Eurasian Journal of Business and Management, 6(1), 2018, 7-22
DOI: 10.15604/ejbm.2018.06.01.002

EURASIAN JOURNAL OF BUSINESS AND MANAGEMENT

www.eurasianpublications.com

THE PENALTY PRODUCTION MODEL – AN ALTERNATIVE WORKING CAPITAL SOLUTION FOR REVERSE SUPPLY CHAINS*

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Abstract

The working capital issue increased lately for small and medium-sized companies which strived to behold their position on the competitive market in the long term. A shift in competition from firm versus firm to supply chain versus supply chain increased the role that every member of the supply chain had in its long-run development or failure. This paper presents an alternative working capital production model which collects its working capital needs by using an auto-financing method in the sorting stage of the recycling process for reverse supply chains. The penalty system was designed by the author (as part of the operative drift for one of the largest Norwegian recycling companies) as an aggregation of penalty types and their respective amounts for each category that a load can comprise at the entrance in the manufacturing area. Results generated by the new production system highlighted the fact that working capital could be obtained by auto-financing mechanisms, and that the total income could be higher than the value based on a fixed-fee penalty system (the complex model doubled previous income already one year after new system was implemented), achieving in the same time better waste control between original waste declaration and handled waste resulted after the sorting process. Moreover, the sorting facility decreased its own production costs (since extra working capital was generated by applying the auto-financing mechanism), and obtained better control for every fraction processed at the plant (dangerous waste presented in this study) between invoiced volumes and quantities shipped forward in the reverse supply chain.

Keywords: Production Model, Reverse Supply Chains, Sorting Process, Supply Chain Finance, Working Capital

1. Introduction

The international supply chain environment has changed significantly in late years due to overseas members involved in the logistics process and complexity of operational and financial transactions, leading to an increasing number of supply chain disconnections. One important issue from a financial perspective has been working capital funding for small and medium-sizes companies which struggled to survive on the competitive market in the long run. From an operational perspective, shifting focus from cost-minimization strategy to profit-maximization approach led to growing expectations from investors towards daily business activities performed by supply chain members, adding financial pressure on these companies in order to obtain better financial results, both short-term and long-term based. Nevertheless, changing competition from

*A preliminary draft was presented as a working paper at The 16th International Conference on Informatics in Economy, Education, Research and Business Technologies (IE 2017) in May 2017, in Bucharest (Romania).

firm against firm to supply chain versus supply chain added complexity to the entire network of actors in general, and small and medium-sized enterprises in particular.

Working capital and investing capital usage has developed into a more detail-based analyze by shareholders due to the short-term versus long-term perspective profits. Despite the fact that operational (non-financial) alternatives regarding supply chain optimization have been closely studied, financial options (with focus on daily-based activity level) had less focus in the research area until late years.

Supply Chain Finance represents the new research environment for finances inside supply chains, with close follow-up upon working capital efficiency in a network of actors, trying to find alternative methods from the members outside the original supply chain (such as financial institutions) in order to supply short-term deficits, especially for small and medium-sized enterprises (SME) like, for example, production levels optimization or continuous capital flow for daily activities.

In terms of financial trustworthiness, SME are those firms that encounter monetary limitations due to their financial reputation on the market, regulations imposed by the government, or higher bankruptcy risk than larger corporations due to their low financial credibility in terms of assets or provisions.

Reverse Logistics, as an area of research, studies closely a new form of supply chain, namely reverse supply chains, with focus on operational and financial aspects such as optimization of the entire supply chain, area elaborated mainly after 2005. From a practical point of view, core questions regarding practical implementation of the new concepts are "*Does it pay to be green*?" (King and Lenox, 2001) or "*Pay to be sustainable*?" (Hoffman and Bazerman, 2007), having focus on environmental-friendly solutions which represent the current trend in the business environment. Large firms are including these solutions as part of their operational strategies, with focus on quality, in combination with financial and non-financial future implications, while SME need to build cost-benefit analyses in order to balance green strategy effects in the long run versus short-term effects, and find the overall benefits of implementing this new approach before deciding whether these strategies can be sustained by the firm.

This research provides a solution for working capital financing in the reverse supply chains in the sorting phase of the manufacturing step of the recycling process, presented in a non- Supply Chain Finance traditional way. The new production model (built as a penalty system) represents a working capital financing solution which was designed by the author in cooperation with the other operational divisions at one of the largest Norwegian recycling company in order to cover all production costs generated by the extra sorting and handling of all fractions delivered at the main sorting facility. Results obtained in 2015 (one year after new system' implementation) show a duplication of the working capital volumes compared to previous years, obtaining a better fraction control for all fractions processed in the manufacturing area (represented here by a selection of hazardous waste types), supporting simultaneously own sorting costs decrease inside the production process.

The new working capital financing perspective in Reverse Supply Chains differs from similar approaches regarding financing of supply chains due to the fact that working capital is obtained based on a non-traditional method (such as financial institution funding) from an existent actor of the reverse logistics, namely the raw material provider (represented in this supply chain by all firms that collect and deliver their returns to manufacturers of the reverse logistics), without financial implications for the producer due to non-refundable and interest-free liabilities that a loan from a financial institution would involve, replaced in this case by an auto-financing method inside the reverse supply chain. Among the results obtained due to this new form of financing can be found optimal sorting daily activities, sustainable sorting times in order to process all returns according to recycling standards, and a higher degree of goods sorted a prior to their entrance in the manufacturing area close to optimal sorting levels due to the learning process that return companies are exposed towards the new form of penalty distribution.

This research is organized as following: Section 2 contains a brief review of the research literature for Global Supply Chains, Reverse Logistics, Working Capital and Supply Chain Finance that provide a contextual environment for working capital financing; Section 3 presents the production model as a working capital financing (projection and methodology); Section 4

describes practical results of introducing the penalty system in the reverse logistics, and Section 5 concludes with author's reflections over the effects that this new system has over the recycling processes, and gives directions about how the model can be adapted to market requirements regarding working capital prerequisites in response to customers' decision to remain loyal to the recycling company after applying maximum penalty rates (without affecting normal business).

2. Literature Review

Working capital represents a core element in forward and reverse supply chains due to its financial support for daily operational activities that all firms perform on the operational level. Despite continuous efforts in providing sufficient funds for daily drift, obtaining needed working capital has become a major issue in latest years, especially for SME due to the boundaries imposed by national governments, financial institutions and general laws and regulations that have been introduced in order to minimize bankruptcy risks. Due to these limitations, companies have actively been involved in finding other financing solutions for daily activities in order to remain on the market in the competitive environment.

