Operational Research in Engineering Sciences: Theory and Applications
Vol. 5, Issue 2, 2022, pp. 152-175
ISSN: 2620-1607
eISSN: 2620-1747
DOI: https://doi.org/10.31181/oresta110722120g

PROCESS MEASUREMENT AND ANALYSIS IN A RETAIL CHAIN TO IMPROVE REVERSE LOGISTICS EFFICIENCY

Gyenge Balázs [1], Zoltán Mészáros [2], Csaba Attila Péterfi [3]*

[1] Hungarian University of Agricultural and Life Sciences, Hungary
[2] Faculty of Finance and Accountancy, Budapest Business School, Hungary
[3] Doctoral School of Economics and Regional Sciences, Hungarian University of Agriculture and Life Sciences, Hungary

Received: 12 April 2022
Accepted: 11 July 2022
First online: 11 July 2022

Research paper

Abstract: *The concept of logistics efficiency, especially reverse logistics efficiency measuring has become one of the key factors in our modern society as business and transportation become increasingly complex and networked. However, reverse logistics involves a high degree of uncertainty, which affects and makes evaluation more difficult. Our motivation and purpose is to present the efforts of one of the world's leading retail companies to improve overall efficiency with a new supplementary measurement and analysis tool. Our initial hypothesis was that unladen logistics returns are inefficient and improvements in this area are more sustainable, so in our design and methodology approach we try to analyze logged data. According to our goals, this study is meant to demonstrate the significance of the reasons and the way to customize data analysis to formulate more adequate suggestions. Through a live practical example, a presentation is given how we can identify and highlight the hotspots to improve reverse logistics. The main results and originality of the paper are to develop a practical scalable model framework which can be customized by companies having a similar problem. Contrary with the well-known DEA models the presented model a system thinking method that provides (up-to-date) information which enables better flexibility and highlights areas of interdependency for development projects.*

Key words: *logistics processes, reverse logistics, efficiency improvement, cost reduction, freight transport*

1. Introduction

The importance of reverse logistics has a massive impact in the companies' life and has a noticeable large influence on their costs as well. Wang et al. (2017) and Bajor et al. (2014) also confirm this idea, saying that reverse logistics is a critical part

* Corresponding author.
gyenge.balazs@uni-mate.hu (G. Balázs), meszaros.zoltan.gabor@gmail.com (Z. Mészáros), peterfi.csaba.attila@gmail.com (C. A. Péterfi)

of supply chain management, and its scope has expanded significantly since its early introduction.

First of all, the concept of activity needs to be clarified, which several people have tried to define: One approach is the task of reverse logistics, by definition, to cost-effectively return products, raw materials, and related information from the place of consumption to the place of origin for the return, repair, remanufacturing, and recycling of products. Inverse logistics thus allows environmental considerations to be met throughout the product life cycle. Supply chains that combine traditional forward logistics with reverse (also known as inverse) logistics are called closed-loop supply chains. Such supply chains cover all value-creating processes from the creation of a product to its cessation (Szász & Demeter, 2017).

In another formulation, reverse logistics is the flow of goods back into the sales channel, that is, the flow of goods from the consumer to the retail store, from the store to the distribution center, and then from the distribution center to the manufacturer. The tasks of reverse logistics also include the storage and transport of packaging (pallets, crates, recyclable glass) and recyclable waste. The packaging is reused as packaging material and the waste must be stored or disposed in accordance with regulations (Agárdi, 2017, Vöröskői et al., 2020; Gyenge et al., 2021). Whereas, according to the third wording, return logistics is the material flow from the customer to the company, where the purpose of returning the product is to use some kind of service, most often for environmental purposes (Chikán, 2020).

Based on the definitions, the main tasks of reverse logistics include the return of unused products and materials from the consumer to the producer, as well as the removal of generated waste and packaging for destruction, recycling and reuse. According to Bajor et al. (2014), the study of reverse logistics issues, even in advanced logistics systems, remains an area that needs to be continuously researched in order to optimize the entire supply chain. Bajor et al.'s (2014) idea is fully consistent with our present research. Huscroft et al. (2013), Guide and Van Wassenhove (2009), and Hazen (2011) believe that this increase in research and practitioner focus reinforces reverse logistics as a key strategic capability appearance within the supply chain. To define the role of reverse logistics for the company, a few words about the role of logistics must be told first, which is to create and maintain a proper flow of raw materials, semi-finished and finished products, either within a company or across company boundaries. Logistics was originally created to optimize transportation and warehousing tasks, but today it has a broader meaning. All flow processes are controlled by logistics in a way that minimizes total cost and maximizes customer satisfaction (see Figure 1). (Kopcsay, 2016)

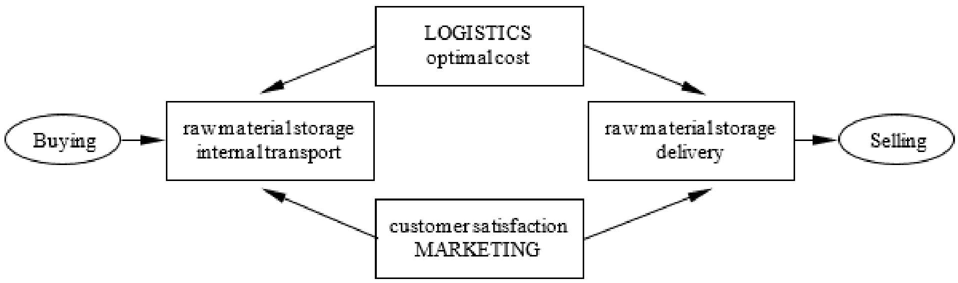

Figure 1: The role of logistics and marketing (Own editing based on Kopcsay, 2016)

So it has a big impact on costs and maximizing customer satisfaction (see Figure 1), as evidenced by Porter's value chain theory, where logistics has been ranked among the primary activities, also known as value-creating activities. Through inbound and outbound logistics, it has an impact on the company's operations, capacity utilization, and cost developments through value-creating processes (see processes of the corporate value chain by M.E. Porter 1985).

Supply chains are formed through the interconnection of logistics processes and value chains across the borders of companies, which provide many benefits to chain members and require much closer collaboration (see Figure 2).

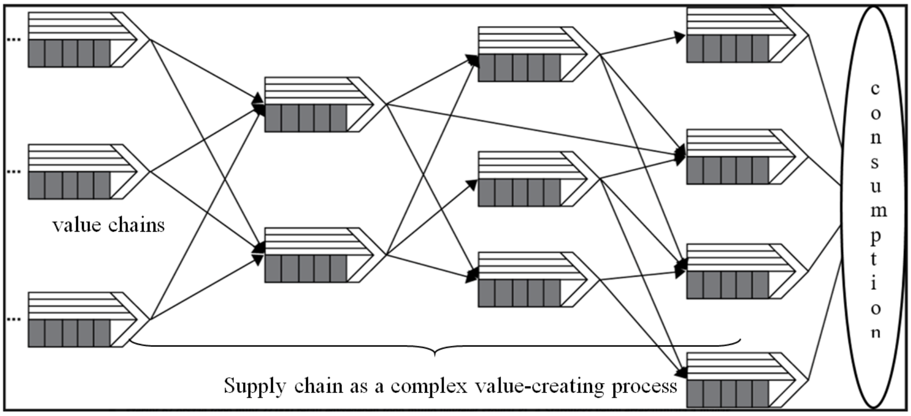

Figure 2: Extending the value chain concept to the supply chain level (Szász & Demeter, 2017)

With the development of supply chains, the chain members coordinated their purchasing, production, sales and information activities, so in the narrower sense, logistics and, more widely supply chain management has got and concentrated particular responsibility. It no longer only affects the profitability of a company through costs and value-creating activities, but also regulates the operations and not just one but all companies are involved in the supply chain efficiency. Therefore, we want to develop a new plug-in tool to deepen the analysis of the problem, and to lay the foundations for the development of reverse logistics integration with our logistics partners.

The second section briefly presents the relationship between reverse logistics and efficiency by comparing the main sources of the topic and the evolution of approach over the years. In the third section, the research method and model background will be presented. The fourth section discusses the results of the analysis in parallel with practical and theoretical aspects, without conclusions in case study-like form. In the fifth section is followed by conclusions and suggestions, in which the paper presents the company's specific results and generalized considerations, as well as the resulting recommendations.

