

## Transitioning to a state-wide circular economy: Major stakeholder interviews

Oanh Thi-Kieu Ho<sup>\*</sup>, Akvan Gajanayake, Usha Iyer-Raniga

*Integrated Circular Economy, Climate Resilience and Clean Energy Platform (IC3P) School of Property, Construction, and Project Management, RMIT University, Melbourne, Australia*

### ARTICLE INFO

#### Keywords:

Circular economy  
Circular economy awareness  
Circular economy transition  
Stakeholder perspectives  
Driver, challenge, Enabler, Barrier

### ABSTRACT

Circular Economy (CE) has received widespread attention from various stakeholders as a preferred solution in response to global issues of environmental changes and resource scarcity. The Australian state of Victoria is in the process of transitioning to CE. In comparison to other states and countries, the literature and practice related to CE implementation in this state are limited. In this context, the research aims to understand CE development through the investigation of CE awareness, drivers, challenges, enablers, and barriers across stakeholders. Semi-structured interviews with major stakeholders were employed to understand how to optimise a CE transition. The research findings suggest that enhancing CE understanding with a focus on CE systems, principles, and processes is crucial to support a genuine CE transition and reduce misinterpretation of CE in being synonymous with recycling and waste management. The relationship between enablers, challenges, drivers, and barriers contributes to the development of CE strategic plans and roadmaps for a state-wide transition.

### Introduction

The traditional economic model of “take-make-use-dispose” has severe impacts on the environment. This model predominantly focuses on output production with insubstantial consideration for resource use, greenhouse gas emissions, and waste generation resulting in high contamination and pollution to the water, air, and land (Ghosh, 2020; Hussain et al., 2020). The current economic model also poses limitations to resolve issues related to raw material consumption and increased demand from population growth. This traditional model shows risks to various businesses, especially the disruption of material supply and unstable material prices (Gaustad et al., 2018). Notably, the linear model has been shown to be unable to support sustainable development (International Resource Panel et al., 2011; Simonis, 2013).

In contrast to the traditional model, circular economy (CE) presents a promising solution and has received widespread attention in recent years (Ranta et al., 2018). More than a hundred CE definitions and various schools of thought exist for explaining CE in more detail and shaping concepts and principles. CE is a model that aims to extend the life cycle of resources by circulating them at their highest value through the different cycles in supply chains as well as designing out waste (EMF, 2013; Charter, 2018). In the CE model, waste is considered a

resource to be mined to become inputs for other cycles. This model allows businesses to extend their control on products and materials over their life cycles such as maintaining ownership of products by offering products as a service to customers (Bocken et al., 2016). It enables a holistic view of economics that considers varied systems to be implemented in businesses and creates resilience and truly sustainable development in conjunction with nature.

CE has been investigated through a wide range of approaches in previous studies comprising CE definitions (Kirchherr et al., 2017; Alhawari et al., 2021), drivers and barriers (Kirchherr et al., 2018; Masi et al., 2018), business models (Bocken et al., 2016; Centobelli et al., 2020), as well as technological innovation (Ghobakhloo, 2020; Bai et al., 2022). Despite the fact that CE has received attention from scholars and practitioners, a common definition of CE has yet to be universally accepted in academic literature. CE has been interpreted based on different frameworks and models. The most commonly used model in academic literature is the one based on R strategies. R strategies commenced with 3R's of “reduce, reuse and recycle” (Pires and Martinho, 2019) to include the fourth R, “recover” (Murray et al., 2017) and moved to 6R's (redesign, reduce, reuse, remanufacture, recycle, recover) and then to the 10R's (refuse, redesign, reduce, reuse, repair, refurbishment, remanufacture, repurpose, recycle, recover) (Kirchherr et al.,

<sup>\*</sup> Corresponding author at: School of Property, Construction and Project Management, RMIT University, GPO Box 2476, Melbourne, VIC 3001, Australia.  
E-mail address: [olivia.ho@rmit.edu.au](mailto:olivia.ho@rmit.edu.au) (O.T.-K. Ho).

2017; Potting et al., 2017). There has also been a growth in the research focusing on CE and technology innovation such as digital technology Industry Revolution (IR) 4.0 (Khan et al., 2022) and data mining as well as Internet of Things (IoT) (Cavaliere et al., 2021).

Australia has been negatively impacted by the waste crisis due to the ban on waste imports in China since 2018 (Halog and Anieke, 2021; Parliament of Australia, 2020). This ban has placed waste issues and landfills at the forefront in Australia due to the inability to deal with waste in the post-2018 period or pre-2019 period. Plastic waste, for example, is one of three types of recycled materials exported. This has resulted in stockpiling of recyclable waste in Australia as approximately 70% of plastic waste was being exported to China (Parliament of Australia, 2018). One million tons of single use plastic is consumed and only 13% is recovered. In other words, 84% of plastic waste ends in landfills (Department of Agriculture Water and the Environment, 2021). To address this issue, Australia has attempted to transition to CE in the last few years. The focus has been on waste management; in particular household waste collection, kerbside bin collections, plastic recycling, infrastructure projects using recycled materials, and levies on landfill for waste disposal (Halog et al., 2021).

CE transition in Australia is observed to be more fragmented and conservative while other countries in Europe such as the Netherlands and the UK have taken a more systematic approach and gained benefits from this approach (Melles, 2021). This fragmentation can be attributed to the Australian system of government as Australia is a federation of states, and each state sets its own policies.

Victoria is a state of Australia with a geographical area of 227,416 square km and a population of 6.5 million (in 2021) (Department of Environment, Land, Water and Planning, 2019). As in other states in Australia, Victoria has faced the same issues of high amount of waste generation. It is predicted that Victoria will generate 20.8 million tonnes (Mt) of waste annually by 2040, which is a significant increase in waste generation from 15.86 Mt between 2019 and 2020 (Parliament of Victoria, 2022). The ban on waste importation from China has exacerbated waste issues. Victoria has made efforts to transition the whole state to CE since 2018 (DELWP, 2019). The state government released a \$37 million Recycling Industry strategic plan in 2017 and CE is considered an important approach to reduce waste via resource recovery (Premier of Victoria, 2019). The state also introduced a CE strategy; "Recycling Victoria: A new economy, 2020" to fundamentally transform the state's recycling sector, reduce waste and create jobs for Victoria's sustainable future (Victoria State Government, 2020). \$300 million has been invested for this plan to shift Victoria to a CE. The Environment Legislation Amendment (Circular Economy and Other Matters) Bill 2022 was passed in Parliament to support the state's transition to a CE (Victorian Legislation, 2021).

The Victorian Government has developed CE action plans to support legislation with a focus on waste and closing the loop. Victoria aims to move to full CE implementation in the near future with an interim transition plan. For this transition to be effective, CE requires changes in all systems and at all scale levels. However, the research focusing on CE transitions within the Victorian context is still limited. Funded by the State Government, a research project of investigating and mapping the Victorian CE ecosystem was undertaken by the research team that included interviews, questionnaire surveys and focus groups. This paper presents one part of the broader research agenda and presents the interview findings of the research. This paper examines the CE transition in Victoria from various stakeholders at different scale levels of macro, meso, and micro to propose recommendations to enable a full CE transition in Victoria. Three research questions were developed to respond to the aim of this paper:

- 1 What is the understanding of CE amongst major stakeholders within the state of Victoria?
- 2 What are the drivers, challenges, barriers, and enablers of CE transition across different stakeholders' perspectives?

- 3 How can the transition to CE be achieved by gaining a clearer understanding of various CE drivers, challenges, barriers, and enablers and relationships between them?

This paper is organised as follows: Section 2 provides a literature review on CE awareness and CE drivers, challenges, enablers, and barriers. Then, Section 3 explains the research methodology to be designed for this study while Section 4 focuses on research findings and discussion. Finally, Section 5 presents the conclusion highlighting the primary findings and implications of this study as well as directions of future research based on research findings.

## Literature review

This section reviews previous studies to understand circular economy awareness and identify drivers, challenges, enablers, and barriers across various countries from diverse stakeholders in different disciplines. A summary of CE awareness in previous studies is provided in Table 1 and a summary of drivers, challenges, enablers, and barriers is presented in Table 2. This step supported the design of the interview questions as well as question prompts for the examination of CE in the Australian state of Victoria.

The literature review also helped to understand key stakeholders in different countries and enabled the selection of key stakeholders to be interviewed for the Victorian CE transition. Datasets such as Web of Science, Google Scholar and Scopus with key words focusing on 'circular economy awareness', 'circular economy perceptions', 'circular stakeholders' and 'circular economy drivers, challenges, enablers and barriers' and their conjugations were used. From an initial pool of journals and papers, these papers were filtered further to remove the papers that were duplicated, not accessible and did not fall into the category of journal papers or reports and did not clearly highlight CE awareness or identify CE drivers, challenges, enablers and barriers. This research project was conducted from 2021 to 2022. Therefore, the literature review focused on papers published 2010 and 2022 as CE has received great attention from scholars since 2010.

### CE awareness across different countries

Understanding CE plays a crucial role in transitioning towards circularity and developing circular value chains, which can utilise either biological or technical cycles. In the biological cycle, nature is regenerated through the biodegradation of materials while in the technical cycle, materials are designed to last longer in different supply chain cycles (Ellen Macarthur Foundation, 2017). CE is able to stimulate cyclical thinking, aiming to produce zero waste and reduce the pressure on natural materials (Afteni et al., 2021).

Existing studies show that high levels of education can increase CE implementation in practice. CE understanding is varied based on participants' disciplinary background and their focus area (see Table 1). An individual's understanding of CE is also influenced by their interactions with the environment, their role in an organisation or community and demographics (such as age/generation groups and education level). As noted by Masi et al., (2018); Van Langen et al. (2021), the CE transition in an organisation is driven by economic considerations resulting in CE concepts emphasizing on "zero waste economy" (Van Langen et al., 2021) as well as resource utilisation and energy efficiency (Masi et al., 2018). CE is implemented within an organisation rather than across different organisations in a supply chain, where CE practices typically focus on eco-design and environmental management. For manufacturing organisations in the EU, the research by Liakos et al., (2019) highlighted the increase in CE awareness with the result of surveys showing more than 70% of respondents being aware of CE concepts. This study also showed that the level of CE understanding was higher amongst organisational governance than amongst individual employees in this organisation (Liakos et al., 2019).

