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BARRIERS AND ENABLERS TO CIRCULAR ECONOMY ADOPTION IN FACILITIES MANAGEMENT PRACTICE

NORAMIRAH NABILAH SULAIMAN[a], FITRIYAH RAZALI[a,b,c*], RAJA NURUL SAKINAH RAJA SYAMSUDDIN[a], MAT NAIM ABDULLAH MOHD ASMONI[a,c], MAIMUNAH SAPRI[a,c]

[a]Faculty of Built Environment and Surveying, Real Estate Department, Universiti Teknologi Malaysia.

[b]Mass Appraisal, Housing and Planning Research Group, Real Estate Department, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia.

[c]Center for Real Estate Studies, Institute for Smart Infrastructure and Innovative Construction (ISIIC), Universiti Teknologi Malaysia.

ABSTRACT

The world faces environmental and economic problems due to increasing waste production and resource depletion. The implementation of circular economy (CE) practices in facilities management offers a sustainable solution in addressing issues faced by the current linear economy "take-make-dispose" method. This paper explores the barriers and enablers that influence the adoption of CE in facilities management practice guided by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. Despite CE's goal to optimise resource use and minimise waste, the adoption of CE in facilities management daily operations remains limited. This paper highlights several barriers, including limited awareness of CE concepts, technical barriers, inadequate CE infrastructure, lack of financial incentives and government support. Meanwhile, tenant involvement and adoption of smart technologies are the key enablers for successful CE adoption. By examining past literature reviews, this paper aims to promote the transition towards a circular economy in facilities management by addressing these key factors.

Keywords: Circular Economy, Facilities Management, Barriers, Enablers, Sustainability, Built Environment

INTRODUCTION

Resource deficiency has become a worldwide issue due to the practice of the linear consumption model, often described as the "take, make, and dispose" approach. This model has resulted in the increase of waste generation and environmental degradation. The linear economy model, generally described as "take, make, and dispose", has created an issue with environmental aspects such as natural resource depletion, increased carbon emission, increased waste generation and scarcity of landfill area (Sariatli et al., 2017). To address this issue, research by the Ellen MacArthur Foundation and other prominent researchers has introduced the circular economy concept, which aims to generate zero waste and increase the opportunity to preserve the resources.

Nowadays, the circular economy has been practised by many scholars and industrial practitioners (Agyemang et al., 2019). Circular economy is defined as a framework for sustainable uses of resources and production to reduce the amount of waste and keep the life cycle of the product for as long as possible (MacArthur, 2013). Homrich et al. (2018) mentioned that the circular economy approach emphasises the technical cycle of a product to achieve the lifestyle extension of sharing, reuse, recycling, remanufacturing and

refurbishment. The operation of management has to shift to the circular economy to enhance the life cycle, reduce waste and at the same time increase the revenue of the production.

This circular economy (CE) concept is closely related to the United Nations Sustainable Development Goals (SDGs), particularly SDG 12, responsible consumption and production, together with SDG 11, sustainable cities and communities, which relates to the built environment and building management. As CE promotes resource efficiency, waste reduction and preventive maintenance, it is positively linked to a good practice of facilities management (Ness and Xing, 2017). The practice of Facilities Management (FM) has the opportunity to integrate the CE concept into the daily operations to ensure the sustainable practice of the facilities maintenance in the long run. The integration of CE ensures the facilities are designed, maintained and operated in ways that extend the asset lifespan, minimise environmental effect and optimise resource efficiency. The practice of the CE approach in FM not only enhances the sustainability performance of the building but also plays a vital role in advancing the practice of FM towards the global sustainable development goals.

This paper aims to study the barriers and enablers to circular economy adoption in facilities management practice. As buildings account for a significant relationship with human lifestyle, it is important to integrate the sustainability aspect to enhance the operational performance and comfortability of the building users. The facility management industry accounts for a significant amount of energy consumption and waste generation (Dixit et al., 2016). Therefore, FM practitioners should strategically integrate CE into FM practices such as the approach of preventive maintenance, refurbishment, recycling, sustainable procurement and waste management.

LITERATURE REVIEW

Circular Economy Principles

Circular economy (CE) is a system where materials never become waste and nature is regenerated (Morseletto, 2020). In CE, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting (Dumée, 2022). CE tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources (Yang et al., 2023). Referring to the Ellen MacArthur Foundation (EMF), CE principles are “eliminate waste and pollution, circulate products and materials (at their high value) and regenerate nature”.

The first principle of CE is to minimise resource exploitation and maximise waste prevention (Velenturf et al., 2021). Hence, material loops are closed, and resources are diverted from landfills and incineration. The second principle by EMF is to circulate products and materials. Products, components and materials are kept in use at their highest utility and value for as long as possible. Materials are kept in use either as a product or as components or raw materials. This is achieved by circulating products, materials and components in ‘technical’ and ‘biological’ cycles (Jansen et al., 2022). Through CE, waste can be reduced, and the intrinsic value of products and materials is retained (Akcil et al., 2019). Next is regenerating nature. CE builds natural capital rather than degrading it, as there is a shift from extraction to regeneration. Practices like regenerating soils and increasing biodiversity are used, and biological materials are returned to nature (Sher et al., 2024).

However, many practitioners and academics have integrated the R-frameworks into the CE ideas (Nazir et al., 2024). The R frameworks are viewed as the “how-to” of CE and thus become the core principle of it (Kirchherr et al., 2017). A core CE achievement goal within each CE transition is to consume fewer natural resources and lessen waste production (Potting et al., 2017). Therefore, incorporating the R-frameworks into property management is highly appropriate in order to transition towards a more circular system.

Definition of Facilities Management

As defined by the International Organization for Standardisation (ISO) and International Facility Management Association (IFMA), facilities management is an organisation that combines people, place, process and technology within the built environment, particularly in a building. For this paper, it is to enhance the quality of life for individuals and the efficiency of the core business. The combination of work responsibilities improves the operations of any business, fostering a situation where systems merge efficiently. Facility managers ensure that occupants enjoy their best and highest-quality experience by directing the operations that contribute to the success of the built environment (Okoro, 2023).

