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A taxonomy of circular economy terminologies: insights from the construction industry

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Abstract

Purpose – Numerous barriers have hindered circular economy (CE) implementation in various contexts, in particular, in the construction industry. Among those barriers, the confusion of CE terminologies together with a lack of awareness is identified as one of the main barriers. Hence, this research focuses on differentiating frequently misused CE terminologies based on their definitions to establish a comprehensive understanding and thereby aims to develop a taxonomy for CE terminologies.

Design/methodology/approach – A qualitative approach was adopted encompassing a comparative literature analysis followed by an expert validation. To carry out the comparison, the academic definitions from Oxford and Cambridge dictionaries were compared and contrasted with the definitions from universal standards and guides or literature sources related to CE. Subsequently, the consolidated definitions were established for selected terminologies, and based on their cognitive meaning, a conceptual hierarchy of the terminologies was identified. These definitions with the identified hierarchy were validated by a selected panel of experts who had expertise in CE in construction and represented academia, industry and policy development sectors to finally propose the taxonomy of CE terminologies.

Findings – The final CE taxonomy presents nine frequently misused terminologies, their definitions and the hierarchical order. This paper further offers examples of the practical usage of each defined terminology based on insights from the construction industry.

Originality/value – The proposed taxonomy can be applied to any context and provides significant guidance for any CE researcher or practitioner on the appropriate usage of CE terminologies.

Keywords Circular economy, Construction industry, Definitions, Hierarchy, Taxonomy, Terminologies

Paper type Research paper

1. Introduction

Circular economy (CE) is a trending concept in many industries, which introduces an opposing approach to the prevailing linear economy approach. The "take-make-dispose" approach in the linear economy has been altered in CE by minimising "take" and "dispose" steps via closed-loop approaches like reusing, recycling, regeneration, etc. (Velenturf and Purnell, 2021). The transition towards CE is complex and necessitates a comprehensive effort to acquire the necessary knowledge for successful implementation (Chembessi, 2023; Illankoon and Vithanage, 2023; Koralage *et al.*, 2024). Research studies that facilitate the transformation towards CE have been in a rapid progression within the last few years and remarkable attention has been given to practical implementation and assessment.

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Guerra *et al.* (2021) and Friant *et al.* (2020) have noted that differences in definitions and terminologies in the CE realm are common. From the viewpoint of Rahla *et al.* (2019), variations in the definitions of these CE terminologies may cause ambiguities, when implementing CE within a particular context. In addition, the boundaries of CE definitions are not well-demarcated, and the ideas have overlapping areas (Pasqualotto *et al.*, 2023). These conceptual uncertainties in CE-related terminologies hinder its theoretical development (De Angelis, 2022). Similarly, Kirchherr *et al.* (2023) insisted that different and conflicting views about CE should not hinder its practical implementation and definitional improvements. Therefore, further studies should be conducted to enhance a holistic understanding of the CE concept and to standardise the definitions that are used for different CE-related terminologies (Ababio and Lu, 2022).

Identifying the above-discussed research problem and gaps, this study aims to develop a taxonomy for frequently misused CE terminologies with their definitions. The upcoming sections of this paper describe the key literature, methodology and research findings with the finalised taxonomy, and the paper concludes with recommendations and future research directions.

2. Literature review

2.1 Overview of the circular economy concept

The term "circular economy" was first mentioned by Pearce and Turner (1990), emphasising that the current economic system should be transformed into a circular one by considering waste as a resource (Andrade *et al.*, 2022). However, till the late 2000s, there was no considerable attention to the concept within the literature. With the Ellen MacArthur Foundation's (EMF) involvement in the early 2010s, the CE concept became popular in many industries. EMF's report in 2012 provided a boost for the CE concept to grow widely and rapidly (Fedotkina *et al.*, 2019).

EMF defines CE as an industrial system that is *"restorative or regenerative by intention and design"* (EMF, 2012). Later, Kirchherr *et al.* (2023) have studied 221 CE definitions to provide a comprehensive understanding of the CE concept but failed in defining other CE terminologies. Multiple government and non-government organisations have further investigated the CE concept and developed several CE principles and CE frameworks to facilitate the implementation of the concept. EMF has developed three principles (eliminate waste and pollution, circulate products and materials and regenerate nature) to wrap up the basic idea of CE and to direct how CE would be implemented within different contexts (EMF, 2012). The "ReSOLVE" framework was developed jointly by EMF and Arup, which has defined six action areas (regenerate, share, optimise, loop, virtualise and exchange) and assist various business sectors to succeed in their CE journeys (Smol *et al.*, 2023).

