CONSTRUCTS AND INDICATORS FOR ASSESSING STAKEHOLDER BEHAVIOUR IN ADOPTING THE CIRCULAR ECONOMY IN CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT: EXPERTS' PERCEPTIONS

Anne Dilogini Rex Ashokkumar[1], Gayani Karunasena, Nilupa Udawatta and Chunlu Liu

School of Architecture and Built Environment, Deakin University, 1 Gheringhap St, Geelong, VIC 3220, Australia

Construction and demolition waste is the world's largest waste source, and it constitutes over 30% of global waste. Researchers have argued that it can be significantly reduced by adopting Circular Economy (CE) principles. However, stakeholder behaviour presents a significant barrier to CE adoption in Construction and Demolition Waste Management (CDWM), and it has not been explored in depth. To address this gap, this study aims to identify and verify a set of constructs and related indicators to assess the behaviour of stakeholders. These were identified through a systematic literature review and verified by 11 experts in Australia. Seven constructs were identified using the Theory of Planned Behaviour (TPB) and the Norm Activation Model (NAM), and 19 related indicators were derived from identified barriers. In addition to this, 12 indicators were suggested by the experts. By focusing on validated indicators, this research equips policymakers, industry practitioners, and researchers to assess the behaviour of stakeholders when implementing circular economy principles in CDWM.

Keywords: circular economy; construction and demolition waste management; constructs; indicators; stakeholder behaviour

INTRODUCTION

The CE is a system where materials never become waste and nature is regenerated (Ellen MacArthur Foundation, 2015). In a CE, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. This approach aims to keep materials in use for as long as possible, thereby lowering the reliance on natural resources in construction projects (Kirchherr *et al.,* 2017). Despite increasing acceptance of CE by various countries, CE has not been fully implemented in CDWM, mainly due to several underlying barriers. The previous studies have established that the behaviour of stakeholders is one of the key barriers to adopting CE in CDWM. To highlight few, obstacles such as perceived higher costs (Tura *et al.,* 2019; Bilal *et al.,* 2020; Urbinati *et al.,* 2021) and

[1] s223627144@deakin.edu.au

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lack of awareness of ecological benefits related to CE practices (Siringo *et al.,* 2020; Charef *et al.,* 2021) reflect stakeholders' attitudes. Ajzen (1991) noted that cost and benefit perceptions are key factors influencing individual attitudes, which is considered as one of the variables in determining an individual behaviour. Moreover, barriers like a lack of skilled employees (Campbell-Johnston *et al.,* 2019), insufficient financial incentives (Tura *et al.,* 2019; Salmenperä *et al.,* 2021), inadequate infrastructure (Adams *et al.,* 2017), and limited waste regulations (Dunant *et al.,* 2017) are closely related to perceived behavioural control, which is shaped by resources and opportunities, including time, money, space, and policy support (Ajzen, 1991) and influence the behaviour of an individual.

Thus, it is evident that stakeholder behaviour significantly impacts CE adoption in CDWM. To overcome these obstacles, it is required to understand and address the fundamental constructs influencing behaviour of construction stakeholders (Geissdoerfer., 2017). A construct is a theoretical concept, theme, or idea based on empirical observations. However, constructs are usually not directly measurable (Bhandari, 2022). Therefore, indicators that are a measurable representation of constructs need to be derived (Bhattacherjee, n.d.).

However, the absence of clearly defined constructs and indicators makes it difficult to assess the behaviour of stakeholders. In addition, the constructs and indicators should be more closely aligned with stakeholders involved in the design phase, as this stage offers a prime opportunity to reduce waste at its source (Ajayi and Oyedele, 2018). To address this gap, this study aims to identify and validate a set of critical key constructs and indicators to assess stakeholders' behaviour towards CE adoption in CDWM. The constructs and indicators are identified through literature review and validated using the expert interviews. Thereby, this study facilitates the assessment of stakeholder behaviour and enables the formulation of targeted actions to enhance the adoption of CE principles.