Waters (2010, p. 9) summarized MIT findings about best supply chains concept which blend "a clear business strategy supported by supply chain strategy and a complementary operational mode, which enables the perfect realization of strategy", emphasizing the value that operational strategies have in building a long-term supply chain. The competition transformation from firm against firm to supply versus supply chain (Lambert and Cooper, 2000), in addition to the instability on the market due to different vulnerabilities such as supply chain (Wagner and Bode (2006) determined a challenging environment for firms' stability in the long-run.

Green logistics concept, as part of green supply chains strategy practical implementation, created an operational component to regular supply chains due to added environmental structures that needed to be included while analyzing with reverse logistics. Min and Galle (2001) studied green logistics consequences for numerous US enterprises with respect to their costs and investments for the green acquisition process' success or failure implementation factor.

Burgess *et al.* (2006) conducted a research for future areas of study in Supply Chain Management domain by creating a general study framework with journals between years 1985 and 2003 from ABI/Inform Global Proquest's database (circa 100 papers). While 90% of the papers focused on Logistics or Operations as supply chain main themes, only a remaining 10% had as main subject Finance as applicability area for Supply Chain Management.

Supply chain optimization in practice has been analyzed from a Supply Chain Finance perspective by Pfohl and Gomm (2009, p. 151), being defined as "the inter-company optimization of financing as well as the integration of financing processes with customers, suppliers, and service providers in order to increase the value of all participating companies".

Chen and Hu (2011) designed a global supply chain framework which contained three different types of flows, namely information, material and finance, structure with an active role inside the network due to supply chain members which have permanently been involved into using these flows for network optimization.

Christopher and Ryals (1999) highlighted the fact that working capital efficiency can provide increased shareholder value, in a paper where the authors explain how durable supply chains can be in conflict with short-term interests claimed by shareholders. The element "people" which contribute to the success or failure of the strategy chosen by firms' management has been added by Scott *et al.* (2011) in order to achieve company's financial plans. From a social point of view, Asikhia (2016, p. 128) mention that "SMEs' innovation and creativity, licensed intellectual property, degree of customers and employees involvement, and network and collaboration are positively related with SMEs' wealth creation", these attributes are being among the core characteristics that SME need in order to ensure the long-term existence of these company-types.

Stonkutė and Vveinhardt (2016) describe in their research regarding SME what are the key success factors that SME need in order to last on the global supply chain market by overcoming the lower bargaining power barrier used in the development of global supply networks.

Reverse Logistics process has been presented by Rogers and Tibben-Lembke (1999, p. 2) as “the process of planning, implementing and controlling the efficient, cost-effective flow of raw-materials in process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or for proper disposal”.

From a logistics perspective, reverse supply chain steps are the direct reuse, repair, remanufacturing, recycling and disposal according to Ilgin and Gupta (2013), and are used in order to process stochastic returns based on their respective characteristics such as variations in materials in both qualitative and quantitative terms. The reverse logistics purpose is the put back on the secondary market used products that have ended their primary life cycle due to different grounds, and which can be set back on the competitive market after the completion of the recycling circle, process which includes processing and handling of different returns.

Bowen *et al.* (2001) suggest the fact that reverse logistics strategies depend on financial terms and operational benefits, while Carter and Rogers (2008) add three major criteria, namely social, environmental and economic responsibilities that can lead to the successful implementation of a strategy with focus on SME which present a reduced credibility on the financial market compared to larger firms.

Chouinard *et al.* (2005) state the importance of integration for both reverse logistics and regular forward supply chains due to the cooperation factor that these supply chains need to apply in order to achieve global efficiency for the whole logistics system.

3. Penalty system – design and methodology

The production model has its fundaments into Chen and Hu (2011) supply chain finance solution for working capital financing regarding optimal quantity ordering, alternative which consists of a minimized supply chain representation with singular members for each level of the network of actors, being formed by one supplier (that is no capital-constrained) and one retailer which has a fixed original working capital (and which might be financially-constrained due to the original/maximal own capital).

The authors study symmetric and asymmetric information situations in order to establish the equilibrium of the model based on working capital financing using various financial institutions as financing methods. The technique of obtaining extra financing resources adds value to the supply chain, and contributes to the value creation inside Supply Chain Finance, where the bank represents an intermediary actor of the forward supply chain. Supplementary working capital is used as means for financing optimal quantity needs by the retailer in the case of insufficient working capital resources, and it can lead to sub-optimality issues if its overall liquidities perspective does not match financing institutions requirements, especially under the asymmetric information assumptions in which the retailer is not obliged to reveal his real financial situation in order to obtain better credit conditions.

Kouvelis and Zhao (2012) built a similar working capital financing structure for optimal quantity ordering, with an additional element to the supplier and the retailer actors in the supply chain, represented by a bank as a short-term financing tool acting like an intermediate actor in the chain. In this case, there are two methods of reaching optimal quantity ordering for the retailer: either by financing needed working capital from a financial institution, or by using an open-trade account together with the supplier at the beginning of the sales season, both solutions being analyzed under bankruptcy risks assumptions. The methodology of using this supply chain structure regarding financing of working capital develops under perfect market conditions, and bases its practical implementation on Stackelberg Game principle from Game Theory in order to find system’s optimal values.

The members of the recycling process in reverse logistics are different than the ones in the forward supply chains, and are represented by waste suppliers (different return companies which collect goods that have been taken out of the primary market), manufacturing plants (or sorting sites which handle these returns) and downstream actors that introduce processed goods which come outside manufacturing areas on the secondary market (Figure 1):

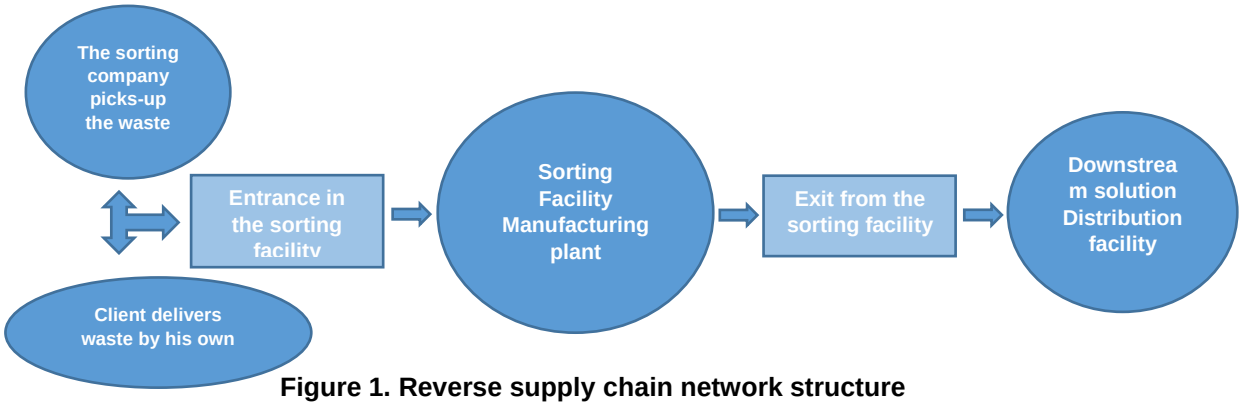

Figure 1. Reverse supply chain network structure
Source: Nicolae and Scarlat (2017, p. 13)