The definition of facilities management is a process involving a multi-skilled approach that supports the basic operations of businesses by integrating the physical workplace with individuals (Suriyarachchi et al., 2019). This indicates that facilities management functions as a supportive service, fulfilling the requirements of the main operations or core business (demand side), while also including the organisation's noncore business (supply side) (Mawed, 2024). Facilities management must combine expertise in both facility operations and management in order to operate successfully. Effective facilities management enhances workplaces by optimising productive processes, creating value, and minimising expenses (Opoku et al., 2022). The scope, range of services, activities, responsibilities, skills, and knowledge of facility management aim to enhance the integration of current operational factors (Desbalo et al., 2024).

Facilities management is essentially about managing both the physical and non-physical facilities, as well as dealing with unpredictable business needs (Opoku et al., 2022). All professionals involved in management need to meet the business goals. From a technical perspective, facilities management and its responsibilities cover tasks that were initially performed by architects, landscape architects, interior designers, civil engineers, building surveyors, valuers, quantity surveyors, and so on (Lee et al., 2021). Furthermore, the services covered in facilities management include building conservation, renovation, cleaning, security, parking, electricity, telephone, fire systems, air conditioning, elevators and other facilities available in the building (Dasandara et al., 2022; Opoku et al., 2022).

Circular Economy in Facilities Management

Circular economy (CE) in facilities management is focused towards minimising waste and efficient use of resources by making a thorough plan of the use of materials, energy and water consumption in a building (Rahla et al., 2021). Having a clear and structured approach to implementing Circular Economy (CE) principles in Facilities Management (FM) practice can contribute to a more sustainable built environment by reducing waste, improving water and energy efficiency, and promoting adaptable spaces that can be repurposed for multiple uses. (Schroeder et al., 2019). To implement CE into the facilities management, it needs to be built based on the four core elements: people, places, process and technology (Bellini et al., 2025). These interdependent elements will create a good framework for facility managers in contributing towards a more sustainable environment.

People

The foundation of any organisation lies in its 'people' – that includes property owners, tenants, and the community, whose well-being, productivity, and engagement are profoundly influenced by strategies implemented by the facilities management (Arampatzi et al., 2020). A holistic approach to facilities management considers the necessities, safety, and comfort of all individuals, as well as sustainability, to guarantee that the facility promotes enjoyable experiences and facilitates professional advancement (Okoro, 2023). Effective engagement with the community about operations, while integrating a circular approach, is crucial for ensuring seamless operation within the facility (Setyadi et al., 2025). Additionally, it can cultivate a feeling of responsibility among stakeholders and renters. The engagement among people enables facility managers to improve decision-making, resulting in increased tenant satisfaction, cooperation and support among tenants in ensuring a circular economy is being practised by both managers and tenants (Sacranie et al., 2022). Consequently, the people element is crucial for establishing effective sustainable facility operations and an overall positive environment that benefits everyone involved.

Process

Efficient processes and procedures represent the foundation of a building's functionality (Cespedes-Cubides et al., 2022). In facilities management, a successful process may reduce waste, improve operations and ensure appropriate resource allocation (Opoku et al., 2022). Preventive maintenance is fundamental to these processes, which includes frequent inspections, service and repairs of equipment to prevent failures and sudden breakdowns that could result in higher costs (West et al., 2024). Preventive maintenance enables facility managers to detect possible issues, which can contribute to extending the lifespan of assets such as HVAC systems, elevators and electrical infrastructure, ensuring efficient operation and user safety. Efficient operations, especially through preventive maintenance, can save on operating expenses, increase tenant satisfaction and boost overall value and performance of the property (West et al., 2024).

Place

The 'place' element includes the infrastructure and spaces where commercial activity occurs (Qi et al., 2024). A properly managed place not only meets the safety requirements but also enhances functionality, visual appeal, and sustainability (Lisboa et al., 2024). This great impact on visitors' perceptions and brand experience lies in the retail setting, extending beyond the store's location (Lisboa et al., 2024). This involves the layout of the space, the landscape, and also its interior design. Effective facilities management will guarantee that the property will remain appealing to renters and visitors (Sanderson et al., 2020). Furthermore, facilities managers must plan to optimise the space to ensure its adaptability in meeting the current and future demands of tenants in order to maximise the efficiency and possible revenue (Sanderson et al., 2020).

Technology

The concept of 'technology' indicates the use of hardware and software systems used primarily to organise, store, and share information that is necessary for the everyday operations of a facility (Mishra et al., 2022). This includes using technologies to oversee both buildings and facility management of the property. Smart building systems, combined with modern technology such as IoT devices, sensors, and automation, have transformed the management process (Jia et al., 2019). These systems provide real-time control and monitoring that is important for building operations, including HVAC systems, lighting, and security, hence optimising energy consumption and minimising operating expenses (Mishra et al., 2022). Utilising data analytics from the smart systems may promote sustainable goals by reducing the energy consumption (Ponnusamy et al., 2021), while also enabling facilities managers to identify trends and predict the need for maintenance and upgrades to make informed decisions in order to enhance performance and tenant satisfaction (Jia et al., 2019).

Barriers to Circular Economy Adoption in Facilities Management

Circular economy (CE) aims to minimise waste and optimise resource use through the R strategies (i.e., reuse, reduce, and recycle) (Dumée, 2022). Despite its benefits, the implementation of CE is challenging, particularly in the building sector, due to the numerous barriers presented in Table 1. The following discussions explain the barriers and sub-barriers that influence the adoption of CE in facilities management.

Table 1: Barriers in Implementing Circular Economy (Ezeudu et al., 2021; AlJaber et al., 2023)

Barriers	Sub-barriers
Awareness barriers	• Limited knowledge of CE • Lack of CE vision • Lack of case studies • Lack of adequate information in building design
Technical barriers	• Building complexity • Materials quality • Lack of CE standardisation
Implementation barriers	• Lack of storage facilities • Inadequate CE infrastructure to support CE management
Support/promotion barriers	• Lack of incentives • Lack of government support

The first barrier is the *awareness barrier,* which plays a critical role in transitioning towards CE practices in facilities management. The most common sub-barriers under awareness are the limited knowledge of CE, followed by the absence of a clear strategic vision and case studies related to CE and the lack of data about the building (Kozminska et al., 2019; Morseletto, 2020). Without strong understanding and awareness of the benefits of CE implementation, stakeholders are less likely to support CE strategies.

