Monika SZCZERBAK • Agnieszka WIKARCZYK

THE USEFULNESS OF MANAGEMENT ACCOUNTING TOOLS IN REDUCING WASTE

Monika **Szczerbak** (ORCID: 0000-0001-8073-7122) – *Military University of Technology Jarosław Dąbrowski in Warsaw, Faculty of Security, Logistics and Management, Institute of Organization and Management*

Agnieszka **Wikarczyk** (ORCID: 0000-0002-1019-3098) – *University of Cardinal Stefan Wyszyński, Social and Economic Faculty, Institute of Economics and Finance*

Correspondence address:
Gen. Sylwestra Kaliskiego Street 2, 00-908 Warsaw, Poland
e-mail: monika.szczerbak@wat.edu.pl

ABSTRACT: Purpose: The aim of the article is to present the usefulness of the tools available in management accounting in the area of cost accounting by monitoring the resource management process, including waste management by the idea of sustainable development. The authors present the importance of the concept of a circular economy in waste management, indicating its positive impact on the environment and the company's financial results. Methodology: an analysis and criticism of literature. Hypotheses: H1. The implementation of the circular economy concept should be supported using management accounting tools. H2. Cost accounting (target costing, Product Life Cycle Costing, and Activity-Based Costing) helps isolate environmental costs. Value: The indication of the potential benefits of effective waste management and the role of management accounting (in the form of cost accounting) in this process.

KEYWORDS: circular economy, "zero waste" concept, management accounting, Product Life Cycle Costing, Activity-Based Costing

Introduction

The growing amount of waste is becoming a challenge for modern civilisation. The idea of the linear economy model used so far, based on the principle: "take – produce – use – throw away" is ineffective. In the face of the greatest challenge in the history of mankind (Schwab, 2016), it does not work. The answer is *the circular economy*. The transition to such an economic model is crucial in building social prosperity and environmental protection. It allows for a broad look at the problem of waste and its impact on the natural environment (Mesjasz-Lech, 2018).

The article aims to assess the usefulness of the tools available in management accounting in the area of cost accounting, monitoring the resource management process, including waste management by the idea of sustainable development. The authors present the importance of the concept of a circular economy in waste management, indicating its positive impact on the environment and the company's financial results.

The authors present the importance of the concept of a circular economy about waste management, pointing to its positive impact on the environment and changes in business models. They indicate solutions in the area of management accounting. Its tools (cost accounting) can monitor the resource management process (incl. waste management). There were put forward two hypotheses:

- H1. The implementation of the circular economy concept should be supported using management accounting tools.
- H2. Cost accounting (target costing, Product Life Cycle Costing, and Activity-Based Costing) helps isolate environmental costs.

Based on the method of analysis and criticism of the literature, it was shown a properly adapted change towards a circular economy, and the implementation of management accounting tools can reduce waste generation (a positive impact on the environment), optimise costs, and consequently, improve the company's financial results. The authors summarised their observations with tips for good practices. In their opinion, they can be a starting point for entrepreneurs to engage in pro-ecological activities.

The evaluation of the presented research in the literature shows that conducting socially responsible activities by enterprises strengthens their position. That relationship was observed during the pandemic: enterprises characterised by high flexibility in the dynamic transformation of business models were in better financial condition (Ratten, 2021). Under current conditions, companies who want to maintain and strengthen their market position should smoothly transform their business models towards socially and environmentally responsible ("green label").

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The Essence of the Circular Economy

Circular economy (abbr. CE) is a general term covering all activities that reduce, reuse, and recycle materials in the processes of production, distribution, and consumption. At the source of this approach is the idea that has long been referred to in ecological circles as the "moderation economy", in social activist circles as the "inclusive economy", and in scientific circles as the "economics of sustainable development" (Reconomy.pl, 2022). Kulczycka emphasises a CE assumes economic management of resources (products, materials, and raw materials) and minimisation of waste generation and emissions (Kulczycka, 2019).

