
The Concept of the “Reverse Iceberg-RIB” in the Application of Account of Total Cost of Ownership for a Reusable Wooden Flat Pallet in its Operating Phase

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Abstract:

Purpose: The main aim of this article is to show that the total cost of ownership of a pallet (which is not restricted to simply owning it) can become both a useful philosophy for purchasing these logistic carriers and an effective tool used to significantly reduce the costs of logistic activity of enterprises.

Approach/Methodology/Design: Key dimensions of competition in the logistics area include the so-called "golden triangle", i.e., time, quality and costs, and that is why they require a revision of the way we consider them, especially in case of the last aspect. This article presents an original approach to the problem of examination of all possible costs that cargo pallets generate in their operational life cycle, using the concept of Total Cost of Ownership (TCO) as an analysis methodology and the survey method for the research sample.

Findings: In the "reverse iceberg" model, obvious and non-obvious costs have been identified in individual groups of costs related to pallet ownership during its operating phase. Considerations undertaken in this article lead to an obvious conclusion that an attempt to implement an approach to this important element of logistic infrastructure, and one can undoubtedly consider wooden cargo pallets as such, from the angle of account of costs allows to find grounds for taking real action leading to a significant reduction of costs of logistic activity in an enterprise.

Practical Implications: The article employs a comprehensive approach to the most complete analysis of cost groups as possible since the authors have adopted a stance that omission of the potential to reduce costs related to material logistics in which wooden pallets are used requires a different perspective.

Originality/Value: Numerous authors point to different sources and types of costs, and also present different views on how to define, interpret and identify their structure. The authors of this article propose thinking in terms of TCO as an alternative to the conventional approach to pallet-related costs at the same time postulating a standpoint based on their own model of "inverted iceberg" (RIB).

Keywords: Logistic Infrastructure, Cost of Ownership, Reverse Iceberg (RIB).

JEL codes: D24, M21, Q56.

Paper type: Research article.

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1. Introduction

Each economic process requires logistic support to ensure its effectiveness and efficiency (Park, 2020). The process of logistic support is a secondary service process, but it determines achievement of assumed organizational and economic goals, thanks to technical and technological support (*logistic infrastructure*) and management and organizational support (*logistics management*). In this approach, logistic infrastructure includes both forces (*social infrastructure*) and resources (*material infrastructure*), which, taken together, condition the achievement of assumed economic goals. In a typological (not systemic) division of logistic infrastructure, the following elements are distinguished: means of transport, storage facilities, handling, communication and packaging. As commonly understood, logistic infrastructure constitutes "technical means enabling movement, handling and storage of goods" (Abt, 2008).

That is why it includes warehouse means (e.g., structures and buildings, storage yards, storage facilities), means of transport (e.g., means of road, rail, air transport and water transport, sea and inland transport and pipelines), IT means (e.g., hardware, software, organizational means, means of communication), handling (internal transport devices and auxiliary devices) and packaging (individual and collective). Due to the fact that it was the first attempt to systematize infrastructure, the "packaging" group itself does not apply to key technical means for this classification, i.e. machinery and equipment.

However, as part of classification of auxiliary handling devices, one can also distinguish a subgroup of cargo pallets. In literature and theoretical studies (Carrano, Pazour, Roy, and Thorn, 2014; Deviatkin, Khan, Ernst, and Horttanainen, 2019), there is a wide range of explanations for the term "a cargo pallet", but according to the Polish standard - *PN-90 / M -78200 - a loading pallet is a device designed for placing loads in it or on it, adapted to mechanized movement as a pallet loading unit (PN-90 / M-78200 , 1990)*. This concept, however, does not emphasise the function of pallets seen from the angle of the logistic chain which has a significant impact on a more effective performance of transport and storage activities, for example thanks to the possibility of mechanization of transshipment and transport works or reduction of mechanical damage to the goods/cargo during transport and storage.