Technical barriers hinder the effectiveness of CE implementation due to the complexity of building structures, which hardens the implementation of CE practices where it is appropriate. Inconsistent quality of the building materials and lack of standardised design for reuse hinder the opportunity of material recovery (Rahla et al., 2021). By addressing these technical issues, it can strengthen the transition towards CE practices for facilities management.

Implementation barriers refer to the obstacles that could arise while implementing CE principles and practices within the sector. These can encompass factors like the lack of storage facilities and inadequate CE infrastructure. Lack of storage facilities contributes to the difficulty for facility managers to manage, reuse and repurpose the materials efficiently (Rakhshan et al., 2020). The existing building is normally designed without circularity in mind, which further limits the opportunities of CE in the facilities management sector.

Support/promotion barriers within the facilities management sector mainly focus on the absence or insufficient support from various stakeholders. It arises from the lack of incentive and insufficient involvement from the government regarding CE practices. CE may be viewed as cost-intensive rather than value-adding without a clear target on the circular approaches (AlJaber et al., 2023). Therefore, it will reduce the willingness of businesses to adopt CE practice into their business. Without government support, clear regulatory frameworks and policy, it will create uncertainty among businesses and investors to implement CE (Kazancoglu et al., 2021). Hence, support from the government also plays an important part in transitioning to the sustainable operational practice.

Enablers to Circular Economy Adoption in Facilities Management

The successful adoption of circular economy (CE) practices in facilities management is influenced by several enabling conditions that support and strengthen sustainable operational approaches. Table 2 shows the list of enablers to CE adoption, followed by discussions for each of the enablers.

Table 2: Enablers in Implementing Circular Economy (Chen et al., 2021; AlJaber et al., 2023)

Enablers
• Stakeholders' collaboration and engagement in CE practices within the building • Financial incentives • Use of smart technologies for efficient consumption monitoring • Awareness campaign

From the literature review, four key enablers that have been identified are stakeholders' collaboration and engagement, financial incentives, smart technologies and awareness campaigns. Each of these enablers plays a different but equally important role in overcoming operational and systemic challenges in CE implementation.

The first enabler in implementing CE in facilities management is through the *collaboration and engagement from the stakeholders*, including building owners, service contractors, tenants and regulatory bodies (AlJaber et al., 2025). This approach ensures shared responsibility among stakeholders in implementing CE practices aimed at optimising the use of resources and minimising waste (Mishra et al., 2021). Through the stakeholders' collaboration and active engagement, they can share knowledge regarding CE and make CE practices part of daily operational practice rather than one-time initiatives.

Next are *financial incentives, which play* a vital role in ensuring both management and buildings' occupants participate in practising the CE approach. Financial incentives can be beneficial, and that includes reduced fees in the collection of recycled materials, rebates, and reductions in tax that improve cost savings and resource-use efficiency (Enriquez et al., 2020). Practicing CE may involve some investment during the initial stage, but with the provided incentives that act as a catalyst, it can help to encourage and motivate organisations to transition towards CE, which can be beneficial in both monetary terms and improving sustainability (De Mattos et al., 2018).

The *use of smart technologies* can accelerate the implementation of CE practices into facilities management, as it can promote environmental responsibility by transforming waste into new and valuable products (Fatimah et al., 2020). Facility managers need to keep track of the advancement of the technology as it provides and tracks real-time data on the water and energy consumption, enabling facility managers to identify the issues and wastage (Ahmed et al., 2017). As a result, smart technologies play an important part in adopting CE into their daily operations, which include mitigating wastage issues and ensuring reused materials meet quality standards and are suitable for their intended purpose (AlJaber et al., 2023).

Finally, *the awareness campaign* is also one of the enablers in promoting CE adoption in facilities management to motivate the stakeholders to adopt circular practices. CE practices involve human participation, such as sorting out waste that can be recycled and reporting maintenance issues, which is why awareness campaigns are vital in ensuring a higher success rate in implementing CE practices (Almulhim et al., 2021). Increased awareness is a crucial aspect, as both occupants and facility managers need to recognise. This is because the daily actions and operational decisions of facility managers should significantly contribute to a more sustainable lifestyle.