At the level of enterprise functioning, the idea of CE is to design a cycle in which the stages (starting with obtaining raw materials, through design, production, consumption, waste collection and ending with their management) will be repeated many times. It is important to treat waste as a secondary raw material. It can be reused in an economically and environmentally appropriate way. An inherent element of the implementation of CE is ensuring the maximum extension of the period of use of products or replacing them with other substitutes. These issues influence the development of innovation, the construction of new business models and a change in society's environmental awareness. The authors agree with the position of Sadowski (Jabłońska & Piorunowska-Kokoszko, 2023), the current concept of "waste" should become a synonym for raw materials, treated as an ideal substitute in all types of economic processes.

Meanwhile, a problem in implementing the assumptions is the social inequalities in access to information or education, as well as income inequalities. They are the reason for achieving different levels of balance. Modern business models must be readapted to the environment, not only to remain competitive but also to serve society and the environment. Many countries, through the CE and sustainable developments and plans for sustainable production, implement the assumptions of sustainable consumption, implementing long-term environmental strategies (Sagan, 2021).

In Poland, it is necessary to define CE as an economic development strategy with appropriate legal and economic instruments, incl. management accounting. There are three the authors want to introduce: target costing, Product Life Cycle Costing (Kryk, 2014), and Activity-Based Costing (Grabny & Kąkol, 2016). They could improve accounting, indicators monitoring the progress of its implementation (as well as IT solutions), and financial results.

The CE model is based on the longest possible product life cycle and focused on waste elimination. It is also worth paying attention to the sustainable use of energy needed to power all devices. Its production has both ben-

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efits and negative effects on the environment (depending on the energy source and technologies). Increasing the share of renewable energy sources in final consumption will ensure environmental benefits and will not limit human social and economic well-being. Today, the transformation of the Polish energy sector is the only way to permanently stop the increase in energy production costs by making it independent of the costs of energy raw materials and the prices of carbon dioxide emission allowances. This is a condition for maintaining acceptable energy prices for enterprises and households and maintaining the competitiveness of the Polish economy (Polski Komitet Energii Elektrycznej, 2022). Research indicates the best motivators for optimisation activities for the surveyed enterprises are reductions in energy-related costs (99% of responses), in addition to ensuring the reliability of energy supplies (95%), and fulfilling obligations arising from legal regulations (84%) and ecology (76%). However, environmental awareness is still low: only 5% of the surveyed enterprises considered it the most important reason for optimisation activities (Enel X, 2023).

Due to the existing coal reserves, the construction of modern coal-fired power plants in recent years and the social aspect, these sources cannot be completely replaced with renewable, gas or nuclear energy in the foreseeable time frame. The Polish energy doctrine should assume a systematic reversal of the roles of individual generation sources and take over the basic work of distributed sources and conventional coal energy. In Polish conditions, it should gradually take over the role of a guarantor of electricity supplies (Nowiński, 2021). The use of waste to generate energy is also one of the directions of sustainable development because the chemical energy contained in a large part of waste can be used for energy purposes (incl. the production of electricity and heat in various technological variants of thermo chemical conversion, e.g., combustion, pyrolysis, gasification) (Faustino et al., 2021; Wasielewski & Bałazińska, 2018).

CE is presented as a concept that can bring economic benefits, contributing to the development of innovation, growth and creation of new jobs, as well as increasing competitiveness and creating new business opportunities (Zhelyazkova, 2018; Jastrzębska, 2017). On the other side, there are questions about whether CE can mutually support environmental sustainability and economic development (Kirchherr et al., 2023). From a company's perspective, closing the loop can lead to cost reductions through more efficient use of raw materials and to revenue growth by introducing new and innovative products to the market (Godlewska-Majkowska et al., 2016). A broad view of the waste problem and taking actions to avoid or reduce the amount of waste (using a Zero Waste business model) is currently gaining importance.

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Zero Waste Concept Assumptions

Zero Waste is an ethical, economical, effective and forward-looking concept which can change people's lifestyles and habits to ones that mimic natural cycles, where all materials (have been thrown away) are designed to become resources for others. It means designing and managing products and processes to systematically reduce the amount and toxicity of waste and materials, conserve and recover all resources, and avoid incineration or land filling ("Zero waste", 2022).