2 Reverse logistics and its efficiency in literature

Reverse logistics also contributes to consumer satisfaction, as the supply chain does not end at the same time as purchase / consumption. The collection and proper processing of non-purchased products, waste generated during consumption and packaging is an essential part of the process. Today, supply chain management cannot be analyzed without considering reverse logistics (Guide & Van Wassenhove, 2009). According to Rubio and Jiménez-Parra (2014), the origins of reverse logistics date back to the 1970s, where raw material recycling was published in some publications. De Brito and Dekker (2004) define reverse logistics as the process of planning, implementing, and controlling the return of materials, process inventory, packaging, and finished products, from the point of manufacture, distribution, or use to recovery or proper disposal. Many discussions have been generated by reverse logistics operations due to the complexity of decision-making and planning (Kumar & Saravanan, 2014). Process difficulties and hardly measurable stochastic behavior situations frequently emerge when residual material and return products collection is planned by enterprises (Costa-Salas et al., 2017).

Eventually, a holistic and strategic approach became prevalent in the 21st century, explicitly acknowledging the coexistence of the forward (from producer to consumer) and the reverse (from consumer to producer) (Dowlatshahi, 2000). This is the source of the Closed Loop Supply Chain (CLSC) concept, which can be defined as a ‘supply chain’ or ‘supply network’ where, in addition to typical material flows from suppliers to end users, there are also reverse flows (Ferguson & Souza, 2010).

The interest in introducing reverse logistics systems is generally attributed to three factors that drive companies: (1) Gaining competitiveness advantage, (2) environmental legislation, and (3) pressure from various stakeholders, also known as profit, environment, and people (Subramoniam et al., 2009).

The task of reverse logistics can be divided into two parts:

- Return Management: which performs the task of returning expired products and packaging, and the failure of any 7R element can cause a return flow without quality issues.
- Waste management: in the concept of consumption and supply chain, it deals with the collection and recycling of waste generated during closer cooperation than before. Costa-Salas et al. (2017) presents the challenges of waste management through the collection of tires.

The main task of reverse logistics is to promote waste recovery and active participation in integrated waste management. It should be noted, however, that reverse logistics is not only the recovery of waste, but also the efficient organization of all return logistics tasks, material and information flows, similar to logistics (Rogers et al., 1999).

Supply chains, from the extraction or production of raw materials to the sale of final products and the processing of waste from final products, are in fact the link between the natural environment and economic activities. Thus, managers responsible for operating value-creating processes in a supply chain cannot circumvent environmental considerations (Szász & Demeter, 2017; Agárdi 2017).

Based on the previously mentioned topics, the organization of return logistics must also take into account environmental goals, and in several cases a parallel can be drawn with better utilization of capacities. For the sake of example after a truck or transport vehicle has completed its primary transport task, it is allowed to perform various valuable logistical tasks instead of returning empty loads to its point of departure:

- Collection of return goods, packaging, waste.
- To carry out a new (raw) material supply.
- Or the return capacity may be sold as a service.

Each is an environmentally conscious activity on the one hand and a cost-effective activity for the company on the other hand.

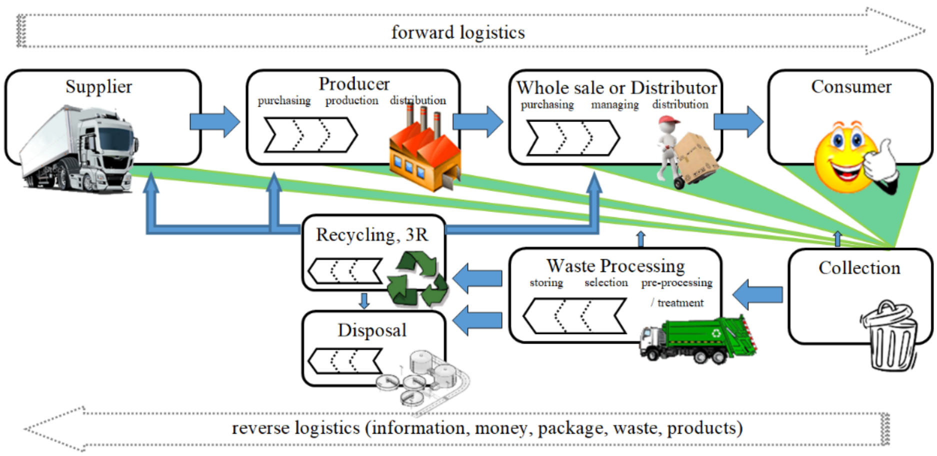

Figure 3: Conceptual framework of the traditional and reverse logistics process (Own edited)

The traditional logistics processes can be seen in Figure 3 in which the product reaches the consumer through value-creating processes, while in contrast, reverse logistics is used to collect, process and recycle waste. Meanwhile, information and packaging flow back in the opposite direction in the supply chain.

Although reverse logistics obviously contribute to the smooth operation of the company, usually it cannot be classified as a value-creating activity, so less attention is paid to it. It must not be ignored in any way because, it can dramatically influence the expenditures and can cause imbalances in transportation flows. Although there is great potential in reverse logistics to increase performance and improve customer relationships, the potential value of its efficiency is often underestimated (Kaynak et al., 2013). As Kaynak et al. (2013) declares *'Lack of awareness of the benefits of reverse logistics, both economically and environmentally, is one of the main factors that provokes resistance to complementing logistics activities with reverse logistics'*.

There are various quantitative and qualitative methods and techniques in literature for measuring performance of logistics and reverse logistics at different levels of the supply chain or company (strategic, tactical and operational) (Andrejić, Pajić & Kilibarda, 2021). It is not an easy question at all, as we can estimate efficiency or effectiveness based on a wide variety of concepts. Efficiency can be defined quite differently depending on what we consider to be a task or a strategic goal. There are various indicators and methods in the literature for optimizing transport efficiency, fleet allocation targets, utilization of vehicle capacity, coordination of transport and pickup-delivery planning, cost-benefit concepts, environmental aspects, legislative concerns, customer service level maximization etc., according to the initial objectives.

One of the best known Data Envelopment Analysis (DEA) methods is a non-parametric linear programming technique that enables mutual comparison of systems, i.e. it determines whether each Decision-Making Unit (DMU, see the introduction of the DMU concept Charnes, Cooper, & Rhodes, 1978), based on input and output data, is relatively efficient compared to other units that are part of the analysis and homogenous enough as well. The DEA method is widely used in logistics to compare different homogeneous Decision-Making Units (Min & Joo, 2006; Momeni et al. 2015; Andrejić, Kilibarda & Popović, 2017; Mitrović et al., 2022). *'The traditional models for DEA type performance measurement are based on thinking about production as a black box'* (Momeni, Azadi, & Farzipoor, 2015). These models successfully compare different logistics units, distribution centers, transportation capacities, warehouse operations, and can successfully determine which groups of indicators represent efficiency better. DEA model can be used to estimate the effectiveness of 3PL efficiency from a provider's perspective (Min & Joo, 2006) and from a user's perspective (Ding, Zang & Jiang, 2008). Some articles analyze the efficiency of reverse logistics (Haas, Murphy & Lancioni, 2003; Ratković, Andrejić & Vidović, 2012, Yoon, & Le, 2013), Distribution Centers' (DCs) efficiency as a part of complex supply chains (Ross, & Droge, 2002) and sometimes the DEA models are combined with other models. (Andrejić, Pajić & Kilibarda, 2021; Sharma et al., 2021) Other researchers have tried to combine indicators from field experts and Delphi, AHP, and TOPSIS methods to determine their relevance, weight, and ranking (Kumar et al., 2021) and ranking the success factor according to expert opinions in the literature (Tyagi et al., 2019) or Failure Mode Effect Analysis (FMEA) method with intuitionistic fuzzy concept (Kushwaha et al., 2020; Gopal & Panchal 2021).

On the other hand, the latest publications approach the topic of reverse logistic from the side of technological developments, such as industry 4.0 (Krstic at al., 2022). Industry 4.0 sets the stage for creating a smart framework based on technologies and applications that enable easy communication and connections between various objects (Bahrin at al. 2016). Krstic and his colleagues used industry 4.0 as a decision support device with a unique method COBRA (Comprehensive Distance Based RAnking). COBRA was compared with multi-criteria decision making (MCDM) techniques to several methods as TOPSIS, VIKOR, WASPAS and so on, and it is stated, that COBRA could be used to solve any MCDM problem in various fields including reverse logistic. According to Ray (Ray et al. 2021), in the field of transportation and logistics, the Internet of Things can make the company more efficient. It shows the connection between companies using IoT and the benefits associated with the technology.