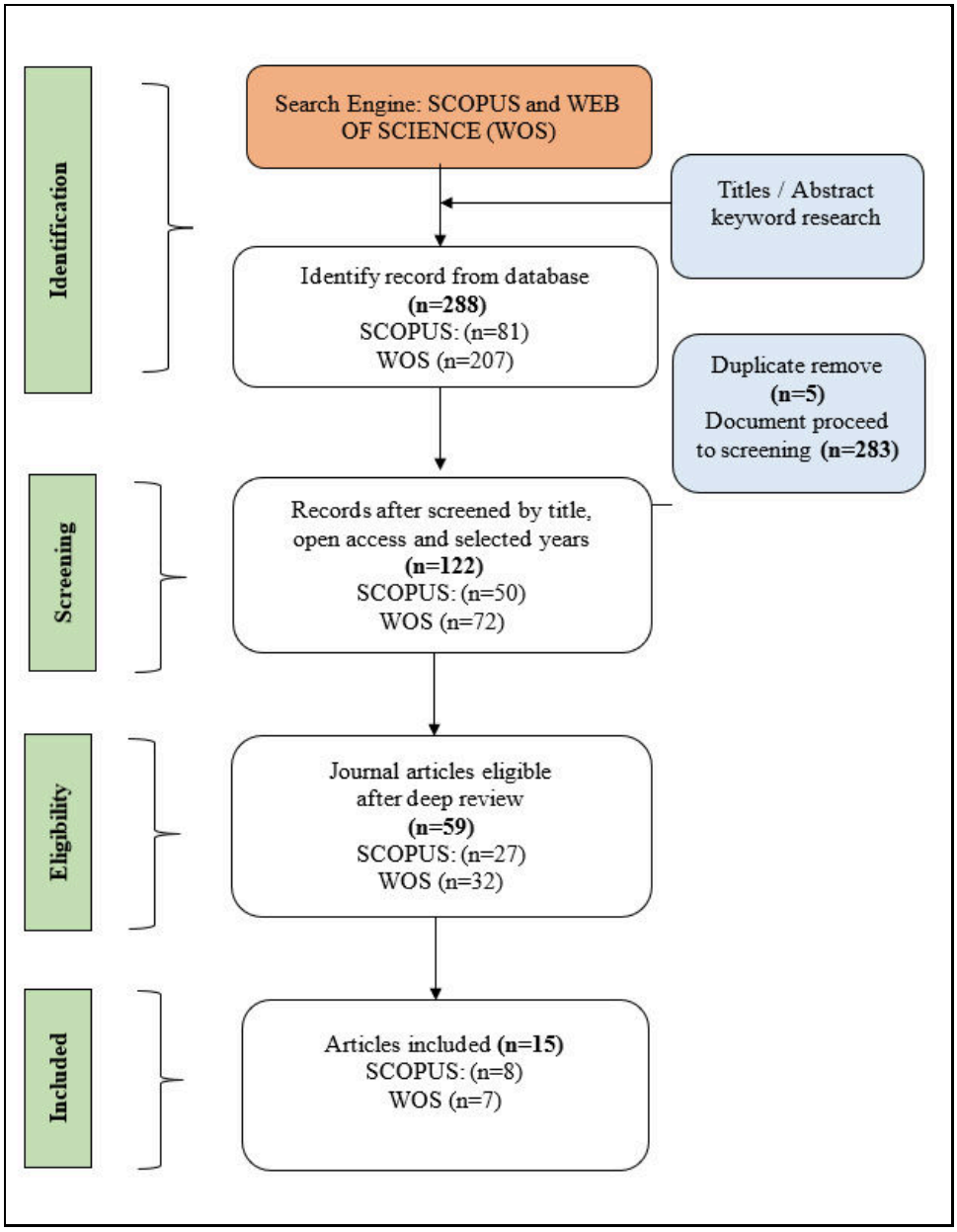
METHODOLOGY

Research Methodology

This study uses a systematic literature review methodology approach, which is suitable for identifying and synthesising existing literature for a specific research subject. This method will help to recognise critical analysis and evaluation of research on the barriers and enablers to circular economy adoption in facilities management practices. This method is led by a determined search strategy with clearly stated objectives of the study.

Throughout this study the paper followed the step-by-step methodology outlined by the protocol of Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) checklist. The protocol guided each stage of the process, including database searching, screening, eligibility assessment, and inclusion of studies relevant to circular economy practices in facilities management. Figure 1 illustrates the entire procedure to guide the present systematic literature review.

Figure 1: PRISMA Literature Review Flow Diagram (Source: Author's own work, 2025)

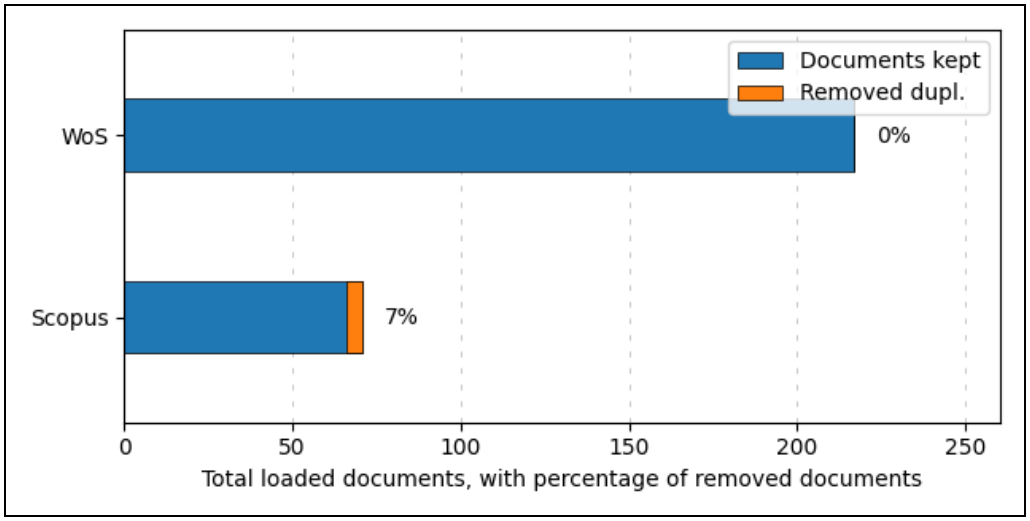


Data Collection

The methodology section outlines are broken down into PRISMA's key steps as stated in Figure 1. First, it explains the data sources and search strategy, identifying SCOPUS and Web of Science (WOS) as the databases for retrieving relevant articles. The inclusion of a robust search strategy, with keywords such as 'circular economy', 'facility management', 'built environment', 'barriers', 'enablers*', and 'enabling*' to ensure a comprehensive search. Criteria for article selection, including language (English) and publication type, which is article journal, and accessibility are also filtered.

Furthermore, the screening phase follows, where the duplicates will be removed by using Scientopy. Review studies are evaluated for its relevance based on their titles and abstracts. This research only applied to studies published within the last 10 years, starting from 2015 to 2025. This is to ensure its relevance for selected literature. Stricter eligibility criteria are applied in this step, and the final list of studies is generated by filtering those most suited to the study. The inclusion and exclusion criteria are defined by using the Boolean operators to combine the refined search terms to reduce or expand search results with the purpose of collecting the literature.