The British Standard Institute (BSI) has also developed six CE principles and published a guideline for CE named British Standard (BS) 8001:2017, which is recognised as the first guideline related to CE. The six principles defined in BS 8001:2017 are (1) systems thinking, (2) stewardship, (3) transparency, (4) collaboration, (5) innovation and (6) value optimisation. According to BSI (2017), these principles would assist organisations and governments in their decision-making. Recently, the International Standards Organisation (ISO) introduced six CE principles, namely (1) systems thinking, (2) value creation, (3) value sharing, (4) resource stewardship, (5) resource traceability and (6) ecosystem resilience (ISO, 2024a). Furthermore, Papageorgiou *et al.* (2021) have carried out a study on available CE principles in the literature and found that "R" principles, starting with 3Rs, have gained wide attention among different types of CE principles. The latest version with 10 Rs includes refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle and recover. These different sets of principles need to be extended to CE implementation and evaluation in different sectors.

At present, major industries like textile, food and agriculture, transport and construction have considered applying the CE concept and principles in their industries. This study includes insights from the construction industry considering its considerable contribution to the global economy and the difference it can make to the economy, society and environment through the adoption of CE.

2.2 Circular economy: the case in construction

Recent urbanisation has triggered massive demand for construction activities worldwide. Being highly resource intensive, the construction industry requires large amounts of natural resources and energy to cater to the aforesaid demand. According to Norouzi *et al.* (2021), these consumptions are about 50% of the global use of raw materials and 36% of the global energy consumption. On the other hand, the high demand for construction activities generates negative output to the environment via solid waste and emissions. The construction industry generates millions of tonnes of waste each year accounting for 30–40% of the global solid waste generation (Petrović and Thomas, 2024). As indicated in the report of the United Nations Environment Programme (2024), energy and process-related CO_2 emissions were 37% in 2022.

According to Lima *et al.* (2021), the weight placed on sustainable construction has increased rapidly around the world in recent years, due to the aforementioned industry's influence on natural resource reduction and massive waste generation. The main reason behind this negative influence is the use of the linear economy model within the construction industry, which eliminates the use of resources in an effective manner while disposing of them straightaway as waste. Thus, CE has been identified as a promising solution to attain a sustainable and circular construction industry.

Different obstacles have been identified in transforming towards a circular construction industry due to the construction industry's unique nature. In particular, the involvement of a variety of stakeholders causes competing aims to be achieved through the project (Jayakodi *et al.*, 2024a). Thus, achieving circularity becomes complex and needs a thorough understanding and coordination (Bertozzi, 2022). Various barriers have been identified by the authors that could occur during the implementation of CE within construction projects (Allam and Nik-Bakht, 2023; Mahpour, 2018; Ottosen *et al.*, 2021; Rahla *et al.*, 2019). Among them, the "ambiguity in CE-related terminologies" has been identified as a main barrier to implementing CE within the construction industry as highlighted below:

(1) Misunderstanding of the circularity concepts has been identified as a barrier to implementing CE within the construction industry (Allam and Nik-Bakht, 2023);

(2) Confusion can be observed regarding the interrelation between the CE meaning and other sustainability aspects in the construction sector (Bertozzi, 2022);

(3) Definitions of CE-associated terms have been used differently by researchers within the built environment context (Ababio and Lu, 2022);

(4) To transform towards a circular construction industry, there is a need for common definitions and terminologies (Ottosen *et al.*, 2021) and

(5) Various CE definitions create a barrier to assessing the circularity in buildings (Rahla *et al.*, 2019).

To overcome the above-discussed ambiguities, the often-misused CE terminologies that need proper definitions are identified in the next sub-section.

2.3 Identification of CE terminologies

This section intends to identify CE terminologies for the development of the taxonomy, based on their frequency of use and tendency to misuse. The term "CE concept" is selected as the starting point of the taxonomy. Based on the CE concept, different entities and individuals have developed "CE principles and frameworks", which have been briefly discussed in Section 2.1. These two terminologies have been utilised interchangeably on some occasions to refer to the same information in the literature. For instance, Papageorgiou *et al.* (2021) propose "R's as CE principles", whereas some authors define those as CE frameworks (Alcalde-Calonge *et al.*, 2022; Chizaryfard *et al.*, 2020).