Despite great results of these papers, it is still a question of what efficiency or effectiveness means technically, because it ultimately depends on the opinion of managers. For example, higher profit rate performance, higher capacity utilization rate or a higher level of a complex indicator is not equal to higher effectiveness or efficiency (which is more closely related to financial considerations) because it could ruin the flexibility expectation of managers or customers. Thus, one of the drawbacks of the above mentioned models is the neglect of harmonizing possibilities of activities. In this chain-like thinking, the outputs from one stage become the inputs to the next stage without a combination of resources (although Momeni et al. 2015 use a multi objective additive network approach). Most of these models focus only on operational efficiency and most of them are trying to measure efficiency with operational performance indicators i.e. working hours of the drivers, duration of the route, distance travelled, number of employees, number of delivers, utilization of a resource, inversion value transport error, inversion value emission of harmful gases. The most of the existing literature focuses on efficiency as an operational issue and measures it using a bunch of different indicators but sometimes results fluctuate wieldy due to the many stochastic factors, such as the partner does not have time to prepare materials, the hand pallet truck not working in the rain, or the truck drivers do not have enough time for more action etc. These decision units are not homogeneous enough and even the repetitions of individual activities are not homogeneous in order to use DEA method. To the best of our knowledge, this paper will try to investigate the problem in a more strategic way and use a holistic approach to highlight the root causes and suggest or develop a modest but relevant number of KPIs for the leaders to monitor and improve collaboration with our partners. That is our originality and motives to provide practical value for the logistics managers by supporting decision-making process and it also represents a good basis for further research.

3. Research method and model background

In a functioning supply chain, efficiency - and cost-effectiveness - is a key focus, especially nowadays when transportation costs can have a decisive impact on a company's profitability or provide a competitive advantage through additional services that is embodied in the efficiency and flexibility of the entire supply chain. Market competition is extremely fierce, so every opportunity must be seized to help maintaining market position. In our research, the reverse logistics of the supply chain will be analyzed in case of a multinational retail company. According to our research method, the measured data is inserted into a basic framework in which they can be combined by two-dimensional, step-by-step cross-comparison, and the conclusion can be drawn hierarchically at each stage, thus proposing a Root Cause Failure Approximation Analysis (RCFAA) step-by-step method to support decision. (See the original RCA concept by Carol, 1989.) The four steps of empirical model are built on each other hierarchically. In our opinion, the presented model is suitable for the application of the method by other company managers with similar problems, as well as for the modification and supplementation of their own industry. We did not aim to create a universal method, but the dilemma that arose during the research made the creation of an assessment method necessary that could answer the following questions. Theoretical RCFAA model of the analysis:

1. Determine the types of problems that occur. Root Cause Analysis (RCA) is a combined approach that represents the methodology and tools for investigating events (Carroll, 1998). RCA is based on the assumption that causes, causal chains and occurrence can be identified by accurate and analytical processes. Although the actual methods (facts vs. belief; 5 Why; is/is not) are simple, but it is very difficult to

formulate assumptions and apply ideas. To identify and capture the root causes of problems that appear in our research, the first step is to follow the causal chain of the current problem to determine the causes in the background that lead to their development. With the help of the actors actively involved in the process (e.g. driver, administrator; shop employee), recurrent causes were coded that cover deviations from normal operation. According to the classification, the most important thing is that the event receives the same code if the root cause (trigger) was very similar.

2. The second step is to examine occurrence and importance. (Which partnerships show more common problems?) In general, most researchers believe that there is a relationship between frequency and importance, especially in the case of failures. Although this is not entirely true, we can make a Pareto distribution, a percentage distribution, or any other classification technique. In our method, the simple distribution percentage by day will show relevant pattern to analyze. The database was extracted directly by the administrator colleagues from the data entry process according to the query formula defined for this purpose.

3. Periodicity analysis. Thirdly, to find out what is the periodic characteristic (pattern or cyclicality) of the emergence of problem types in short- and long-term? Analysis can be used to characterize the causes of the problem, observations can be made by processing the data and by using different distributional indices. In the paper the daily periodicity was exanimated by distributions and reason analysis.

4. Cross-correlations (causal analysis). By projecting the variables (factors) on each other and examining cross-correlations, can key areas be identified (relationships) or 'hotspots' that must be taken into account in management decisions and the management of reverse logistics, as well as the need for adequate efficiency? According to the analysis, independent impact factor pairs were used to construct cross-combinations, especially days and partners by failure types.

The levels of the model described below are as follows:

1. Descriptive statistical analysis of the failure types, e.g.: frequency of occurrence, distribution of error causes, distribution of errors by destinations.
2. Search for correlations between failure causes and occurrence times (days) and for correlations between failure causes and destinations using a categorized intensity cross-tabulation method.
3. Combined examination of impact factor pairs (aka independent variables) for failure or error rates. To define these particularly critical relationships.
4. Time series studies to examine whether there are trend-like correlations in relation to the examined factors and to what extent.

Model framework.

The examined data was measured in the period 20.07.07.27-2021.09.03, under average operating conditions. Apart from the pandemic in the industry, under investigation there were no significant environmental distorting effects during the period considered. It is worth knowing that the surveyed company delivers to its nearly 200 stores every day of the week. This extremely large-scale logistics task is based on a fleet of nearly 100 trailers, with an average of 120-140 routes per day. Of course, this means that there is a theoretical possibility for the same number of return journeys per day.

Trucks usually perform back freight transporting (backhauling), which can be:

- Waste, packaging, return collection.
- Participation in procurement transport by selling backhaul capacity.

Of these, procurement service, or in other words 'delivery' is primary because it is easier to monetize through close collaboration with other participants of the supply chain. The company has contracted with some other suppliers in the supply chain to take over some freight tasks, generating beneficial effects on both sides.

- The supplier does not have to maintain its own fleet.
- Some of the return trip capacities has been sold.

Nevertheless, the focus of this study is more on the first return logistics task related to waste, packaging and returns, which, while not generating direct added value and revenue in the supply chain, has a major impact on operations and stores. For example, packaging (empties) / waste / and returns accumulated in stores makes their day-to-day operations more difficult or even disruptive, so proper and regular collection is essential. At this point, however, delivery and collection are also linked, because the more accurate the collection, the more deliveries can be made to the company, and in addition to facilitating the work of the stores, it is also possible to increase the company's revenue. Overall, rotation time improves and flexibility increases.

Hereinafter, thus satisfactory data management is not considered a goal but an indispensable tool and has been developed below. The apparatus for supporting value creation consists of the following:

- The staff who handle it.
- The technical environment in which the data is stored and processed.
- Needs, i.e. the partly constant and partly changing needs of the economic and logistical processes served.

In general, when we talk about data management, perhaps our first thought is the corporate management information systems itself (like, ERPs - Enterprise Resource Planning Systems) or (EIS - Executive Information Systems) which appears to us as a kind of super integrated entity. It is a well-documented area, and it is also a fact that the examined logistics system that provides the day-to-day supply of goods to more than 200 stores cannot exist without prosperous automation and robust technical orientation for trouble-free operation. However, robustness also means limitations, so it is worth implementing project-based methods that give opportunities for new ideas, which, if necessary, further expand the scope of corporate management information systems by using engineering work. What does this look like in reality and what is the main obstacle of the implementation?

Experience has shown that in many cases, in addition to corporate management information systems, the semi-operative network of Excel spreadsheets, which usually serve tangible business needs and even implement online teamwork, provide information to management and so on. Briefly, their value in use far exceeds the requirements imposed on them. The main problem is that over time, this jungle that initially seems customized goes beyond users to such an extent that it becomes almost a corporate standard. But as long as the modules of a corporate management information system meet the required engineering standards, this not to be expected from ad-hoc generated tables, which are often unsuitable for making a validated business decision and it is even more annoying that over time the original idea and 'domain' knowledge begins to fade. Our experience is that after a short period of usefulness, these tables and functions are lost, the original motivation has been eroded, they reappear later at new users increasing redundancy, the technical concept and the cooperation are often lost with the creator colleague himself. There is always only one thing left, the decision situation and the different concepts associated with it. In our study, we attempt to provide insight into the process of using an easily accessible software tool, data analysis and project management methodologies to develop an analytical environment or model concept that can serve as a specification for further development of a 'large' system to develop new plug-in modules.