LITERATURE REVIEW

Javid *et al. (*2021) defined behaviour as "Behaviour is the approach in which one performs certain actions in a given scenario concerning a set of targets." Studies have shown that both rational and moral factors significantly influence behaviour, particularly in contexts requiring sustainable decision-making (Ding *et al.,* 2023). Rational behaviour is the practice of making choices that result in the most optimal level of utility or benefit for the individual, based on logical evaluation and consistent with their self-interest and goals" (Becker, 1976). Moral behaviour is the conduct that is by accepted principles of right and wrong, and is often driven by ethical standards, societal norms, and the desire to act in a way that is valuable to others and society as a whole" (Schwartz, 1977).

Several inter-disciplinary research highlights the importance of incorporating rational and moral dimensions since the behaviour of the environment is a combination of altruistic concern and self-interest (Shi *et al.,* 2017). The CE adoption is considered environmentally friendly since it intends to minimise the usage of resources, waste reduction, and foster the reusing, recycling, and re-manufacturing of products and materials. By reducing environmental degradation, pollution, and resource waste, CE contributes to the well-being of the ecosystem and future generations (Ellen MacArthur Foundation, 2015). As a result, CE adoption has a characteristic of altruism and self-interest. Hence, it is required to assess both the rational and moral behaviour of an individual. Most research to date has focused on the rational

behavioural perspective, and, the moral behavioural perspective, has been comparatively underexplored. Ozaki (2011) described cognitive behavioural theories involves a rational assessment. On the other hand, Schwartz (1977) developed normative behavioural theories that emphasize personal norms and moral obligations. The TPB, developed by Ajzen (1991), is a cognitive theory explains behaviour through attitude, subjective norms, and perceived behavioural control. While TPB effectively models intentional decision-making, it has been criticised for neglecting moral and altruistic influences (Shi *et al.,* 2017). In contrast, the NAM, introduced by Schwartz (1977), focuses on moral obligations, personal norms, and awareness of consequences in shaping behaviour. However, NAM does not account for rational factors such as perceived behavioural control, social influences, and situational constraints (Fang *et al.,* 2021), limiting its applicability in complex decision-making environments like CE adoption.

Studies suggest that combining TPB and NAM can overcome these limitations, as it integrates both self-interest and altruistic motivations (De Groot and Steg, 2009). Therefore, integrating both rational and moral perspectives provides a comprehensive understanding of stakeholder behaviour. Ding *et al. (*2023) developed a behavioural assessment framework by integrating the TPB and the NAM. However, their study was limited to examining the behaviour of a single stakeholder group; contractors and focused exclusively on one CE principle; recycling. This narrow scope overlooks the broader array of CE principles, which are equally critical to comprehensive CE adoption. Furthermore, the effective implementation of CE in CDWM necessitates the participation and behavioural change of multiple stakeholder groups across the project lifecycle. Although some studies have discussed behavioural indicators in construction sector, there is a lack of comprehensive and validated indicators specifically designed to measure the constructs underpinning CE adoption in CDWM. This gap is particularly pronounced in the Australian context, where such indicators have not been empirically tested or contextualised to local industry practices.

METHOD

The TPB and the NAM are used as the theoretical underpinnings and identified through the systematic literature review as the most relevant theoretical frameworks to understand stakeholder behaviour in the context of CE adoption for CDWM. Based on these theories, a total of seven behavioural constructs were derived, four from TPB and three from NAM. Furthermore, the specific indicators used to assess each of these constructs were also identified through the literature review. These indicators were developed by analysing the behavioural barriers frequently reported in the literature. For example, according to the TPB, attitude is a key construct influencing behavioural intention. As noted by Ajzen (1991), cost is one of the factors that can significantly shape an individual's attitude. As stated by Curado *et al. (*2024), the perception of higher costs has been identified as a barrier to the adoption of CE, and from this, perceived cost has been derived as an important indicator influencing stakeholder attitude. The PRISMA methodology (Moher *et al.,* 2009) was employed for a structured and transparent review process, using Web of Science and Scopus, to source relevant studies published in the last ten years (Geissdoerfer *et al.,* 2017) concerning CE and CDWM. After applying inclusion and exclusion criteria, 26 articles were selected. The identified constructs and indicators are verified through semi-structured expert interviews. Purposive sampling was used to select experts from Australia to verify the context-specified constructs and indicators, and interviews were conducted with 11 experts. This non-probability sampling method is especially