The implementation of Zero Waste should lead to the complete elimination of harmful substances that threaten the health of the Earth, humanity, animals and plants into the soil, water, and air (Zero Waste International Alliance). This means abandoning the approach of waste disposal in favour of resource management. If a product cannot be reused, repaired, rebuilt, upgraded, refurbished, resold, recycled or composted (Michniewska & Grodkiewicz, 2017), it should be restricted, redesigned or discontinued. However, the Zero Waste philosophy is not limited only to increasing the level of recycling but also assumes the prevention of waste, valuation of resources derived from waste and changing consumer behaviour (Pietzsch et al., 2017), according to Zaman (2014), the Zero Waste philosophy can be defined as a combination of product design and management, taking into account the principles of waste management to eliminate potential threats to the environment caused by consumption and behaviour of society. Environmental pressure is of great importance (Seroka-Stolka, 2016).

The CE system allows to close the life cycle of products. An important element of this concept is the effective design of products, which will minimise the costs of waste management and transfer them to entities specialising in their reuse (Hordyńska, 2021) This use of waste results in significant savings for companies and has a positive impact on the implementation of the idea of sustainable development. A properly functioning closed economy system allows for material and environmental savings, which in turn has a positive impact on the companies' financial results. Recycling companies create a closed loop in a way that tries to integrate it into the processes typical of individual industries and their final stages of production processes. Without cooperation and mutual understanding of the benefits, it is not possible to develop common thinking in the spheres of production, trade and consumption, effectively supported by legal provisions (Jabłońska & Piorunowska-Kokoszko, 2023).

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Benefits and recommendations for the CE model

Research conducted by many scientists (Michalski & Sitko, 2016) shows waste prevention, eco-design, waste reuse, and similar activities can bring net savings of up to EUR 600 bln or 8% of annual turnover to enterprises in the EU while leading to reducing total greenhouse gas emissions by 2-4% annually (Zarębska, 2017). This thesis is also confirmed by research conducted in 76 dairy enterprises in Poland, most of which implemented pro-environmental activities consistent with the concept of sustainable development. As a result of the research, it was confirmed in addition to the environmental aspect (concerns the protection of basic natural components), these activities also had an economic aspect because their result was saving raw materials, energy and materials used in the production process, which translates into financial savings (Hadryjańska, 2018). A waste management model leads to pro-ecological activities of the organisation at individual stages: planning, organising, directing and controlling. This model is consistent with the "7R" assumptions: rethink, reduce, reuse, repair, refurbish, recycle, and recover (Gralak, 2021). It assumes raw materials are used in whole or in greater part, and the elements we get rid of go back into circulation. As a summary of waste management, it is recommended:

- start from the production preparation process, assuming waste minimisation by using optimisation in production, e.g. waste utilisation,
- store and reuse the waste in processes for various purposes,
- sell waste to entities that use it in their production processes,
- prepare containers/ places for appropriate waste storage (but also planning changes in a technological cycle, waste disposal and its logistics).

Following these tips is the first step in taking part in pro-ecological activities. Constant cooperation can motivate enterprises to achieve mutual benefits, managers to be involved in the waste management process, and the willingness to improve the state of the environment.

Target costing and Product Life Cycle Costing as tools for separating environmental costs

Sustainable production is a decisive factor in achieving eco-innovation (Zhou et al., 2016) because it is an industrial activity that transforms raw materials into products with higher added value. It seeks to minimise negative environmental impacts through the reduction of materials, energy consumption and natural resources (Rodríguez Sánchez et al., 2018; Drury, 2018). In such a context, target costing can be useful. It is a system that helps

