EMBEDDING SUSTAINABILITY INTO ASSET MANAGEMENT: A CASE STUDY

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Abstract Industrial and manufacturing systems have a major impact on all aspects of sustainability. Asset management is an important factor for companies seeking to improve their sustainability performance. This paper examines the areas in which companies incorporate sustainability aspects into their asset management decisions and activities. It uses two Slovenian companies as an empirical case study. The results show that both companies actively incorporate sustainability into their asset management practice. The weakest inclusion was found in asset management policy, strategy and objectives. Risk management is another area to focus on, as well as activities related to asset information. The stronger involvement of sustainability in asset management activities was related to organization and people. Support from top management was found to be moderate rather than strong. The study's findings underscore the areas where asset managers should focus to boost their contribution toward sustainability.

Keywords:: asset management, sustainability, ISO 55001, case study.

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1 Introduction and literature review

According to Scopus, 222,827 studies on sustainability were published from 2012 to 2022 (Source: Scopus. Search term: "sustainability"). Although sustainability is an important research topic, there is still a lack of research on linking it to asset management (Gavrikova et al., 2020). Our literature search revealed 361 studies combining the topics of sustainability and asset management (Source: Scopus. Search term: "sustainability" AND "asset management"). However, in relation to physical or engineering asset management in the context of sustainability, only 10 (source: Scopus. Search term: "sustainability" AND "physical asset management") and 5 studies were found in the Scopus database (Source: Scopus. Search term: "sustainability" AND "engineering asset management"), respectively. In addition to the Scopus search, the same keywords were used in the Google Scholar search. See Table 1 for a summary of the literature.

Table 1: Literature summary

Reference	Methodology	Main asset management topics studied
(García-Gómez et al., 2021)	Literature review/ Conceptual paper	Study presents a methodological framework for the inclusion of sustainability aspects in the risk management of industrial assets.
(Maletič et al., 2018)	Empirical study	Asset management framework (consisted of four sub-constructs, namely Physical Asset Management Policy & Strategy, Physical Asset Risk Management, Physical Asset Lifecycle Management, and Physical Asset Performance Assessment) is developed. Study examined the impact of physical asset management practices on sustainability performance, namely economic, environmental, and employee-related social performance.
(Franciosi et al., 2021)	Literature review/ Conceptual paper	Relevant factors related to sustainability and maintenance performance measurement system are presented and discussed.
(Marlow et al., 2010)	Case study	A qualitative study was conducted to examine the link between asset management and sustainability principles from the perspective of Australian water utilities.
(Henderson et al., 2014)	Literature review/ Conceptual paper	Proactive maintenance from an integrated asset management perspective is discussed and its role in improving all aspects of sustainability.

Sustainability has become a popular topic in recent decades and is usually explained in terms of three areas, namely society, the economy, and the environment. The concept of sustainability plays an important role in asset management as well. The reason for this lies in the fact that there is a close connection between the effective use of asset management and long-term sustainability - from an economic, environmental and social perspective (ISO 55001, 2014). Prior research (Maletič et al., 2018) has provided evidence that physical asset management contributes to sustainability performance (in terms of achieving economic, environmental, and social performance). As such, physical assets, namely engineering assets, are important to create value not only for the organization itself but also for a wide range of stakeholders that are external to the organization (Almeida et al., 2021; Maletič et al., 2018; Maletič, Maletič, et al., 2020; Maletič et al., 2022; Trindade et al., 2019). Optimum realization of value from assets involves a holistic approach and the consideration of complex and often contradictory expectations of different stakeholders, but it provides the organization with important competitive advantages. To achieve this, organizations use a structured approach to their asset management to prioritize competing priorities and achieve long-term benefits. An asset management system (AMS), based on the ISO 55000 family of standards, helps an organization develop a systematic approach and coordinated deployment of appropriate resources and activities. It also includes elements for monitoring and continuous improvement to ensure the sustainable achievement of strategic objectives (ISO TC 251, 2018). AMS can help organizations to meet their sustainability goals by development and implementation of processes that link the required purpose and performance of the assets to the business objectives; through the implementation of processes to ensure performance across all lifecycle phases; by implementing processes for monitoring and continuous improvement; and by providing the necessary resources and competent people to be successful (ISO TC 251, 2018). More specifically, asset management enhances an organization's sustainability using the asset lifecycle management approach in pursuing the performance benefits. It can help organizations in managing expenditures and activities to achieve their goals. Further, effective risk management and decision making are essential elements in managing industrial assets (Lima et al., 2021; Maletič et al., 2018; Maletič, Maletič, et al., 2020; Maletič, Pačaiová, et al., 2020; Pačaiová et al., 2017; Trindade et al., 2019). Asset management also improves efficiency and effectiveness by reviewing and improving processes, procedures, and asset performance. In addition, asset management processes clearly demonstrate social