The roles for suppliers and retailers vary considerably in recycling processes than the ones in regular supply chains. While forward logistics suppliers are raw material providers and the retailers represent manufacturing companies that assembly these materials into primary-finished products that are inserted on the primary market, for reverse logistics these roles are taken by return companies (collectors of used products, acting as raw material providers) and sorting facilities with the main function of handling these returns in order to either deliver them furthermore on the secondary market (acting as manufacturers on primary market) or dismantle them as end-of-life products. The quality of the returns is irregular and stochastic due to different stages in which these goods are delivered by return companies, determining a high variation in the quantity produced by reverse supply chains at the sorting facility (the manufacturer in this case).

The core idea of the production model is how to cover extra production costs in the sorting phase of the recycling business in order to reach the given sorting level for all products delivered further down in the reverse supply chain to downstream actors. Each member has a role in determining the sorting degree which is needed in order to reach general and industry-specific prerequisites for each fraction (Figure 2), with focus on the sorting phase in reverse logistics:

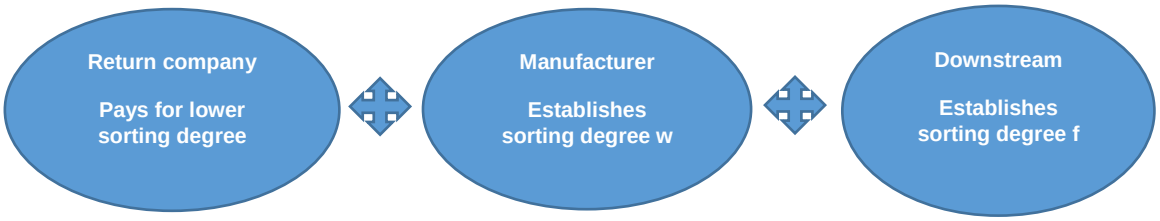

Figure 2. Roles for reaching given sorting degree of the new penalty system
Source: Nicolae (2018, p. 92)

As it can be seen in Figure *2,* the members of the supply chain which agree and establish the sorting degree are the manufacturer and the downstream actor, their roles being changed compared to forward supply chains where the supplier (in this case the return company) determines the selling price (the exogenous value in the regular supply chain), being the decision-maker which sets the price level of the raw material that the manufacturer needs to pay in order to continue its operational activities.

Due to the stochastic quality of returns in the recycling environment, total working capital needs are depending mainly on the products' characteristics that enter the production site. In this case, each return that has a lower sorting degree than the one required by the sorting facility will generate an additional cost for the manufacturer. The variable ***w*** in Chen and Hu model (2011) (selling price of the raw material) is replaced in the reverse logistics by the sorting level which is determined by the manufacturer and downstream members of the supply chain. Working capital

needs can be sustained in the production phase of the reverse logistics by one of the following alternatives:

- By covering all production costs without any external capital financing from another member of the supply chain/a financial institution – situation which might determine sub-optimality at the sorting facility and/or of the whole supply chain if the sorting level of products which enter the production area continuously does not reach at least exogenous value ***w*** (sorting degree). Here, the manufacturer can decide to not apply any type of penalty methodology, or to use an existent penalty system with a fixed-fee rate, situation that might lead to an eventual supplementary working capital less than the handling and production costs associated with extra processing costs due to the steady penalty system.
- By funding needed working capital from an external contributor each time the sorting level of an original waste delivery is under w level (accepted sorting degree), by taking into consideration the magnitude (quantity and quality) of erroneous deliveries in accordance to the sorting facility standards by using a new penalty system built as a cumulative penalty rating system which fines each wrongly-sorted item.

The new production model has its bases in a primary fixed-fee penalty system used in reverse supply chains in order to obtain additional working capital needs generated by each wrongly-sorted delivery in the production phase. The original system was a simplified penalty-rate model which was applied to all deliveries that encompassed at least one wrong article in the original load declared by the return company. The general form was the following (1):

$$A = \mathrm{B} + \mathrm{s} \tag{1}$$

Where
A= penalty total value for each delivery
B = penalty fee (a fixed rate; used regardless the penalty magnitude, size or number of erroneous items)
S – hourly-based fee calculated only for high time-consuming penalties.

The new penalty system was designed at the request of the billing department (where the author was working at the time) inside the largest Norwegian recycling company, Norsk Gjenvinning AS, as a response to the financial implications that each wrongly-sorted delivery had over the overall production costs by applying the fixed-fee penalty model. The above-mentioned penalty system comprised fixed-fee daily penalties for each load that contained at least one wrongly-sorted item, without taking into account general and specific production costs associated with returns' extra handling and processing operations for these loads in period 2012 – 2014, costs determined by wide differences regarding quality requirements for same materials, but which were not fined accordingly. As a response to these issues, the company decided to rebuild the penalty system in such a manner as to depict the actual production costs, and to apply a corresponding penalty methodology.

The roles that operational departments had in the implementation phase of the new production model were different than the day-to-day business roles, and included various functions (Figure 3):