Nevertheless, at present, there should be a clear division of logistic infrastructure into "intralogistics" (e.g., devices of warehouse logistics) and "extralogistics" (e.g., roads or warehouse facilities). In addition, pallet management, although also formally separated within warehouse management of each company, is often marginalized due to the fact that a pallet is perceived from the perspective of low costs (it is relatively cheap), from the angle of easy availability (it is a common carrier) and low modernity (its structure has remained essentially unchanged for years, which makes it a historically repeated medium for the most part). For this reason, a vast majority of companies operating on the market adopt a traditional

approach when selecting pallet supplier(s), which is based primarily on the price of the carrier and its certified quality (compliance with the so-called pallet evaluation form). Requirements for the construction of a EUR-pallet are included in the International Union of Railways (UIC) standards: UIC 435-2 V - standard for a wooden flat pallet measuring 800 x 1200 mm and UIC 435-3 V - standard for a steel box pallet measuring 800 x 1200 mm.

Loading pallets are most often recorded in accounting books of enterprises in a manner similar to other packages, which are tangible components of their current assets. A quantity-quality inventory register of packaging owned by an enterprise is kept (the Accounting Act, 1994, Art. 34, section 4) in the books by showing at the same time quantity and value of packages according to homogeneous groups, types and other distinguishing features in same valuation price or purchasing price for each group of packages and by persons responsible for entrusted assets. In addition, in the course of a trading year, enterprises may evaluate packaging at purchasing prices or at prices accepted for records, adopting a method of determining total disbursements (the Accounting Act, 1994, art. 34, section 4) according to the FIFO, LIFO formula, weighted average or real price. For the above reasons, account of costs of a pallet in the traditional approach from the point of view of a company (the user) is based solely on the cost calculation of purchase of these pallets. If the value of purchased pallets is not particularly important from the point of view of the company, the person responsible may decide to write them off in full as at the date of purchase (the Accounting Act, 1994, Art. 17, section 2).

One of the modern concepts of account of costs proposed by the authors is a model based on the principle of taking into account all possible sources of costs arising from the beginning of the project until its completion. This approach fits in with the idea of *circular economy* (circularity), and this technique is referred to as "Total Cost of Ownership - TCO" (Wouters, Anderson, and Wynstra, 2005). The aspect of "ownership" is of course a broader aspect than the aspect of "possessionship", because under civil law the latter means a transfer of ownership (through, for example, purchase) and an unlimited right to dispose of a given thing. The term "ownership", on the other hand, necessarily also implies the responsibility for the "fitness" of the possessed thing for use, for example through its repair or servicing.

Although TCO is a purely economic concept, it has consequences extending the financial sphere as it uses the financial dimension for both financial and non-financial attributes (Morssinkhof, Wouters, and Warlop, 2011). The TCO model was developed in 1997 by Gartner Company in the USA, as a model for estimating all costs that may occur in a life cycle of an IT system, starting from the moment the system has been acquired, through its use and maintenance to its decommissioning (Castellani, Grasso, O'Neal, and Tolmie, 2005). However, due to the fact that this approach allows to determine total costs related to e.g., acquisition of goods in a standard life cycle of a given product, each stage of which is associated with

different costs (purchase, planning, physical management, support and abolition), its use is becoming wider.

2. Data and Methods

The scientific aim of this research was to determine the current level and cost structure of logistic infrastructure in relation to wooden pallets in their operating phase. The authors adopted the following model of scientific procedure, based on the common economic practice of recording costs of pallets as part of a one-off full write-off of their costs. Therefore, empirical research was conducted based on an in-depth interview and the territorial scope of the interview covered the administrative borders of Zachodniopomorskie Province and was carried out using an interview questionnaire. The companies were selected using a random selection amount entities recorded by the Statistical Office in Szczecin.