responsibility and ethical business practices by improving the ability to reduce emissions, conserve resources, and adapt to climate change (ISO TC 251, 2018). Nowadays, asset managers are using smart assets, cyber-physical systems and deeper knowledge of the environment to transform infrastructure systems such as energy, transportation and waste management.

Therefore, it is important to note that while there is theoretical evidence in the literature to support the proposition that an organization can benefit from a sustainability perspective in asset management, there is still a lack of research examining how to incorporate sustainability considerations into asset management. Previous research (Marlow et al., 2010) provided insights into how the Australian water sector is attempting to combine the concepts of asset management and sustainability. A more recent study (García-Gómez et al., 2021) has made an effort, mainly to provide a methodological framework for the inclusion of sustainability aspects in the risk management of industrial assets. Prior studies has focused on maintenance and asset management performance management system by considering sustainability considerations (Franciosi et al., 2021) as well as investigating the role of maintenance for sustainable manufacturing (Franciosi et al., 2018). Our study further contributes to filling the research gap by providing a case study of where and how companies incorporate sustainability into their core AMS activities.

2 Methodology

The paper uses a case study approach focusing on the two Slovenian manufacturing companies (Table 2). Therefore, a case study approach was used in this paper to gain insights into the phenomenon under study (Yin, 2009). The main reason for using a qualitative approach is that sustainability in relation to asset management is a relatively new field of study and a comprehensive theory for it is still lacking. The selection of the appropriate organization was based primarily on what could be learned in relation to the purpose of the study. The main criteria considered in the selection were:

1. asset intensive industry;
2. a size between 50 and 499 employees.

Table 2: Case study demographic information

	COMPANY A	COMPANY B
Industry type	Manufacturing/Services	Manufacturing
Size	250 - 499 employees	50 - 99 employees

The data collection methods included a questionnaire prepared in advance to help respondents to assess the integration of sustainable aspects into asset management activities. Questions were developed based on the previous literature on asset management and sustainability (Crespo Márquez et al., 2020; GFMAM, 2014; Maletič et al., 2018, 2022; Maletič, Maletič, et al., 2020; Ratnayake, 2013). The final results take into account all available data and may differ from the self-assessment reported in the questionnaire. For confidentiality reasons, no number is given. For the purposes of the study, a 5-point scale is used, where ✓ means very weak and ✓✓✓✓✓ means very strong. The assessment does not reflect the maturity of the asset management system. It represents an assessment of the integration of certain sustainability aspects into asset management, regardless of the fact that companies may or may not have an AMS formally meeting ISO 550001 requirements.

