

## 論文の要旨

題 目 A STUDY ON IMPROVING SUSTAINABILITY OF CLOSED-LOOP SUPPLY CHAINS WITH SOCIAL RESPONSIBILITY  
(社会的責任を考慮した閉ループサプライチェーンの持続可能性向上に関する研究)

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Over the last 50 years, social responsibility in the supply chain has changed from involving a single corporation to involving multiple companies. The empirical data show that social responsibility in the supply chain can be divided into five main streams: Purchasing Social Responsibility (PSR), Sustainable Transportation (ST), Sustainable Packaging (SP), Sustainable Warehousing (SW), and Reverse Logistics Social Responsibility (RLSR).

The aim of this thesis is to perform comprehensive modeling and analysis of integrated social responsibility in the supply chain for building sustainability. One of five main streams of integration are selected that is RLSR. RLSR is selected since it involves most of actors in supply chain who has an impact from social responsibility.

The aim of this thesis is achieved by three main issues. The first issue focuses on System Dynamics (SD) model building of RLSR based on interrelated sustainability dimensions. The second issue focuses on building efficient flexible capacity planning policy for RLSR to tackle product lifecycle with its inherited uncertainty for optimal interrelated sustainability dimensions' performance. The third issue focuses on the impact of product lifecycle disruption on the second issue model.

First, the challenge for involving as many actors in the supply chain for doing corporate social responsibility, has force the actors in supply chain to do RLSR. This force comes with difficulties ranging from multi-dimensional performance focus, to the short-long term sustainability orientation. Combines with the additional complexity of supply chain, it creates much more than a trivial exercise. Here, a simplified single-product system dynamics model consists of complex supply chain actors doing reverse logistics social responsibility, is developed. The market response due to premium price and environment performance are featured. Social contribution level and reverse logistics capacity planning policy are delivered as policy options with interrelated triple bottom line as performance measurement. The results show how corporate social responsibility produces economic, environment and social return through reverse logistics.

Second, product lifecycle uncertainties in Closed-Loop Supply Chains (CLSCs) are costly and frequently unavoidable. So the aim of this step is to develop efficient flexible long-term capacity planning policy for CLSCs that considers social responsibility or a supply chain with RLSR. This aim is to answer an important research question on how to tackle the lifecycle with its inherited uncertainty to achieve optimal sustainability dimensions performance. Here, a single-product SD model of the supply chain with RLSR is used. This SD model considers interrelated sustainability dimensions and adopts the product lifecycle with its inherited uncertainties, such as the length of the product lifecycle, pattern of the product lifecycle, and residence index. Finally, a mathematical model of the developed policy is constructed and a simplified non-linear multi-objective algorithm is proposed to solve this mathematical model. In addition, Taguchi Design is used to minimize the number of simulations needed in the numerical experiment. The findings of this study show that the developed policy could be used to tackle the lifecycle with its inherited uncertainty to optimize the sustainability dimensions

performance. These findings have some limitations, however, the findings underscore this paper's contribution to the relatively limited but important academic knowledge on capacity planning development for research on social responsibility issues in CLSCs. In practice, the results will give managers a better understanding of how to tackle product lifecycle uncertainties in RLSR and will therefore lead to better capacity planning to achieve optimal sustainability dimensions performance.

Third, RLSR is preferred as a social responsibility activity in the supply chain since it involves most of the supply chain actors who have an impact on social responsibility. So here, a single-product SD model of the supply chain with RLSR is developed. The product lifecycle with its inherited uncertainties, such as the length of the product lifecycle, pattern of the product lifecycle, and residence index, is adopted by considering interrelated sustainability dimensions. Efficient flexible capacity planning is established as a policy option by considering a social responsibility fund from the premium price that is contributed by consumers. The Taguchi design of experiment is used for analysis of the numerical simulation. Finally, the significance with its power is measured to show the power of the relationship between policy and uncertainty for the sustainability dimensions' performance. These features will be used to analyze the impact of capacity planning on product lifecycle for performance on sustainability dimensions in RLSR by using an SD approach. The findings show that the policy parameters have an effect on any measured performances and uncertainties with some conditional exceptions. These findings reveal three interesting facts regarding RLSR due to the considered model features. First, the economic performance is a result of a direct influence of policy. Second, the environmental performance results from the indirect effect of the policy. Third, the social performance is the performance that is hardest to influence by policy. Therefore, the findings underscore this paper's contributions to the relatively limited academic knowledge on the examination of the impact of behavior in reverse logistics as a social responsibility due to capacity planning and the product lifecycle with its inherited uncertainties. These contributions offer managers a better understanding of the relationship between capacity planning, product lifecycle with its inherited uncertainties, and sustainability performance. This better understanding will lead to better capacity planning to tackle product lifecycle with its inherited uncertainties for sustainable RLSR.

**Keywords:** Sustainable Supply Chains, Reverse Logistics Social Responsibility, System Dynamics