Currently, each process necessarily involves several administrative processes, which on one hand ensure the operation and monitoring of legal regulations and on the other hand provide an opportunity to collect measurement data that can be used to increase the efficiency of tasks. As a first step, since measurability can provide an opportunity for improvement, we established a database in which all unrealized return transport tasks have been collected (usually interpreted as "failure" or resource underutilization). In an initial step, the following data have been collected based on Excel to distinguish destinations: date; route number; store count; store name; reason for obstruction i.e. P – packaging (empties) / W – waste; driver; company. The recording and processing is illustrated in the following figure (see Figure 4):

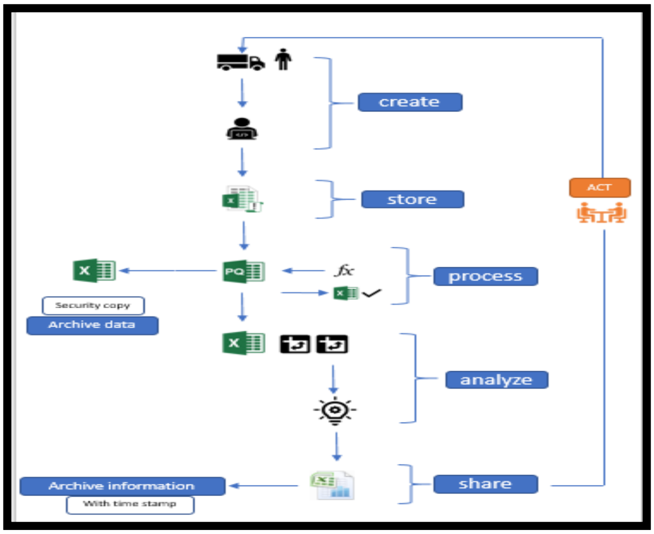

Figure 4: Data acquisition and processing process used for decision support, Practical Process Survey Model, Source: Own editing

Phases of the process (Practical Process Survey Model):

- Create: In our case, the information is recorded by the administrator after the completed return trip. In consultation with the delivery team leader the reason of the unladen status will be recorded from predefined categorized codes in an Excel spreadsheet.
- Store (storage, data acquisition): In order for error-free recording and smart data entry, the recorder stores the data in a table with a VBA macros assigned to a button and predefined selection lists (i.e. automatic store and subcontractor check, cause selection with poka-yoke tools etc.)
- Process - validation & preparation (data, processing, enrichment, verification): Data saved by the VBA macro in tabular form are loaded into the Excel Power Query module. Using the built-in functions, each record gets new fields e.g. day name, calendar week number, anonymization to avoid recording errors. In this case, it is also possible to receive an additional report on data that may have been incorrectly modified (e.g. subsequent irregular corrections, etc.) Raw data is validated, extended and verified.
- Analyze - preprocess & analyze: From the records that have undergone Power Query processing, PIVOT tables are created according to the analysis criteria: which can be one-dimensional or two-dimensional matrices and time series. After the update, the new data is loaded and the information from the data becomes available.
- Share: A visual and textual summary is created from the cross-tables to identify intervention points, track trends, and detect deviations from goals. The summaries or reports prepared this way are sent in separate files to the project stakeholders, thus passing on the representative and pragmatic inputs to the 'Application' section.
- Archive: The Power Query processing interface also provides a data storage function and backs up the processed data. Finally, a saved copy of the analysis result is made to ensure traceability or detection of any progress in the application phase.

4. Survey model and results

In this section, the results of data analysis in parallel with practical and theoretical aspects are presented from the first step to the end. The company under study places great emphasis on warehousing and transportation logistics indicators, but this is not the case for reverse logistics, so we assume that the whole scale operation would be more satisfactory for both owners and customers by developing an analysis and a secondary indicator, that does not override the main logistics indicators but can help the developing of reverse logistics. In the next section, the new analysis (Practical Process Survey Model) for reverse transport in practice and how the indicators were formulated in collaboration with Management Board will be presented as a case study. The data was collected from 27.07.2021 to 03.09.2021, 138, data sets were added to our database. Sampling is not very large yet but maybe suitable for monitoring trends. Analyzing the data, the following trends can be observed about backhauling: Step 1: When trucks are primarily booked to deliver goods and the truck returns to its base with no goods are carried on its back, describes a failure in backhauling and unperformed reverse transport tasks. In the first step, the analysis assesses the failure rate with a standard time-dimensional distribution by every causes.

Table 1. Distribution of unperformed transport tasks by calendar days (as part of the reverse logistics) Source: data analysis in 2021

Breakdown by calendar day	
Days	Distribution
Sunday	22%
Wednesday	20%
Thursday	18%
Friday	15%
Saturday	14%
Tuesday	7%
Monday	4%
Total	100%

Table 2 shows the distribution of unperformed transport tasks by calendar days (which means the percentage of the failed return task by day). The average ratio between failed tours and days of the week is 14%. So, Sundays, Wednesdays, Thursdays and Fridays are worse than average. At this stage the theoretical reasoning (Reason Analysis) is much more important than the numbers. So the deviations can be explained by the fact that there is a 'truck stop' on Sundays in Hungary, which means that only fresh goods can be delivered and the adhesive packaging can be returned from the destinations (constrain 1). If there is not enough quantity in the store to load the truck (constrain 2), there is no possibility to redirect it to another store. The other reason that can generate a high rate on Sundays is that the waste processing warehouse (constrain 3) is closed on Sundays, so trucks can only bring packaging, return goods or take delivery freight, but not waste.

Table 2. Distribution of unperformed reverse transport tasks by causes Source: data analysis in 2021

Distribution by cause			
	Reason	Distribution	Quantity
1st	Shop (store) did not give (not given)	44%	61
2nd	There was no P – packaging (empties) / W – waste on the last station and the next shipment followed (no P/W & next shipment followed)	27%	37
3rd	There was not a forklift truck (no forklift)	9%	13
4th	There was no P / W on the last station and could not be diverted due to expiring working time (no P/W & expiring working time)	8%	11
5th	The driver make a call too late / did not make a call, so he did not receive P / W (later or missing call)	7%	9
6th	Shop did not give because of the rain (weather conditions)	4%	6
7th	There was nowhere to redirect (nowhere to redirect)	1%	1
	Total	100%	138

The higher values on Wednesdays, Thursdays and Fridays are explained by the fact that the volume delivered is also higher on these days, so more routes release to the shops, as a result of which a vehicle has to deliver more freight. In this case, any diversion is also more difficult due to the limited working hours of drivers. To better understand the specifics and constraint background of reverse logistics, the following table can help to analyze the main causes.

Examining the distribution by causes (see Table 3), it can be seen that 80% of all failed tours were caused by three causes, in order: *'the store did not give'*; *'there was no P / W on the last* station *and the next shipment followed'*; *'there was not a forklift'* Numerically, 111 of the 138 were caused by the above three types. It can be observed that despite the relatively small population, the values converge according to the Pareto principle. The case study-like processing also reveals that the most common reasoné for unperformed reverse transport tasks is *'the store did not give'*. This may be due to e.g. a shortage of consignees, congested trucks at the store, or no quantity to be returned. This is followed by *'there is no P / W at the last station, but there is another shipment'*, so there is no time to redirect the truck to another store because it needs to hurry back to the warehouse to deliver the next shipment. The 4th most common reason is also related here, with the difference that the driver's *'...working time expires'* and therefore cannot be redirected.

As it can be observed in the deeper analysis, the latent correlation may be 1; 4 and 3 because the lack of a tool generates overtime that participants (drivers; employee) cannot always afford. This is a good example of how records and numeric data can conceal the real causes and many aspects that can be improved by cooperation. In our approximation method (RCFAA), it means another repetition of the analysis with different codes. Another critical lesson is that unloading takes place on a ramp, but packaging and waste are usually stored in the backyard outside the store, so in the absence of a forklift, only unloading is possible, but loading is not possible. Furthermore, it cannot be loaded during raining with an electric forklift or in the case of uncovered storage. At this point, a key question arises as how much the quality of the partners or the suitability of the partners, can affect the efficiency of reverse logistics. The following business-by-business analysis helps to analyze this issue (see Table 4).