According to the Polish Classification of Activity (PKD), enterprises were selected from the following sections: C - Manufacturing, G - Wholesale and retail trade, H - Transportation and storage, and F - Construction. The sample unit in the study consists of enterprises registered in Zachodniopomorskie Province, operating in the above-mentioned industry sectors operating on the market for more than five years. A total number of 929 enterprises in Zachodniopomorskie Province met these criteria. 194 respondents answered the survey questions, which constitutes almost 21% (20.88%) of the sample and has been used to formulate conclusions about the entire general population.

3. Empirical Results

The authors believe that the application of the TCO model in an enterprise to optimize costs of logistic activity is becoming an important challenge nowadays, especially since only "full awareness" of costs incurred allows for the formulation of a systematic set of "thoughtful activities" that will most likely contribute to a lasting reduction in costs of logistic activity as a whole. The possibility of a full calculation of the total cost of ownership (including the obvious cost of possessionship) allows manufacturing or commercial companies to include all aspects of a sustainable approach to logistic processes in the management of a pallet pool.

At the same time, the term "pallet pool" is also understood ambiguously, although it is most often defined as: "a system of pallet rental (turnover), managed by a specialized operator" (Dictionary of logistics terminology, 2016) which consequently means "shared use of equipment by a number of users who have invested in these devices". Thus, according to the authors, "pallet pool" should be treated as a "pallet trading system, which consists in their co-use by entities forming a supply chain (senders and recipients as well as logistics operators), with a dominant entity (a leader) in the entire chain, which coordinates management of this

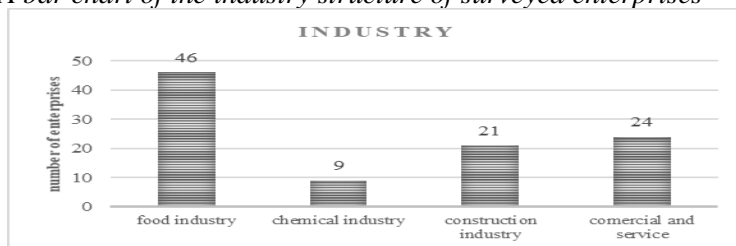
pool and which, due to the form of ownership of pallets themselves, may be own, mixed or rented pool".

The concept of product life cycle was developed and disseminated in literature in the 1960s. It assumes that products are introduced to the market, grow, mature and are removed from the market and that the measure of the "viability" of a product on the market is its sale - the product "lives" as long as there is demand on it so as long as someone needs it. Thus, the product life cycle reflects a purchasing process of a product and then the process in the course of which it loses its ability to meet needs and expectations of consumers (Garbarski, Rutkowski, and Wrzosek, 2001). The length and the course of the product life cycle and its individual phases depend on many factors, including among other things, type of product, nature of need satisfied, product's susceptibility to technical and technological progress, to changes in fashion and trends, a possibility to differentiate and modernize product features, market structure, structure of entities operating on the market or the intensity of competition. Thus, it can be assumed that in modern supply chains a pallet is a key aspect of logistic infrastructure which is often overlooked. According to the authors, the full form of costs related to a pallet in its operating phase is determined by the following groups:

- Total costs of possessionship - a purchasing price of the pallet (manufacturing costs borne by a manufacturer to produce it plus trade margin and VAT due).
- Total costs of maintenance - total costs of storage (storage sheds), total costs of repair (repair costs), total costs of physical and moral wear and tear (costs of impairment on resale).
- Total Cost of Ownership - the total costs of ownership of a pallet plus its maintenance throughout its life cycle and decommissioning management).

Therefore, an account of the total cost of ownership of a load pallet is a comprehensive cost formula that allows to obtain a full spectrum of costs (both obvious and not obvious ones), the identification and systematics of which creates a potential to optimize the costs of logistic activity for each manufacturing or trade and service company. Therefore, the study was conducted on a representative group of manufacturing and trade and service companies managing the largest pallet pools, and its results have been presented below (Figure 1).

