is immatureness in science regarding performance measurement systems of reverse logistics.

## 2. State of the Scientific Knowledge and Need for Action

This section gives an overview about the state of the scientific knowledge regarding reverse supply chains, reverse logistics (RL), closed loop supply chains, international supply chains as well as barriers, drivers and success factors for reverse supply chains. Furthermore, the need for action is pointed out.

### *2.1. Reverse Supply Chains*

According to Rogers and Tibben-Lemke, the term reverse supply chain is defined as following:

"The process of planning, implementing and controlling backward flows of raw materials, work-in-progress, finished goods and information, from the point of consumption to the point of recovery or proper disposal. " [7, p.2]


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Guimarães, Silveira and Salomon defined the term reverse logistics as following:

”The RL has the objective to facilitate the return of consumer goods or their constituent materials to production or business cycle, adding economic value, ecological, legal service and location. “ [8, p.140]

Guide and van Wassenhove defined the term reverse supply chain management more generically:

„It’s the series of activities required to retrieve a used product from a customer and either dispose of it or reuse it.” [9, p.2]

A scientific consideration of the differentiations between the two terms reverse logistics and reverse supply chains is done by Larson et al. [10]. For this paper, the terms are used as synonyms.

Another term that has to be defined is the closed loop supply chain. According to Guide et al., closed loop supply chains consist of forward and reverse supply chain activities. [11].

Further definitions regarding reverse supply chains can be found in the framework of Lambert et al. [12].

### *2.2. Drivers for Reverse Supply Chains*

The main drivers for reverse supply chains were pointed out by Scott et al. [13]:

- Legislation
- Profit
- Corporate citizenship

These drivers were used as rudiments for this paper.

### *2.3. Reverse Supply Chains versus Forward Supply Chains*

According to Gupta, reverse supply chains are facing a higher uncertainty as forward supply chains [14]. Furthermore, Tibben-Lembke et al. pointed out, that forecasting is easier in forward than in reverse supply chains [16a, 16b].

One reason for the uncertainty in reverse supply chains is the varying quality of products that enter the reverse supply chain [14, 16a].

One of the main differences between forward and reverse supply chains was described as the Many-To-One problematic by Fleischmann [17]. Within forward supply chains, the material flows from the lower number of supply chain participants, as for example factories, to the higher number of participants, as for example end customers [15].

Klaus and Krieger pointed out that the costs for stock must be lower in reverse supply chains as in forward supply chains, due to the lower value of the products [18].

Further, differences between forward supply chains and reverse supply chains, which were pointed out by Tibben-Lembke et al, are summarized in the following [15]:

- Undefined routes of products
- Aggravated price calculation
- No mature inventory management
- Low awareness of reverse supply chains at the management level
- Higher transportation costs
- Lower value of the products

### *2.4. International versus National Supply Chains*

Zamjirani Farahani [19] and MacDonald [20] pointed out, that the management of international supply chains is a much bigger challenge as the management of national supply chains. Especially the variety of challenges is higher [19, 20].

Further differences of international supply chains compared to national supply chains, according to Zamjirani Farahani, are named in the following [20]:

- Differences in language and culture
- Differences in law and currencies
- Longer distances and thus longer delivery times
- Higher costs for transportation and storage
- Higher uncertainty
- Security and technology problems

### *2.5. Barriers for Reverse Supply Chains*

The barriers for efficient reverse supply chains, described in scientific literature, were condensed by Agrawal et al. in their study in 2015 [21]. The 59 barriers identified by Agrawal et al. were structured into eight categories. Following are the eight barrier categories:

- Resource scarcity
- Awareness of the top management
- Legislation
- Customer preference
- Poor knowledge regarding reverse logistics
- Poor IT infrastructure, forecasting methods
- Undefined recycling technologies
- Poor knowledge regarding taxes

### *2.6. Success Factors for Reverse Supply Chains*

Verweiji et al. described the success factors for reverse supply chains in a study in 2015. Table 1 illustrates an overview of the ranked success factors for reverse supply chains, according to Verweij et al. [22].

Table 1. Success Factors for Reverse Supply Chains, according to [22].

| **Success factor** | **No.** |
|---|---|
| Strategy focus on avoiding returns | 1 |
| Detailed insight in cost and performance | 2 |
| Strategic partnerships with chain partners | 3 |
| Top management awareness | 4 |
| Reclaiming value from returns | 5 |
| Capability to put returned products rapidly in the market | 6 |
| Visibility of quality and value in product life cycle | 7 |
| Automating returns process | 8 |
| Efficient gatekeeping | 9 |
| Track and trace capabilities | 10 |
| Strategic partnership with other producers | 11 |