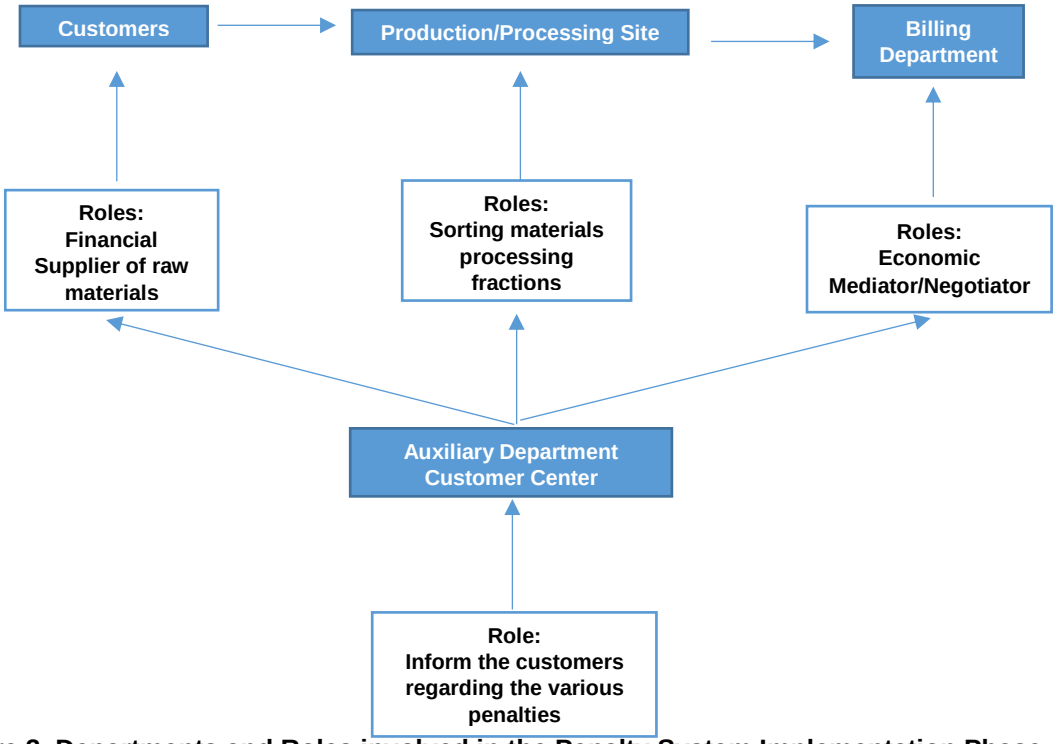

Figure 3. Departments and Roles involved in the Penalty System Implementation Phase
Source: Nicolae (2018, p. 88)

When applying external working capital coverage approach (as presented above), due to potential additional costs larger than a fixed-fee penalty system, a new and wider production model was recommended in order to be possible to gather at least all additional costs associated with wrong-sorting at the production area. The innovative and complex system obtained its finances from those return companies which in reverse supply chains represent original waste suppliers, and which delivered wrongly-sorted loads, as a sanction to their lower-than accepted sorting level degree regarding waste quality, with the general form (2):

$$A = K + p_s * \sum_{i=1}^{m} s_i + p_m * \sum_{i=1}^{n} m_i + p_l * \sum_{i=1}^{o} l_i + r + p_{sorting} * s \quad (2)$$

Where

A – penalty total value

K – base (fixed amount applied to all loads – described as the fee in order to start the wrongly-sorted waste control)

p_s – price for small penalty category

p_m – price for medium penalty category

p_l – price for large penalty category

$\sum_{i=1}^{m} s_i$ – the total amount of small penalties in a wrongly-sorted load

$\sum_{i=1}^{n} m_i$ – the total amount of medium penalties in a wrongly-sorted load

$\sum_{i=1}^{o} l_i$ – the total amount of large penalties in a wrongly-sorted load

r – reclassification fee, as a fixed value (regardless of the material wrongly-declared or the quantity reclassified)

$p_{sorting}$ – the sorting price per hour that a delivery can produce in addition to the normal sorting time for pure and correctly-declared fractions

s – sorting time per hour, determined by the production waste controllers every quarter (each 15 minutes).

The system was defined with three possible penalty types (small, medium and large) according to the recycling company's standards and Norwegian regulations, a reclassification fee attached for each wrong waste categorization at the client site, and a sorting time associated in the eventuality of an additional sorting time. The complexity of the system is given by the fact that each wrongly-sorted article will determine a category type that is counted to the total penalty fee, method which might result in a combination of penalty types and fees for loads that contain more than one wrongly-sorted article. Also, the new system provides the general context for invoicing the quantity of wrongly-sorted waste type found in the original fraction, which will determine a more accurate waste handling, counting and categorization performed by the sorting company, which in turn generates a detailed invoice (in accordance to company's rules and procedures) to the return company that delivered the load.

Due to the characteristics and complexity of the waste handling system, the production model constitutes an elaborate representation of various penalty types that can be found in a waste delivery, and it implies combined logistics, operational and financial solutions at the manufacturing area, since it provides fixed and variable cumulated production costs. Moreover, the solution represents an improvement of the entire reverse supply chain, based on financial and material flows from the point of origin (with return companies as extra working capital needs and waste generators) to the production area which is in charge with proper waste sorting and handling (logistics and operational returns-handling), and downstream solutions which collect pure fraction types (as high-end products) in order to fulfil the industry-specific and own standard waste requirements.

The total working capital value for extra sorting and handling costs contains cumulated penalties during a given period, and determines an integrated penalty equation for finding optimal working capital demand by the production in order to reach given sorting degree ***w.*** The total working capital focuses on covering extra sorting capital needs daily, covering pure fractions costs (related to deliveries to downstream companies), reducing sorting times at the production site in order to minimize human workforce, and nurturing all collecting firms (represented by suppliers in reverse logistics) how to discriminate between different waste types in accordance to the standards established a prior and sorting degrees accepted by downstream actors.

The optimal solution is represented by a maximization problem of cumulated working capital needed in the production phase of the recycling process (3):

$$Max(B + \sum_{i=1}^{p} A_i) \tag{3}$$

Where

W = sorting degree, established a prior (by the downstream company first, followed by the sorting facilities in order to comply with the standard given)

$B \geq 0$, or the original working capital; given (often set in 0 since it is associated with the additional working capital based on sorting activities determined by wrongly-classifications at the return companies site).

$\sum_{i=1}^{p} A_i \geq 0$ – cumulated penalties resulted as a consequence of applying the new penalty system for each delivery wrongly - sorted (see equation (2) regarding general form of each penalty total value applied to all loads wrongly-delivered at the plant).

The new system main objective is to acquire the optimal value for each parameter of the penalty model with the components described previously, values which support working capital needs for all additional costs caused by each item wrongly-categorized by return companies in the original load.

The theoretical model has a linear form depending on the total penalty amounts generated by each catgory, with fixed values for all penalty types (small, medium and large), reclassification and sorting components.

Due to a permanent change in the recycling industry regarding business activities between supply chain members, the variation of the returns' quality and the differences between client types, penalty rates are in constant change, with their bargaining power depending on the market share that each customer has on the competitive environment.

4. Empirical results of the new penalty system. Norsk Gjenvinning case

This research studies closely the implementation of the penalty system at one of the largest Norwegian recycling companies, Norsk Gjenvinning AS, in 2015 (model introduced by the firm at its largest manufacturing plant in Norway) in order to minimize own production costs, targeting in the same time a better waste type control for all waste types and volumes processed inside the production area in a given period of time.