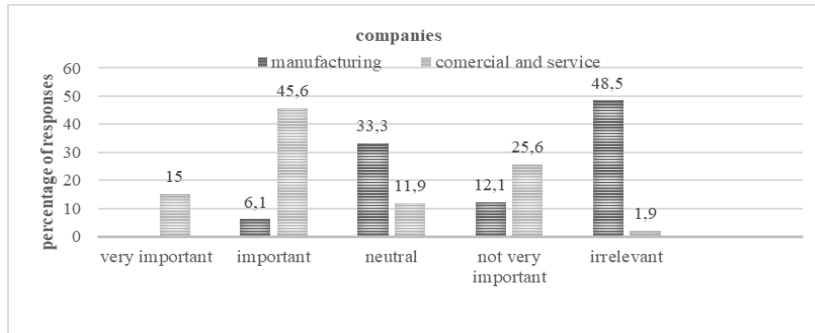
Figure 1. A bar chart of the industry structure of surveyed enterprises



Source: Own study.

The analysis of structure by industry (Figure 1) of surveyed enterprises indicates that the largest number, as much as 46% of the enterprises participating in the survey, represented the food manufacturing industry, followed by 21% of enterprises from the construction industry, and the smallest group in terms of numbers were enterprises from the chemical industry, which constituted 9%. The remaining 24% were enterprises from the following sectors: wholesale and retail trade as well as transport and storage.

Figure 2. A bar chart of the structure of importance of pallet economy in surveyed companies



Source: Own study.

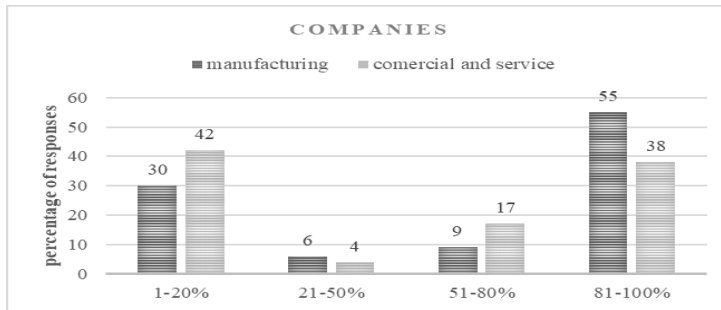
The analysis of structure of assessment of the level of importance of pallet economy (Figure 2) in manufacturing companies shows that more than half of them considered the importance of pallet economy to be irrelevant or indifferent (48.5% and 33.3% respectively), and it was of little importance for 12.1% of surveyed companies. As far as respondents from trade and service companies are concerned, more than half of them indicated that pallet economy is very important and important (15% and 45.6% respectively).

However, a quarter of them indicated that it was insignificant or insignificant (25.6% and 1.9%, respectively), and for 11.9% of surveyed enterprises it was indifferent. It can therefore be concluded that the issue of proper management of pallet pool is addressed appropriately only in trade and service companies as in these enterprises process phases are longer and a pallet is subjected to a greater number of manipulation, warehouse and transport operations, and additionally, the requirement of rational pallet pool management is also dictated by the complexity of the structure of the distribution channel. In case of manufacturing companies, a factor that contributes to a relatively low importance of pallet economy is the fact that finished products are most often placed on disposable pallet carriers.