Figure 2: Total loaded documents, with percentage of removed documents (Source: Author's own work, 2025)



Additionally, Boolean operators were used to narrow down the search results and guarantee that the papers chosen closely matched the goals of the study (Lau & Goh, 2006). Boolean operators create more intricate search queries by combining keywords. By combining keywords with operators like "AND," "OR," and "NOT," the search method was optimised to keep the research that satisfied the inclusion requirements while eliminating irrelevant ones. Unless there are overlaps in CE principles, this step should concentrate on research that is directly related to CE practices in property management while omitting associated industries like building, which will be filtered and rejected if not needed.

Table 3: The Boolean Query in Scopus and WOS Databases (Source: Author's own work, 2025)

Database	Boolean Query	Total Number of Publications for Search within Title-Abs-Key
SCOPUS	TITLE-ABS-KEY (((facility management AND circular economy AND barriers OR enablers* OR enabling AND (LIMIT TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ENVI")) AND (LIMIT-TO (LANGUAGE , "English"))) AND PUBYEAR > 2015 AND PUBYEAR < 2025	81
WOS	TITLE-ABS-KEY (((facility management AND circular economy AND barriers OR enablers* OR enabling AND (LIMIT TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ENVI")) AND (LIMIT-TO (LANGUAGE , "English"))) AND PUBYEAR > 2015 AND PUBYEAR < 2025	207
Total		288

In conclusion, the selection phase entails a careful evaluation of the entire texts of the included studies to ascertain their eligibility, quality, and relevance in relation to the study's objectives. For data extraction and synthesis, studies that satisfy all inclusion requirements and are of adequate quality are chosen. A final list of significant, pertinent research for the systematic review or meta-analysis is produced by this methodical approach, which also helps to guarantee transparency and repeatability. The number of articles that were found, screened, and included in the final synthesis must be displayed using a PRISMA flow diagram. Key themes and conclusions from the analysed research are further examined in this section, including CE integration for ESG performance and differences in real estate practices, particularly with regard to property management.

FINDINGS AND DISCUSSIONS

The current state of Circular Economy (CE) adoption in facilities management, a systematic literature review was conducted using the PRISMA approach. The selected articles cover a range of geographical contexts, building typologies, and research methods, offering a broad view of how CE principles are interpreted and implemented across the built environment. The studies examine key themes such as stakeholder collaboration, digitalisation, material reuse, policy support, awareness levels, and organisational readiness. The table below summarises the purpose, key findings, summary insights, and research gaps identified in each study. This overview provides a foundation for analysing how CE can be effectively integrated within facilities management practices and highlights where further research is required to address existing barriers and strengthen enablers.

Table 4: List of articles included in PRISMA finding (Authors, 2025)

No	Citation	Years	Database	Country	Purpose of Study	Key Finding	Summary Finding	Research Gap
1	Toward a systematic integration of digital technologies in facility management organizations and services (Vigren et al., 2025)	2025	WOS	Sweden	This article focuses on the complex relationship between digital technologies (DTs) and Facility Management (FM), aiming to develop frameworks to systematically integrate DTs into FM organizations and services.	Digital technologies have many positive effects in FM, such as improving efficiency, sustainability, and reducing labor shortages. However, there are still major challenges, including poor data integration, lack of standardization, limited digital skills, and organizational resistance.	It is found that digitalization offers strong potential for value creation in FM, its implementation remains fragmented due to technical, cultural, and managerial barriers. To move forward, the industry needs clearer frameworks, shared standards, and better alignment between technology design and FM needs.	Limited explore on how different systems integrate, how return on investment (ROI) is assessed, and how cultural and organizational factors influence digital adoption.
2	Enabling circular economy in facility management through digital twins: a case study	2025	SCOPUS	Norway	Circular economy (CE) principles can enhance the sustainability and	The study found that project participants had **different understandings of circular economy**	The main finding shows that there is a **lack of holistic and lifecycle integration** of CE in facility management.	There is **limited research** on how to **apply circular economy**

	from Norway (Bellini et al., 2025)				regenerative potential of built environments through facility management (FM). This study aims to explore how FM can support the implementation of CE during the use phase of a building, with a focus on applying digital twin technologies.	**(CE)** depending on their roles. Project owners focused on **material reuse** and **tenant engagement**, while architects emphasized **building adaptability** and **resource efficiency**. CE strategies were mostly seen as part of the **project phase**, not the **use phase**.	While the idea of circularity is understood, it is not fully applied during the building's use phase.	**principles during the use phase** of buildings, especially through facility management
3	Towards Zero-Waste Cities: An Integrated and Circular Approach to Sustainable Solid Waste Management (Makan et al., 2025)	2025	SCOPUS	-	The purpose of this study is to develop an integrated waste management system based on circular economy and zero-waste principles.	The key findings highlight that connecting different waste facilities increases efficiency, promotes resource recovery, and reduces environmental impact. The system can also be adapted to different cities and supports sustainable development. However, successful implementation requires strong policies, public support, and good	The study found that an integrated waste management system combining sorting, composting, energy recovery, and inert waste processing can improve recycling, reduce landfill use, and support circular economy goals. It also shows potential to lower pollution, generate renewable energy, and create new economic opportunities through recovered materials.	The research is mainly conceptual and lacks real-world data or pilot testing. Further studies are needed to assess its actual performance, costs, and public acceptance focus in adoption of CE approach facility management