**Table 1**

Previous studies in peer-reviewed journals focusing on CE awareness/understanding.

Sources	Research aim	Research method	Research Finding
(Van Langen et al., 2021)	To extend the individual knowledge on CE concepts and CE implementation in practice with different R-principles of “reuse, repair, remanufacturing, recycling” and to understand the CE perceptions/awareness of researchers and policy makers.	34 papers reviewed. Surveys with researchers, economists, and administrators in EU and non-EU countries	CE perception: A “Zero waste economy” was perceived as CE amongst administrators with the focus on job creation and economic growth. Differently, environmental benefits from CE implementation were highly stressed out by researchers and economists. CE approach: a holistic top-down approach was mentioned by researchers while a bottom-up approach guided by the civil society was stated by economists and administrators. 70% of CE awareness level was improved. Also, manufacturing organisations significantly focused on environmental impacts rather than resource scarcity and economic benefits.
(Liakos et al., 2019)	To examine awareness levels and CE practices in manufacturing.	Surveys with manufacturing organisations	CE practices associated with resource and energy utilization efficiency were a substantial focus in businesses while investment recovery, green purchasing and customer cooperation were less considered in such businesses.
(Masi et al., 2018)	To examine CE taxonomy that were used in practices.	Surveys with 77 companies.	CE behaviours in the community focused on waste segregation and buying recycled, remanufactured products. Sharing and collaborative economy practices were the considerations from residents’ perspective. There was a positive correlation between CE awareness and educational levels.
(Smol et al., 2018)	To understand awareness and attitude related to CE in Malopolska region.	Surveys and interviews in Malopolska, Poland.	CE behaviours in the community focused on waste segregation and buying recycled, remanufactured products. Sharing and collaborative economy practices were the considerations from residents’ perspective. There was a positive correlation between CE awareness and educational levels.
(Nogueira et al., 2019)	The research aims to develop a framework of systems thinking to get insights the CE transition	Literature review	Eight capitals (natural, financial, manufactured, human, social, cultural, political and digital) support understanding

**Table 1 (continued)**

Sources	Research aim	Research method	Research Finding
			various variables in socio-ecological systems regarding the CE transition.

Source: Authors.

From yet another lens of understanding CE awareness, previous studies highlighted that awareness was varied due to backgrounds and ages of stakeholders. Younger generations claimed to be familiar with CE concepts through their behaviours such as purchasing recycled and preowned items and waste separation (Smol et al., 2018) while elderly people typically resist changes in their purchasing habits. Researchers and economists believed that CE needs to focus on environmental benefits supporting the concept of regeneration whereas administrators emphasised economic growth and job opportunities as being the most important aspects underpinning the concept of CE and its implementation (Van Langen et al., 2021). Interestingly, the research by Van Langen et al. (2021) highlighted a mixed set of holistic top-down and bottom-up approaches for a CE transition. It also noted the leading role of political intervention in this transition.

The literature indicates that CE awareness has been increasing when various aspects associated with the concept of CE were mentioned such as economic growth, zero waste economy, resources utilisation, energy efficiencies, top-down and bottom-up approaches. Although understanding of CE is considered an influential factor for a comprehensive transition to circularity, academic research in understanding CE awareness and its influence in the implementation of CE within the Victorian context remains limited.

#### *Drivers, challenges, enablers and barriers for CE transition*

Drivers, challenges, enablers and barriers of CE transition have gained traction in the literature and these factors have been investigated in a wide range of previous studies (Kirchherr et al., 2018; Van Keulen and Kirchherr, 2021). Table 2 presents these factors in selected articles as a review. These studies underpinned the approach to examining these factors in the Australian state of Victoria.

Previous studies have shown that the two main barriers to CE transition were cultural – “a lack of consumer interest and awareness and a hesitant company culture” and market – “a lack of synergistic governmental interventions” (Kirchherr et al., 2018; Masi et al., 2018) while technology was not considered as a core CE barrier (Kirchherr et al., 2018). Customers were generally hesitant to purchase CE-related sustainable products and packages despite being aware of the concept of CE. There is still a gap between customer awareness and action, which means that their behaviour toward CE implementation needs to be changed (Biekert, 2021). Higher upfront costs/initial costs for CE initiatives was the primary barrier for businesses, especially small and medium enterprises (SMEs) (Guerra and Leite, 2021; Kirchherr et al., 2018) as these enterprises had a tight budget and limited cash-flow to assist their CE transition. Such organisations need to have financial subsidies to demonstrate economic viability when transitioning to circularity.

Research by Sørensen (2018) investigated CE drivers and barriers within three pillars of sustainability: social, economic and environmental. For the social pillar, education was the primary CE driver as it was evident that the higher the educational level, the more R strategies (such as recycling and reuse) were used. In other words, highly educated respondents were able to act upon the higher R-strategies on the circularity scaffold. Behaviour resistance was a main barrier as elderly people were normally resistant to changing their behaviour to use CE products. For the economic pillar, wealth was a CE barrier while “a special income tax regime” was a CE driver. This study also showed that environmental

**Table 2**  
Previous studies focusing CE drivers, challenges, enablers and barriers across different sectors.

Sources	Research method	Drivers, challenges, enablers and barriers	Other Research findings
(Kirchherr et al., 2018)	208 surveys and 47 interviews in the EU	The research indicated two primary themes of CE barriers. The first were cultural barriers, including “a lack of consumer interest and awareness, a hesitant company culture from businesses and policy makers perspectives”. The second were market barriers, especially a lack of synergistic governmental interventions considered as the most important barrier to hinder CE transition.	The research finding showed that technologies were not considered a primary barrier and “limited funding for circular business models” wasn’t ranked amongst CE barriers. A push from the government was much needed for a CE transition. Future research direction was to indicate CE barriers in particular sectors as well as business models by expanding the research sample size.
(Masi et al., 2018)	Surveys with 77 companies	Barriers included “significant upfront investment cost, lack of awareness or sense of urgency to transition to CE”.	CE driver was economic considerations rather than environmental considerations. The deployment of practices wasn’t across the supply chain yet. CE transition happened within organisations.
(Van Keulen and Kirchherr, 2021)	7 months observation to a case study of a coffee value chain	CE barriers were “silo thinking” of industries and standardization of circular design while CE enablers were a common awareness and vision and design of solid business models.	It was needed to identify a strong focal company or focal player with strong mediating and connecting capacity to improve CE implementation success.
(Shi et al., 2008)	AHP models, questionnaire surveys with SMEs in China	Top three barriers include: “lack of economic incentives and policies, lax environment enforcement and high initial capital cost”.	The research recommended governmental policies to change their priorities with a high priority to external policy and financial barriers instead of internal technical and managerial barriers.
(Sørensen, 2018)	Empirical analysis, annual panel data for 19 EU countries.	The research aims to assess factors of society, economics and environment in a CE transition. Regarding social consideration, education is a primary CE driver. Literature demonstrated that “a higher educational level increases the propensity to recycle”. On the other hand, behaviour resistance especially with old people was a main barrier. Regarding economic perspective, income played an important role in a CE transition. The wealth was considered a barrier to a CE based on the theory of consumer choice. “A special income tax regime” was a driver of transitioning to CE. Regarding the environment, CE drivers included environmental awareness and environmental regulation.	The research recommended regulations should be developed from economic and social motivation. The regulations also needed to focus on the ages and education level of customers to create an efficient mechanism to make the change to market behaviour.
(Tan et al., 2022)	Literature review	The research explored that an “intention-action gap” was a primary social-cultural barrier. Another barrier was green premiums that customers need to pay for sustainability alternative.	The research recommended stakeholder alignment as when interest aligns, knowledge and technology could be shared amongst stakeholders to support transition to CE.
(Guerra and Leite, 2021)	Interviews and surveys	Major barriers included “upfront cost, project schedule, lack of awareness and regulations and current business models” while primary enablers were “education and cultural change, data availability, policies and incentives, and voluntary stewardships”.	With the focus on the built environment discipline, the research found out that “open-loop recycling, selective demolition and prefabrication” were popular but “design for disassembly, design in layers, and close-loop recycling” were still less considered in a construction project.

Source: Authors.

awareness was a barrier while environmental regulation was a driver under the environmental pillar for CE transition.

Focusing on a specific sector and business, previous studies have highlighted drivers and barriers for a CE transition in a particular context such as the coffee industry (Van Keulen and Kirchherr, 2021), construction sector (Guerra and Leite, 2021) and SMEs in China (Shi et al., 2008). The research by Van Keulen and Kirchherr (2021) underlined silo thinking and standardisation of circular design were major barriers for the coffee industry while the enablers were the existence of a common CE awareness/vision and the presence of solid business models. It was identified that the start-ups needed to have some knowledge of CE implementation to commence their initiatives and a focal company or player in this industry was suggested for mediating and then increasing the uptake of CE initiative implementation in SMEs.

Aligned with previous studies, silo thinking is also a barrier in the construction industry causing the gap between CE theories and practices (Guerra and Leite, 2021). The study highlighted “higher upfront costs and, lack of awareness and circular business models” were the main CE barriers while “education and culture change, data availability, policies and incentives, voluntary stewardships” enabled a CE transition in this industry. For SMEs in China, Shi et al., (2008)’s research indicated three main barriers; being high initial costs, lack of economic incentives and associated policies and lax environmental enforcement. This study recommended the higher priorities of CE implementation should be considered in government policies to reduce these barriers.

Previous studies have indicated barriers and enablers for CE

transition but there is still a lack of research focusing on a relationship of these factors to enable a CE transition. As Victoria transitions to a CE, it is crucial to identify barriers, drivers, challenges and enablers from the perspective of major stakeholders and practitioners within the region. These factors can be used to develop more targeted strategies and policies. This study addresses this gap in knowledge, particularly from a Victorian context.