Among the reasons of introducing a complex penalty-rates model was a financial factor for the company: the reduction of high production costs related to sorting and handling various waste types, in addition to an operational factor: decreasing working hours generated by the human workforce involved in the returns handled in the manufacturing area due to high degree of unsorted goods delivered at the entrance into the recycling plant, and a logistics factor: low waste control system; all factors mentioned here being studied between 2012 -2014. The firm was using before 2015 a simplified penalty model (as described at equation (1)) with an unique penalty type and value for all customer types, regardless of the magnitude/sorting degree of each delivery that came inside the plant through the weighing area or the amount of wrongly-sorted items found in the original waste).

Author's main contributions to the conceptualization and design of the new penalty model were to indicate the financial consequences in the production phase of the recycling process based on visual checks in terms of working capital financing (penalty outcome generated by the fixed-fee penalty system lower than the total production costs related to wrongly-sorted loads), and to participate together with the operational team of the company in finding a better solution for the working capital constraint issue without implying an external-financing source such as financial institutions or members outside the original reverse supply chain.

The new penalty system is based on three different penalty types (small, medium or large items), a reclassification fee for wrongly-declared waste types, together with an extra sorting time in order to measure the additional time used for each load that contains at least one wrong item according to the original waste type declared before the entrance in the production area, and it's built as a result of the agreement between the operational departments at the largest sorting facility in Norway, Groruddalen Environmental Park (production, sales, documenting, reporting and finance), having its beginning on the visual observations on the penalty pictures sent by the production control with respect to the quality of the returns delivered that contained high variation of the penalty magnitude, but which were treated identical from an invoicing point of view.

The information analysed were:

1. Significant dangerous waste materials (based on the largest volumes handled inside the plant) – represented by different types of impregnated wood, floors with polyvinyl chloride or phthalates, insulation with polyurethane foam, waste with cellular rubber, or dangerous roof appliance that might contain traces of asbestos.
2. For the materials analyzed was studied the trend between 2012 and 2015, both in terms of quantities invoiced (and calculated based on customers' waste declaration originally) at the weighing area on the way in, and on shipped volumes to downstream companies. In order to test financial control, income versus cost analysis was applied for each waste type.
3. Cumulated penalty amount each year, value obtained by applying the penalty system (fixed-fee and type-related fee) to all loads delivered at the sorting facility, regardless of the original waste type declaration.

In the following graphs are depicted the evolutions of the dangerous materials specified earlier in this section, trends which can be extended to regular waste type evolutions also due to the fact that they present similar characteristics and alternatives to an improved penalty model for all waste types.

For impregnated wood control the results in period 2012–2015 have continuously improved from a negative trend between invoiced versus shipped volumes in both quantity and liquidities (2012 – 2013, *fig. 4 a and b*) to better financial control in 2014 (the finances obtained for this material type were higher than production costs, *fig. 4.c*) to positive differences for both quantities and financial benefits in 2015 (*fig. 4 d*):

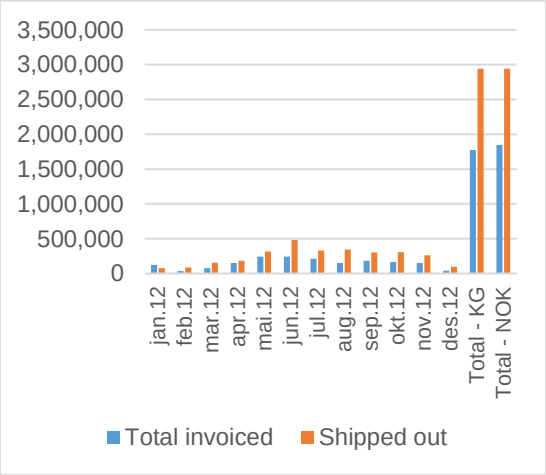

Figure 4.a. Impregnated wood – 2012 results
Source: Nicolae (2018, p. 80)

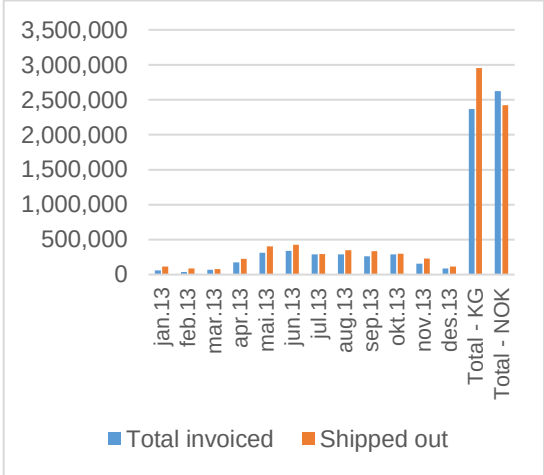

Figure 4.b. Impregnated wood – 2013 results
Source: Nicolae (2018, p. 80)

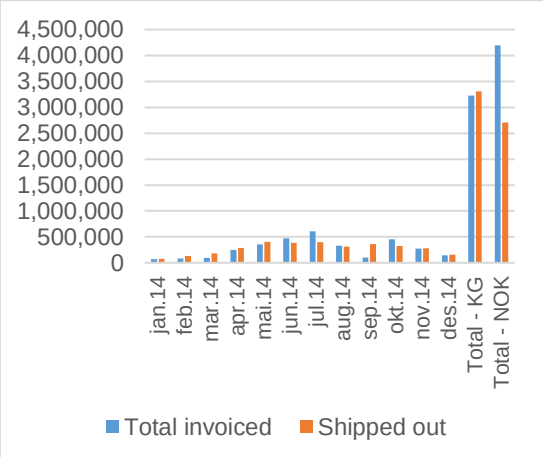

Figure 4.c. Impregnated wood – 2014 results
Source: Nicolae (2018, p. 80)

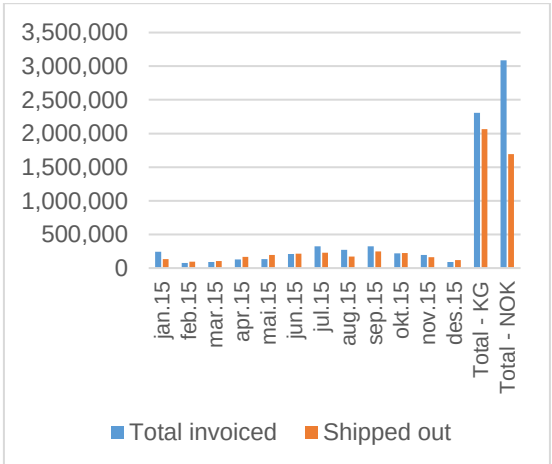

Figure 4.d. Impregnated wood – 2015 results
Source: Nicolae (2018, p. 103)

According to the data analysed, in 2012 the company invoiced ca. 1000 tons less than the amount delivered to downstream firms (3 000 tons), while in 2015 the company invoiced a larger volume than the quantity delivered furthermore in the reverse supply chain (300 tons more, with a positive result of 2 300 tons versus 2 000 tons, *fig. 4.d).* Moreover, the firm obtained a significant profit margin in terms of net income generated by this fraction in terms of selling price versus production cost (see *fig. 4.d*).