3 Case studies analysis and findings

Both companies studied are aware of sustainable principles. Although neither company has established a formal ISO 55001 AMS, asset management activities are part of organizational processes. Thus, there was no formal integration of asset management into existing processes, nor do the companies have all the necessary documented information as required by ISO 55001 (e.g., strategic asset management plan, asset management policy, etc.). However, the purpose of this analysis was not to review the current maturity of asset management or the AMS, but to assess the degree to which sustainability issues have been incorporated into their informal asset management practices. Both companies have implemented several management systems, including a quality management system in accordance with the requirements of ISO 9001 and an environmental management system in accordance with the requirements of ISO 14001. It is evident from the publicly available documents that both companies promote quality and safety as well as environmental aspects. In this regard, Company B specifically emphasizes in its environmental policy that it considers itself to be an environmentally friendly company by protecting the natural environment, introducing environmentally friendly

technologies, ensuring the rational use of energy, continuously improving, etc. Company A strongly advocates sustainability as an important direction. The focus on employee and customer satisfaction is evident in both Company A and B. For example, the company A regularly measures employee satisfaction. It is evident that there was a slight increase in the last year measured. Other aspects of sustainability, such as sustainability goals, are evident from the companies' environmental policies or annual reports. The following table (Table 3) summarizes the key findings on where companies are making the greatest efforts or have or have opportunities for improvement in terms of sustainability in relation to asset management.

Table 3: Summarize of key findings

Asset management core elements	Measurement scale: level of inclusion of sustainability into asset management ✓very weak ✓✓✓✓✓very strong	
	COMPANY A	**COMPANY B**
Strategy and planning		
We consider the principles of sustainable development when planning the objectives of the asset management.	✓✓	✓✓
We identify key segments of sustainable development within the asset management strategy.	✓✓	✓✓
We use demand analysis to determine market absorptive capacity for environmentally friendly products and services and analyse future needs.	✓✓✓	✓✓✓
We promote the compatibility of environmental requirements, the needs of the economy and the needs of society in asset management policy.	✓✓	✓✓
In strategic planning, we coordinate the scope of activities, maintenance and improvements in line with cost analysis and sustainable development considerations.	✓✓✓	✓✓✓
Asset management decision-making		

We integrate sustainable development principles into the investment planning decision-making process.	✓✓	✓✓
We consider the quality requirements of stakeholders in the operational decision-making process.	✓✓✓	✓✓✓✓
The economic, social and environmental impacts are considered throughout the life cycle of physical assets.	✓✓	✓✓✓
The provision of the necessary resources is carried out rationally.	✓✓✓	✓✓✓
We take into account all functions of the company, energy consumption and optimal utilisation in the management and planning of production shutdowns in order to avoid production losses.	✓✓✓	✓✓✓✓
Life cycle delivery		
Disposal of physical assets is in accordance with environmental impact analysis and regulatory requirements, and waste and radiation are controlled.	✓✓✓	✓✓✓
In case of accidents, we increase the safety of employees through a systematic response.	✓✓✓✓	✓✓✓✓
We reduce production costs, increase efficiency and ensure greater prevention through sustainable maintenance and the use of more modern technologies.	✓✓✓	✓✓✓
We strive for more rational operation or use of alternative sources of energy and materials.	✓✓✓	✓✓✓
In planning and procurement, we identify the characteristics of physical assets that meet economic, social and environmental considerations.	✓✓✓	✓✓✓
Asset information		
The information systems strategy aims to deploy green information	✓✓	✓✓

technologies with better energy efficiency, lower carbon footprint and reduced environmental impact.		
The information system supports more efficient and quality information within the AMS.	✓✓✓	✓✓✓
Information standards define the necessary availability, scope, and quality of data to support the organisation's operations and decision making.	✓✓✓	✓✓✓
The use of green IT technologies is encouraged.	✓✓✓	✓✓✓
The information systems strategy supports the organisation's sustainability goals.	✓✓✓	✓✓✓
Organisation and people		
Supply chains ensure greater integration into the local environment.	✓✓✓✓	✓✓✓✓
Top management supports continuous training and motivation of the workforce.	✓✓✓	✓✓✓✓
We promote ethical and moral values in building an organisational culture.	✓✓✓✓	✓✓✓✓
We ensure equal treatment, opportunities for promotion and critical thinking within the organisation.	✓✓✓✓	✓✓✓✓
Top management promotes collaboration, motivation for change and environmental awareness/integration of sustainable development principles.	✓✓✓	✓✓✓✓
Risk & Review		
When addressing risk, we consider economic, social and environmental criteria.	✓✓✓	✓✓✓
We measure the sustainability performance.	✓✓	✓✓✓