## Research method

The research employed semi-structured interviews as the research instrument to understand CE awareness/perceptions and CE enablers, barriers, challenges and drivers for a CE transition across major stakeholders. The interview questions were designed as open-ended exploratory questions. The questions were developed to elicit information on CE understanding within the organisations, drivers and challenges faced to transition to CE, enablers, and barriers. The structure of interview questions and related prompts were designed based on the literature review, as this background provided a foundational understanding of current CE understanding and the factors of drivers, challenges, enablers and barriers seen in other regions (Fig. 1). The interview questions are provided in Appendix.

Interviews were conducted to elicit insights into these factors where interview participants indicated drivers, challenges, enablers and barriers. The importance of these factors was based on the frequency mentioned in the interviews, which were analysed using thematic

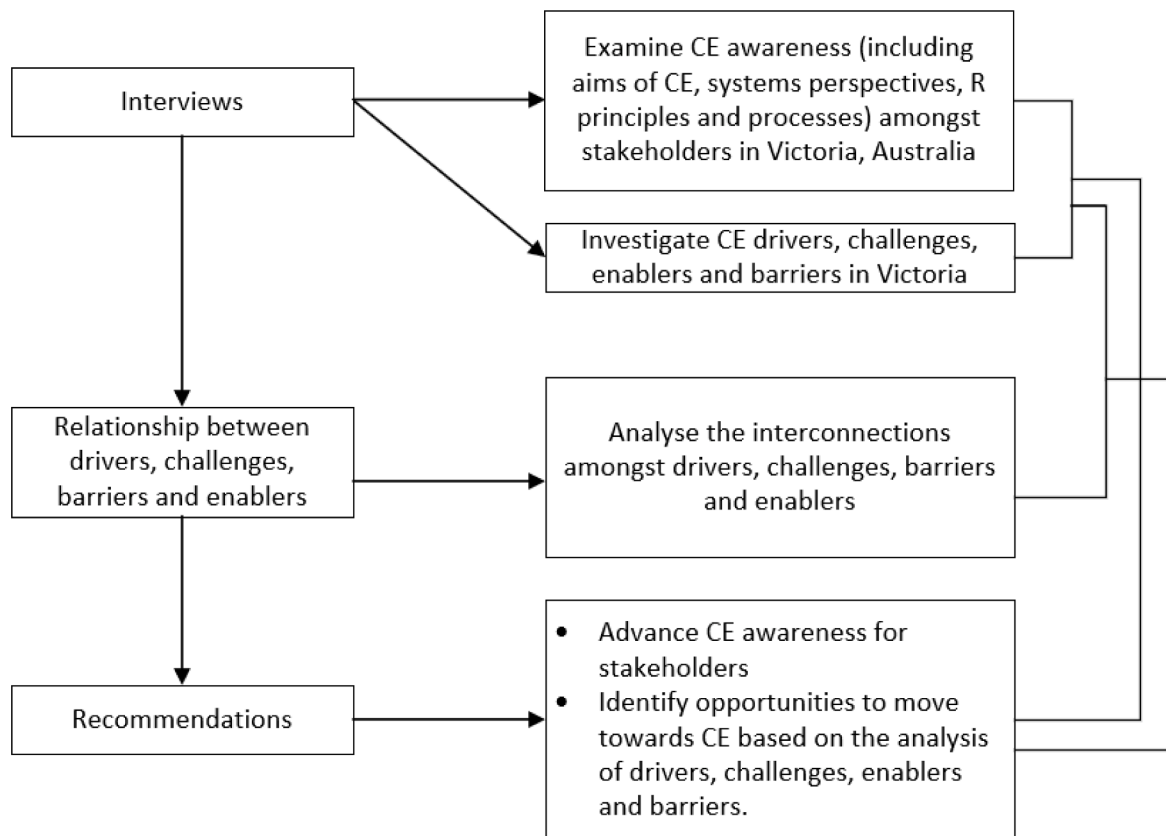


Fig. 1. Research method.

analysis. No weighting scale was used to evaluate the significance of each factor. The sample for interview was determined by a purposive selection with the focus on key actors in Victorian CE transition. Interview participants were recruited based on the list of key actors who had practical experience in CE implementation in different sectors and worked in Victorian government departments, local councils, and businesses. Forty-two organisations were identified based on their CE expertise and experience demonstrated by their published achievements and reports. These organisations were then invited to participate in research interviews via emails. The potential participants were also contacted by peer-to-peer recommendations. Finally, twenty-three participants agreed to be interviewed in this research project. Amongst the interview participants, 43% were from government departments while 22% were from businesses. They represented two key actors for CE

transitions from the macro and micro levels. The next 17% of participants were from not-for-profit organisations. The last 9% comprised of local councils and industry associations, respectively (Fig. 2). The participants were able to represent the key stakeholders in Victorian CE transition.

Semi-structured interviews were conducted and the interviews were discontinued when saturation was achieved in data collection (Wue-therick, 2010). The sample size of 23 was deemed suitable since Creswell and Poth (2016) suggested 5 to 25 participants for phenomenological research whereas Bertaux (1981) recommended the minimum number of participants as 15 for the qualitative method. Therefore, the sample size of 23 interviewees met the requirements of saturation criteria and sample size. The participant backgrounds are presented in Table 3.

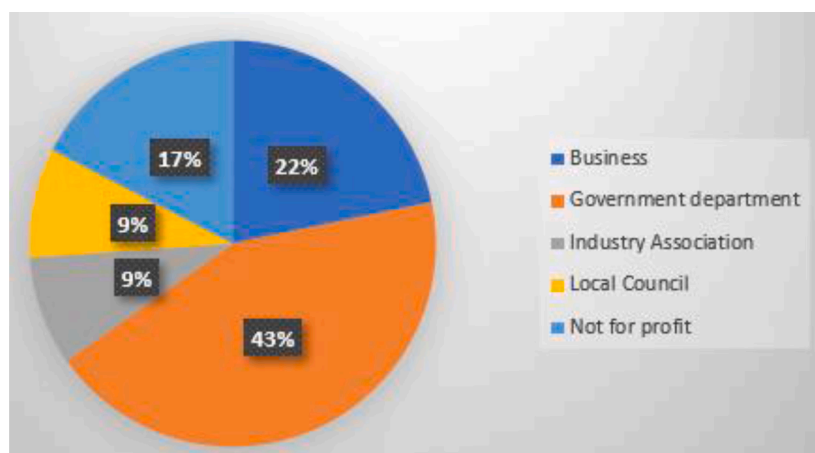


Fig. 2. Participants organisation types.

**Table 3**  
Interview Participant backgrounds.

Code	Organisational Type	Organisation/Sector
P1	Industry Association	Waste and resource recovery
P2	Government	Infrastructure
P3	Government	Environment
P4	Local Council	Waste and resource recovery
P5	Business	Construction
P6	Government	Waste and resource recovery
P7	Not for profit	Second-hand markets
P8	Not for profit	Circular Economy
P9	Government	Infrastructure
P10	Not for profit	Packaging
P11	Not for profit	Waste and resource recovery
P12	Local Council	Waste and resource recovery
P13	Government	Design
P14	Government	Environment
P15	Business	Second-hand markets
P16	Government	Business and economics
P17	Government	Waste and resource recovery
P18	Government	Waste and resource recovery
P19	Government	Education
P20	Industry Association	Business and economics
P21	Business	Construction
P22	Business	Construction
P23	Business	Construction

The interviews were recorded and transcribed for further data analysis. The research team checked and reviewed the interview transcripts to ensure that the interview contents were correctly transcribed.

For the data analysis of CE awareness, participant responses to CE understanding questions were analysed against CE academic definition from Kirchherr et al., (2017)'s research. The four aspects of the CE definitions such as aims of CE, systems perspectives, R strategies, and processes involved were considered for the analysis of CE awareness. This analysis allowed the researchers to indicate similarities and differences in the understanding of CE amongst stakeholders against academic definitions.

Regarding the data analysis of CE drivers, challenges, enablers and barriers, thematic analysis was used as both the breadth and depth of issues needed to be explored to respond to the research questions. The thematic analysis aids in identifying the patterns in data collection and comprises six steps: "(1) becoming familiar with the data, (2) generating coding categories, (3) generating themes, (4) reviewing themes, (5) defining and naming themes, and (6) locating exemplars" (Scharp and Sanders, 2019). Following these steps, drivers, challenges, enablers and barriers were first analysed from the transcripts of participant responses. A total of 276 factors were identified and then coded. The next step was to cluster these factors in 73 themes and recheck these themes to ensure alignment with the coded extract as well as whole dataset. The next section presents the major themes that were identified through this process.

## Research findings

This section discusses findings from interviews to show the alignment between research objectives and primary interview results. The themes identified based on the broader understanding of CE and major drivers, challenges, enablers, and barriers are presented first followed by a discussion on the relationship of these factors for a CE transition.

### CE awareness

CE awareness was analysed against four criteria: CE aims, systems perspective, R strategies and processes based on the CE definition from the research of Kirchherr et al., (2017) and R strategies identified from previous studies (Kirchherr et al., 2017; Potting et al., 2017) (Table 4).

Interestingly, the research found the aim of CE was aligned between participant responses and the academic definition. The aim of CE

**Table 4**  
CE understandings based on participant responses.

Criteria	Participant responses	Academic definition
Aims	Sustainability with a focus on triple bottom line of economic, environmental, and social.	Sustainable development with emphasis on economics, environment, and society.
Systems perspective	Waste and industrial systems	Economic system
R Principles (based on Potting et al., (2017)'s research)	Emphasise R9(Recover), R8 (Recycle) and R3 (Reuse).	To replace the concept of the end of life by 10R-principles, from R9 (Recover) to R0 (Refuse) and also targeting to Regeneration.
Processes	Focus on end-of-pipe waste disposal	Entire production system; extraction, production, consumption and disposal

essentially has a sustainability focus, based on the three pillars of economic, environmental, and social considerations. However, there were considerable gaps in the systems perspective, R-strategies and processes between participant responses and the academic definition. Regarding the systems perspective, the focus on academic definition was an economic system while participants focused on waste and at most industrial systems. The participants highlighted that CE was considered and implemented to resolve the waste crisis in Victoria due to the impact of China's National Sword policy. This focus is demonstrated by the R-strategies applied in practice that underscore the lower R scaffold of Recover, Recycle and Reuse. However, in the academic literature, CE implementation was interpreted to cover all 10R-strategies with a high focus on Refuse and Rethink (Morsetto, 2020; Rezaie et al., 2022). Moreover, R-strategies are extended to Regeneration as targeted for CE implementation in recent years (Rodríguez et al., 2020).