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determine the assumed (target) cost of a product at the pre-production stage in order to reduce all cost components of a given product throughout its entire life cycle. It takes into account cost data from the research, development and design departments through production marketing until the product is withdrawn from the market. Essentially, the desired (target) selling price for a specific product is identified during the design phase, and the target profit margin is subtracted to determine the target cost of producing the product (Szczypa, 2012). The specific quality and functionality of a product are taken into account, and a precise product specification, better design and construction are prepared. In addition, various departments are integrated during the implementation of the project. Aspects of research, development, and technological processes, production, marketing, distribution, and customer service stages are systematically assessed (Gałązka, 2008). This is the main axis of the narrative of many studies. It is emphasised this system is aimed at reducing the costs of new or modified products while taking customer's requirements (e.g. price, quality and functionality), competitors' activities, pressure on cost reduction and strategic profit planning (Wikarczyk & Szczerbak, 2022; Kruk, 2018; Orliński, 2014). Target costing is used in rationalisation (it can help reduce waste – the final type of cost) or modernisation of already manufactured products. Unfortunately, this element was rarely taken into account during descriptions or calculations (Clermont et al., 2018; Pajrok, 2014), and surveys showed that in Poland, only 14.7% of surveyed entities used this tool (Łada, 2011). In subsequent years, e.g., in Turkey in 2020, 57% of furniture firms used it (Celayir, 2020). Due to the broader concept of the Zero waste principle, a Product Life Cycle Costing (abbr. PLCC) has been introduced.

The PLCC can be considered from the perspective of the producer or consumer. Due to the topic, the former should be accepted. This view allows us to distinguish two approaches: marketing and production. In the first one, the PLCC refers to the time it is offered on the market by the manufacturer and distinguishes the phases of shaping the sales volume and value. The second approach takes into account the measurement of the financial consequences accompanying the product in its life cycle, which includes the pre-production, production and post-production stages (Table 1). Important costs are identified, incl. recycling and waste disposal (RICS, 2016).

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Table 1. Stages and their main costs distinguished in the PLCC (production perspective)

Pre-production stage	Production stage	Post-production stage
Costs of:		
• product research & development • planning • design • product & prototype testing • tangible & intangible investments	• purchase • manufacturing • management • sales (incl. marketing) • customer service • repairs & complaints • research & development of the product	• completion of production (incl. disassembly) & withdrawal of the product • after-sales service (incl. customer service) • repair & claim • recycling • waste disposal

Source: authors' work based on Jaruga et al. (2014).

This is a calculation that allows one to look at the product comprehensively (Biernacki 2011). It can include costs associated with end-of-life (e.g. dismantling, disposal, recycling, renovation) after the end of its useful life (Figure 1).

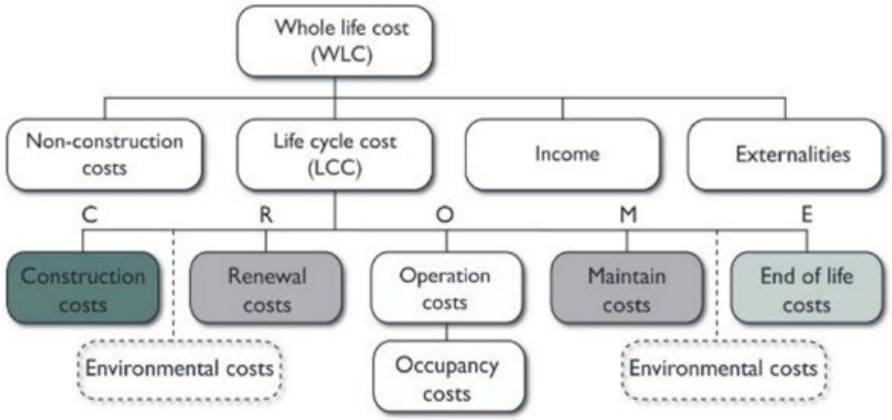

Figure 1. Key cost categories of WLC (Whole Life-Cost) and LCC (Life-Circle Cost)
Source: RICS, 2016, p. 5.