Table 3. Distribution of unperformed reverse transport tasks by stores Source: data analysis in 2021

	Distribution by stores	
	Store code	Distribution
1st	9	7%
2nd	5	6%
3rd	7	5%
4th	3	4%
5th	19	4%
6th	6	4%
7th	8	4%
8th	35	3%
9th	10	3%
...	...	...

Examining the distribution by store, it turned out that the value of 1% is very common, from which it was concluded that this was due to fluctuations in the 'normal' business, so we did not deal with them. In our study from all business destinations only the 9 highest values highlighted that visibly stands out from random effects (see Elimination of Random Effects). The affected stores, which have been coded for proper data management, are as follows: 9; 5; 7; 3; 19; 6; 8; 35, 10. In the present case, these 9 stores have generated 40% of all failed tours. At this point in our study, it can be said that one of the primary goals has been achieved, which was to narrow the analysis horizon by focusing on 'hotspots' of relationships.

Step 2: Two-dimensional relationship studies using categorized intensity coefficients in cross sections and edge frequencies. Our goal is to further refine the assumed impact factors. In our study, two factors were examined and intensity categories were defined, which were represented by colors for easier evaluation.

Table 4. Distribution of unperformed reverse transport tasks by days and causes
Source: data analysis in 2021

The combined effect of days and causes on the distribution of unperformed tasks (%)								
Days	shop did not give	weather conditions	later or missing call	nowhere to redirect	no forklift	no P/W & expiring working time	no P/W & next shipment followed	Distribution
Wednesday	9%	1%	3%	0%	1%	4%	9%	26%
Thursday	12%	1%	1%	0%	2%	0%	9%	24%
Friday	6%	0%	2%	1%	4%	2%	6%	20%
Sunday	18%	1%	1%	0%	4%	0%	5%	29%
Distribution	45%	3%	7%	1%	11%	6%	28%	100%

According to the distribution table (see Table 5: Days & Causes), it can be observed that the relationship between Sunday and Thursday *'Shop did not give'* has a significant effect, while in the case of Wednesdays and Thursdays was more typical as the reason was marked *'There was no P / W on the last station and the next shipment followed'*. The code of *'There was not a forklift truck'* was also more common on Fridays and Sundays.

Table 5. Distribution of unperformed reverse transport tasks by stores and causes
Source: data analysis in 2021

Effect of shops and causes on the distribution of default (%)								
Days	shop did not give	weather conditions	later or missing call	nowhere to redirect	no forklift	no P/W & expiring working time	no P/W & next shipment followed	Distribution
9	7%	2%	0%	0%	5%	0%	4%	18%
5	7%	0%	2%	0%	0%	2%	4%	15%
7	5%	0%	0%	0%	0%	2%	5%	13%
3	7%	0%	0%	0%	0%	0%	4%	11%
19	5%	2%	0%	0%	0%	0%	4%	11%
6	5%	0%	2%	0%	0%	0%	2%	9%
8	5%	0%	0%	0%	0%	0%	4%	9%
35	5%	0%	0%	0%	0%	0%	2%	7%
10	0%	2%	2%	0%	0%	0%	4%	7%
Distribution	49%	5%	5%	0%	5%	4%	31%	100%

One of the prominent values of the 6th two-dimensional cross table above for store 9 shows *'There was not a forklift truck'*. It can be observed that almost everywhere the highlighted combinations are either *'Store did not give'* or *'There was no P / W on the last station and the next shipment followed'* and store 7 is an outlier from the others. Based on the above, it is worth paying less attention to information gaps, as indicated by the distribution of the code *'Make a call too late / did not make a call'*. Overall, the first and last codes *'Store did not give'* and *'There was no P / W on the last station and the next shipment followed'* could be subdivided because half of the cases are related to them in some ways. According to the research, our second result concerns the importance of redesigning the current code system.

Step 3: The next step is also a two-dimensional relationship study, but between the independent impact factor pairs, which can reveal particularly important critical combinations as 'hotspots'. Examining the co-occurrence of 'Store Code' and 'Days' in Table 7 below, it can be seen that 9 is the most affected. For store 9, three days are the most valid, and for other stores, there are usually only two key days. Most problems emerged in case of 9;5;7;3 stores, from which the store 3 is affected by 'truck stop' and 5 and 7 generate the most problems on Wednesday (see Table 6).

Table 6. Distribution of unperformed reverse transport tasks by stores and days
Source: data analysis in 2021

The combined effect of shops and days on the distribution of default (%)								
Shop code	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Distribution
9	0%	2%	2%	5%	4%	5%	0%	18%
5	0%	4%	4%	2%	2%	2%	2%	15%
7	2%	0%	4%	2%	2%	2%	2%	13%
3	0%	0%	0%	4%	2%	0%	5%	11%
19	2%	2%	0%	2%	4%	2%	0%	11%
6	0%	0%	2%	0%	4%	4%	0%	9%
8	0%	0%	0%	4%	0%	2%	4%	9%
35	0%	0%	2%	0%	2%	0%	4%	7%
10	0%	2%	0%	2%	4%	0%	0%	7%
Distribution	4%	9%	13%	20%	22%	16%	16%	100%

Based on the above, the potential impact of the days can be examined on a store-by-store basis. No trend-like regularity can be detected yet, which is likely to be better reflected in the larger sample. Presumably, after a few months of performing the same analysis, a clearer picture may be obtained (see Table 6).

Step 4: Time series studies to examine whether there are trend-like correlations in relation to the factors examined and to what extent. Our goal is to reveal trends. We also start with simple time-series statistics in the fourth step and examine the results in several steps (see Table 7).

Table 7. Weekly distribution of unperformed reverse transport tasks Source: data analysis in 2021

Time series number of causes	
calendar week	Quantity
30	27
31	25
32	30
33	28
34	23
Total	133

Examining the selected five weeks, after a significant fluctuation there is a slight downward trend in the number of unperformed reverse transport tasks (see Table 7). Putting the non-compliance data in context and comparing it with the total number of shipments gives the following result (see Figure 5):

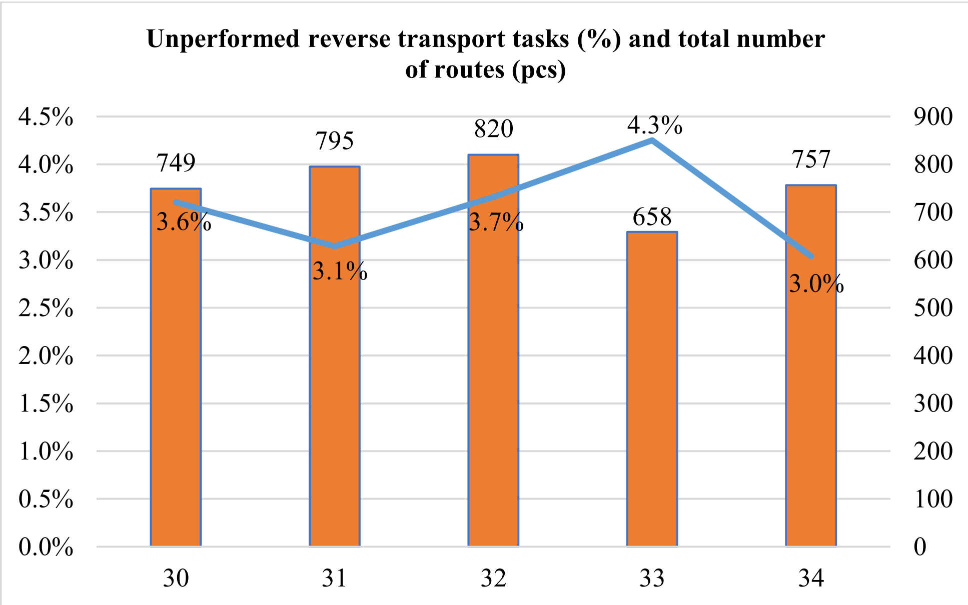

Figure 5. Relationship between unperformed reverse transport tasks ratio (%) and total number of routes by week, Source: data analysis in 2021

It can be assumed that there is a negative, non-coherent relationship between the total number of tours and the proportion of unperformed reverse transport tasks. It can be seen that we encounter some weeks where the number of unperformed reverse transport tasks are higher than the average, but the total number of tours are also outstanding, so the proportion of unfulfilled transport tasks will remain low.