In the case of floors containing phthalates or polyvinyl chloride, waste with cellular rubber, and insulation with polyurethane foam, the fractions have been analyzed together due to their similar proprierties regarding waste delivery and control which allow them to be handled either as

a singular fraction, or as separate fractions in accordance to downstream firms' regulations. In 2012 can be noted a positive trend in both quantity control and amount invoiced, largely based on low amounts of fractions delivered to the manufacturing site (*fig. 5 a*), while in the next two years (period 2013-2014) the difference between amounts invoiced versus delivered further in the supply chain were negative (*fig. 5 b and c*), having a decreasing control in financial terms also.

For this fraction control, in 2015 have been obtained better results in terms of net profit between quantities invoiced and quantities shipped out to the next supply chain actor, keeping in the same time a low fraction control in terms of amounts invoiced (lower quantity invoice level compared to the real volume shipped to downstream actors) (*fig. 5 d)*. Taking into account the positive trend and the slightly negative difference, there is a high potential in terms of waste type control in the following years for these dangerous waste types combination.

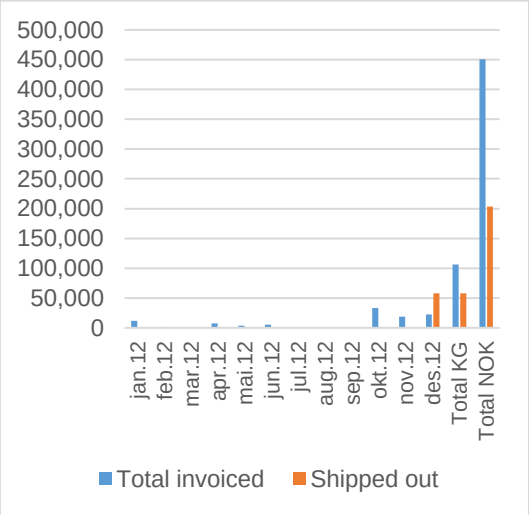

Figure 5.a. Floors with polyvinyl chloride or phthalates, waste with cellular rubber and insulation with polyurethane foam - 2012 results
Source: Nicolae (2018, p. 81)

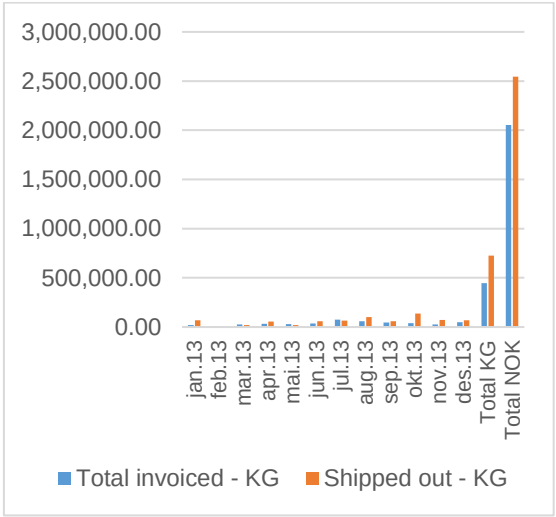

Figure 5.b Floors with polyvinyl chloride or phthalates, waste with cellular rubber and insulation with polyurethane foam - 2013 results
Source: Nicolae (2018, p. 81)

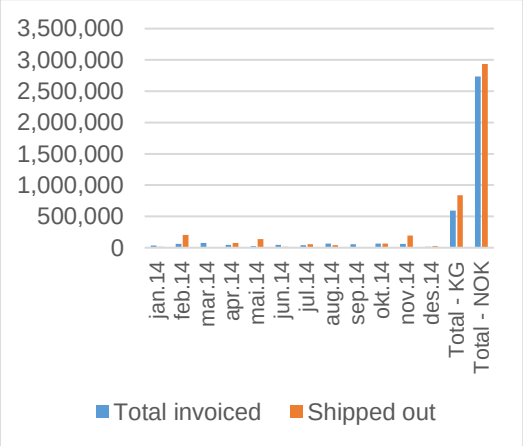

Figure 5.c. Floors with polyvinyl chloride or phthalates, waste with cellular rubber and insulation with polyurethane foam - 2014 results
Source: Nicolae (2018, p. 82)

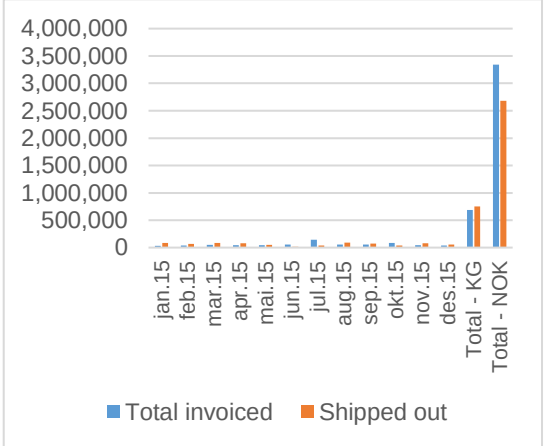

Figure 5.d Floors with polyvinyl chloride or phthalates, waste with cellular rubber and insulation with polyurethane foam - 2015 results
Source: Nicolae (2018, p. 104)

The graphs show a good control of the selling price evolution in 2015 compared to the previous 2 years (2012 presenting an abnormal price rate compared to production costs),

improvement that is given by production costs coverage of the sorting firm towards downstream companies, in addition to a better fraction control. Despite minimizing the difference in quantity (invoiced vs. shipped), the waste amount sent further to downstream firms is higher than the one invoiced, fact that involves a closer monitoring to this fraction combination in the future.

For the dangerous roof appliance waste control has been registered data in terms of volume control of the shipped material starting with 2014 due to a dual declaration of this fraction in Norway since this waste type can be both regular and dangerous material according to Norwegian regulations. As a result, the figures for period 2012-2013 show an eventual registration error and are not relevant for this fraction control overview (*fig. 6 a* and *b*), while period 2014-2015 reveals significant improvements in terms of waste monitoring, with volumes and quantities invoiced both towards the return companies as suppliers, and towards downstream companies due to production waste amounts and costs. Nevertheless, volumes for 2014 – 2015 present a closer-to-industry-specific regulations waste classification into the correspondent category (dangerous waste – studied here, as well as regular waste), with invoiced volumes lower than shipped quantities (*fig. 6 c* and *d*).