They may constitute – as indicated – a significant part of them (Table 2). In the example, the total cost of the pre-production stage was planned at PLN 511,980 (3.67% of the total costs would constitute *initial investment cost*). In this area, the *cost of environmental impact analysis* appeared with a 0.14% share in costs. In the production stage (4 years) of manufacturing the tested refrigerators and freezers, the costs would amount to a total of PLN 9,791,680.00 (91.91% of the costs), incl. the largest share of *fixed costs*

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Table 2. Example of PLCC (incl. dismantling and disposal costs) with cost structure

Life cycle stage	Pre-production	Production				Post-production	Total	Cost share [%]
	stage							
year	0	1	2	3	4	5		
Production [in pcs.]		2,000	4,000	6,000	4,000		16,000	-
Salesrevenue		*4,996,000*	*9,992,000*	*14,988,000*	*9,920,000*		*39,824,000*	-
Initial investment cost, incl.:	*390,980*						*390,980*	3,67
- environmental impact analysis cost	15000						15,000	0,14
- cost associated with organization and recovery	6,400						6,400	0,06
Installation and commissioning cost	*121,000*						*121,000*	1,14
Energy cost		*7,489.8*	*7,489.8*	*7,489.8*	*7,489.8*		*29,959.2*	0,28
Fixed costs, incl.:		*2,433,100.95*	*2,433,100.95*	*2,433,100.95*	*2,433,100.95*		*9,732,403.8*	91,35
- materials and raw materials costs		1,223,960.83	1,223,960.83	1,223,960.83	1,223,960.83		4,895, 843.32	45,95
- production losses costs		24,000	24,000	24,000	24,000		96,000	0,90
Variable costs, incl.:		6,598	13,842	4.391	4,486		29,317	0,28
- break costs		4,523	2,897	2,961	3,656		14,037	0,13
Dismantling and disposal costs, inc.:						*350,400*	*350400,0*	3,29
- transport cost with carrier's margin						166,400	166 400,0	1,56
- processing cost (after deducting revenues from the sale of raw materials)						158,400	158,400	1,49
- cost of disposal of hazardous materials						25,600	25,600	0,24
Total costs							10,654,060	100

Source: authors' work based on Selech and Kurczewski (2012).

(91.35%). Within this framework, 0.9% of the costs would be production loss costs. In the post-production stage, there would be a cessation of production and the introduction of new products to the market. Disassembly and disposal costs of PLN 350,400 would be incurred (3.29% of the total costs). This cost was reduced by revenues from the sale of raw materials from the dismantling of the refrigerator-freezer (Selech & Kurczewski, 2012). In this example, the costs of the pre-production and post-production stages were very similar.

The introduction of last-phase costs resulted in a change in the approach – there were made efforts to extend the product life cycle, which is consistent with the assumptions of sustainable development. It may be a source of additional revenues that will affect the financial result (RICS, 2016; Jaruga et al., 2014). This is a broader concept because it covers more than just making current and strategic decisions regarding certain cost groups. It is also related to improving the quality of the manufactured product/service offered, changing the operating cycle (to prolong (Nitkiewicz, 2015)) and searching for new applications in the long term.

Activity-based costing as a cost-reporting tool

Another cost accounting is Activity-Based Costing (abbr. ABC). It is described as a method of measuring the costs and effectiveness of activities, resources, products and other cost objects (Kruk, 2018). It is an accounting tool that could facilitate the implementation of CE solutions. The justification is a sharp increase in indirect production costs (incl. depreciation and quality maintenance, office and administration, utilities, advertising and promotion, fuel, insurance, storage, but also waste storage) with a decrease in the share of direct costs (e.g., materials, goods, salaries; external services) as a result of optimising the latter (Mokrzycka, 2018; Bochenek, 2017). It was noted little emphasis was placed on reusing waste and qualifying it for action. ABC is aimed at identifying all related activities in the company, systematically reducing costs (as a result of drawing conclusions from diagnosed deviations from model activities). They affect the effective and efficient resources used, eliminating the formation of excessive waste (allows to reduce waste, but may also affect their qualification: from fixed costs into variable ones) and increasing the financial result. ABC allows to adapt to changes in the environment (reducing consumption), to effectively implement the planning and control process (incl. production in progress and after). It takes into account the costs development at the level of performing specific, but main activities allow for settling the costs of materials and processes like Waste Management (Table 3) (Nasution & Siregar, 2018). For this reason, it can also be used

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in service and commercial activities, although on a different scale (which should also be related to costs and financial results).