A more thorough examination of the issue has revealed to us that the efficiency and effectiveness of unperformed reverse transport tasks from the perspective of the entire logistics process requires a time-sensitive approach and cannot be marked with static indicators. If we want to measure and know the effectiveness (and later efficiency) it is necessary to develop a dynamic measurement and active fine-tuning in time with more accurate cooperation and continuous redirection based on current (on-time) data. The method presented above and its resilience allows for any continuous fine-tuning as well as the development of resource and IT integration of our partners.

Certainly, a temporary metric (over a certain time horizon) will help us decide how to evaluate the performance for a given week. However, a well-designed metric or indicator also provides a kind of default target value for continuous monitoring of deviations, which is also advantageous from a control point of view. Examining the chosen 5 weeks, it can be seen that the average is around 3.5% in terms of the ratio between the total number of tours and the number of unperformed reverse transport tasks. As we can see 31;34 weeks are better than the average only.

Comparing the 32nd and 33rd values (see Figure 5) by unperformed reverse transport tasks and total number of tours, the week 32(3.7%) which corresponds to 30.3 occasions or URTTs (Unperformed Reverse Transport Task) and week 33(4.3%) 28.3 URTTs. According to the ratio the 32nd is better than the 33rd if we take into account the much smaller number of transports in the 33rd week. Based on the average value of 3.54%, the Management Board (as the stakeholders) temporarily set the target value of URTT as 2% for all tours. For the confirmed target value, a visual management method was used to visualize the monitoring system (see Figure 6). In the figure the target value, shown in green, is 2% of the planned number of tours, which is around 15 at week 30, and the current value is 3.6% (URTT ratio), which corresponds to 27 and the deviation of 12 can be seen easily.

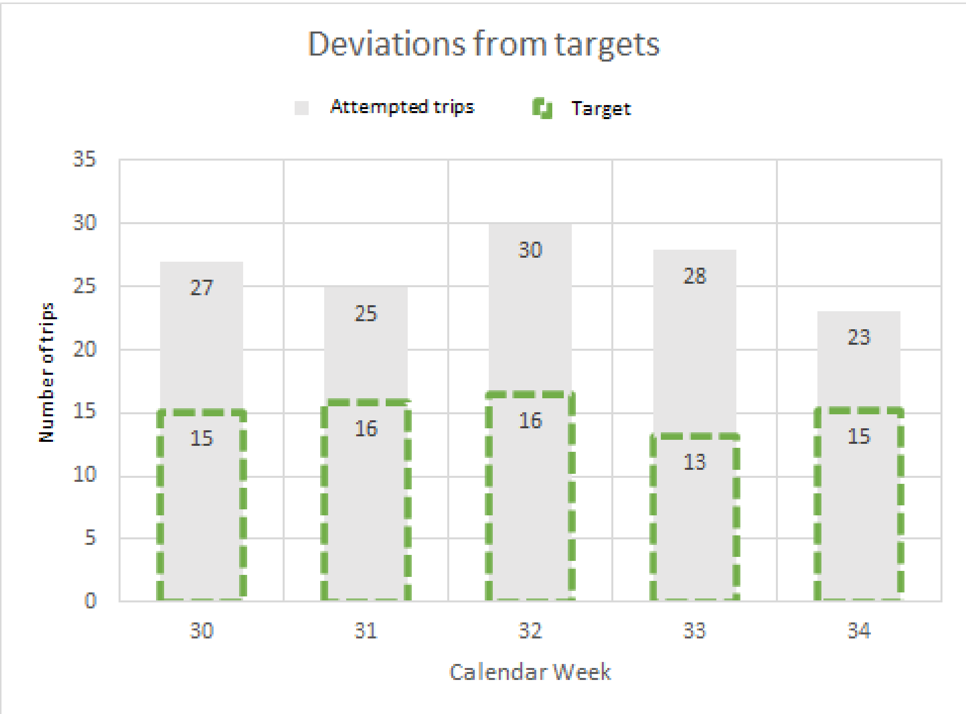

Figure 6. Deviation from target values unperformed reverse transport tasks Source: data analysis in 2021

In the fourth step of our model study, another result is obtained, which can also be expressed in the form of a management support indicator. As we can see, the resulting indicator is very easy to calculate and use, meaning that at the current level of strategic requirements, 2% of the total number of tours should be targeted. Looking back at this calculation, we can also estimate the magnitude of significant deviations from the previous goal.

To sum it up, with the present methodology, we have successfully investigated the fulfillment and non-fulfillment of the examined segment of reverse logistics processes, the root causes, and we have been able to formulate new, forward-looking results in each phase of the proposed RCFAA application, in order to make effective progress. The results and conclusions obtained by generalizing the model are summarized below.

5. Conclusions and recommendations

The importance of return logistics is becoming increasingly important in the competition of our globalized world, where companies must do everything they can to create a competitive advantage. First of all, the topicality of the present study is, to move forward and go beyond the classic concept of the corporate value chain in order to move closer to the concept of the supply chain management and a more sustainable value flow in practice. This study is the real evidence that the examined company has taken a significant step in the direction of that not only economic aspects can control and measure the complex system of value flows, but also the degree of cooperation with partners especially, in the field of reverse logistics. The first steps were taken to map and learn about the reverse logistics of a large international company, while a practical methodology for creating a customized database was developed to examine the effectiveness of reverse logistics processes in the field of freight transport.

In the framework of the present study, two practical methodologies have been developed with the aim of standardizing the previously separated measurement processes and the method of analysis itself. It was presented in a case study through a live practical example of how these models were developed and work in practice.

Theoretical (or logical) model of Root Cause Failure Approximation Analysis (RCFAA) which is a scalable model framework, is flexible enough for customization to other companies or other economic conditions and to apply different methods. According to our research method, the measured data is inserted into the framework in which they can be examined with cross-comparisons step by step, and the conclusion can be drawn hierarchically at each stage.

The Process Survey Model is a practical model for standardizing the data collection and processes used for decision support. This model is a simple guide for colleagues to involve and empower them to conduct the survey. These standards help integrate results into the enterprise knowledge system, and is an ideal way to analyze data and highlight critical ‘hotspots’ (root causes) regardless of the company’s specifics. The method presented above has enough resilience to allow any continuous fine-tuning in time, and the development of resource and IT integrations with our partners.

We hope that our method presented here for the first time can be applied by others and, after some customization, they will be able to successfully measure their own reverse logistics performance. From the above case study, it can be clearly seen that with conceptual data collection we can create an opportunity to measure processes, resources, efficiency, and even to determine the basis of effective countermeasures. By analyzing the data collected in the database and using the simple methodology presented, i.e. the RCFAA 4-step model and intensity cross-tabulations, the main impact factors and hotspots were successfully identified. Using the model in the case study, the following observations were made in connection with the reverse logistics transportation tasks as conclusions:

When a recorded data tries to support a measured indicator or connected to different causes then lot of mix can be observed between the root cause and the coded cause. Especially in the case of reverse logistics, because the factors are connected more complex ways (comparing to the manufacturing processes). It requires constant code updating.

A more thorough examination of the data patterns has revealed that the efficiency or effectiveness of unperformed reverse transport tasks (URTT) from the perspective of the entire logistics process requires a time-sensitive approach and cannot be marked with static indicators. If we want to measure and know the efficiency it is necessary to develop a dynamic measurement.

In the case of reverse logistics, there are more participants (as stakeholders) in the material flow (e.g. waste processing companies; disposers; state and municipal authorities; institutions; logistics service providers) and in addition, more constraints (e.g. increased weather exposure; 'truck stop'; partner duty; any restrictions; lack of information; working time constraints etc.) which causes high degree of uncertainty and greater imbalances in time; making the reverse logistics assessment significantly more difficult, and as a result it is not enough to examine or apply direct indicators.

With the presented model study methodology a new practical result was obtained, relevant hotspots were identified for the unperformed reverse transport tasks (URTT) and their root causes. We have successfully investigated non-compliance causes, and with the consent of the Management Board, were able to formulate a general default target value between 2%-3.5% URTT for all tours. A visual management method has been developed to control transport processes with a confirmed target value to easily monitor deviations. At the current level of strategic requirements, it works better than a static KPI.