Sustainable risk management aligns profit goals with a company's environmental policies.	✓✓	✓✓✓
Environmental responsibility is included in risk management process.	✓✓✓	✓✓✓
The processes within the AMS strive for a long-term orientation and take into account the interconnectedness of the economic, social and environmental aspects of the company.	✓✓	✓✓✓

Understanding the organizational context in relation to asset management, setting up the appropriate asset management policy, objectives and strategy is vital for efficient and effective AMS. Optimizing costs, risks and performance may lead to improved sustainability performance as evident in the literature (Maletič et al., 2018). Inclusion of sustainability aspects and principles in activities that help build the asset management system are needed in order to improve organization's sustainability. Since both companies have several management systems in place, they are expected that they would be aware of the importance determining external and internal issues, organizational context by understanding stakeholders needs and expectations, setting up the appropriate planning process, strategy etc. The organisation must be aware of all the factors that can influence it, whether external factors such as suppliers, authorities, and customers, or internal factors such as beliefs, values, employees, and others. Accordingly, the analysis of the organizational context is an important input for the analysis of sustainability performance (Nunhes et al., 2021). It is evident that Companies A and B are aware of this, and making efforts on this filed. However, inclusion is rather weak to moderate. Stronger impact of sustainability is present in activities such as reduction of costs, improving production efficiency through more sustainable maintenance etc. Results of both companies are comparable, especially as regards the organizational context. Another important element to consider while striving to achieve sustainability is risk management. Risk analysis related to management systems contributes to the sustainability of the organization by covering the identification, analysis and mitigation of economic, environmental and social risks (Nunhes et al., 2021). Risk management is also a very important element of AMS. Company B performed slightly better in this area. Though, risk management should also be considered an important factor in the transition to sustainability. Inefficient risk management could have a negative impact

on all three dimensions of the Triple Bottom Line (TBL). Further, asset management policy is influenced by various factors (strategic, technical/technological, economic, organizational, regulatory/legal, security, markets, competition, etc.). Therefore, the asset management decision process should consider the relevant factors to balance risks, performance, costs and benefits (Komljenovic et al., 2019). Decision-making can also help organizations in their transition towards better inclusion of the sustainability into their business. Again, Company B performed better in this area. However, both companies have the opportunities to further improve decision-making process from an economic, environmental and social point of view.

In order to achieve the desired level of sustainability, one should measure the outcome. Company A is slightly weaker in this area, similarly as regards the top management support. Although on the other hand companies are building culture to promote ethical and moral values, environmental awareness etc.

Effective asset management requires asset information, including the performance of individual assets and the effectiveness of the overall AMS. The ISO 55001 contains specific requirements for the collection, management, and storage of asset-related information. Design and implementation of information systems that contribute to sustainable business processes in essential support in the journey towards sustainability. Company A and B performed similarly in moderate manner.

4 Conclusion

The objective of this paper is to contribute with an evaluation of the extent to which sustainability is integrated into asset management practices. The case studies of two companies have shown that sustainability aspects are incorporated into all key elements of asset management practice, namely strategy and planning, asset management decision making, life cycle delivery, asset information, organisation and people, and risk & review. However, greater integration of sustainability into asset management is needed in the strategic aspects of asset management. Companies should therefore place more emphasis on sustainability when developing asset management policy and strategy and setting up the objectives. In addition, companies should be more committed to sustainability as part of the decision-making process in order to successfully integrate it into asset management. Risk management is another area to focus on, as well as activities related to asset

information and measurement of results. Our results show that the stronger integration of sustainability into asset management is in the activities related to the group organization and people. One of the companies has the opportunity to improve top management engagement and further promote sustainability issues within the company.

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