Terminologies like "CE strategies" and "CE practices" are frequently found in CE literature and are vital for the transition towards CE in the construction industry (Klein *et al.*, 2020; Koralage *et al.*, 2024). These two terminologies have been used interchangeably in CE literature to indicate the same content (Gamage *et al.*, 2024). For instance, design for disassembling building components is indicated as a "practice" (Adams *et al.*, 2017; Benachio *et al.*, 2020; Ishan *et al.*, 2023) and as a "strategy" (Ghobadi and Sepasgozar, 2023; Guerra and Leite, 2021; Lee *et al.*, 2023). Besides, the same fact has been identified as a CE principle by Cheshire (2019).

Furthermore, there are commonly used terminologies in assessing CE implementation as "indicators", "indices", "measures" and "metrics" (Corona *et al.*, 2019; De Oliveira *et al.*, 2021; Khadim *et al.*, 2022), which are often used interchangeably in the literature (De Oliveira *et al.*, 2021), thus need clarification. There are several other related terminologies such as metre, scale, parameters and assessment frameworks occasionally used in CE assessments, which are not considered in this study.

Based on the above discussion, CE terminologies selected for this study are CE concept, CE principle, CE framework, CE strategy, CE practice, CE indicator, CE index, CE measure and CE metric.

3. Methodology

This research aimed to develop a taxonomy for frequently misused CE terminologies with their definitions in order to overcome existing ambiguities and support CE implementation and assessment within the industry. The research methodology of the study was chosen to align with this research aim, and the objectives to achieve the aim were formulated as: (1) to select CE terminologies that are frequently misused in the literature (presented above in Section 2.3), (2) to establish consolidated definitions for selected CE terminologies and (3) to develop a taxonomy of CE terminologies. An in-depth understanding of the CE terminologies and their application within a particular context was required to achieve the research objectives. According to Saunders *et al.* (2019), qualitative research methodology is ideal for developing new knowledge based on in-depth analyses. Thus, this research employed a qualitative research methodology encompassing a comparative analysis and a validation phase through an expert panel to achieve Objectives 2 and 3. The overall research process is shown in Figure 1.

A comparative analysis is a method that analyses phenomena and then puts them together to find the points of differentiation and similarity (Miri and Shahrokh, 2019). According to Esser and Vliegenthart (2017), comparative research focuses on understanding how the surrounding context influences communication outcomes, emphasising the explanatory significance of the environment and its role in shaping communication phenomena across diverse settings. According to Pickvance (2001), there are four types of comparative analyses: individualising comparison, universalising comparison, variation-finding comparison and encompassing comparison. Individualising comparison entails identifying generalities between two or more cases. Universalising comparison only highlights similarities and variation-finding comparison only highlights dissimilarities between cases. Encompassing method extends to explain the causes of the differences. Among the identified types, this research employed individualising comparison by comparing dictionary definitions with context-specific literature to identify generalities for consolidated definitions.

To achieve the second objective, the study referred to online academic dictionaries (Oxford and Cambridge) to find the generic definition of selected CE terminologies. Online specialised free dictionaries offer assistance to everybody in need of information while facilitating immediate responses (Caruso *et al.*, 2011). The authors further identified dictionaries as the best terminological resources. Subsequently, the universal standards, i.e. ISO 59000 series, guides published by various government and non-government organisations, and finally, CE literature was referred to where required, as shown in Figure 1, to find the definitions of the selected terminologies in the CE context. Then, the identified definitions were compared and