In terms of CE process, the academic definition considers the life cycle of materials and products from extraction, production, consumption, to disposal. It encourages the implementation of different cycles in supply chains to change the concept of end-of-life cycle of products and materials by extending their life cycles and gradually closing the loops (Sousa et al., 2021). However, the interview analysis revealed that current CE practices focused more on the consumption and disposal phases of the economy and less on the extraction and production phases. Such responses are similar to the findings of previous studies when CE understanding mainly focused on product consumption and waste management (Van Langen et al., 2021; Smol et al., 2018).

Although participants interpretations of CE were influenced by their organisational contexts, it was clear CE concepts were not been fully understood. Interviews demonstrated that CE aims were aligned between academics and participants responses, but CE implementation showed the gaps in systems, R-strategies and processes. The implementation of CE was still at 3R-strategies of "Reduce, Reuse and Recycle" (Pires and Martinho, 2019), while focusing on Recover and Recycle. Compared with previous studies, the analysis of R-strategies of CE concept has been explored and it demonstrates the necessity of CE awareness improvement which should be more holistic and systematic to provide a fuller understanding on CE concepts underlining CE systems, R-strategies and processes.

### CE drivers, challenges, enablers, and barriers

Literature demonstrates that CE drivers, challenges, enablers, and barriers play a crucial role in the CE transition (Van Keulen and Kirchherr, 2021; Tan et al., 2022). To comprehend the Victorian context for CE transition, CE drivers and challenges were explored in the interviews to understand factors that historically drove and challenged organisations to transition towards CE, whereas CE enablers and barriers were used to understand factors that propel and impede CE transition presently and in the future. These factors are interrelated and dependant on a

particular CE context that influences them. The primary factors of CE drivers, challenges, enablers, and barriers are identified and presented below.

### CE drivers

The interview analysis demonstrated three primary drivers for organisations to move towards circularity were CED1 - Waste related issues (waste crisis, waste strategy and waste management), CED2 - Market considerations (business mindset, leadership, and market growth) and CED3 - Financial benefits (business sustainability and commercial viability) mentioned by interview participants (Fig. 3. Top CE drivers within Victoria).

Eight interviewees pointed out that the factor of CED1 - Waste related issues was the key driver for transitioning toward CE. Participants based in government organisations highlighted that the waste crisis drove the Victorian government to shift to circularity (Lee, 2021). P3 mentioned that "... there was a crisis in Victoria's waste sector with international forces beyond our control, particularly China's national sword policy... This crisis... determined some of the timing". Victorian regulations and policies related to CE have been developed due to this crisis (Victoria State Government, 2020).

Regarding CED2 - Market considerations, interview participants underlined market opportunities for materials and products implemented within CE principles was another major driver. The culture of reusing and recycling products has existed in Victorian and Australian consumers for many decades. This culture created an opportunity for a CE transition. However, the interviewees pointed out the necessity of breaking down social stigma around second-hand products that might limit the community to gain a fully understanding of CE concepts and support CE implementation. The terms of "preloved or unwanted" items have been used to replace the term second-hand products in some organisations as a strategy. By doing that, the market opportunities for reused and recycled products could be increased. As P15 mentioned: "[we] shifted away from saying second hand to using pre-loved and unwanted so the items have had greater value". Interview participants also noted the leadership in sustainability areas could be advantageous to support CE movement in an organisation. P12 stated that "[the organisation] has been a leader in a lot of sustainability areas throughout the years... so [it could be] a driver to transition to CE".

The theme of CED3 - Financial benefits was a major driver for CE transition. Interview participants explained that financial benefits could arise from cost differences between virgin materials and recycled materials. P5 explained how the cost could be saved using recycled asphalt in infrastructure projects. P5 also highlighted the environmental benefits from the reduction of material mining and greenhouse gas emissions through the use of recycled asphalt. P5 noted "The whole process started with recycling asphalt and there are environmental benefits of that, the biggest one being [is that] you don't have to import bitumen from overseas... It means you don't have to mine oil and don't have to process

it in Singapore, don't have to ship it back to Australia and transport on the roads. That's the biggest carbon saver for us and it is also to save us money... So, if we can reuse other materials that are a lot cheaper than virgin materials ... it saves money... that was probably one of the main drivers". In social organisations, interview participants admitted that financial benefit was another consideration for them transitioning to circularity although social benefits were the core organisational activities.

### CE challenges

Participants were interviewed on challenges that their organisations faced with to move towards CE. The interview responses were analysed and clustered into more than twenty-two themes. In this paper, the three most important themes of CEC1 - Lack of awareness on CE, CEC2 - Financial issues and CEC3 - Organisation structure are presented as in Fig. 4- Top CE challenges within Victoria.

Seven interview participants underscored the CEC1 - Lack of awareness/understanding on CE was the initial challenge to move away from the traditional linear economy. Lack of full understanding of CE or limited understanding of CE had caused negative impacts on CE mindset and internal leadership which were unable to support the development of CE strategies in an organisation. Creating the background for top management to look at CE favourably was highlighted as an important factor to transition organisations towards CE. Such an environment should be built based on organisational CE awareness and capabilities. P4 stated that "it's about educating the whole [organisation] and having that capability uplift... there can be a good understanding [on CE] .... at officer level [but not so much] at the executive level". The understanding of CE should be expanded to all levels in an organisation from senior to junior levels. As stated by interview participants, the CE strategies and policies in Victoria were understood as "recycling plus" with an emphasis on materials recycling and waste reduction. Along these lines, P4 highlighted that "it's immature, in the sense that our approach to circular economy is still right at the bottom of the waste hierarchy... We are still talking about recycling and about... having different bins [for waste separation]". The mindset of waste management and recycling for CE implementation was a considerable challenge for the state-wide development of CE.

Participants also stated that CEC2 - Financial issues was another challenge for CE transition. Indeed, CE initiatives required organisations to have short-term financial viability for the incorporation of circular business models. Despite long-term positive return from CE implementation, organisations both for-profit and not-for-profit needed to have financial assistance to commence their transition from linear to circular economic models. P4 noted that "as a very commercial organisation, our executive is really focused on outcomes that are not strictly about the services that we offer... There is a lot of other attention that they pay to run the organisation as a business". Participants additionally highlighted economic benefits as "better return on investment" for CE

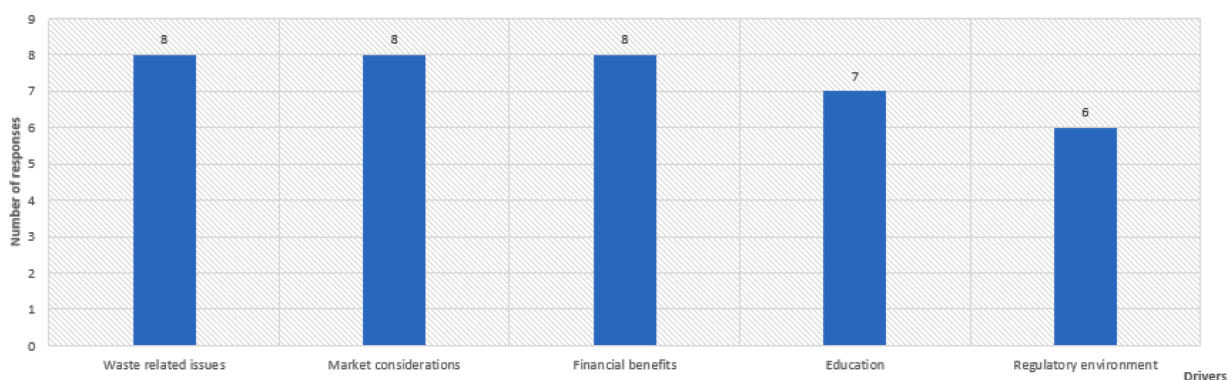


Fig. 3. Top CE drivers within Victoria.

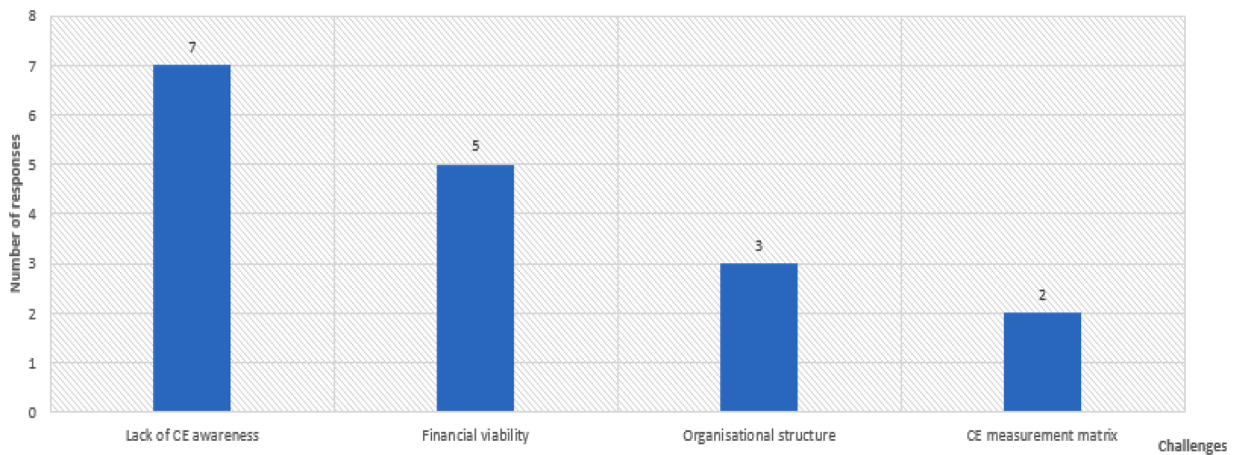


Fig. 4. Top CE challenges within Victoria.

implementation within the supply chains and life cycle considerations to products and materials. As such, P6 mentioned that “why [we should] move to a circular economy, and framing that in terms of ... not because you like the environment and want to be good in the world, but in terms of viability and long-term cost. And how can you in the long term, deliver services to the community when you understand that you need... to shift your understanding of supply chains and design, and end of life use so that you can achieve better return on investment”. The interviews demonstrated that organisations needed to face the challenges of short-term financial issues for CE transition although they had their motivation to integrate CE in their businesses.