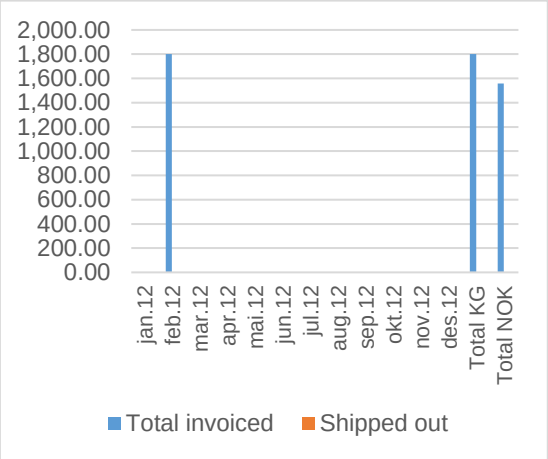

Figure 6.a. Dangerous roof appliance 2012 results
Source: Nicolae (2018, p. 82)

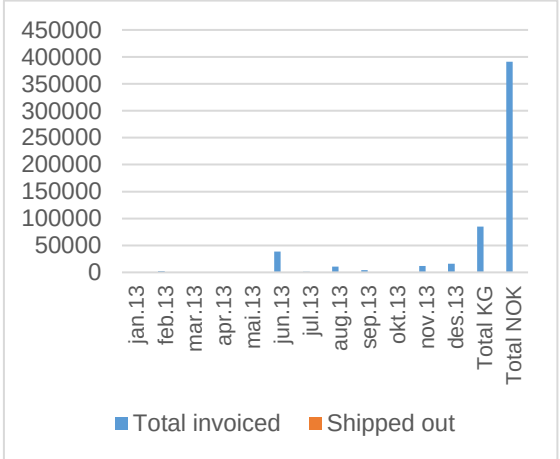

Figure 6.b. Dangerous roof appliance 2013 results
Source: Nicolae (2018, p. 83)

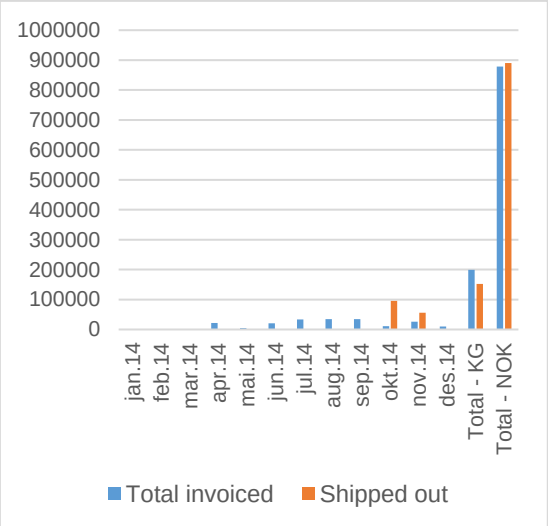

Figure 6.c. Dangerous roof appliance 2014 results
Source: Nicolae (2018, p. 82)

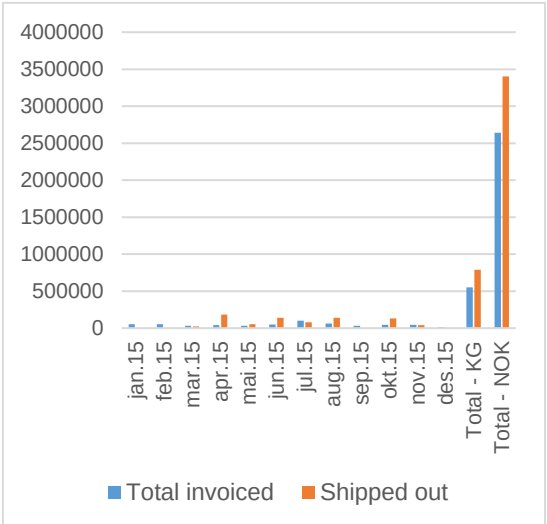

Figure 6.d. Dangerous roof appliance 2015 results
Source: Nicolae (2018, p. 105)

In terms of working capital benefits, dangerous roof appliance had in 2015 a lower value in both fraction control and net financial results for invoiced versus shipped quantities. In this case, additional waste controls are required in terms of price applied to the return companies (selling price) and quantities invoiced towards the return companies as suppliers (when divided into the right category – regular or dangerous waste) in order to stabilize this material (quantity and quality-based controls).

While the penalty system showed improvements in the sorting, processing and handling of various waste types, cumulated working capital obtained by using the complex production model has doubled its total amount in 2015 (compared to the previous 2 years), result which constitutes a success of the system in both financial (penalty fees) and operational terms (overall waste control). The penalty system evolution from a financial perspective is depicted in Figure 7.

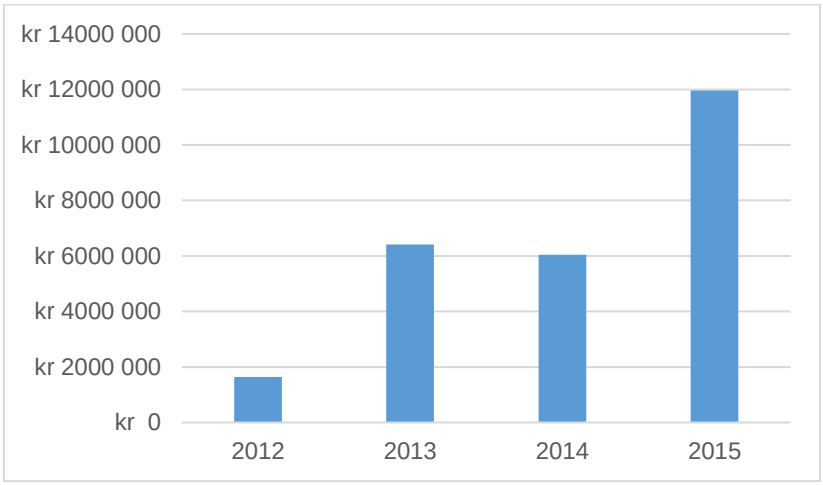

Figure 7. Cumulated working capital due to the penalty system in period 2012 - 2015
Source: Nicolae and Scarlat (2017, p. 18)

From an operational point of view, the system managed to discriminate between penalty types according to different criteria (small, medium and large types, reclassification and sorting fees), being able to explain the complex penalty construction by penalty's magnitude applied to each delivery with at least one wrongly-sorted item. This aspect, together with a detailed description of the penalty type by the billing department towards all return companies with at least one penalty has led to a positive result of the operational implementation of the new penalty system. The immediate result of the new system was a cumulated doubling of all penalty types in 2015 (see Figure 8 for cumulated penalty numbers in period 2012 - 2015).