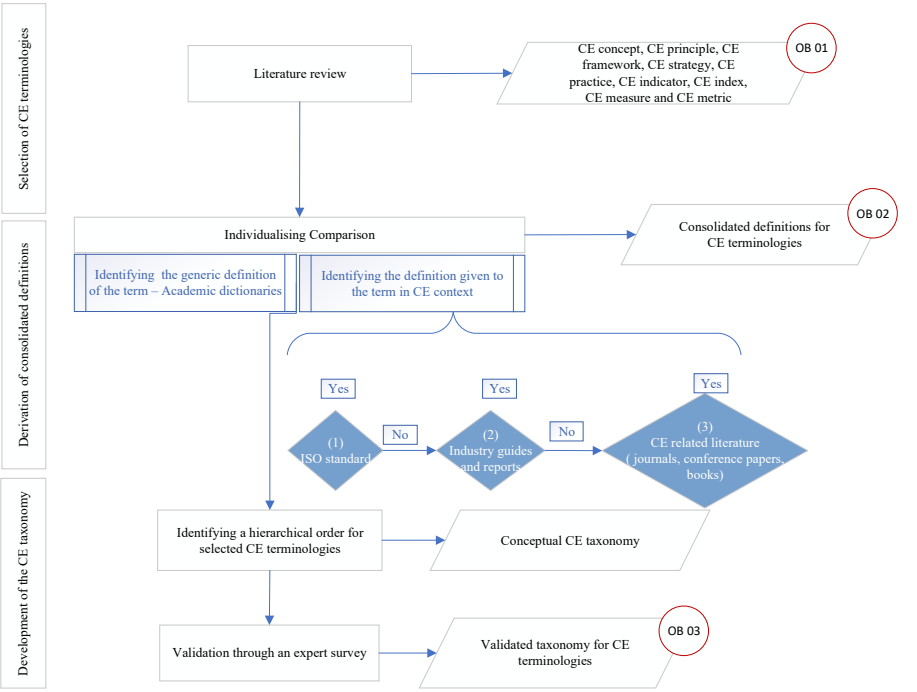

Figure 1. The overall research process. Source: Authors' own work

contrasted to identify the similarities and dissimilarities of the definitions to establish consolidated definitions for the selected CE terminologies.

Thereafter, the taxonomy development approach/method was employed to achieve the third objective of the study. Taxonomy is a methodology that involves systematically classifying elements in a defined hierarchical form. According to Liu *et al.* (2012), taxonomies are important in organising knowledge associated with a particular domain systematically so that users can easily refer to and analyse the relevant information. Nickerson *et al.* (2013) carried out a comprehensive survey analysis of the existing taxonomy development approaches and classified them into three categories: inductive, deductive and intuitive. The inductive approach entails observing empirical cases, which are subsequently analysed to identify dimensions and characteristics within the taxonomy. The deductive approach creates a taxonomy based on theory or conceptualisation, followed by testing with empirical findings. In an intuitive approach, researchers employ their own comprehension of the entities to be categorised to suggest a classification system. This study adopted a deductive approach, beginning with the establishment of a hierarchy of terminologies through a conceptual taxonomy.

Thereafter, an expert panel was consulted to validate the developed conceptual taxonomy of CE terminologies. The convenient sampling method under non-probability sampling was applied to select the experts. Since the theoretical aspects of CE is still evolving and often misinterpreted, a limited number of experts were carefully selected for the validation purpose, who were able to rationally comment on the developed taxonomy. As also supported by Gilbert and Prion (2016), in the areas where it is difficult to find experts, it is adequate to go with 5–10 experts for a validation process. Accordingly, the panel consisted of six experts. In order to represent various professional areas and levels, two experts from three clusters in the construction industry (academia, industry and policy development), who have more than 3 years of experience with CE were selected. The profiles of the experts are shown in Table 1.

Table 1. Expert panel's profile

Code	Designation	Experience in CE context	Cluster
Expert 01	Circular economy specialist, expert in circular design and sustainable solutions	Engaged in CE implementation and promotion activities in construction projects	Construction industry
Expert 02	Mining and environmental manager	Specialised in environmental aspects of CE in construction projects	Construction industry
Expert 03	Senior lecturer	Conducted research on CE and waste management in construction sector	Academia
Expert 04	Associate professor	Conducted research on CE assessment in construction sector	Academia
Expert 05	Head of circular economy development	Contributed to many industry forums and discussions to disseminate CE-related knowledge	Policy development
Expert 06	Circular economy lead	Engaged in council-level CE implementation and management activities	Policy development

Source(s): Authors' own work

During the validation phase, the experts were presented with the consolidated definitions for each terminology derived from the study, and they were asked to provide their opinions on the definitions. Thereafter, the developed conceptual taxonomy was presented, and the opinion on the hierarchical order of the CE terminologies was obtained. In the instances where their opinions deviated from the proposed definitions and the hierarchical order, the rationale for such deviations was also obtained. Manual content analysis was utilised to analyse the manageable amount of data arising from the experts' opinions, also considering its ability to assess data in a flexible manner allowing creativity and critical thinking compared to a software approach. Based on the findings, the final taxonomy for CE terminologies was developed.

4. Analysis and discussion

4.1 Derivation of definitions for CE terminologies

This section discusses how the definitions for the selected terminologies were derived step-by-step. The findings are summarised in Table 2. It starts with the comparative analysis of each terminology (column 1) between dictionaries and other sources (columns 2 and 3) to derive the conceptual definitions (column 4) and then considers the expert opinions summarised from the content analysis (column 5) to refine and validate the proposed definitions (column 6).