appropriate because it enables the intentional selection of individuals who possess specific expertise and experience pertinent to the research topic (Palinkas *et al.,* 2015). The profile of the experts is provided in Table 1.

Table 1: Profile of Experts

Category	Designation, Code and Experience (years)
Industry	Design specialist (E01, >15), Non-executive director and company secretary (E02, >25), Urban planner (E03, 10), CE consultant and Civil engineer (E04, 10), Principal and consultant (E05, 20), CE specialist (E06, 10), CE pioneer and head of CE (E07, >30), Project leader (E08, >26), Environmental Sustainability Lead (E09, 10)
Policy	Policy designer (E10, >25), Senior environmental advisor and officer of the CEO (E11, 18)
Academia	Lecturer (E01, >15), Lecturer (E02, >25)

The participants in this study, with industry experience ranging from 10 to 30 years, possess the depth and breadth of knowledge required to validate the indicators for CE adoption in CDWM. Their experience aligns with the evolution of CE principles over the past decade, during which CE gained global recognition and became embedded in policies such as Australia's National Waste Policy Action Plan (2019) and Victoria's Recycling Victoria Policy (2020). Out of the 11 participants, 8 have expertise in CDWM and CE, while 3 specialise solely in CE. This distribution ensures that the study benefits from insights directly related to industry practices and the broader sustainability framework. Additionally, 2 participants have experience spanning both academia and industry, allowing for a balanced perspective between theoretical research and practical application. Furthermore, 2 participants are involved in policymaking, bringing an understanding of regulatory frameworks and government-driven initiatives. In comparison, the remaining 7 participants come from industry backgrounds, contributing firsthand knowledge of challenges and opportunities in CE implementation within real-world projects. This diverse mix of expertise ensures the study is grounded in both practical application and policy relevance, making the findings robust and applicable to the sector. The frequency analysis is employed as the analysis technique to identify the most stated indicators to measure each construct.

FINDINGS AND DISCUSSION

Seven key constructs have been identified by integrating TPB and NAM, including attitude, subjective norms, perceived behavioural control, and behavioural intention from TPB. The first three constructs are antecedents of the behavioural intention (Ding *et al.,* 202), and the intention can be derived by assessing those 3 constructs. On the other hand, personal norms, awareness of consequences, and ascribed responsibilities are derived from NAM. Further, as suggested by Marsh *et al. (*1998), a minimum of three indicators was used to measure each construct in this study. These indicators were derived from the identified behavioural barriers. The findings as illustrated in Table 2, will be discussed, focusing on the validation of these indicators and insights into their applicability in the context of Victoria. The table comprises the constructs, indicators, number of expert respondents who validated the indicators, and the agreed percentage, reflecting the extent of expert consensus obtained using the following formulae.

Percentage agreed = (Number of respondents who agreed/ total number of respondents) * 100

Rational Behaviour (TPB)

Attitude is an individual's favourable or unfavourable assessment of engaging in a particular behaviour (Ajzen, 1991). To measure stakeholder attitudes toward CE adoption, three indicators were developed from the literature by translating key

behavioural barriers into measurable elements. First, the barrier related to the perception of higher costs (Curado *et al.,* 2024) was captured as the indicator perceived cost, reflecting stakeholders' concerns that CE practices require more financial investment.