In order to determine sources of a specific approach to the importance of pallet economy, the share of palletized goods in surveyed manufacturing and trade and service enterprises has been examined. It turned out that it is similar in terms of distribution of structure and price range (Figure 3). However, in manufacturing

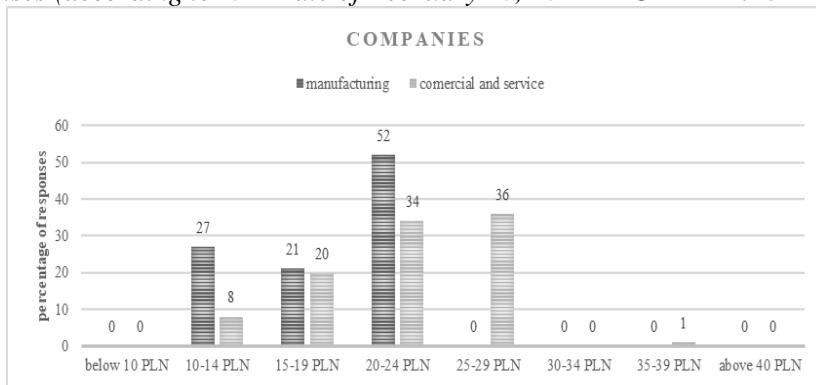
companies, almost all goods were shipped on cargo pallets, while in the case of trade and service companies, the opposite was true, which may result primarily from the fragmentation of structure of customer (consumer) orders. A full form of a unitary pallet loading unit may be lost along the distribution channel (due to displacement by various customer requirements along the distribution channel to a collective pallet loading unit, or to a non-palletized unit). In trade and service companies, a pallet unit may result only from the requests of customers waiting for goods, but also from the amount of goods they receive in a single delivery.

Figure 3. A bar chart of the structure of the share of palletized goods in surveyed companies



Source: Own study.

Figure 4. A bar chart of an average cost of acquiring a pallet in surveyed enterprises (according to NBP rate of February 10, 2021 - EUR 1 = 4.48 PLN)

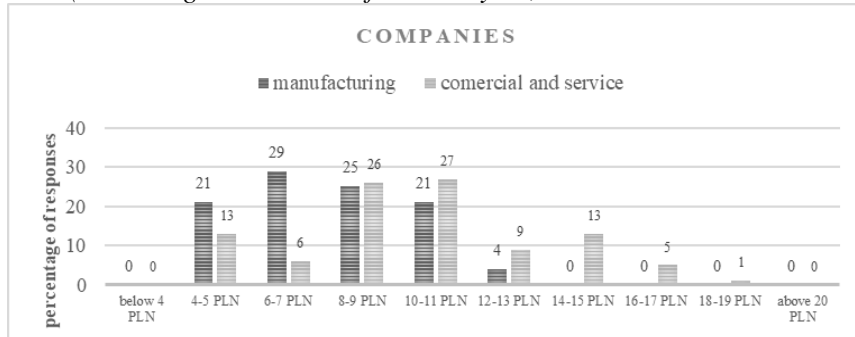


Source: Own study.

By analysing an average cost of acquiring a pallet in surveyed companies (Figure 4) we find out that the highest cost of acquiring a pallet, namely one that is in price range of 35-40 PLN, is borne by trade and service companies and only 36% of these companies acquire pallets in price range of 25-30 PLN. In 52% of manufacturing and 34% of trade and service companies an average cost of acquiring a pallet was in price range of 20 - 25 PLN and in 21% of manufacturing and 20% of trade and service companies this cost was in price range of 15 - 20 PLN. The lowest cost of

acquiring a pallet up to 15 PLN was indicated in 27% of manufacturing companies and 8% in trade and service companies. It turns out that trade and service companies are able to pay much more for pallets than manufacturing companies, which may result from a need to maintain standards of goods and minimize natural losses in the warehouse and transport process (care for condition of goods during their operation, for which they are responsible).

Figure 5. A bar chart of an average cost of acquiring a pallet in surveyed enterprises (according to NBP rate of February 10, 2021 - EUR 1 = PLN 4.48)



Source: Own study.

The interview showed that manufacturing companies avoid incurring too high costs of pallet disposal. In case of trade and service companies, on the other hand, this ranges amount to 8-10 PLN and 10-12 PLN (26% and 27% respectively). However, an average cost of pallet disposal may reach 20 PLN (1%). Thus, trade and service companies are able to pay about 40% more for pallet disposal than manufacturing companies (Figure 5).