It should also be kept in mind that these indicators are not carved in stone. They need to be constantly monitored in the light of processes and partnerships. The main problem with static indicators or KPIs is the ability to reduce the corporate interests behind the processes to the individual effectiveness of peers (individual efficiency of the members), thereby eliminating the entire supply chain concept and perspectives. Instead, this study identified a need that is more important than a KPI and the balanced and smooth operation of the stores can increase revenue more than focusing on separate efficiencies.

Using the methods presented, the following observations were made and the following complex analytical results were obtained in our own example. The distribution by days of the week revealed that on higher-traffic days (Wednesday, Thursday, and Friday), in addition to the Sunday (which is classified as a critical day and inferior in efficiency and effectiveness) there are more tours that do not perform their reverse tasks. We found that in many cases the main reasons behind the failed return logistics tasks were. The store does not return packaging / waste on the last station. There is not enough packaging / waste in the last station and the driver cannot switch to another shop due to the next transport task or the end of working hours. In the absence of a forklift truck, there is no one to carry out the loading. In addition, there are outstanding differences among our store partners, which can be traced back to certain typical reasons, such as labor shortages (e.g. lack of forklift driver, receiving clerk). These shortages represent an opportunity for cooperation.

After plotting and examining the variables leading to failed tasks, it can be shown that correlations can be observed between the days of the week, the causes, and the stores, e.g.: Thursday, Sunday – 'Shop did not give'. Wednesday, Thursday – 'There was no P / W on the last station and the next shipment followed'. For stores 9 and 5, we have identified the typical disincentives that could serve as a basis for development proposals.

From the weekly representation of failed tasks, a higher control resulting from measurability can be observed, as we can see a slightly decreasing trend. (The proverb says we can only improve on what we measure.) Finally, in agreement with stakeholders, a metric was determined against which the company's reverse logistics could be assessed and was proportional to outbound shipments.

Recommendations:

After a systematic and conceptual examination of the processes and the resulting knowledge, a number of focus points came to the fore, on which we formulate development proposals in order to increase efficiency, which are the following:

In case of reverse logistics tasks, the first and foremost is the continuous provision of measurability based on the implemented model and the databases already used. With the help of the information obtained, it is necessary to standardize the data processing, which must be evaluated and checked at least weekly. This is also important because our studies show that the performance of reverse logistics is more sensitive and hectic than forward logistics due to the greater uncertainty.

According to our studies, the secondary indicators were used to measure and evaluate reverse logistics, which means that the primary efficiency was controlled by transportation tasks of forward logistics and the hierarchically subordinate target values of the reverse tasks can take place if they are not inconsistent with them.

The analysis shows that in most cases it is not possible to pick up the packaging / waste at the last shops on the tours for various reasons. Our proposal was to further development a system with the help of the partners, which allows for the preliminary measurement and monitoring of exact quantities (e.g. formerly transported, estimated by habits etc.) and the lack of adequate manpower can also be indicated, even due to shifts. This would prevent most of the unperformed transportation tasks. In most cases, in the spirit of the supply chain concept, it means IT development and information sharing.

Certainly, the data presented and collected in its current state reflects only five weeks of data collection. Our future goal is to continue the survey toward a broader time horizon, which will certainly lead to the discovery of new correlations, trends and patterns over time. The perspectives and possible future research directions include extending the time horizon, extending the scope of survey to other reverse logistics tasks such as warehousing and different materials, aspects of cooperation with our partners and developing mutual IT systems and their information sharing concepts for better redirection (e.g. predicting information). The data will be reviewed regularly in the future. Nevertheless, in our present study, we have succeeded in highlighting some important focal points that increase the profitability and efficiency of the company with our proposals and have a positive impact on the operation of our partners in the spirit of supply chain management. By further structuring the research, it seeks to encourage the use of analytical methodologies that analyze performance from root causes through the entire supply chain, highlighting a number of points that would not be possible with other methods.

References

Agárdi I. (2017). Kereskedelmi marketing és menedzsment (Commercial marketing and management), Budapest: Akadémiai Kiadó.
https://doi.org/10.1556/9789634540168 Accessed: 20 Aug. 2021.
https://mersz.hu/hivatkozas/dj233kmem_242_p10#dj233kmem_242_p10

Alarcón, F., Cortés-Pellicer, P., Pérez-Perales, D., & Mengual-Recuerda, A. (2021). A Reference Model of Reverse Logistics Process for Improving Sustainability in the Supply Chain. Sustainability 2021, 13, 10383.
https://doi.org/10.3390/su131810383

Andrejić M. M., Pajić V., & Kilibarda, M. J. (2021). Measuring efficiency change in time applying MALMQUIST productivity index: a case of distribution centres in Serbia. Facta Universitatis Series Mechanical Engineering 19(3), pp. 499-514. DOI:10.22190/FUME201224039A

Andrejić, M. M., Kilibarda, M.J., & Popović V. (2017). Efficiency of logistics processes in customs procedures. Serbia: University of Belgrade - Faculty of Transport and Traffic Engineering, 3rd Logistics International Conference, p. 243.
https://logic.sf.bg.ac.rs/wp-content/uploads/LOGIC_2017_ID_26.pdf

Bahrin, M. A. K., Othman, M. F., Nor, N. H., Azli, M. F. T., & Talib, M. F. (2016). Industry 4.0: A Review on Industrial Automation and Robotic. Journal Teknolgi 78(6-13), pp. 137–143. https://doi.org/10.11113/jt.v78.9285

Bajor, I, Novačko, L., & Ogrizović, D. (2014). Processing reverse logistics inventories. Scientific Journal of Maritime Research, 28(1), 10-16.
file:///C:/Users/hu523301/Downloads/295_bajor_novacko_ogrizovic.pdf

Carroll, J. S. (1998). Organizational learning activities in high-hazard industries: the logics underlying self-analysis. Journal of Management Studies, 35(6), pp. 699-717. https://doi.org/10.1111/1467-6486.00116

Charnes, A., Cooper, W.W., & Rhodes, E. (1978). Measuring efficiency of decision-making units. European Journal of Operational Research 2(6), pp. 429-444. https://personal.utdallas.edu/~ryoung/phdseminar/CCR1978.pdf

Chikán A. (2020). Vállalatgazdaságtan (Business economics) Budapest: Akadémiai Kiadó. https://doi.org/10.1556/9789634545897 Accessed: 20 Aug. 2021. https://mersz.hu/hivatkozas/m795valgt_185_p36#m795valgt_185_p36

Costa-Salas, Y. J, Sarache, W., & Überwimmer, M. (2017). Fleet size optimization in the discarded tire collection process. Research in Transportation Business and Management, 24, 81–89. https://doi.org/10.1016/j.rtbm.2017.08.001

de Brito, M. P., & Dekker, R. (2004): A framework for reverse logistics. In Dekker, R., Fleishchmann, M., Inderfurth, K., van Wassenhove, L. N., (Eds.) Reverse Logistics – Quantitative Models for Closed-Loop Supply Chains (pp. 3–28). Berlin: Springer-Verlag, (Capter 1). ISBN 978-3-540-24803-3 https://www.researchgate.net/publication/322797660_Chapter_1_A_Framework_for_Reverse_Logistics

Ding, B., Zang, X., & Jiang, L. (2008). Third-party Logistics Provider Efficiency Evaluation Based on Information Entropy-DEA Model, International Seminar on Future Information Technology and Management Engineering, (2008), pp. 166-170. DOI: 10.1109/FITME.2008.98.