Table 3. Basic, auxiliary and management processes in the enterprise

Basic processes (directly associated with cost objects: products, services, etc.)	Auxiliary processes (not directly related to cost objects)	Management processes (applies to the entire enterprise)
• production • sale • marketing • quality control • external transport • shopping/supply • Customer Service • complaints	• Human Resource Management • Production Management • Quality Management • Waste Management • Strategic Management	• accounting services • IT support • storage • work control • technology

Source: authors' work based on Mokrzycka (2018).

The analysis of the interdependencies of activities and processes necessary to create the ABC model is a source of information about the involvement of resources used in individual phases of product production processes. Constructing a model provides the management staff with a lot of information in order to avoid unnecessary actions and reorganise and simplify processes operating in the enterprise (Quesado & Silva, 2021). Controlling activities may contribute to reducing the business activities costs, incl. those related to waste (proposal: placing waste management as an auxiliary process to the production, when the carrier would be the area of a landfill, the number of waste imported per day/week). The management staff can carry out corrective actions, incl. elimination of unprofitable products or those generating excessive waste, replacing them with substitutes, and improving the production process (the action may be a product quality control, and the carrier may be the number of inspections carried out (Kister, 2021), investing in modern technologies, changing policy and operational strategy (Kaplan & Cooper, 2000).

A challenge for ABC could be a need to (Mokrzycka, 2018):

- creating appropriate measures to reliably reflect the scope of waste management implementation, as it was noticed there is little emphasis on reusing waste and qualifying it for activities,
- describe the scope of activities and job positions of persons responsible for waste,
- creating an appropriate computer system to record waste-related costs in the activity system.

ABC can include several closely related types of activities, e.g., handling waste deliveries, internal transport, quality control to re-direct specific waste

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for management, accounting and storage. After separating the level of activities and assigning the corresponding resources and detailed activities (treated as costs), the indirect costs of individual activities should be allocated to the types of products produced. Then, the unit costs of products should be determined, which requires the following calculations: the cost rate of specific activities, the number of units of a given activity (the so-called activity cost carrier) and the costs of activities charged to particular types of products as the product of the cost rate and the activity measure (Mokrzycka, 2018; Kowalski & Klich, 2011). In this context, ABC would facilitate the identification of activities (cost objects) in order to determine the cost of a cost object, which would be waste management. Unfortunately, in many cases, such management is not yet of such extensive interest, so this is an area to analyse and propose solutions tailored to production processes.

Summary

The CE is an economic system offering an innovative, revolutionary and holistic approach to aspects of resource management (incl. waste) and taking into account the search for economically effective business models. The implementation of such solutions requires a transparent and long-term development policy, as well as systematic and evolutionary changes. Even minor changes introduced in the area of consumption or production – in accordance with the principles of CE – are the stones that move an avalanche of new ideas and solutions.

As a result, it is possible to achieve a new level of care for the management of natural resources while building new market value. This requires solutions in management accounting and tools enabling the introduction of changes in cost management, which confirms hypothesis 1. They are related to the possibility of separating environmental costs (incl. waste), affecting the amount of costs but also the financial result. This confirms hypothesis 2. Practice and literature show good results can be achieved by companies who use or combine tools in advance (Kruk, 2018; Szczypa, 2014). Saving raw materials, rational use of materials and energy, and producing heat from waste may become one of the recipes for the environmental crisis and promoting the Zero Waste concept.

The economic dimension is important in the waste management business models, but the non-economic dimension (ESG) is also becoming more important. According to the authors, presenting business models heading towards a CE model and creating good practices is an educational element, opening the field for the exchange of observations and experiences. Implementing management accounting tools can bring benefits, such as identify-

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ing and eliminating waste (improves the company's operational efficiency), savings due to cost optimisation, extending the product life cycle, and effective and efficient management of resources (waste). As a result, entrepreneurs face many tasks, incl. opening up to new materials and technologies, changing the approach to secondary raw materials, adapting to climate change, taking into account the environmental footprint, increasing energy efficiency and financial results.

The contribution of the authors

Conception, M.S. and A.W.; analysis and interpretation of data, M.S. and A.W.; literature review, M.S. and A.W.

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