						coordination among stakeholders.		
4	Circular Economy in the Building Sector: Investigating Awareness, Attitudes, Barriers, and Enablers through a Case Study in Saudi Arabia (Aljaber et., al 2024)	2024	WOS	Saudi Arabia	This study explores the current levels of awareness, perception, and implementation of CE principles among local building sector stakeholders and assesses the potential for CE expansion in the region.	The study found that **most building stakeholders in Saudi Arabia (about 70%) are not aware of Circular Economy (CE) principles**, and only a small number (19%) have applied CE in their projects. However, there is a **positive attitude** toward future adoption, as 85% of participants believe CE should be implemented in upcoming projects.	The main **barriers** include a **lack of certification and standards for reused materials**, **limited markets for recycled products**, **negative perceptions**, **supply chain fragmentation**, and **high upfront costs**. The main **enablers** identified are **more recycling and storage facilities**, **the use of BIM**, **technological innovation**, **CE-supportive policies**, and **clear standards and certifications**.	The research highlights a gap in **how FM knowledge is transferred and applied** during the early stages of building projects. There is limited research on creating a **standardized framework** that connects FM teams with designers and constructors to ensure smooth handover and long-term sustainability.
5	Enablers and Barriers to Implementation of Circular Economy Practices in the Built Environment: An Exploratory Study (Izquierdo et al., 2024)	2024	SCOPUS	US	The purpose of this study is to identify the most common circular economy (CE) practices used in the built environment sector and to explore the factors that	The research showed that **project success factors, contractual requirements, and preconstruction planning** are strong enablers of CE adoption. Meanwhile, **design limitations, project constraints, and lack of**	The study found that construction firms still rely on a linear take–make–use–dispose model, causing environmental harm and resource depletion. It identified twelve circular economy (CE) practices from literature and, through interviews	The study is limited to a small regional sample and qualitative interviews, so the findings may not represent all construction contexts. There is also a need

					enable or hinder their implementation in construction projects	**stakeholder experience** act as major barriers. Among all CE practices, **selective demolition, material selection, design for prefabrication, use of waste materials, and design for adaptability** have the highest potential for current implementation.	with industry professionals in the Pacific Northwest, found seven main enablers and barriers that influence CE adoption in the built environment sector.	for **quantitative validation** of the identified enablers and barriers, and for further research on **how policy, technology, and stakeholder collaboration** can support broader CE adoption across different regions and project types.
6	Examine the impact of green methods and technologies on the environmental sustainability of supportive education buildings, perspectives of circular economy and net-zero carbon operation (Moghayedi et sl., 2024)	2024	WOS	South Africa	This study investigates the barriers and drivers of using green methods and technologies (GMTs) in supportive educational buildings (SEBs) in South Africa, and assesses them impact on the circular economy (CE) in achieving net-zero carbon goals.	The **key finding** shows that using GMTs such as smart meters, solar panels, rainwater harvesting, and energy-efficient systems helped reduce water and electricity use, lower carbon emissions, and improve students' well-being.	The **main finding** is that GMTs supported the university's move toward a circular economy (CE) and net-zero goals by improving facility management efficiency and encouraging sustainability awareness among students and staff. However, challenges like high costs, limited budgets, heritage building restrictions, and lack of collaboration between departments slowed	Lack of research on how GMTs can be applied in different types of facilities, especially older or heritage buildings, and how facility managers can balance cost, policy, and community engagement to achieve long-term sustainability and CE goals.

							down full implementation.	
7	Barriers and Enablers to the Adoption of Circular Economy Concept in the Building Sector: A Systematic Literature Review (Aljaber et., al 2023)	2023	SCOPUS	UK	This paper using PRISMA approach, focusing on the barriers and enablers influencing the adoption of the CE concept in the building sector	The review shows that applying the Circular Economy (CE) in construction and facility management still faces many problems. Most people in the industry have low awareness and limited knowledge about CE. There are also technical issues such as complex building designs, poor material reuse, and lack of proper tools or systems. High costs and weak government or policy support, make the situation harder. Overall, the industry is still not fully ready to adopt CE practices.	The main findings show that technical barriers are the biggest challenge, followed by financial, awareness, and policy issues. The construction and facility management sectors still rely on traditional methods and are slow to change. However, with more training, better policies, and government incentives, CE adoption can improve. Digital tools like BIM and material tracking can also help facility managers manage reuse and recycling more effectively.	Limited research that clearly identifies and compares the specific barriers and enablers to Circular Economy (CE) adoption in the building sector focus on facility management
8	Circularity in Facility Management: Conceptualisation and Potential Areas for Circularity-Oriented Actions (Baniya et al., 2023)	2023	WOS	Australia	This paper uses a literature review and qualitative content analysis to identify three main areas—**procurement**, **building use**, and **end-of-life**—along with their	The **key finding** shows that even small changes in core facility activities, such as how products are purchased, how maintenance and refurbishment are done, and how assets are managed at the	The main finding is that facility management, if guided by circular thinking across its people, process, technology, and place dimensions, can **transform building operations into more circular and**	Although the study explores how circular economy (CE) can be applied in facility services, the concept is still mostly theoretical and

					related circular actions in facility service delivery.	end of their life, can help promote **circular economy practices**.	**sustainable systems**. However, the concept of circularity in facility services is still **not widely applied or well understood**, showing room for further development.	not yet tested in real facility management practice
9	Systems Thinking and Solid Waste Management in Puerto Rico: Feedback Loops over Time (Brinton et al., 2023)	2023	WOS	US	This research focuses on a case study using a historical lens to explore the policies and stakeholder dynamics that shape a system's behavior, where the behavior is in reference to the flows of discarded materials either entering the circular economy or the island's waste disposal facilities.	The **key findings** show that digital technologies have many positive effects in FM, such as improving efficiency, sustainability, and reducing labor shortages. However, there are still major challenges, including poor data integration, lack of standardization, limited digital skills, and organizational resistance. The study also found that human-centered approaches, better change management, and collaboration across stakeholders can support successful digital adoption.	The **main finding** is that while digitalization offers strong potential for value creation in FM, its implementation remains fragmented due to technical, cultural, and managerial barriers. To move forward, the industry needs clearer frameworks, shared standards, and better alignment between technology design and FM needs.	The **research gap** lies in the lack of practical, data-based research on how circular economy policies can be successfully applied in island or similar developing contexts. Future studies should test how stakeholder collaboration, financial incentives, and enforcement strategies can create lasting positive ("virtuous") feedback loops in real waste management systems.