Table 2: Validation of Constructs and Indicators

Constructs	Indicators and agreed %	Definition of indicators
Theory of Planned Behaviour (Rational behaviour)		
Attitude (A)	Perceived cost (100)	Monetary cost that the user thinks he/she incur by adopting CE
	Perceived environmental benefits (100)	Beliefs about the positive outcomes associated with adopting CE in response to a real or perceived threat
	Policy objectives (81.82)	A set of ideas or plans that is used as a basis for making decisions to adopt CE
	*Education/ Knowledge (9.09)	Stakeholders' awareness, understanding, and technical literacy around CE principles, practices, and outcomes
	*Procurement and contract models (9.09)	Structure, conditions, and requirements embedded in procurement processes and contractual agreements that influence whether and how CE practices are adopted
Subjective Norms (SN)	Peer influence (81.82)	Process by which peers affect one another's behaviour to adopt CE
	Government pressure (100)	Formal mechanisms, such as laws and regulations, that authorities employ to influence individuals and group to adopt CE to align with societal norms and objectives
	Public pressure (100)	The influence that people feel from others in their social circle or society at large to act, think, or behave in a certain way
	*Leadership/ hierarchical influence (9.09)	Describes how organisational leaders or supervisors directly shape employee behaviours and norms, especially in hierarchical industries like construction
	*Company vision/ internal culture (9.09)	The degree to which a company's purpose or sustainability values influence individual decision-making
	*Shareholder and reputational pressure (9.09)	The external pressure from investors which influences organisations to adopt sustainable practices
Perceived Behavioural Control (PBC)	Skills (100)	The ability to retrieve knowledge and apply it to a task in a proficient manner
	Training (100)	The process of learning the skills you need to do a particular job or activity
	Financial incentives (100)	Monetary benefit paid by an organisation to motivate and encourage people to adopt CE
	Infrastructure accessibility (100)	The basic physical and organisational systems that enable people to adopt CE
	*Digital platforms (9.09)	Presence of digital systems that enable transparency, traceability, and operational ease in CE implementation
Norm Activation Model (Moral behaviour)		
Personal Norms (PN)	Personal commitment (100)	Individuals feel a sense of moral duty to engage in CE practices
	Environmental perception (100)	Stakeholders' views of environmental issues shape their sense of personal responsibility
	Balance of short-term and long-term considerations (100)	Consideration of long-term benefits over short-term costs in adopting CE
	*Social motivation and values (9.09)	individual's sense of responsibility or drive that arises from broader societal concerns rather than purely environmental or economic incentives.
	*Morality (9.09)	Internal ethical framework that guides decisions about what is right or wrong
Awareness of Consequences (AC)	Environmental benefits (100)	Knowledge among decision-makers about CE's ecological benefits
	Economic advantages (100)	Awareness of CE's economic potential
	Social implications (100)	Social outcomes of CE adoption
	*Existential threat and climate anxiety (18.18)	Awareness driven by emotional responses to environmental crises, including fear of collapse or concern for future generations
	*Consequences of inaction (9.09)	Understanding not just the benefits of CE, but the risks of continuing with business-as-usual practices.
Ascribed Responsibility (AR)	Guidelines (100)	A command or authorisation to act in a particular way on a public issue given by the electorate to its representative
	Mandates (100)	A command or authorisation to act in a particular way on a public issue given by the electorate to its representative
	Resource depletion (81.82)	Reduction of available natural resources due to unsustainable extraction and consumption.
	*Local impact awareness (9.09)	Feeling responsible when the consequences of their actions are tied to their immediate environment or community
	*Future harm and fear, and shame (18.18)	Emotional states that can trigger or strengthen one's sense of moral obligation to act sustainably.

*New indicators () Agreed %

Second, the barrier lack of awareness or appreciation for environmental benefits (Munaro and Tavares, 2023) informed the indicator perceived environmental benefits, which aimed to assess whether stakeholders recognise the environmental value of CE implementation. Finally, the lack of coherent policies and the persistence of regulatory frameworks that favour linear models (Mubarik *et al.,* 2024) led to the indicator policy objectives, intended to reflect how existing policies influence stakeholders' perceptions of CE.

