



Eco – Eco Model Cellulose and Paper

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Eco – Eco optimizing model utilization in the closed – loop supply chain

The aim of this paper is to link the current problem of reciprocal effect of economic and environmental influence in the present times and to describe the eco-eco models utilization in the closed-loop supply chain, which are a part of reverse logistics. The goal is creation of concrete eco-eco model of closed-loop supply chain.



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The explosive growth of reverse logistics is related to two basic factors, namely environmental and economic. Environmental aspects are in the reverse logistics primary and they are also reflected in the extensive environmental legislation.



The economic part of model

Every subject of economy is trying to optimize the criteria and find the way that ensures the best competitiveness, market position and return on investment. The economic part of the model is directly linked to reverse logistics processes such as sorting, dismantling and processing of used products.



The ecological part of model

It is a primary part of reverse logistics. The object of his interest is the possibility of recycling of municipal and industrial waste in connection with increasing environmental requirements, which are mainly driven by pressure from environmental legislation.



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Cellulose and paper is very large and capital intensive part of industry and in many countries is an important trade for the economy.

Introduced eco - eco model is a fictitious case, despite the application of it to be treated as a real case.

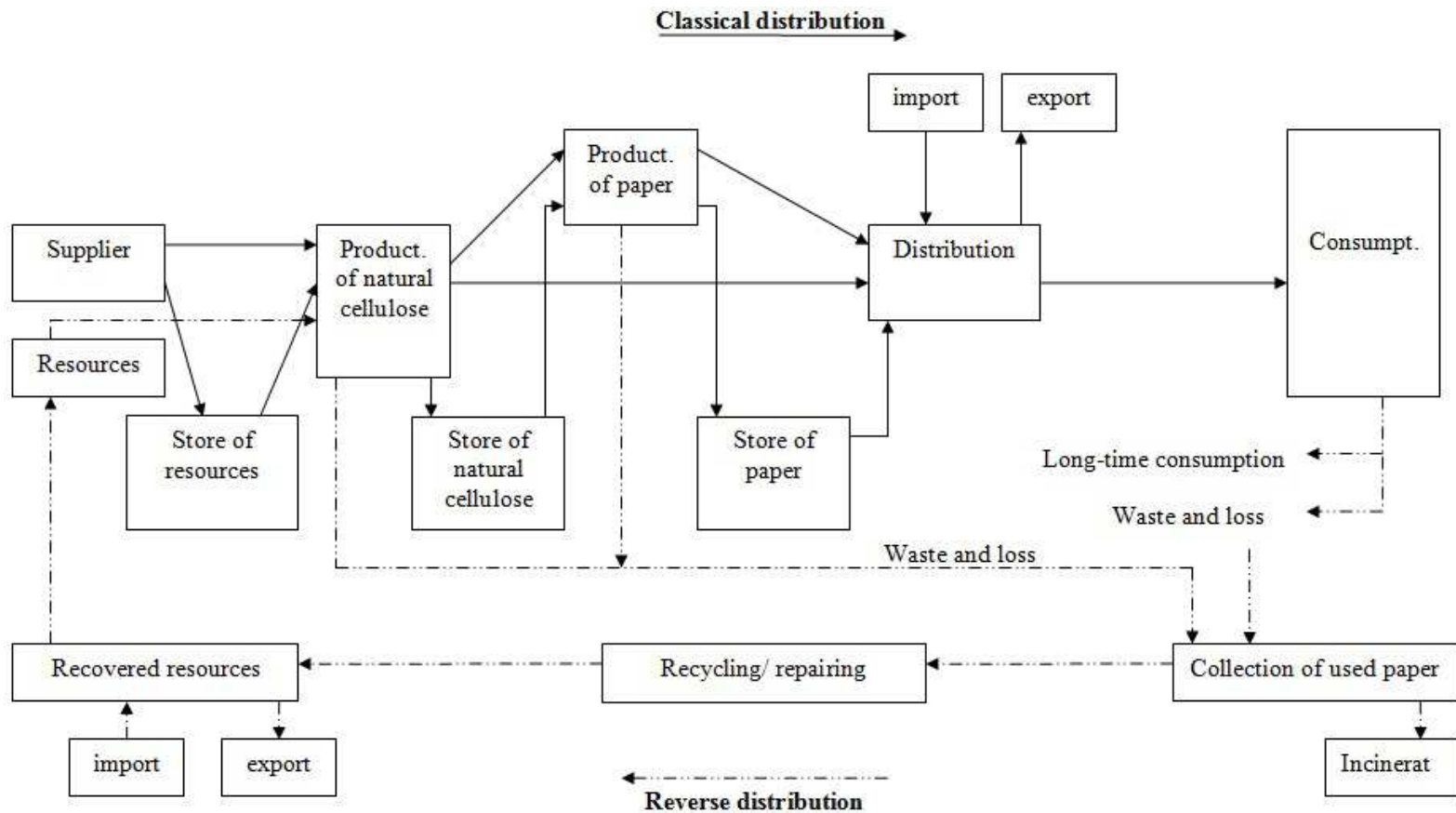
The question is to find a compromise between the economic and ecological aspects.