Figure 6. A bar chart of an average cost of maintaining a pallet pool in the surveyed enterprises (according to the NBP rate of February 10, 2021 - EUR 1 = PLN 4.48)



Source: Own study.

The analysis of data presented in Figure 6 shows that manufacturing companies are characterized by significantly lower average costs of maintaining a pallet pool, and at the same time this range is reduced to three classes (and in the case of trade and

service enterprises there are as many as seven). The highest average cost of maintaining a pallet pool is borne by trade and service companies. The average cost of maintaining a pallet pool at the level of 6,000-7,000 PLN was indicated by 10% of enterprises, 5,000-6,000 PLN - 3% of enterprises, and the average cost of maintaining a pallet pool in the range of 4,000-5,000 PLN was indicated by 26% of enterprises. However, most enterprises indicated an average cost of maintaining a pallet pool at the level of 1000-2000 PLN, 75% and 36% of which were manufacturing and service and trade enterprises respectively. Finally, it can be assumed that the structure of cost elements in the total cost of ownership is as per the proportions shown in Table 1.

Table 1. Structure of cost elements in total cost of ownership (Proportion of cost elements to total cost)

Cost elements	Percentage (%)
purchasing cost of a pallet (price): <ul style="list-style-type: none"> - pallet manufacturing costs borne by a manufacturer - average trade margin - VAT due 	50
operating costs: <ul style="list-style-type: none"> - wear and tear costs and moral wear costs - storage costs (a storage shed / a place in a storage yard) - impairment costs on resale 	36
costs of repair	4
costs of pallet decommissioning <ul style="list-style-type: none"> - liquidation - disposal 	10
Total	100

Source: Own study.

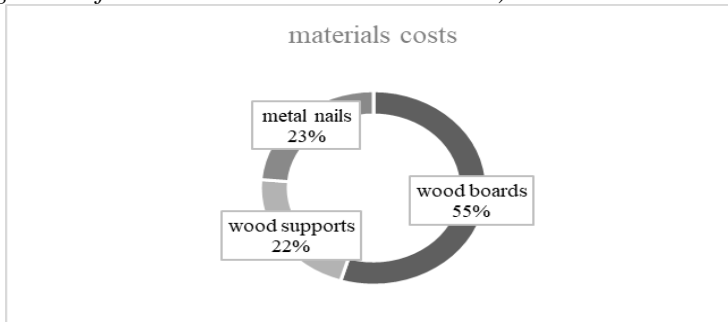
The research also shows that an average life cycle of a loading pallet is 12 months, which corresponds to 60 rotation cycles. Therefore, each new activity that contributes to the extension of this period is a desired one since it leads to decrease of costs of logistic activities.

In relation to the costs structure shown in Table 1, the proposed approach based on the TCO model provides an understanding and consideration of future costs that are non-obvious when a pallet is purchased. EPAL wooden pallet consists of 88 elements, 20 of which are made of wood, i.e., 11 boards and 9 supports (blocks). Additionally, there are connecting metal elements in a total number of 66 pcs. Total costs of all construction materials of EPAL 1 wooden flat pallet are as per market prices (as of February 2021) amounts to 5.96 EUR, and their percentage structure is presented in Figure 7.

Thus, it turns out that manufacturing costs of a single EPAL 1 pallet by a manufacturer (material costs) are almost equal to the purchase of a comparable single used pallet of the first grade, which amounts to 6.16 EUR. However,

purchasing a licensed new pallet in the same phase costs more than 10 EUR (10.03 EUR). Hence, there is a justified need to take a holistic view of all costs associated with the operating phase of a pallet in supply chains. It is a type of calculation that allows to determine indirect and direct costs of ownership, and its idea is based on the so-called "Reverse Iceberg" model (RIB).