Most experts agreed with these indicators and emphasized their continued relevance in practical settings. However, the policy objectives indicator received the most critical feedback. While acknowledged as important, several experts questioned its real-world effectiveness. Rather than viewing it as a stand-alone motivator, they believed its value lay in the way policy drives market incentives or procurement strategies. To highlight a few, "Policies should create market value and financial incentives, not just set guidelines (E10)." One expert noted that without enforcement, policy lacks behavioural power: "Having a policy is good… but actioning it is where we want them to get to (E03)." Apart from these indicators, several additional indicators were highlighted. Education/ knowledge of environmental benefits is highlighted by E03, and the expert emphasized that without understanding the benefits of CE, people may not develop a positive attitude towards its adoption. In addition, E06 emphasized procurement and contracting models as a possible indicator to measure attitude. The expert emphasized that CE adoption is heavily influenced by regulatory changes like mandatory Building Information Modelling use and how procurement is structured, especially in large projects where financial motivations override sustainability goals.

The social influences that individuals experience from others who hold significance for them when they are making decisions about their behaviour are defined as the subjective norms (Ajzen, 1991). To assess the influence of social pressure on stakeholder behaviour in CE adoption, three indicators were developed based on barriers identified in the literature. The barrier of resistance or scepticism from peers (Sajid *et al.,* 2024) informed the indicator peer influence, acknowledging the role of professional networks in shaping behaviour. The lack of support or endorsement from authoritative bodies (Mahpour, 2018) was translated into the government pressure indicator, reflecting the importance of top-down regulation and guidance. Lastly, the negative public perception of construction waste (Curado *et al.,* 2024) led to the public pressure indicator, which captures the broader societal expectations toward sustainable waste management. Although the government pressure and public pressure were acknowledged by all the participants, peer influence received mixed responses. While some experts agreed that colleagues and industry norms play a role, others disagreed or offered a reframing of this indicator. For example: "I don't think I would add pressure from peers… maybe more around the goal of your company as a whole (E02)." "Construction is a very hierarchical exercise... if your boss doesn't care about it, well, you won't care about it (E05)." Apart from this leadership or hierarchical influence (E05), company vision or internal culture (E06), and shareholder and reputational pressure (E04) are added by the experts.

The perceived behavioural control is the perceived difficulty or ease of carrying out the behaviour (Ajzen, 1991). The construct of PBC was conceptualised through three key indicators derived from barriers identified in the literature. The lack of skilled employees (Munaro and Tavares, 2023) informed the indicator skills and training,

highlighting the need for stakeholders to possess the necessary knowledge and competencies to implement CE effectively. The absence of financial incentives or supportive regulatory frameworks (Debnath and Sarkar, 2023) was translated into the indicator of financial incentives, acknowledging the influence of economic motivators in empowering sustainable decisions. Finally, the inadequacy of infrastructure for sorting, recycling, or reusing materials led to the indicator accessibility of infrastructure, reflecting how logistical and physical constraints limit behavioural control. Across the expert interviews, there was strong and consistent agreement on these indicators. The interviews also surfaced several important indicators such as technological tools and tracking systems, internal values and beliefs and logistics to measure the PBC. E03 recommended including tools like digital platforms, material passports, or product tracking systems to improve visibility and coordination across the supply chain by stating, "It would be great if we had platforms or systems… that allowed people to know where materials are going or how to reuse them".