The third substantial challenge to CE transition was CEC3 – Organisational structure. Interviewees explained that the traditional organisational structure could be an impediment to overcome for the CE movement. For CE transition, the collaboration between stakeholders in supply chains and collaboration at the macro level of government was very important to manage the life cycle of products and materials as well as extend their lives. However, the current organisational structures were siloed with their own goals and strategies. The shared goals and strategies in circularity between stakeholders were not supported by the current structure and it was a challenge to change the organisational structure or to adapt CE strategies to existing structure.

**CE enablers**

Participants were interviewed on enablers for CE transition in Victoria, Australia. Two top CE enablers indicated by participants were CEE1 – regulatory environment and CEE2 – collaboration as presented

in Fig. 5 Top CE enablers within Victoria.

In terms of CEE1 – Regulatory environment, 100% of participants agreed that this factor played an enabling role to support a systematic movement for the whole state. As mentioned by most of interview participants, the most important policy for Victorian CE transition was the State’s CE strategy, “Recycling Victoria: A new economy” (Victoria State Government, 2020) which initially provided targets for the state to transition to CE. Participants also highlighted CE Act 2021 enacted in Victoria and the product stewardship program. The regulatory environment was considered as a top-down enabler to encourage the CE movement within the state. P12 explained that “Circular Economy Act and the new authority will help this. Bringing together those sorts of clusters, but in a more localised way, where there’s smaller facilities dotted around the place will really support that localisation of processing and manufacturing opportunities that doesn’t exist at the moment, but the industry is really moving towards that”.

CEE1-Regulatory environment could set the rules for businesses and community to play their role in the CE ecosystem. This environment could provide orientation and instruction to support businesses to set their goals and roadmap to transition to CE. Otherwise, the transition would be decided by the market forces which were made by large organisations, and such changes could take longer time. P18 underlined that “If you don’t have the regulations, then it’s all pushed by... the biggest players [who] are international companies. All those international companies are set up in Europe. [They] have strong laws, they’re not just going to change [how things are done] in [Europe], they are going to change the entire model [globally]. So, we are going to get it,

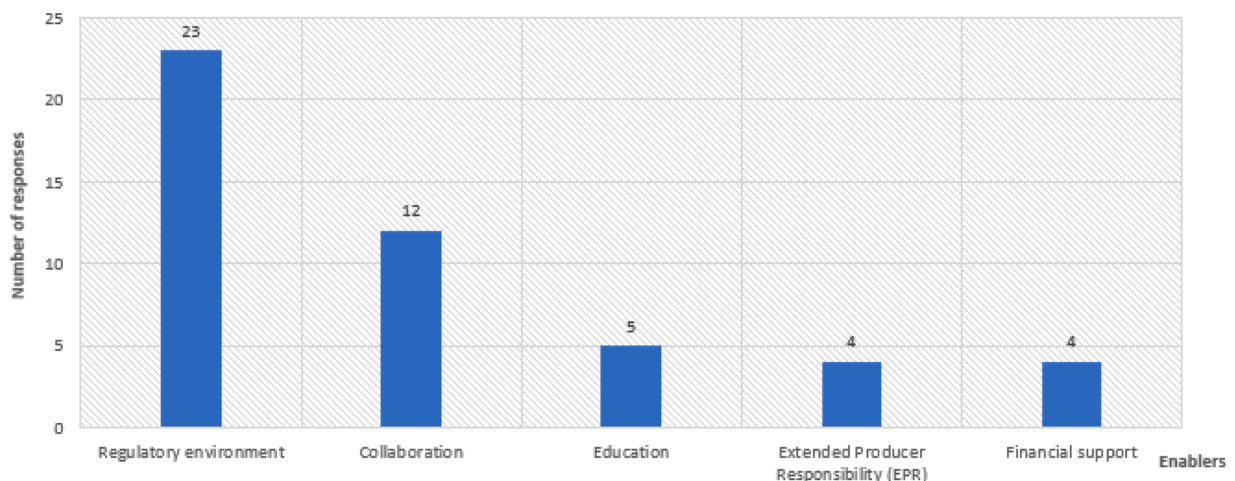


Fig. 5. Top CE enablers identified.



but it's going to take time". In support, P17 stated that all organisations would comply with the rules when "certain CE parameters were laid down". Along these lines, P18 highlighted that "if you don't have regulations, then it's all pushed by ... the biggest players [who] are international companies. All those international companies are set up in Europe and they have strong laws... they're not just going to change [how things are done] in [Europe], they are going to change the entire model [globally]. So, we are doing to get it, but it's going to take time". Thus, CEE1-Regulatory environment could be considered the most crucial factor to enable CE transition in Victoria.

CEE2 – Collaboration was another important enabler mentioned by over 50% of participants. Collaboration was the key to unlock the connections between stakeholders in the supply chain to consider the lifecycle of products and materials as well as to find approaches to extend this lifecycle through circular design solutions or technical innovations. Collaboration could support CE implementation in various stages of products and materials: P11 noted that "collaboration is probably one of the formulas for success.... We're a charity which means that we can get funding.... but we take a partnership approach to everything whether it is our supply chain, customers ... We've codesigned supply chain arrangements with customers so that it best meets customer needs. We're solving a business problem, so we need to collaborate and codesign with them".

Collaboration was identified as an enabler not only by businesses but also by government authorities, where collaboration between government entities could help improve regulations and policies that provide a full understanding and implementation of CE concepts. This would support the systematic movement towards CE rather than the current fragmented approach of CE implementation in different areas and fields. P4 stated that during the development of the State policy "lots of departments had views on what our circular economy and waste strategy should be, and all of them were aired out.... [the process needs] to build that kind of momentum and support within government for circular economy".

#### CE barriers

Based on the interviews conducted, three top groups of barriers for CE transition were identified. They were: CEB1- the lack of specific guidelines and standards, CEB2 - general perception of CE being synonymous with waste, and CEB3 - financial challenges, as shown in Fig. 6 - Top CE barriers identified. These factors were the key barriers to hampering circular transition.

CEB1 - Lack of specific guidelines and standards were cited as one of main barriers by 22 out of 23 respondents. Regulations played a crucial role to direct CE implementation, but the current regulations mostly targeted waste, waste reduction and waste management as end-of-life

solutions. These targets limited the implementation of holistic CE actions with regards to other R-strategies such as rethinking, repurpose, refuse, and regenerate. Yet P2 cited standards were too old to include CE implementation to incorporate recycled materials. P2 pointed out that "[there is a] need to reform and update [regulations] for reflecting more performance based rather than prescriptive [standards]". As such, P23 gave an example of how current standards discouraged the use of recycled materials, stating that "recycled asphalt lacks specification standards". Further, participants underlined the shadow side of regulatory instruments causing unintended consequences. For example, the increase of illegal dumping and contamination of recyclables were partly as a result of the increase of landfill levy that significantly impacted businesses. In addition, P7 mentioned the unintended consequences from the bans of e-waste to landfills and waste export. P7 noted "Sometimes the unintended consequences of some policies can hurt charities. For example, the E waste ban in Victoria... What that led to was people dumping e-waste on charities. And then we've got it and it's like, well, what do we do with it?". It could be seen that the support of regulations and standards was still lacking in the place of CE implementation.

CEB2 - General perception of CE being synonymous with waste was considered a key barrier to CE transition by 15 out of the 23 responses. According to P12, CE perception was still around waste which hindered the systemic economic wide transition to products and design or other higher order of R strategies. P12 commented that "the biggest barrier is going to be really changing people's view from waste to... circular [economy principles which are] .... more about product and design and move up the hierarchy [towards] repair and longevity". The common understanding of CE was "recycling plus" leading to CE strategies being at lower order of R-strategies: recycling and recovery. There were less considerations for other R-strategies such as redesign and refuse as well as to discover circular business models. Along the same lines, P18 noted the need of increasing CE knowledge amongst stakeholders to understand waste as resources and change feedstock. P18 said: "A lot of the time, the barrier is knowledge... the understanding of how you can use some wasted resource and change your feedstock and produce the same type of materials that meet specifications is not completely understood by businesses.... Using soft plastics for asphalt or construction is not something that everyone knows or that everybody has the money to invest in research to make that change.... They want to get on their jobs and not lose their markets .... [so they] just keep going the way that it is". This demonstrated that CE perception needed to be improved to have a full understanding of CE, not just only focusing on waste and recycling. The improvement in CE understanding could proactively drive CE implementation rather than forcing to adopt CE strategies.

Lastly, the factor of CEB3 - financial challenges was cited as a major barrier. The participants underscored that financial viability was

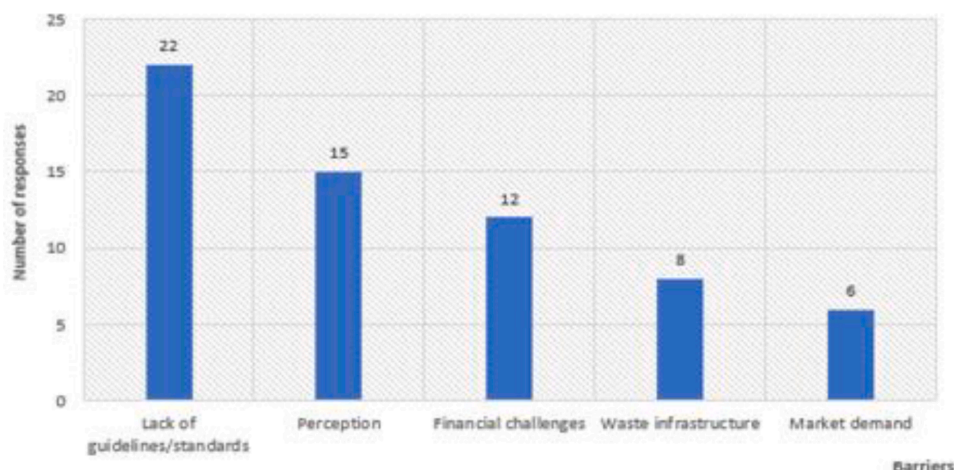


Fig. 6. Top CE barriers within Victoria.

extremely essential for starting CE initiatives. Although grants and funding were available for businesses and communities to apply for, some issues relating to time considerations, lack of awareness on funding opportunities and limited access were considered the major barrier. P20 highlighted that “A lot of the [grants and funding] are only open for a very short amount of time ... by the time [businesses] find out, it is only few days left”. Further, the current investment analysis tools regarding financial evaluation have been limited in the evaluation of CE contributions since these tools were developed based on linear economic principles that were unable to facilitate circular evaluation. Innovative assessment to CE contributions, especially at the initial stage of CE projects, was required to develop to support project stakeholders to evaluate project feasibility. P13 stated that “Projects go through business case stages which inform the budget.... if the business case design is like a reference design and isn't undertaken with lateral opportunities, then the budget won't meet [the purpose] .... therefore, it is important [for it] to be embedded early on”. Therefore, financial challenges apparently impacted the willingness of stakeholders to implement CE strategies.