10	Towards Circular Social Housing: An Exploration of Practices, Barriers, and Enablers (Çetin, S., et al., 2021)	2021	WOS	Netherlands	This research focuses on Dutch SHOs and uses the Delphi method to examine CE practices in their asset management, as well as the main barriers to and potential enablers of its uptake.	The key finding shows that these organisations are starting to reuse materials and improve sustainability, but their actions are still limited and mostly small-scale.	The main finding is that although there is growing awareness of CE, the adoption in facility management is still slow due to a lack of clear guidelines, knowledge sharing, and collaboration across stakeholders.	The research gap lies in the need for more practical frameworks and examples that show how facility managers can apply CE strategies effectively in building operations and maintenance.
11	Key approaches to construction circularity: a systematic review of the current state and future opportunities (Chen, Q et al., 2021)	2021	SCOPUS	Abu Dhabi	To identify the scope of key approaches to construction circularity to Systematic Literature Review	Five categories resulted from the coding process during the systematic review which is material design, building design, construction and **facility management**, urban sustainability and system precondition	**-Service Life Prediction** – Lack of accurate lifespan data is a barrier **-Digital Platforms (BIM / Blockchain)** – Poor digital integration is a challenge, yet these tools can enable better tracking, communication, and reuse of materials. **-Legal and Contractual Frameworks** – Unclear laws and certification systems make reuse risky, but improved standards and policies	**-Lean construction** and CE are not well linked or explored together. -No clear or accurate **service life prediction models** for building materials. **-Digital tools** like BIM and blockchain are not widely used or tested in practice.

							can support CE adoption. **-Financial and Policy Support** – Limited incentives and funding are barriers; government grants or tax benefits can act as strong enablers. -**Stakeholder Collaboration** – Weak coordination between construction and FM teams hinders circular practices, but stronger partnerships and early FM involvement can make circularity more achievable. **-Awareness and Skills** – Low knowledge of CE principles in FM is a barrier, but training and awareness programs can empower managers to implement CE strategies effectively.	**-Legal and policy support** for using recycled materials is still unclear. -Little research on **financial incentives or funding** for CE adoption. **-Poor collaboration** between construction and FM teams. -Lack of **training and awareness** about CE among facility managers.
12	Enablers and barriers to implementation of circular economy in solid waste valorization: The case of urban markets in Anambra, Southeast Nigeria (Ezeudu et al., 2021)	2021	SCOPUS	Nigeria	The purpose of this study is to **analyse the enablers and barriers** to introducing the **Circular Economy (CE)**	The study found that urban markets in Anambra State already have several positive practices that can support Circular Economy (CE) adoption. These	There is a strong foundation for CE implementation in the markets due to existing informal recycling, institutional structures, and community participation. However,	There is **limited research** on how to integrate informal recycling systems with formal waste management

					in solid waste management practices within **urban markets in Anambra State, Nigeria**. It aims to understand the current situation, identify what supports or hinders CE adoption, and provide recommendations for improving waste management towards circular practices.	include active waste recycling by traders and scavengers, strong waste management policies, organized leadership, and financial systems for waste collection. There is also a high rate of waste collection, and traders show willingness to pay for clean market environments.	poor waste sorting, lack of advanced waste treatment facilities, and weak enforcement of recycling policies remain major barriers that limit full circular waste management.	policies to achieve circular economy goals in developing countries.
13	Smart cities and enabling technologies: Influences on urban Facility Management services (C Talamo et al., 2019)	2019	SCOPUS	Italy	The purpose of this study is to develop a framework that connects **Smart City concepts** with **Urban Facility Management (UFM)** using **Information and Communication Technologies (ICTs)** such as IoT, Big Data, and smart	-Smart Urban Facility Management (UFM) combines **physical and digital infrastructures** to improve how cities manage services. -Smart UFM also supports the **Circular City Model** by helping to reduce waste, maximize resource use, and involve citizens in improving services	-Technology plays a big role in making cities smarter, more sustainable, and more connected. -To achieve true smart and circular cities, urban services need **horizontal integration** — where departments and stakeholders share data and work together in networks rather than alone.	-The research highlights a lack of **interoperability and integration** among different city systems and technologies. -Most existing studies focus on single sectors like mobility or energy, but there is limited research on how to link all

					applications. The study aims to classify and analyze how these technologies can improve UFM services, support sustainability, and contribute to **circular economy practices**	- Using **ICT tools** like IoT, Big Data, and real-time data sharing helps decision-makers understand city behavior, make faster decisions, and improve service quality		systems together under one smart, circular framework
14	Initiatives to integrate operational knowledge in design: a building client perspective (Rasmussen et al., 2019)	2019	WOS	Denmark	This paper aims to focus on deliberate actions by the building client to integrate knowledge of facilities management, in particular building operation, in design and construction of sustainable facilities.	The study found that many initiatives can help improve the **integration of facility management (FM)** knowledge into building projects. In the DTU Campus Service case, the FM team was involved in several initiatives that supported smoother transitions from construction to operation. This involvement helped identify ways to improve building performance, energy use, and maintenance planning. However, the study also found that many of these	The main finding shows that there is a **lack of holistic and lifecycle integration** of CE in facility management. While the idea of circularity is understood, it is not fully applied during the building's use phase. Most circular actions are isolated and not connected to a clear CE strategy. Digital twins have strong potential to make CE more practical in FM, but successful implementation depends more on **organizational commitment and data management** than on technology itself.	Less investigate **how to connect project and use phases**, ensure data sharing between stakeholders, and develop **practical frameworks for circular facility management** using digital tools.

						initiatives are not well coordinated or fully applied across all facility projects.		
15	Operationalizing Industry 4.0: Understanding Barriers of Industry 4.0 and Circular Economy (Halse et al., 2019)	2019	SCOPUS	Norway	This paper addresses how manufacturers perceive Industry 4.0, what motivates their investments in Industry 4.0, and what barriers they see in adapting Industry 4.0 followed by a literature review identifying barriers for adhering to CE in the manufacturing industry sector.	Most companies know about Industry 4.0 but understand it in different ways. The main barriers are high costs, lack of skills, and unsuitable processes or products. For the Circular Economy (CE), the main problems are difficult product disassembly, complex supply chains, poor coordination, low material quality, and high start-up costs.	The study shows that companies are aware of Industry 4.0 and CE but find them hard to apply. Cost and lack of knowledge are the biggest issues. Both concepts depend on digital technology, but most companies still focus only on improving their own operations instead of full digital or circular practices.	There is little research on how Industry 4.0 and Circular Economy can work together in real practice. More studies are needed to create clear steps or models to help companies use digital tools, build skills, and reduce costs for adopting CE and Industry 4.0.