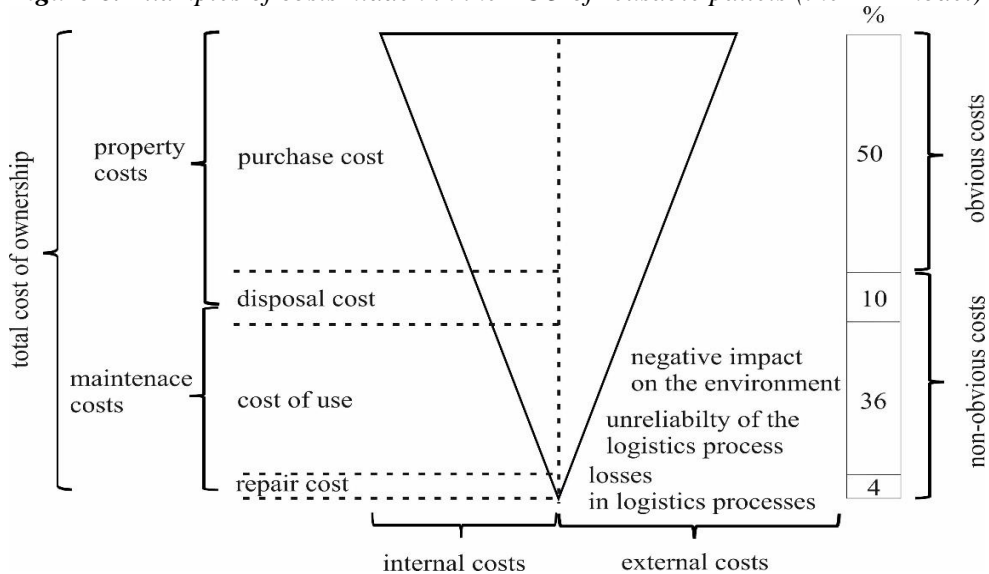
Figure 7. Structure of material costs of EPAL 1 pallet (according to the NBP exchange rate of 10/02/2021 - EUR 1 = 4.48 PLN)



Source: Own study.

Figure 8 below can be taken as a quasi-iceberg in the "Reverse Iceberg" model, but proportions are not as differentiating as they would be from a perspective of wooden pallet manufacturers (proportion 80/20 would be appropriate for them) which results from the fact that those considerations are related only to the operating phase of a pallet.

Figure 8. Examples of costs hidden in the TCO of reusable pallets (the RIB model)



Source: Own study.

Figure 8 shows that a holistic view from the angle of Total Cost of Ownership in an enterprise must take into account both total ownership costs of possessionship, which include purchasing price (consequently - its material accountancy) plus decommissioning costs (disposal costs), which is a legal responsibility of a manufacturing/trade and service company, as well as costs of ownership of a pallet itself (maintenance costs), which consists in costs of use, related to its use in logistics processes and costs of potential repair (repair costs).

It should be noted that unlike total costs of possessionship of a pallet, which for a logistics decision-maker are rather obvious, but not always significant (they have a potential to reduce costs of logistics activity), total costs of ownership, and especially total maintenance costs, related to maintaining a pallet in a proper condition in its operating phase, namely total costs of storage (e.g. separate area in a storage yard/shed), total costs of repair (e.g. costs of wooden/metal materials and repair of construction elements), total costs of wear and tear and moral wear (impairment on resale), in most cases ought to be considered as non-obvious costs.

In addition, every decision-maker/user, such as a manufacturing company/ trade-service company, should recognize that even a marked increase in awareness of nature, sources and methods of TCO management concerns their perception solely from the angle of internal costs, perceived by each company individually or possibly throughout the entire supply chain. It is therefore important to develop such an approach to external costs as only it will allow to create a full picture of costs, especially in relation to negative impact on the environment in case of e.g., premature pallet decommissioning or heavy wear and tear. Additionally, a quantitative reduction of the potential of a pallet pool (when a pallet is decommissioned) or a qualitative reduction (when a faulty pallet is allowed to be used) increases the risk of logistic processes taking place in the entire supply chain and reduces its flexibility and reliability.