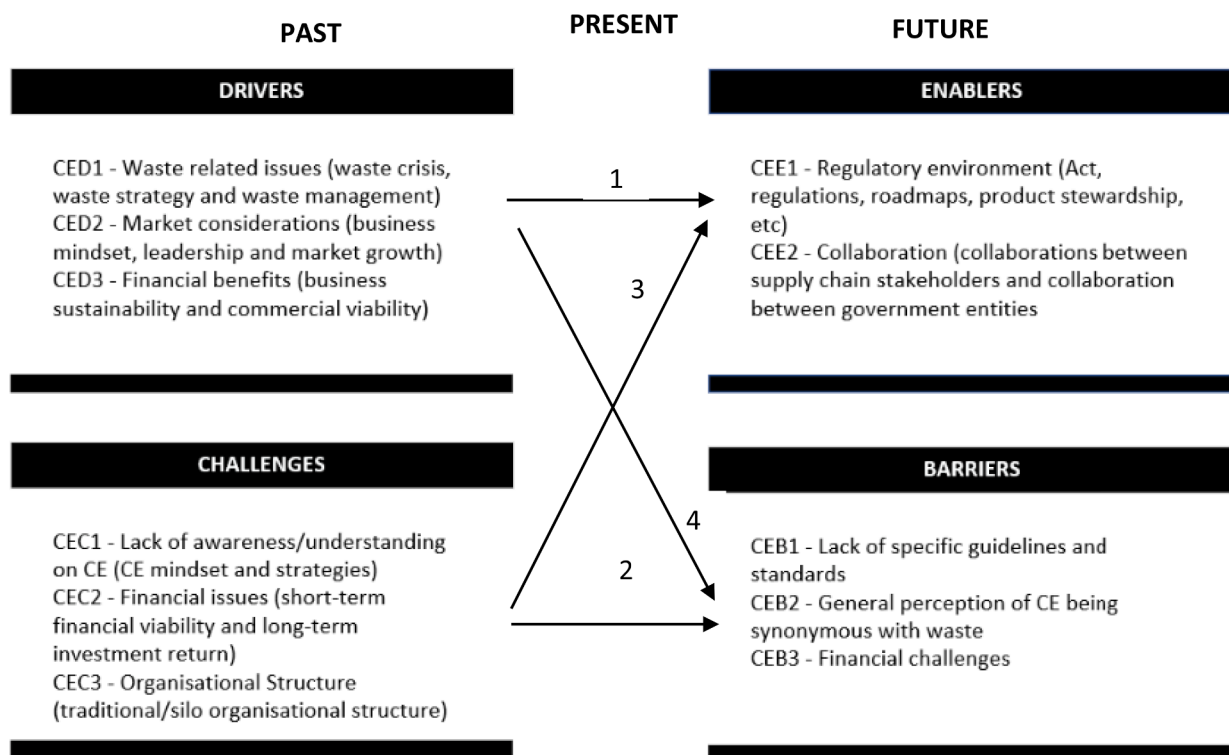
*Relationship between drivers, challenges, enablers and barriers*

The relationship between drivers, challenges, enablers, and barriers for CE transition in Victoria is presented in Fig. 7 based on the research findings. The relationship of these factors can be strategically used to enable CE transition. As shown in this figure, drivers and challenges provide the sense of past whilst enablers and barriers focus on the present and future. It becomes clear that if challenges and barriers are tackled, they can be considered as drivers and enablers for CE transition (Houston et al., 2018). Based on this relationship, CE strategies can be built up to take advantages of enablers as well as overcome barriers for moving towards CE (Fig. 7).

The visual presentation provides the best overview and shows the inter-connection amongst how the different drivers, challenges, enablers, and barriers influence each other. The driver of CED1 – Waste

related issues is the motivational factor for Victoria to move towards CE and has influenced the barrier of CEB2 – General perception of CE being synonymous with waste. Indeed, regulations and policies in Victoria focus on waste and recycling which shape businesses and communities understanding of CE at waste hierarchy and recycling measures to reduce waste. Regulations and policies are very important for the commencement of CE implementation as they support to create the environment for encouraging innovation and entrepreneurship in circularity as well as provide the instruction for businesses and community to commence their CE journey (Briguglio et al., 2021). Yet, the challenge of CEC1 – Lack of awareness/understanding on CE has not been solved in the past and leads to the barriers of CEB2 for CE transition. In fact, CE is not included as part of the education system yet and business and communities are still unclear how to interpret and implement CE in their operations. Under Victorian regulatory environment, they interpret CE at the level of waste and waste management which has become their organisational strategies. This leads to the barrier of CEB2. To overcome CEB2, the enabler of CEE1 – Regulatory environment needs to be developed highlighting full CE understanding. Also, CE principles and implementation should be reflected in regulations and policies.

Regarding the financial perspective, the figure demonstrates how financial factors can be a driver, challenge, enabler and barrier. The driver of CED3 – Financial benefits motivates businesses to commence their CE journey because CE creates incentive benefits for all stakeholders in a supply chain. However, financial aspect becomes a challenge for businesses shown as CEC2 – Financial issues in the model. Businesses require financial support for CE initiatives, especially for SMEs as they have limited financial investment for changes. This becomes the barrier of CEB3 – Financial challenges when this challenge was not tackled in the past. To overcome the CEB3 barrier, the enabler of CEE2 – Collaboration can support this as collaboration can enable stakeholders to play their roles in the supply chain with their capabilities and resources.



**Fig. 7.** Relationship between drivers, challenges, enablers, and barriers for Victorian CE transition. Notes: 1. Ensure that drivers from the past inform enablers in the future. 2. Understand challenges from the past to better overcome barriers in the future. 3. Develop future enablers based on past challenges. 4. Mitigate future barriers from past drivers.

Financial consideration was identified as either a driver or challenge. It could be understood that CE activities were able to create incentives to stakeholders involving the supply chain. However, it was a financial question for CE initiatives, especially for SME businesses when their profit margins were low. CE actions could be implemented within a traditional linear business models before moving to the implementation of circular business models. The dichotomy between the short-term and long-term financial benefits needs to strategically work out for CE transition as it could be a major factor of enabling or impeding CE implementation in businesses.

## Discussions

The results of the study present the relationships between drivers, challenges, enablers and barriers, which demonstrate the connection between existing literature and research results on CE awareness and factors impacting the CE transition. The theory and practice implementations are discussed in this section.

### *Understanding of CE amongst major stakeholders within Victoria*

A review of the literature has shown that CE awareness plays a crucial role in CE transition. The awareness is varied based on different factors such as participants' background, their roles in an organisation, and community interaction in their environment (Van Langen et al., 2021; Liakos et al., 2019). The literature also reveals a dearth of research focusing CE awareness in Victoria when this state is in the process of the CE transition. The research finding demonstrates that CE has not been fully understood in Victoria. The understanding of CE from research participants is aligned with the CE aims based on the academic definition. However, there is still a gap in the interpretation of CE systems, principles and process which substantially impact businesses to implement CE in their strategies and operation. The in-depth understanding of CE and its implementation are very crucial for all stakeholders. For policy makers, better understanding of CE assists them in designing policies to synchronise the whole state toward circularity at the macro level (Rizos et al., 2017) while for businesses, this full understanding supports the design and development of their circular business strategies throughout different CE aspects to keep materials and products staying longer in a supply chain rather than only focusing on recycling and waste reduction.

Due to the impact of the waste crisis, the state of Victoria has focused on waste management and waste reduction. This focus is still at the low order R-strategies highlighting the most basic 3 R-strategies of "Reduce, Reuse and Recycle" (Pires and Martinho, 2019). What is needed is to extend the R-strategies to higher orders (refuse, rethink, regenerate) and encourage CE implementation in different cycles of supply chains with more objective strategies and roadmaps (Sousa et al., 2021). Circular thinking and design need to be improved to increase the uptake of CE practices in different sectors as well as across sectors to achieve the shared goals and shared gains.

The main recommendation resulting from the findings of this research is the need to advance CE understanding for businesses and communities in theory and practice. It is important to disseminate the CE targets of the state and the policies that support CE transition to businesses and communities, so that they can have a clearer CE vision and precisely incorporate this vision into their strategies and activities. The government can develop or support local councils in establishing and developing CE knowledge hubs where CE understanding, challenges, barriers, drivers and enablers can be shared to support policy improvement (Giorgi et al., 2022) and facilitate CE transformation.

### *Drivers, challenges, barriers, and enablers of CE transition in Victoria*

Although CE has been widely implemented in various countries and states, Victorian CE transition is facing many challenges and barriers that need to be addressed to smoothly unlock CE movement within the state. Although the literature review indicates a list of enablers and barriers occurring in different sectors and countries, the research analysis has provided an in depth understanding of drivers, challenges, enablers and barriers in a particular context.