4.1.1 Circular economy concept. Oxford Dictionary defines a "concept" as "an idea that is connected with something existing in thought but not having a physical reality and often relates to something new". As a pioneer organisation in the development of the CE concept, EMF has defined CE as "an industrial system that is restorative or regenerative by intention and design" (EMF, 2012, p. 14). Recently, the ISO has defined CE as "an economic system that uses a systemic approach to maintain a circular flow of resources by recovering, retaining or adding to their value, while contributing to sustainable development" (ISO, 2024a, p. 1). Both definitions fulfil the characteristics of the "concept" as they refer to a system that exists in thoughts but does not have a physical reality yet. Hence, there is no contradiction in the dictionary meaning of the term "concept" and how it appears in the CE-related standards and guides. The definition given by EMF is widely used to define "circular economy", though many definitions came into existence later. Therefore, the authors believed that both "restorative and regenerative characteristics" should be included in the definition.

Table 2. Summary of the definitions of CE terminologies

Terminology (1)	Definition for the generic term (without CE) from dictionaries (2)	Related definitions from universal CE standards and guides (3)	Consolidated CE definition by authors, combining (2) and (3) = (4)	Expert opinion on the consolidated definition (5)	Final validated definition by combining (4) and (5) = (6)
Circular economy concept	"An idea that is connected with something existing in thought but not having a physical reality and often relates to something new"	"An economic system that uses a systemic approach to maintain a circular flow of resources by recovering, retaining or adding to their value, while contributing to sustainable development." (ISO 59004:2024) "A system that is restorative or regenerative by intention or design." (EMF, 2012)	"An idea about a system that is restorative or regenerative by intention and design"	• Proposed to incorporate part of ISO definition (2) into the consolidated definition (3) developed by the authors • Proposed to consider the regeneration of nature within the definition	"An idea about an economic system that uses a systemic approach to restore or regenerate nature by intention and design, while contributing to sustainable development"
Circular economy principle	"A basic idea or rule that explains or controls how something happens or works"	"Fundamental basis for decision-making." (ISO 59004:2024) – their general term for principle	"A fundamental rule or belief on which circular economy implementation is based"	• The term "belief" adds a low value to this definition • No need to keep the "implementation" word in the definition as this is a philosophical-level term	"A fundamental rule, on which a circular economy is based"
Circular economy framework	"A system of rules, ideas, or beliefs that is used to plan or decide something"	"Structure of processes and specifications designed to support the accomplishment of a specific task." (ISO 59004:2024) – their general term for a framework	"A system which is developed from CE principles and outlines a set of ideas to facilitate CE implementation within a particular context"	• This should not be specified to a context if at a higher level • No need to keep the "implementation" word in the definition as this is a philosophical-level term • The "set of ideas" can be written more specifically as "a structure of processes and specifications."	"A system, which is developed from circular economy principles, outlining a structure of processes and specifications to facilitate a circular economy"

(*continued*)

Table 2. Continued

Terminology (1)	Definition for the generic term (without CE) from dictionaries (2)	Related definitions from universal CE standards and guides (3)	Consolidated CE definition by authors, combining (2) and (3) = (4)	Expert opinion on the consolidated definition (5)	Final validated definition by combining (4) and (5) = (6)
Circular economy strategy	"A plan, scheme, or course of action designed to achieve an overall aim"	Note: could not find related definitions from universal CE standards or guides	"A plan to achieve a CE related goal established in the construction industry"	• Industry is a broader context. Therefore, better to narrow down the definition • A CE strategy should be an overall direction and purpose for an organisation towards its CE adoption, not a specific goal-oriented thing	"An overall direction and plan for circular economy implementation in a particular entity"
Circular economy practice	"An activity or action considered as being the realisation of a theory"	Note: could not find related definitions from universal CE standards or guides	"An activity that contributes to the implementation of a CE strategy in the construction industry"	• One expert suggested using "an implementation of a CE goal" instead of "the implementation of a strategy", while others agreed to keep it as it is • Industry is a broader context. Therefore, better to narrow down the definition	"An activity that contributes to the implementation of a circular economy in a particular entity"

(*continued*)