According to the initial study by Vigren et al. (2025), digital technologies may greatly increase facility management's sustainability and efficiency, but organizational opposition, fragmented systems, and a lack of digital skills prevent their widespread implementation. It highlights the necessity of more uniform frameworks and better coordination between the use of technology and facilities management activities. This is related to the adoption of CE since improved resource monitoring and lifecycle management are made possible by efficient digital integration.

The second paper by Bellini et al. (2025) demonstrates that while stakeholders are aware of the CE principles, the practices are mostly implemented during the building's design and construction stage despite the operational stage. Although digital twin technology has been recognized as a potential enabler, the advantages depend on mutual understanding and well-coordinated use. This implies that integrating CE into regular facilities management efforts requires bridging lifecycle stages.

In order to lessen reliance on landfills, Makan et al. (2025) designed a circular waste management system that links the sorting, composting, and recovering processes. It illustrates how important policy support and stakeholder collaboration are to reaching zero-waste objectives. Although encouraging, the approach is still conceptual and requires actual testing in facility settings to confirm that CE adoption is feasible.

Despite favourable opinions toward future adoption on CE practices, a study by Aljaber et al. (2024) revealed that CE awareness is low among Saudi Arabian construction sector players. The report names increased recycling facilities, regulatory assistance, BIM, and technical innovation as important enabler. The results show that infrastructure, regulatory support, and education are critical to improving CE adoption in facilities management.

According to Izquierdo et al. (2024), collaborative planning is a key enabler for the practical CE techniques of selective demolition, prefabrication, and material reuse. Design restrictions and a lack of stakeholder expertise are the barriers in adoption CE into facilities management operations. According to the research, CE in building and facility settings may be supported by increasing technical expertise and organised teamwork.

According to a study by Moghayedi et al. (2024), implementing green technologies such as smart meters and renewable energy systems supports CE by lowering emissions and resource consumption in educational buildings. However, adoption is slowed by high costs and poor institutional coordination. It emphasizes that in order to grow CE-driven FM practices, financial assistance and cooperative planning are essential.

Meanwhile, a review by Aljaber et al. (2023) highlights that poor CE knowledge, financial cost concerns, and technological difficulties prevent CE adoption in the building industry. It implies that government incentives and technology tools may aid in removing these barriers. However, the study suggests that in order to facilitate CE incorporation into facilities management, the regulations must be properly organised and training initiatives are required.

Furthermore Baniya et al.'s conceptual study in the year of 2023 describes CE potential in facilities management coupled with building operations, end-of-life management, and procurement. The study makes the case that, when directed by well-defined frameworks, even minor operational changes can improve circularity. It points out that CE comprehension in FM is still theoretical and has to be shown in the actual world.

The CE comprehension is important as stated by Brinton et al. (2023) through a case study that demonstrates how stakeholder cooperation and policy decisions affect waste system performance over time. The study states that common commitment and human-centred coordination are necessary for effective transformation. The results from the study suggest that long-term collaborative governance, not only technology, is necessary for the long-term adoption of CE in FM.

According to Çetin et al. (2021), although social housing organisations have begun implementing CE principles, their efforts are constrained by the lack of collaboration and information exchange. The report

emphasises the necessity of useful recommendations for scaling CE in facilities management operations. The study conclude that more thorough CE implementation would be supported by stronger institutional structures.

Referring to the study of Chen et al. (2021), inadequate digital integration and ambiguous legislative frameworks continue to be significant obstacles to circularity, while digital platforms, financial incentives, and stakeholder collaboration are important facilitators. Chen et al. (2021) also states that in order to empower facility managers, awareness and training are required, which suggests that for CE to be successful, organisational and technological readiness are both necessary.

Ezeudu et al. (2021) highlights that CE adoption in urban market trash systems is supported by substantial community engagement and informal recycling activities. However, development is hampered by a lack of sophisticated waste processing facilities and uneven enforcement. The results emphasize how crucial it is to combine formal and informal systems in order to improve CE performance.

As per mentioned in the article from Talamo et al. (2019), better urban facility management and circular resource usage are linked to smart city technologies like IoT and big data. The study emphasizes that interdepartmental cooperation and shared data systems are necessary to create a circular city. The study shows that without integrated governance; technology is insufficient on its own.

Facility management involvement during the early stage of building design can enhance long-term sustainability and operating efficiency, according to research by Rasmussen et al. (2019). Such participation, however, frequently lacks organised planning and is inconsistent. The barriers imply that using CE standards throughout a building's lifespan requires lifecycle integration.

Finally, Halse et al. (2019) note that high costs, a lack of experience, and ambiguous processes hinder the adoption of both Industry 4.0 and CE practices in organizations. The findings argues that more detailed implementation roadmaps are needed to support digital and circular transitions. The findings show that capacity building and cost support are essential CE enablers.

CONCLUSION

This study has examined the barriers and enablers of circular economy practices to be adopted in facilities management practice. The study highlights the significant need for a transition from the conventional linear “take–make–dispose” approach to the circular economy concept. The PRISMA literature review reveals the critical aspect of reducing waste, extending asset life cycles, and improving resource efficiency; its implementation in facilities management remains limited. Meanwhile, the key barriers include the low amount of awareness and understanding of CE principles, financial constraints, insufficient policy support and infrastructure, together with low collaboration between stakeholders to implement CE in their practice. These challenges demonstrate that CE adoption is not merely a technical change but a shift that requires the operational, managerial, and organisational realignment. The findings further identified the potential enablers that support the successful integration of CE in facilities management. The enablers include stakeholder collaboration, financial incentives, smart technologies adoption, and ongoing awareness campaigns to encourage behavioural change and operational transformation in FM practices. Overall, this study identified the role of FM practice as the forefront to enhance the sustainability aspect through CE, which at the same time contributes to the global sustainable development goals.

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