#### Drivers:

- CED1 – Waste related crisis which is the main driver for Victoria to transition to CE as a solution to the waste crisis resulting from the waste import bans imposed by Asian countries.
- CED2 – Market consideration where reusing and recycling have been existing as a culture in the Victorian society. This factor can be seen as a motivator to move towards CE.
- CED3 – Financial benefits, which are clearly evident in the CE practices, particularly in the cost differences between using reused/recycled materials and virgin materials.

#### Challenges:

- CEC1 – Lack of awareness/understanding on CE, which can impact interpretation and implementation of CE in a particular context. The current knowledge of CE is still at low level waste hierarchy, primarily focused on recycling, waste separation and bin systems.
- CEC2 – Financial issues can be considered a key challenge and confirmed by the literature (Shi et al., 2008; Rizos et al., 2016). The majority of businesses need to have financial support for CE initiatives. This finding is consistent with the research by (Kirchherr et al., 2018) where higher upfront costs of CE initiatives are affected by the organisation's economic viability (Shi et al., 2008; Masi et al., 2018).
- CEC3 – Organisational structure with the siloed characteristic may not be conducive to working on shared goals or shared resources in CE models.

#### Enablers:

- CEE1 – Regulatory environment which is vital in driving a systemic movement towards circularity. This environment is a localised and top-down approach to enable businesses and communities to play their roles in a CE ecosystem. This finding is aligned with research by (Shi et al., 2008) where enabling CE transition in a region or country needs to be supported by government policies.
- CEE2 – Collaboration is key to unlocking the CE transition. It can support co-thinking and co-design in supply chain arrangements and reduce the fragmented and siloed CE implementation in different businesses and organisations.

#### Barriers:

- CEB1 – Lack of specific guidelines and standards. This barrier is also highlighted in the literature (Hart et al., 2019) when recycled materials are used in manufacturing products. It also raises concern about policies that can impact businesses as demonstrated by the example of e-waste bans to local charities to deal with illegal dumping of electric waste. This core barrier aligns with the literature that examines barriers for a CE transition (Van Keulen and Kirchherr, 2021)

- CEB2 – General perception of CE being synonymous with waste that leads to the implementation of lower order R strategies to resolve the waste issues.
- CEB3 – Financial challenges, with the main concern being the higher upfront costs for CE initiatives which can impact the financial viability of an organisation.

The list of factors with their explanations can provide a holistic view of the current CE transition in Victoria. These key factors can be used by government and businesses as a reference to develop and strengthen their strategies as well as deciding on a course of action.

#### *A relationship of CE drivers, challenges, barriers and enablers to enable a state-wide CE transition*

The influential relationship between drivers, challenges, enablers and barriers was presented in Section 4.3. This relationship highlights the importance of using drivers to tackle challenges and crystallise them into enablers for the CE transition. If challenges are not overcome, they can become barriers to hinder the movement toward circularity. A strategic plan and road map for a state wide CE transition can be developed based on the relationship of these factors.

Importantly, the Victorian Government needs to put enormous effort into improving CE understanding in businesses and communities to reduce the challenge of CEC1 - Lack of awareness and the barrier of CEB2 – General perception of CE being synonymous with waste. The government needs to review their policies with a focus on other CE aspects such as technology innovation for extending material lifespan and circular design thinking for reversibility and disassembly rather than only focusing on waste reductions and bin systems. Different educational programs that can improve the understanding of CE from businesses and communities are needed to complement the policies. The government can also build online data of CE case studies and practices to demonstrate the practical implementation of CE concepts in different sectors within Victoria and beyond Victoria so that businesses and communities can develop their understanding around practical implementations of CE and strategically apply CE concepts in their contexts.

The Victorian Government needs to support collaboration across sectors as well as states and countries to enable businesses to seek CE opportunities and cooperate on shared goals and shared resources to support their roles in the CE ecosystem. This collaboration would sustain businesses in positively implementing CE practices across different stages of a supply chain from the mining stage to the end-of life stage, thus closing the loop. It would also help businesses to overcome the challenge of CEC2 – Financial issues and the barriers of CEB3 – Financial challenges and create the driver of CED3 – Financial benefits. The government could consider providing financial subsidies to businesses to initiate CE implementations in their operations.

#### **Conclusion**

This study explored the understanding of CE from different stakeholder perspectives and examined the drivers, challenges, enablers, and barriers to a CE transition. Twenty-three participants in the Australian state of Victoria were interviewed and the data analysed using thematic analysis.

The study illustrates a gap in CE understanding and provides an explanation of how these disconnects impact CE transition. The research presents the relationship of drivers, challenges, enablers, and barriers as well as the connections among these factors. It shows how to utilise this relationship to develop CE strategies for different stakeholders. There is no singular approach for a CE transition in different contexts and countries. Therefore, this research contributes to understanding how the CE transition in Victoria may be supported. The future direction for this research is to further deep-dive into drivers, challenges, enablers, and barriers for specific sectors. Accordingly, detailed recommendations for

each sector can be developed and implemented in practice. Another research direction is to investigate these factors in other regions to support the outcomes of the current research in different regions, adding to the knowledge derived from this research. The findings of this study can be developed in greater detail to support various stakeholders to set their own CE goals, strategies, and action plans to elicit place-based responses.

The paper contributes to the understanding of interrelationship amongst enablers, challenges, drivers and barriers which haven't been considered together in previous studies. This relationship may be used to develop and differentiate strategic plans and roadmaps for transitioning to CE in specific contexts. This paper also denotes CE awareness/ understanding of different stakeholders across macro, meso, and micro levels. The research recommends advancing CE understanding with a focus on CE system, principles, and process where CE aims have been clearly interpreted by stakeholders.

The interview sample size can be considered a limitation of this study given the numbers. As the focus of the research was to understand perceptions from major stakeholders, relevant representatives of these stakeholders were selected to be interviewed. Although the participants were directed to answer interview questions from their organisational perspectives, there is a possibility that personal opinions/ideas may have been included in responses, posing a limitation in generalising findings across other states of Australia. However, given the inherent geographic idiosyncrasies present in CE ecosystems, this level of generalisation will be a challenge.

#### **CRedit authorship contribution statement**

**Oanh Thi-Kieu Ho:** Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Akvan Gajanayake:** Conceptualization, Investigation, Formal analysis, Writing – review & editing. **Usha Iyer-Raniga:** Conceptualization, Investigation, Supervision, Writing – review & editing.

#### **Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships that could influence the work reported in this paper.

#### **Data availability**

The data that has been used is confidential.

#### **Acknowledgement**

This study was funded by Recycling Victoria Innovation Fund of the Circular Economy Business Innovation Centre (CEBIC), Sustainability Victoria. The authors would like to thank Sean Trewick for his guidance in this research project and for the conceptualisation of the method to visually present the relationships between CE factors.

#### **Appendix. Interview questions**

##### *Interview questions*

*Research project title: researching the climate for transitioning to a circular economy*

- 1 Would you please introduce yourself/ your organisation and department?
- 2 What is your understanding about Circular Economy?
  - 2.1 What is the role your organisation plays, if at all, in the transition to CE?

- 2.2 Supply chain / Enabler / Catalyst / Thought leader / Facilitator.
- 3 What are the main internal drivers of incorporating CE within your organisation?
  - 3.1 Leadership/strategic commitment
  - 3.2 Financial/ revenue streams
  - 3.3 Sustainability/CSR/ESG
  - 3.4 Efficiency / cost savings
  - 3.5 Regulatory
- 4 What are the internal challenges your organisation faces moving towards a CE?
- 5 What are the external enablers for your organisations move towards CE?
  - 5.1 Economic
  - 5.2 Social
  - 5.3 Technological
  - 5.4 Regulatory
  - 5.5 Collaborations
- 6 What are the external barriers for your organisations move towards a CE?
  - 6.1 Economic
  - 6.2 Social
  - 6.3 Technological
  - 6.4 Regulatory
- 7 What changes/developments would enable a systemic move towards a CE?
  - 7.1 Economic
  - 7.2 Social
  - 7.3 Technological
  - 7.4 Regulatory
- 8 Who are the other major actors we need to interview as part of this research?
- 9 Would you like to be involved in future research work on this project?