Table 2. Continued

Terminology (1)	Definition for the generic term (without CE) from dictionaries (2)	Related definitions from universal CE standards and guides (3)	Consolidated CE definition by authors, combining (2) and (3) = (4)	Expert opinion on the consolidated definition (5)	Final validated definition by combining (4) and (5) = (6)
Circular economy indicator	"Something that shows what a situation is like or how it is changing"	"Metric used to measure one or more circularity aspects." (ISO 59004:2024) "A quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor." (Organisation for Economic Co-operation and Development, 2014)	"A factor used to measure the CE adoption and transition of some construction entity"	• Proposed to use "metric used to measure one or more elements of an organisation's activities or solutions that interact with the circular economy." • Remove the phrase "some construction entity." • Rearrange the definition to a specific context • This should be at different levels • Remove "adoption and transition" and replace it with "assessment"	"A quantitative or qualitative factor that is used to measure different circularity aspects and, assess changes in circular economy implementation"
Circular economy index	"A number giving a measurement of something compared with a particular standard"	Note: could not find related definitions from universal CE standards or guides	"A quantitative measure that typically incorporates a range of indicators or measures to assess CE performance and progress, facilitating comparisons over time and across different entities"	• In general, experts agreed with the authors' definition, though saying it is vague and can be improved • One expert said that the use of a CE index is often redundant, as many indicators are already representing an aggregation of data. Therefore, the use of "CE Index" is likely to confuse more than clarify	"A quantified number that typically incorporates a combination of indicators to assess overall circular economy performance, facilitating comparisons over time and across different entities"

(*continued*)

Table 2. Continued

Terminology (1)	Definition for the generic term (without CE) from dictionaries (2)	Related definitions from universal CE standards and guides (3)	Consolidated CE definition by authors, combining (2) and (3) = (4)	Expert opinion on the consolidated definition (5)	Final validated definition by combining (4) and (5) = (6)
Circular economy measure	"A way of achieving something, or a method for dealing with a situation"	Note: could not find related definitions from universal CE standards or guides	"A specific action implemented to assess, monitor, and promote the transition towards a CE at a more focused and granular level"	• Remove the word "promote" as it is not aligned with assessment • See the definition for CE practice. The definition shown here is confusing with it, as here it starts with mentioning "a specific action". Rather it is "a method to assess circularity"	"A method of assessing circularity at a more focused and granular level"
Circular economy metric	"A system of measurement that uses metres, centimetres, litres, etc"	Note: could not find related definitions from universal CE standards or guides	"A unit that is used to measure the CE measures"	• See the definition of Circular Economy Indicator and distinguish it to align better with the dictionary definition	"A unit that is used in circularity measurement"

Source(s): Authors' own work

Thus, combining the generic definition of the term "concept" and EMF's definition of CE, the initial definition derived for the "CE concept" is "an idea about a system that is restorative or regenerative by intention and design". Afterwards, considering Expert 01's suggestion to incorporate the ISO definition and Expert 06's suggestion to incorporate the "regeneration of nature" within the definition, the initial definition of the term "*CE concept*" is altered as "*an idea about an economic system that uses a systemic approach to restore or regenerate nature by intention and design, while contributing to sustainable development*".

"CE concept" is a broader term at the philosophical level, which should be studied further and narrowed down until real implementation is possible. The upcoming sections will discuss the terminologies that are commonly used when narrowing down the CE concept.

4.1.2 Circular economy principles and frameworks. According to the Cambridge Dictionary, a "principle" is "a basic idea or rule that explains or controls how something happens or works" and a "framework" is "a system of rules, ideas or beliefs that is used to plan or decide something". The dictionary definitions depict that principles are established to inform and shape concepts, whereas frameworks can be a set of principles rolled together along with relationships and probable actions, which aid in planning something. The recent publication of ISO on CE defines a "principle" as "a fundamental basis for decision-making" and a "framework" as "a structure of processes and specifications designed to support the accomplishment of a specific task" (ISO, 2024a, pp. 3 and 9). Accordingly, within the CE context, CE principles shape the CE concept providing the fundamental basis. Thus, the authors primarily defined a "CE principle" as "a fundamental rule or belief on which CE implementation is based". Simultaneously, a "CE framework" was initially defined as "a system which is developed from CE principles and outlines a set of ideas to facilitate CE implementation within a particular context". Subsequently, these definitions were presented to the experts for validation and their opinions are summarised in Table 2. According to the experts' opinion, both terms are at the philosophical level; thus, it is not necessary to narrow down the definition to an implementation within a particular context. In addition, Expert 03 opined that the word "belief" in the definition of the "principle" lowers its magnitude and suggested removing the word. Furthermore, there was a suggestion that some wordings in the proposed definitions can be altered with the wordings given in the ISO standard to be consistent. In agreeing to these suggestions, the authors proposed the final definitions of a "*CE principle*" as "*a fundamental rule, on which a circular economy is based*" and a "*CE framework*" as "*a system, which is developed from circular economy principles, outlining a structure of processes and specifications to facilitate a circular economy.*"

