



## **Optimised technical resource management of networked recycling**

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Strategies for environmental protection and recycling of used appliances, industrial and communal wastes are helpful in order to create a closed loop economy. The EU membership of Hungary gives not only technological, but also moral, legislative and financial support to contributing to the success in avoiding global environmental catastrophes. This contribution address economical valuation of technical and organisational measures and their optimisation in a technical and an economical sense but also in respect to other factors like logistics of networked recycling enterprises. Besides globalisation of market and competition relations not only the reduction of the life cycle of products, technologies and services but also the rising of complexity of recycling processes can be witnessed. The enterprises with a traditional organisational structure are no longer in the position to sell their services and respond to the changing environmental-related policies. The solution can be given by networked enterprises. The authors focus on three optimisation problems of networked recycling enterprises:

1. Optimisation of purchasing process of networked recycling enterprises: Authors describe a mathematical model and a heuristic optimisation method to design the optimal just in time purchasing system of networked recycling enterprises from the point of view production, material flow and land use aspects. An optimisation method and software was implemented to select the optimal purchaser, the optimal order and the optimal scheduling. The models for the logistic planning and control of the virtual enterprise incorporate only the global problems but they have to be accommodated to the inner logistics of the individual elements of the virtual enterprise. The main elements of the model for global logistic planning and control encompass the following factors: formation of the delivery system of production companies, choice of methods of transport and

companies carrying out transportation, formation of the order of satisfying orders, scheduling the outgoing delivery, matching the devices for transport and loading, for making unity of stack to each task, determining the level of stock of the received goods, optimum placement of collection and distribution storerooms, determining the capacities of stock, choosing the enterprise carrying out the outgoing delivery and choosing the destination of the outgoing delivery, scheduling the delivery into and out of the collection-distribution storage places, choosing the system of information flow related to the material flow.

2. Geographical optimisation of the multi-level purchasing system of networked recycling companies: authors describe an optimisation method and a software, which makes it possible to select the optimal purchasing structure (one, two or three-level collection and distribution system). The software was tested within the frame of the development of Hungarian recycling system for wastes of electric and electronic equipment. The analysis shows the effect of the different collection systems on logistic parameters such as routes, material handling intensity, type of collection routes.
3. Member solution of virtual recycling enterprises: Authors will describe a mathematical model and a genetic algorithm based genetic algorithm to optimise the available resources of possible members of virtual recycling enterprises. The model includes several objective functions for selecting partners of the virtual enterprise: creation costs, capacities and their risks, transportation costs, the candidate' history in the virtual enterprise, and subjectivity. To implement the selected objective function, a genetic algorithm was selected because of the complexity and non-linearity of the objective function. The implementation phases begins with specification analysis and justifies why an own implemented genetic algorithm was selected. The development process is documented in details, describing GA classes, implemented operators graphical user interface, database creation for virtual enterprise resources, settings' form and own implemented custom .NET control. The test process is also detailed which leads to the need of custom genetic operators and the integer value representation of the objective function to solve the VE's partner and resource selection problem. Testing the modified genetic algorithm gives good results from the point of view optimisation process. Authors purposes further steps and tests.

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