4. Discussion and Conclusions

The perception of costs of logistic activity in relation to such carrier as a reusable wooden flat pallet and the presented concept of total cost of possessionship undoubtedly allows to determine its total operating costs and forces one to indicate insightful and systemic actions that will increase its operational life. An assumption that the total cost of ownership consists of the sum of the total cost of possessionship of a pallet plus the cost of maintaining it in a proper technical condition throughout its operating life and managing its decommissioning (recycling/disposal costs) meets these expectations.

The proposed model of Reverse Iceberg based on the TCO concept contributes to the recognition of relatively all groups of costs (their structure) which are related to the entire operating phase of a reusable wooden pallet in logistic chains, which also allows a better understanding and recognition of future costs to be born, which may

not be obvious at the time a pallet is purchased. While purchasing costs of a pallet as a carrier are relatively easy to estimate by decision-makers, it is much more difficult to calculate the costs of maintenance, repair, impairment or, finally, decommissioning. However, it is a one-sided approach included in internal costs. A look on a cargo pallet from the angle of principles of sustainable development requires to take into account, apart from purchasing costs, estimated costs as well (e.g., in case of purchase - costs of transport and storage, in case of operation - maintenance costs, costs of consumables, repair costs and finally decommissioning costs - dismantling, transport and disposal costs).

The article presents an original perspective on modes, types and sources of development and directions of application of TCO of pallet pool by manufacturing and service and trade companies based on reusable wooden flat pallets. It points to obvious costs, but also formulates a postulate to extend this approach by taking into account non-obvious costs, included in commonly promoted principles of sustainable development. It outlines, but at the same time leaves for discussion, subsequent scientific challenges related to parameterization, estimation and systematization of these costs as a whole.

References:

- Abt, S. 2008. Zarządzanie logistyczne. Warszawa: PWE.
- Carrano, A., Pazour, J., Roy, D., Thorn, B. 2015. Selection of pallet management strategies based on carbon emissions impact. *International Journal of Production Economics*, 164, 258-270.
- Castellani, S., Grasso, A., O'Neill, J., Tolmie, P. 2005. Total cost of ownership: Issues around reducing cost of support in a manufacturing organization case. *Seventh IEEE International Conference on E-Commerce Technology Workshops, Proceedings Paper*, 122-130.
- Deviatkin, I., Khan, M., Ernst, E., Horttanainen, M. 2019. Wooden and Plastic Pallets: A Review of Life Cycle Assessment (LCA) Studies. *Sustainability*, 11(20), 1-17.
- Garbarski, L., Rutkowski, I., Wrzosek, W. 2001, *Marketing. Punkt zwrotny nowoczesnej firmy*. Warszawa, PWE.
- Morssinkhof, S., Wouters, M., Warlop, L. 2011. Effects of providing total cost of ownership information on attribute weights in purchasing decisions. *Journal of Purchasing and Supply Management*, 17(2), 132-142.
- Park, S. 2020. *Transport Policy 99 2020*. Quality of transport infrastructure and logistics as source of comparative advantage. *Transport Policy*, 99, 54-62.
- PN-90/M-78200 1990. Palety ładunkowe i nadstawki paletowe - Terminologia i podział. Warszawa, Wydawnictwa Normalizacyjne ALFA
- Słownik terminologii logistycznej, Biblioteka Logistyka, Poznań 2016, Wyd. II, 146.
- The Accounting Act of September 29, 1994. *Journal of Laws 1994*, no. 121, item 591.
- Wouters, M., Anderson, J., Wynstra, F. 2005. The adoption of total cost of ownership for sourcing decisions—a structural equations analysis. *Accounting, Organizations and Society*, 30(2), 167-191.