The CE principles developed by the EMF and ISO can be identified as examples, which comply with the characteristics of the derived definition. The "ReSOLVE" framework described in Section 2.1 is an example of a CE framework at a higher level. During the practical implementation, separate entities like organisations, institutes and the government may develop their strategic plans based on these principles and frameworks. For instance, Iyer-Raniga (2019) has customised the ReSOLVE framework considering the emerging markets in the construction industry. Furthermore, it can be noted that the "Rs" do not comply with the definition of CE principles, as Rs represents a structure of processes rather than a fundamental rule. Since Rs exhibit the characteristics of a CE framework, it is appropriate to name them as frameworks.

4.1.3 Circular economy strategies and practices. According to the Oxford Dictionary, "strategy" means "a plan, scheme or course of action designed to achieve an overall aim" and "practice" means "an activity or action considered as being the realisation of a theory". The authors did not come across CE-related definitions for these two terms in universal standards and guides. Quoted dictionary definitions exhibit a clear difference between these two terminologies. Strategies are more from the managerial level, and they refer to an overall plan to achieve CE, which may contain practices as part of it. According to van Bueren *et al.* (2019), strategies refer to the theoretical picture, whereas practices refer to the practical picture of CE implementation. As mentioned in Section 2.3, there is some confusion between these two terms and the term principle. However, as per the derived definitions in Section 4.1.2, the term "principle" is at a high level in the hierarchy of CE-related terminologies.

Accordingly, consolidated definitions were formed by the authors, considering the need for a clear distinction between the two terminologies in order to avoid confusion and overcome theoretical obstacles in CE implementation. Hence, a CE strategy was defined as "a plan to achieve a CE-related goal established in the construction industry", while a CE practice was defined "as an activity that contributes to the implementation of a CE strategy in the construction industry". These consolidated definitions were presented to the experts, and their opinions were considered in deriving the final definitions of the two terms. As highlighted by most of the experts, the definition of the strategy is the same for any industry, and it should be an overall direction and purpose for an entity towards its CE adoption. Furthermore, Expert 02 suggested narrowing down the definition from the industry point of view, as "an industry" is a broader context. Considering the opinions of the experts, the term "*CE strategy*" can be finally defined as "*an overall direction and plan for* circular economy *implementation in a particular entity.*" Expert 02 had the same idea on the word "industry" in the consolidated definition of "practice" as well. In addition, Expert 03 suggested using the phrase "an implementation of a CE goal" instead of the phrase "the implementation of a strategy." Considering this point further, the authors reflected that the practices can be there with or without targeting a goal or strategy. Thus, the final definition of the term "*CE practice*" is defined as "*an activity that contributes to the implementation of a circular economy in a particular entity.*"

Various CE principles and frameworks discussed in Section 4.1.2 could help in setting CE strategies and practices. When the construction industry is considered, a strategy can be formed by different entities like the government, relevant institutions or top management of the construction organisations, whereas a practice can primarily occur in a construction project context. For example, a strategy implemented by an organisation can be achieved through multiple practices at the project level and applying practices may differ according to the project context. Thus, a CE strategy should be at a higher level compared to a CE practice. Gamage *et al.* (2024) identified a comprehensive list of commonly used CE practices in the construction context with their interrelationships.