Moral Behaviour (NAM)

Personal norms are the moral responsibility to carry out or refrain from activities, which is the prerequisite to behavioural intention (Schwartz, 1977). PN is defined using three indicators derived from literature on behavioural barriers to CE adoption. The lack of personal commitment to sustainability (Takacs *et al.,* 2022) was addressed through the indicator personal sustainability commitment, capturing whether individuals feel a sense of moral duty to engage in CE practices. The barrier related to prioritisation of short-term gains over long-term environmental goals (Bertolotti and Roman, 2024) led to the indicator short- and long-term consideration, reflecting the internal conflict between immediate rewards and sustainable outcomes. Lastly, poor environmental perceptions or beliefs (Chrispim *et al.,* 2024) informed the environmental perception indicator, which examines how stakeholders' views of environmental issues shape their sense of personal responsibility. These indicators were broadly supported by experts during interviews, yet they also revealed deeper insights into the drivers of personal norms. Experts offered meaningful additions to the indicators, which include social motivation and values, and financially rooted morality. E011 highlighted that "Circular isn't just environmental, it's social… you have to think about small business, lower cost for end-users, and job creation."

Awareness of the negative impacts on others or valued aspects when failing to act pro-socially is defined as the awareness of consequences (Schwartz, 1977). The barrier lack of knowledge among decision-makers about CE's ecological benefits (Kirchherr *et al.,* 2017) informed the indicator knowledge of environmental benefits. The limited awareness of CE's economic potential (Nujen *et al.,* 2023) led to the indicator economic advantages, and the overlooked social outcomes of CE adoption (Chakraborty *et al.,* 2022) were translated into the indicator social implications. These indicators were broadly endorsed by expert participants, who agreed that awareness of consequences is fundamental to changing stakeholder behaviour. However, interviews revealed that awareness is often lacking, particularly around the non-environmental impacts of CE. Existential threat and climate anxiety, and the consequences of inaction are mentioned as additional indicators. Particularly noted in interviews 06 and 07, experts emphasized that stakeholders especially younger generations, are increasingly influenced by fear-based awareness of global environmental collapse, where E06 stated that "Existential threat means the fear of dying… the global crisis has created anxiety amongst young people."

A sense of accountability for the adverse effects resulting from not engaging in pro-social behaviour is defined as the ascribed responsibility (Schwartz, 1977). To measure this, three indicators were developed based on the barriers identified in the literature. The lack of understanding among political decision-makers about CE's ecological impacts (Kirchherr *et al.,* 2017) informed the indicator mandates and guidelines, highlighting the role of formal frameworks in assigning responsibility. Most experts agreed with these indicators in principle, affirming that stakeholders are more likely to engage with CE when they perceive it as part of their role or obligation. However, the indicator resource depletion (part of social and environmental implications) was seen by some as too abstract or removed from people's daily experience. E05 reflected: "You talk about indicators of resource depletion. I kind of feel that they're too much for most people." Experts recommended local impact awareness, narrative of future harm and fear, and shame as drivers as additional indicators to measure AR.

CONCLUSION

This study identifies the key constructs and indicators necessary for assessing stakeholder behaviour in the adoption of CE principles in CDWM. The research systematically develops these constructs and identifies suitable indicators to measure each of them. Since the study was conducted in Australia, the identified indicators were validated through expert interviews to ensure contextual relevance. The findings confirm that attitude, subjective norms, perceived behavioural control, personal norms, awareness of consequences, and ascribed responsibility are crucial constructs influencing CE adoption. Experts unanimously validated the 19 key indicators identified in the literature, highlighting their importance in shaping stakeholder behaviour. Additionally, education/ knowledge of environmental benefits, procurement, and contracting models to measure attitude; leadership or hierarchical influence, company vision or internal culture, and shareholder and reputational pressure to measure subjective norms; technological tools and tracking systems, internal values and beliefs and logistics to measure the PBC; social motivation and values, and financially rooted morality to measure personal norms; existential threat and climate anxiety, and the consequences of inaction to measure awareness of consequences; local impact awareness, narrative of future harm and fear, and shame as drivers to measure ascribed responsibility are identified as additional indicators through expert interviews. The study contributes to existing knowledge by providing an empirically validated constructs and indicators for assessing stakeholder behaviour in CE adoption. Future research can be done to assess the behaviour of stakeholders to adopt CE in CDWM by using the validated constructs and indicators from this study. Also, studies can be conducted on how to change the behaviour of stakeholders to accelerate the adoption of CE in CDWM.

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