Dowlatshahi, S. (2000). Developing a Theory of Reverse Logistics, Informs Journal on Applied Analytics, 30(3). https://doi.org/10.1287/inte.30.3.143.11670

Ferguson, E., & Souza, G. C. (2010). Closed-Loop Supply Chains: New Developments to Improve the Sustainability of Business Practices, (1st ed.). New York: Auerbach Publications, p. 257. ISBN 978-04-2925-056-9 https://doi.org/10.1201/9781420095265

Gopal, N., & Panchal D. (2021). A structured framework for reliability and risk evaluation in the milk process industry under fuzzy environment. Facta Universitatis – series: Mechanical Engineering, 19(2), pp. 307-333. https://doi.org/10.22190/FUME201123004G

Guide, V. D. R., Van Wassenhove L. N. (2009). The Evolution of Closed-Loop Supply Chain Research. Operations Research, 57(1), 10–18. http://www.jstor.org/stable/25614727

Gyenge, B., Máté, Z., Vida, I., Bilan, Y., & Vasa, L. (2021). A New Strategic Marketing Management Model for the Specificities of E-Commerce in the Supply Chain. Journal of Theoretical and Applied Electronic Commerce Research 16(4) 1136-1149. https://doi.org/10.3390/jtaer16040064

Haas, D. A.; Murphy, F. H., & Lancioni, R.A. (2003). Managing reverse logistics channels with data envelopment analysis, Transportation Journal, 42(3), pp. 59-69. https://www.proquest.com/scholarly-journals/managing-reverse-logistics-channels-with-data/docview/204597736/se-2?accountid=28776

Hazen, B.T. (2011). Strategic reverse logistics disposition decisions: From theory to practice. International Journal of Logistics Systems and Management, 10(3), 275–292. http://www.inderscience.com/offer.php?id=43118

Huscroft, J. R., Hazen, B. T., Hall, D. J., Skipper, J. B., Hanna, J. B. (2013). Reverse logistics: Past research, current management issues, and future directions. International Journal of Physical Distribution and Logistics Management, 24(3), 304–327. https://www.econbiz.de/Record/reverse-logistics-past-research-current-management-issues-and-future-directions-huscroft-joseph/10010231037

Kaynak, R., Koçoğlu, İ., & Akgün, A.E. (2013). The Role of Reverse Logistics in the Concept of Logistics Centers, Procedia - Social and Behavioral Sciences, p. 109, 438–442. https://doi.org/10.1016/j.sbspro.2013.12.487

Kopcsay L. (2016). A marketingcsatorna menedzselése. (Marketing channel management) Budapest: Akadémiai Kiadó. https://doi.org/10.1556/9789630597630 Accessed: 23 Aug. 2021. https://mersz.hu/hivatkozas/dj109amm_40_p1#dj109amm_40_p1

Krstić, M., Agnusdei, G. P., Miglietta, P. P., Tadić, S., & Roso, V. (2022). Applicability of Industry 4.0 Technologies in the Reverse Logistics: A Circular Economy Approach Based on COmprehensive Distance Based RAnking (COBRA) Method. Sustainability, 14(9), 5632. https://doi.org/10.3390/su14095632

Kumar, B.M.; Saravanan, R. (2014). Network design for reverse logistics — A case of recycling used truck tires. Applied Mechanics and Materials, 592-594 (2014), pp. 2677-2688. https://doi.org/10.4028/www.scientific.net/AMM.592-594.2677

Kumar, N., Tyagi M., Garg, R.K., Sachdeva, A., & Panchal D. (2021). A framework development and assessment for cold supply chain performance system: a case of vaccines, In: Sachdeva, A., Kumar, P., Yadav, O., Garg, R., Gupta, A. (Eds.), Operations Management and Systems Engineering, Select Proceedings of CPIE 2019. Lecture Notes on Multidisciplinary Industrial Engineering. Springer, Singapore. (Chapter 22), pp. 339-353. https://doi.org/10.1007/978-981-15-6017-0_22

Kushwaha, D. K., Panchal D., & Sachdeva, A. (2020): Risk analysis of cutting system under intuitionistic fuzzy environment, Reports in Mechanical Engineering, 1(1), pp. 162-173. ISSN: 2683-5894. https://doi.org/10.31181/rme200101162k

Min, H., & Joo, S. J., (2006). Benchmarking the operational efficiency of third-party logistics providers using data envelopment analysis. Supply Chain Management 11(3), pp. 259-265. https://doi.org/10.1108/13598540610662167

Mitrović, M., Andrejić, M., Radivojević, G., Popović, D., & Kilibarda, M. (2022). Measuring the efficiency of the transport process in distribution centres of a trading company. International Journal For Traffic And Transport Engineering (IJTTE), 12(1), pp. 94-110. DOI: 10.7708/ijtte2022.12(1).07

Momeni, E., Azadi, M., & Farzipoor, S.R. (2015). Measuring the efficiency of third party reverse logistics provider in supply chain by multi objective additive network DEA model. International Journal of Shipping and Transport Logistics. 7(1), pp. 21-41. DOI: 10.1504/IJSTL.2015.065893

Porter, M. E. (1985). The Competitive Advantage: Creating and Sustaining Superior Performance. New York: Free Press; London: London: Collier Macmillan. p. 557. ISBN: 0684841460 (Republished with a new introduction, 1998.)

Ratković, B., Andrejić, M., Vidović, M. (2012). Measuring the efficiency of a healthcare waste management system in Serbia with data envelopment analysis, Waste Management and Research, 30(6), pp. 635-638. https://doi.org/10.1177/0734242X11426172

Rey, A., Panetti, E., Maglio, R., & Ferretti, M. (2021). Determinants in adopting the Internet of Things in the transport and logistics industry. Journal of Business Research, 131, pp. 584–590. https://doi.org/10.1016/j.jbusres.2020.12.049

Rogers, D.S., & Tibben-Lembke, R.S. (1999). Going backwards: Reverse logistics trends and practices. Reno: The University of Nevada, Center for Logistics

Management and Pittsburgh, PA: Reverse Logistics Executive Council. https://www.academia.edu/31734734/Going_Backwards_Reverse_Logistics_Trends_and_Practices Accessed: 29 Aug. 2021

Ross, A., Droge, C. (2002). An integrated benchmarking approach to distribution center performance using DEA modelling, Journal of Operations Management, 20(1), pp. 19-32. DOI:10.1016/S0272-6963(01)00087-0

Rubio, S., Jiménez-Parra B. (2014). Reverse Logistics: Overview and Challenges for Supply Chain Management. International Journal of Engineering Business Management (IJEBM), 6 (2014). https://doi.org/10.5772/58826

Sharma, N. K., Kumar, V., Vermac, P., & Luthrad S. (2021). Sustainable reverse logistics practices and performance evaluation with fuzzy TOPSIS: A study on Indian retailers. Cleaner Logistics and Supply Chain, 1 (2021), 100007. https://doi.org/10.1016/j.clscn.2021.100007

Subramoniam, R., Huisingh, D., & Chinnam, R. B. (2009). Remanufacturing for the automotive aftermarket-strategic factors: Literature review and future research needs. Journal of Cleaner Production, 17(13), 1163–1174. https://doi.org/10.1016/j.jclepro.2009.03.004

Szász L., & Demeter K. (Eds.) (2017). Ellátásilánc-menedzsment (Supply-Chain Management), Budapest: Akadémiai Kiadó
https://doi.org/10.1556/9789634540335 Accessed: 20 Aug. 2021.
https://mersz.hu/hivatkozas/dj255em_142_p8#dj255em_142_p8

Tyagi, M., Panchal, D., Singh, R. P., & Sachdeva, A. (2019). Modeling and Analysis of Critical Success Factors for Implementing the IT-Based Supply-Chain Performance System. In: Sachdeva, A., Kumar, P., Yadav, O. (Eds.), Operations Management and Systems Engineering, Select Proceedings of CPIE 2018. Lecture Notes on Multidisciplinary Industrial Engineering. Springer, Singapore. (Chapter 4), pp. 51-58. https://doi.org/10.1007/978-981-13-6476-1_4

Vöröskői, K., Földesi, P., Kóczy, L. T., & Böröcz, P. (2020). Fuzzy Approach for the Decision on Disposable or Returnable Packaging. Sustainability 12(18) Paper: 7304. https://doi.org/10.3390/su12187304

Wang, J. J., Chen, H., Rogers, D. L., & Ellram, L. M. (2017). Grawe, S.J. A bibliometric analysis of reverse logistics research (1992–2015) and opportunities for future research. International Journal of Physical Distribution and Logistics Management, 47, 666–687. https://doi.org/DOI:10.1108/IJPDLM-10-2016-0299

Yoon, J. J., Le, Y., (2013). Analysis of the transport efficiency of reverse logistics in Japan, International. Journal of Urban Sciences 17(3), pp. 399-413. DOI: 10.1080/12265934.2013.819172