Verbalism formulation of Eco – Eco Model Cellulose and Paper

The three regions produce and then collect and recycle three natural cellulose types and three paper types. For their manufacture and production use recycled resources. A part of the natural cellulose is directly consumed in consumption and a part is often used also for paper. Waste from various productions is collected at the collection of used paper. In point of consumption, the consumer decides to use the product for long-term consumption or the inclusion of the harvest. Subsequently, in the collection of paper waste is this separate for recyclable and not recyclable. Recovered resources are re-used in the production process.

Graphical formulation of Eco – Eco Model Cellulose and Paper



Ecological objective function of eco – eco model

Optimization of ecological part of eco – eco
model based on minimizing the environmental
impact function:

$$\min \sum_{i \in I^+} \sum_{c \in C} ev_{ic} PC_{ic} + \sum_{i \in I} er_i PR_i + \sum_{i \in I} ei_i LW_i + \sum_{i \in I^+} \sum_{j \in I} et_{ij} \sum_{c \in C} TC_{ijc} + \sum_{i \in I} \sum_{j \in I} et_{ij} \left(\sum_{p \in P} TP_{ijp} + TW_{ij} \right)$$

Economic objective function of eco – eco model

Optimization of economic part of eco – eco
model based on minimizing the total cost
function:

$$\begin{aligned}
 \min & \sum_{i \in I} cS_i \times S_i + \sum_{i \in I^+} \sum_{c \in C} cPC_{ic} PC_{ic} + \sum_{i \in I^+} \sum_{p \in P} cPP_{ip} PP_{ip} + \sum_{i \in I} cRP_i PR_i + \sum_{i \in I} cSS_i SS_i + \sum_{i \in I^+} \sum_{c \in C} cSC_{ic} SC_{ic} + \\
 & + \sum_{i \in I^+} \sum_{p \in P} cSP_{ip} SP_{ip} + \sum_{i \in I} cTS_i S_i + \sum_{i \in I^+} \sum_{c \in C} cTCP_{ic} PCP_{ic} + \sum_{i \in I^+} \sum_{c \in C} cTCU_{ic} TC_{ic} + \sum_{i \in I^+} \sum_{p \in P} cTPU_{ip} TP_{ip} + \\
 & + \sum_{i \in I, j \in I, c \in C} cTC_{ijc} TC_{ijc} + \sum_{i \in I, j \in I, p \in P} cTP_{ijp} TP_{ijp} + \sum_{i \in I, j \in I} cTW_{ij} TW_{ij} + \sum_{i \in I} cLW_i LW_i
 \end{aligned}$$

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$$\sum_{c \in C} PCU_{ic} + \sum_{p \in P} PP_{ip} + \sum_{c \in C} wc_{ic} + \sum_{p \in P} wp_{ip} \leq S_i \quad i \in I$$

$$PC_{ic} = PCP_{ic} + PCU_{ic} + \sum_{j \in I, j \neq i} TC_{ijc} \quad i \in I, c \in C$$

$$PP_{jp} = dp_{jp} + \sum_{k \in I, k \neq j} TP_{jkp} - \sum_{i \in I, i \neq j} TP_{ijp} \quad j \in I, p \in P$$

$$iS_i \leq SS_i \leq lS_i \quad i \in I$$

$$iC_{ic} \leq SC_{ic} \leq lC_{ic} \quad i \in I, c \in C$$

$$iP_{ip} \leq SP_{ip} \leq lP_{ip} \quad i \in I, p \in P$$

$$\sum_{i \neq j, i \in I} TC_{ijc} + PC_{jc} = dc_{jc} + \sum_{k \neq j, k \in I} TC_{jkc} \quad j \in I, c \in C$$

$$\sum_{i \neq j, i \in I} TP_{ijp} + PP_{jp} = dp_{jp} + \sum_{k \neq j, k \in I} TP_{jkp} \quad j \in I, p \in P$$

$$pi_{jp} + \sum_{i \in I, i \neq j} TP_{ijp} + PP_{jp} = dp_{jp} + \sum_{k \in I, k \neq j} TP_{jkp} + pe_{jp} \quad j \in I, p \in P$$

$$\sum_{i \neq j, i \in I} TW_{ij} + ws_j - LW_j = dw_j + \sum_{k \neq j, k \in I} TW_{jk} \quad j \in I$$

$$dc_{jc} = PC_{jc} + \sum_{i \in I, i \neq j} TC_{ijc} - \sum_{k \in I, k \neq j} TC_{jkc} \quad j \in I, c \in C$$

$$dp_{jp} = PP_{jp} + \sum_{i \in I, i \neq j} TP_{ijp} - \sum_{k \in I, k \neq j} TP_{jkp} \quad j \in I, p \in P$$

$$PR_j = de_j \quad j \in I$$

$$ws_i = wc_i + wp_i + w_i \quad i \in I$$

$$LW_i = l_i ws_i \quad i \in I$$

$$PR_i = ws_i - LW_i \quad i \in I$$

$$dc_{ic} = \sum_{p \in P} \mu_{cp} (1 - A_{ip}) \times \rho_p \times PP_{ip} \quad i \in I, c \in C$$

$$de_i = \sum_{p \in P} A_{ip} \times \rho_p \times PP_{ip} \quad i \in I$$

$$A_{ip} \leq \lambda_p^{\max} \quad i \in I, p \in P$$



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Solution of our eco - eco model gives answers for economical and ecological part.

Current society should accept and use solutions of eco - eco models.