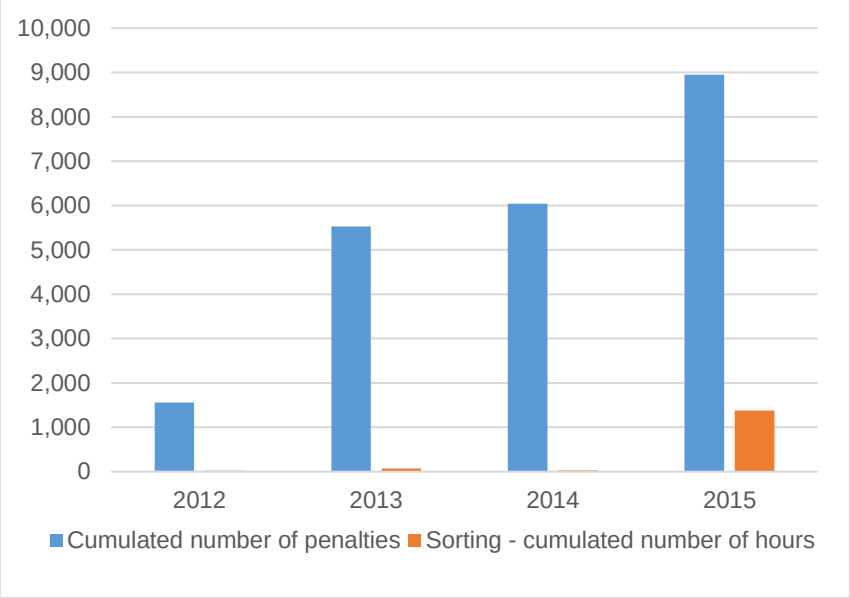

Figure 8. Cumulated penalty numbers in period 2012 - 2015
Source: Nicolae (2018, p. 105)

The success of penalty system's implementation in 2015 confirms the possibility of obtaining additional working capital in the sorting phase of the recycling process without requiring external finances from actors outside the original reverse supply chain by using an improved penalty structure which is adapted to the magnitude of the sorting degree for each load entering the production area in a given time.

In this case, the Supply Chain Finance methodology does not use a traditional finance alternative that would imply capital returns with added financial constraints to the manufacturer, developing a penalty model which extracts needed working capital by using an auto-financing solution from all return companies that deliver loads below a given sorting degree, providing the manufacturer the extra liquidities generated by additional sorting and handling activities. Nevertheless, the specifications that each penalty type has are used as a tool for the educational role that the manufacturer has towards return companies, facilitating the total penalty value approval, decreasing in the same time the failure rate for those return companies that deliver various waste types on a regular basis.

5. Conclusions

In late years, increased and variate factors, both domestic (such as environmental or societal) and international (for e.g. favorable overseas transactions or limited conditions from governments) determined a constant competition on the business market. In the SME situation, a shift from firm against firm to supply chain versus supply chain led to additional financial limitations in terms of working capital that can be obtained from financial institutions due to bankruptcy risk exposure. Supply Chain Finance suggests traditional working capital financing from either the financial market, or by open-trade accounts that would facilitate working capital liquidities, automatically implying a capital return at the end of the final sales season.

This article suggests a different solution than the traditional Supply Chain Finance theories regarding working capital financing, namely an auto-financing method that provides financial liquidities from an existent member of the reverse supply chain (the manufacturer in reverse logistics) in the sorting phase of the recycling process where all returns are processed and handled prior to sending them further in the supply chain.

Here, the financing method is based on a penalty mechanism which collects all additional working capital from the source/s that generated all extra costs in the sorting phase of reverse supply chain (return companies), system that helps the sorting company obtaining all extra capital

from another actor of the chain, namely the original waste delivery actor, removing the option of financial institutions working capital borrowing that would lead to additional financial constraints for the manufacturer, and to a financial return to the borrowing institution.

The penalty model presented in this paper has been designed by the author, together with the other operational departments in 2015 at one of the largest recycling companies in Norway, Norsk Gjenvinning AS, at its main sorting plant (GMP, Oslo), as a result of high production costs in the sorting phase of the recycling process and lower returns generated by a fixed-fee penalty system used previously and applied to all loads with a sorting level below the requirements, regardless of the penalty size or type.

The new system contains three different penalty categories (small, medium and large), a reclassification fee, and an additional sorting time for extra sorting and handling hours, each penalty type being applied in the corresponding category with respect to penalty's magnitude generated by lower-than-required sorting levels used on all deliveries on their entrance in the manufacturing area. Moreover, the mechanism includes a waste reclassification for those materials declared originally in the wrong category, functioning as a waste discriminator and control. Nevertheless, the new model generates a cumulated penalty value composed by penalty types, amounts, and reclassified waste types according to penalties' dimension, contributing to an overall improvement of the sorting process and methodology.

The outcome generated by applying the new penalty system showed that in the first year after the implementation (2015) cumulated working capital doubled its value, improving waste types control at the manufacturer area in the reverse logistics (represented by shipped versus invoiced quantities for selected waste types presented in this article - impregnated wood; floors with polyvinyl chloride or phthalates, waste with cellular rubber, and insulation with polyurethane foam; and dangerous roof appliance), results that can be generalized to more waste types due to their common characteristics related to various waste deliveries. In the same time, the manufacturer's own production costs generated by additional sorting and handling processes have reduced their value due to external financing coming from return companies as waste suppliers. Another result of a higher and discriminatory penalty system induced a higher sorting degree at the return companies' point of delivery in order to have an overall lower production cost, fulfilling one of the system's objectives, namely the educational role in terms of waste sorting at the original site.

Future areas of research regarding working capital obtaining based on auto-financing methods include an improved penalty system based on the complex penalty model implemented in 2015, system which takes into account market share and return companies' purchasing power on the competitive market. The author would like to develop a model that discriminates between customer types in order to improve potential working capital financial results, and obtain a better fraction control which involves invoiced quantities towards original return companies greater or equal than their shipped volumes declared by the manufacturer further in the reverse supply chain. The results of this study are published in Nicolae and Scarlat (2017), but can be improved by adding additional criteria to the penalty system.

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