## References

- Afteni, C., Păunoiu, V., Afteni, M., 2021. Study on the Transition from the Linear Economy to the Circular Economy. *Annals of "Dunarea de Jos" University of Galati, Fascicle V, Technologies in machine building* 39, 49–55.
- Alhawari, O., Awan, U., Bhutta, M.K.S., Ülkü, M.A., 2021. Insights from circular economy literature: a review of extant definitions and unravelling paths to future research. *Sustainability* 13, 859.
- Bai, C., Orzes, G., Sarkis, J., 2022. Exploring the impact of Industry 4.0 technologies on social sustainability through a circular economy approach. *Indus. Market. Manag.* 101, 176–190.
- Bertaux, D., 1981. *Biography and History: The life History Approach to Social sciences*. Sage, Beverly Hills, CA.
- Biekert, M., 2021. Ikea CEO Says Greenwashing Less dangerous than silence on climate. In: *Bloomberg Green*, 10.
- Bocken, N.M., De Pauw, I., Bakker, C., Van Der Grinten, B., 2016. Product design and business model strategies for a circular economy. *J. Indus. Product. Eng.* 33, 308–320.
- Briguglio, M., Llorente-González, L.J., Meilak, C., Pereira, Á., Spiteri, J. & Vence, X.J.S. 2021. Born or grown: enablers and barriers to circular business in europe. 13, 13670.
- Cavaliere, A., Reis, J., Amorim, M., 2021. Circular Economy and Internet of Things: mapping Science of Case Studies in Manufacturing Industry. *Sustainability* 13, 3299.
- Centobelli, P., Cerchione, R., Chiaroni, D., Del Vecchio, P., Urbinati, A., 2020. Designing business models in circular economy: a systematic literature review and research agenda. *Bus. Strat. Environ.* 29, 1734–1749.
- Charter, M., 2018. *Designing For the Circular Economy*. Routledge.
- Creswell, J.W., Poth, C.N., 2016. *Qualitative Inquiry and Research design: Choosing among Five Approaches*. Sage publications.
- Delwp, V.S.G. 2019. A circular economy for Victoria: creating more value and less waste. Department of Agriculture Water and The Environment. 2021. *National plastics plan summary* [Online]. Available: <https://www.dcceew.gov.au/environment/protection/waste/publications/national-plastics-plan-summary#:~:text=Fact%20about%20plastics&text=One%20million%20tonnes%20of%20Australia's,and%20only%2013%25%20is%20recycled.> [Accessed 10th Jan 2023].
- Department of Environment, Land; Water and Planning. 2019. *Victoria in Future 2019 - Population projections 2016 to 2056* [Online]. Available: [https://www.planning.vic.gov.au/\\_data/assets/pdf\\_file/0032/332996/Victoria\\_in\\_Future\\_2019.pdf](https://www.planning.vic.gov.au/_data/assets/pdf_file/0032/332996/Victoria_in_Future_2019.pdf) [Accessed 10 Jan 2023].
- Ellen MacArthur Foundation. 2017. *The butterfly diagram: visualising the circular economy* [Online]. Available: <https://ellenmacarthurfoundation.org/circular-economy-diagr>
- am#:~:text=In%20the%20technical%20cycle%2C%20products,the%20Earth%20o%20regenerate%20nature. [Accessed 24 April 2023].
- EMF, 2013. Volume 1: Towards the Circular economy, Economic and Business Rationale For an Accelerated Transition. Ellen MacArthur Foundation, Cowes, UK, pp. 21–34.
- Gaustad, G., Krystofik, M., Bustamante, M., Badami, K., 2018. Circular economy strategies for mitigating critical material supply issues. *Resour. Conserv. Recycl.* 135, 24–33.
- Ghobakhloo, M., 2020. Industry 4.0, digitization, and opportunities for sustainability. *Clean. Prod.* 252, 119869.
- Ghosh, S.K., 2020. *Circular economy: Global Perspective*. Springer.
- Giorgi, S., Lavagna, M., Wang, K., Osmani, M., Liu, G., Campioli, A., 2022. Drivers and barriers towards circular economy in the building sector: stakeholder interviews and analysis of five European countries policies and practices. *J. Clean. Prod.* 336, 130395.
- Guerra, B.C., Leite, F., 2021. Circular economy in the construction industry: an overview of United States stakeholders' awareness, major challenges, and enablers. *Resour. Conserv. Recycl.* 170, 105617.
- Halog, A., Anieke, S., 2021. A review of circular economy studies in developed countries and its potential adoption in developing countries. *Circul. Econ. Sustainab.* 1, 209–230.
- Halog, A., Balaney, R., Anieke, S., Yu, T.Y., 2021. Circular economy across Australia: taking stock of progress and lessons. *Circul. Econ. Sustainab.* 1, 283–301.
- Hart, J., Adams, K., Giesekam, J., Tingley, D.D. & Pomponi, F.J.P.C. 2019. Barriers and drivers in a circular economy: the case of the built environment. 80, 619–624.
- Houston, J., Casazza, E., Briguglio, M. & Spiteri, J. 2018. Enablers and Barriers to A Circular Economy. *R2PI H Project Deliverable. Stakeholder Views Report*.
- Hussain, Z., Mishra, J., Vanacore, E., 2020. Waste to energy and circular economy: the case of anaerobic digestion. *J. Enterpr. Inform. Manag.*
- International Resource Panel, United Nations Environment Programme & Sustainable Consumption & Production Branch, 2011. *Decoupling Natural Resource Use and Environmental Impacts from Economic Growth*. UNEP/Earthprint.
- Khan, S.A.R., Shah, A.S.A., Yu, Z., Tanveer, M., 2022. A systematic literature review on circular economy practices: challenges, opportunities and future trends. *J. Entrepreneursh. Emerg. Econ.* 14, 754–795.
- Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., Hekkert, M., 2018. Barriers to the circular economy: evidence from the European Union (EU). *J. Ecol. Econ.* 150, 264–272.
- Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. *Resour. Conserv. Recycl.* 127, 221–232.
- Lee, W.J.Y., 2021. The political economy of Australia's waste crisis: from neoliberalism to the circular economy agenda. *Circul. Econ. Sustainab.* 1–19.
- Liakos, N., Kumar, V., Pongsakornrunsilp, S., Garza-Reyes, J.A., Gupta, B., Pongsakornrunsilp, P., 2019. Understanding circular economy awareness and practices in manufacturing firms. *J. Enterpr. Inform. Manag.*
- Masi, D., Kumar, V., Garza-Reyes, J.A., Godsell, J., 2018. Towards a more circular economy: exploring the awareness, practices, and barriers from a focal firm perspective. *Prod. Plann. Control* 29, 539–550.
- Melles, G., 2021. Figuring the transition from circular economy to circular society in Australia. *Sustainability* 13, 10601.
- Morseletto, P., 2020. Targets for a circular economy. *Resour. Conserv. Recycl.* 153, 104553.
- Murray, A., Skene, K., Haynes, K., 2017. The circular economy: an interdisciplinary exploration of the concept and application in a global context. *J. Bus. Ethics* 140, 369–380.
- Nogueira, A., Ashton, W.S., Teixeira, C., 2019. Expanding perceptions of the circular economy through design: eight capitals as innovation lenses. *Resour. Conserv. Recycl.* 149, 566–576.
- Parliament of Australia. 2018. *Chapter 2 Waste management and recycling in Australia* [Online]. Available: [https://www.aph.gov.au/Parliamentary\\_Business/Committees/Senate/Environment\\_and\\_Communications/WasteandRecycling/Report](https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Environment_and_Communications/WasteandRecycling/Report) [Accessed 10th Jan 2023].
- Parliament of Australia. 2020. *Waste management and recycling* [Online]. Available: [https://www.aph.gov.au/About\\_Parliament/Parliamentary\\_Departments/Parliamentary\\_Library/pubs/rp/BudgetReview202021/WasteManagementRecycling](https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/BudgetReview202021/WasteManagementRecycling) [Accessed 10th Jan 2023].
- Parliament of Victoria. 2022. *Plan to avoid repeat recycling crisis* [Online]. Available: <https://new.parliament.vic.gov.au/news/environment/plan-to-avoid-repeat-recycling-crisis/> [Accessed 5 Jan 2023].
- Pires, A., Martinho, G., 2019. Waste hierarchy index for circular economy in waste management. *Waste Manage. (Oxford)* 95, 298–305.
- Potting, J., Hekkert, M., Worrell, E. & Hanemaaijer, A. 2017. *Circular economy: Measuring Innovation in the Product Chain*. PBL publishers.
- Premier of Victoria. 2019. *Strengthening Victoria's Recycling Industry* [Online]. Available: <https://www.premier.vic.gov.au/strengthening-victorias-recycling-industry/> [Accessed 13 February 2023].
- Ranta, V., Aarikka-Stenroos, L., Ritala, P., Mäkinen, S.J., 2018. Exploring institutional drivers and barriers of the circular economy: a cross-regional comparison of China, the US, and Europe. *J. Resour. Conserv. Recycl.* 135, 70–82.
- Rezaie, S., Englund, M., Vanhuyse, F., Melati, K., Jintarath, P., Nikam, J., Fadhila, A., 2022. Accelerating the Transition to a Circular Economy Through Impactful and Actionable Research. Stockholm Environment Institute.
- Rizos, V., Behrens, A., Van Der Gaast, W., Hofman, E., Ioannou, A., Kafyke, T., Flamos, A., Rinaldi, R., Papadelis, S., Hirschnitz-Garbers, M., 2016. Implementation of circular economy business models by small and medium-sized enterprises (SMEs): barriers and enablers. *Sustainability* 8, 1212.

- Rizos, V., Tuokko, K., Behrens, A., 2017. The Circular Economy: a review of definitions, processes and impacts. CEPS Pap.
- Rodríguez, R.W., Pomponi, F., Webster, K., D'amico, B., 2020. The future of the circular economy and the circular economy of the future. *Built Environ. Proj. Asset Manag.* 10, 529–546.
- Scharp, K.M., Sanders, M.L., 2019. What is a theme? Teaching thematic analysis in qualitative communication research methods. *Commun. Teach.* 33, 117–121.
- Shi, H., Peng, S., Liu, Y., Zhong, P., 2008. Barriers to the implementation of cleaner production in Chinese SMEs: government, industry and expert stakeholders' perspectives. *J. Clean. Prod.* 16, 842–852.
- Simonis, U.E., 2013. Decoupling natural resource use and environmental impacts from economic growth. *Int. J. Soc. Econ.*
- Smol, M., Avdiushchenko, A., Kulczycka, J., Nowaczek, A., 2018. Public awareness of circular economy in southern Poland: case of the Malopolska region. *J. Clean. Prod.* 197, 1035–1045.
- Sørensen, P.B., 2018. From the linear economy to the circular economy: a basic model. *Finanz-Archiv: Zeitschrift für das Gesamte Finanzwesen* 74, 71–87.
- Sousa, P.M., Moreira, M.J., De Moura, A.P., Lima, R.C., Cunha, L.M., 2021. Consumer perception of the circular economy concept applied to the food domain: an exploratory approach. *Sustainability* 13, 11340.
- Tan, J., Tan, F.J., Ramakrishna, S., 2022. Transitioning to a circular economy: a systematic review of its drivers and barriers. *Sustainability* 14, 1757.
- Van Keulen, M., Kirchherr, J., 2021. The implementation of the circular economy: barriers and enablers in the coffee value chain. *J. Clean. Prod.* 281, 125033.
- Van Langen, S.K., Vassillo, C., Ghisellini, P., Restaino, D., Passaro, R., Ulgiati, S., 2021. Promoting circular economy transition: a study about perceptions and awareness by different stakeholders groups. *J. Clean. Prod.* 316, 128166.
- Victoria State Government 2020. *Recycling Victoria: A new Economy.*
- Victorian Legislation. 2021. *Circular Economy (Waste reduction and recycling) Act 2021* [Online]. Available: <https://www.legislation.vic.gov.au/as-made/acts/circular-economy-waste-reduction-and-recycling-act-2021> [Accessed 25 July 2022].
- Wuetherick, B., 2010. Basics of qualitative research: techniques and procedures for developing grounded theory. In: *Can. J. Univ. Contin. Educ.*, 36.