4.1.4 Circular economy assessment-related terminologies. According to the Oxford Dictionary, an "indicator" refers to "something that shows what a situation is like or how it is changing". An indicator is further defined as "a quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect changes connected to an intervention, or to help assess the performance of a development actor" (OECD, 2014, p. 13). EMF (2015) has explained that CE indicators can be used to assess the CE implementation of any entity. By considering dictionary definitions and other definitions from professional organisations, the consolidated definition of "CE indicator" was formed as "a factor used to measure the CE adoption and transition of some construction entity". When validating this definition with expert opinions, Expert 01 suggested better incorporating the definition for CE indicator in the ISO59020: 2004 Standard. The standard has defined the "CE indicator" as a "metric used to measure one or more circularity aspects" (ISO, 2024b, p. 3). It provides evidence that indicators can be of a quantitative or qualitative nature. Even though the standard explains the indicator as a "metric", the word "factor" provides a holistic view to better reflect a range of indicators. Expert 01 further commented that indicators are focused on measuring one or more elements of an organisation's activities or solutions that interact with the CE. For example, Jayakodi *et al.* (2024b) identified such CE indicators relevant to construction organisations covering the construction project and organisational levels. Expert 02 suggested removing the word "some construction entity" and not specifying any context in the definition. Moreover, Expert 05 opined that "adoption and transition" should be replaced with "assessment". Considering the above expert opinions, the final definition for the "*CE indicator*" was derived as "*a quantitative or qualitative factor that is used to measure different circularity aspects and assess changes in* circular economy *implementation.*"

"CE index" is also identified as a misused term in CE literature. According to the Oxford Dictionary, an "index" refers to "a number giving a measurement of something compared with a particular standard", while "indices" refer to the plural form of the term index. Universal

standards or guides did not offer a suitable definition for the term "CE index". Therefore, the authors developed the conceptual definition based on the dictionary definition and evidence from the CE-related literature (mentioned in Figure 1). For example, EMF has developed an index for the material circularity indicator. The organisation has considered material inputs (what the product is made of and where those components come from) and waste outputs (what happens at the end of the product's life) and provided a quantitative value to show the level of material circularity of a product. Similarly, González *et al.* (2021) developed separate indices for material, energy, water and social circularity for construction projects. Accordingly, the conceptual definition for the CE index is termed as "a quantitative measure that typically incorporates a range of indicators or measures to assess CE performance and progress, facilitating comparisons over time and across different entities". During the verification phase with expert opinions, most of the experts agreed with the author's proposed definition. However, some opined that there is a further opportunity to improve to enhance its clarity. As a result, the authors considered some improvements such as replacing the phrase "quantitative measure" with "quantified number" and removing the words "measures" and "progress". Additionally, one of the experts commented that the use of a CE index is often redundant, as many indicators are already representing an aggregation of data. While the authors accept that it is true in the case of some indicators, the term "CE index" provides a collective figure of the overall circularity of an entity, which can easily communicate the level of circularity to the interested stakeholders. For instance, the Circularity Gap Report states that global circularity in 2023 is 7.2% (Fraser *et al.*, 2023). Accordingly, the finalised definition for "*CE index*" is "*a quantified number that typically incorporates a combination of indicators to assess overall circular economy performance, facilitating comparisons over time and across different entities*".

According to the Cambridge Dictionary, a "measure" refers to "a way of achieving something, or a method for dealing with a situation", while a "metric" refers to "using or relating to a system of measurement that uses metres, centimetres, litres, etc". Therefore, compared to indicators, measures are at a more focused and granular level. For both terms on CE measure and CE metric, the definitions from universal standards or professional bodies were not found. Therefore, the initial definitions were merely based on the dictionary definitions and evidence from the existing CE literature. For example, the study conducted by Torgautov *et al.* (2022) on the CE performance assessment of construction organisations elaborated on 52 CE measures. As the metrics of the identified measures, the authors have defined percentages as suitable metrics. It explains that measures and metrics are different and that the metrics are used to measure something. Hence, at the conceptual stage, "CE measure" is identified as "a specific action implemented to assess, monitor and promote the transition towards a CE at a more focused and granular level" and the "CE metric" was defined as "a unit that is used to measure the CE measures". When validating these definitions through experts, Expert 02 suggested removing the word "promote" as it is not aligned with the assessment. Additionally, two experts have commented that the conceptual definition of "CE measure" is confusing, as it starts with mentioning "a specific action", which is similar to the definition of "CE practice". Instead, "a method to assess circularity" was suggested by an expert, also to comply with ISO 59020:2024 Standard's term on "circularity". Taking all these expert views into account, the final definition of "*CE measure*" was rearranged as "*a method of assessing circularity at a more focused and granular level*". For the "*CE metric*", a slight change was made based on experts' comments and its final definition is "*a unit that is used in circularity measurement*".

4.2 Development of the taxonomy of circular economy terminologies

In order to address the ongoing issue of misusing CE-related terminologies in the literature, this study developed a taxonomy of CE terminologies, which is shown in Figure 2. The authors initially came up with a conceptual order of the CE terminologies, as shown in Table 2, and Figure 2 shows the final taxonomy that was verified by the experts.

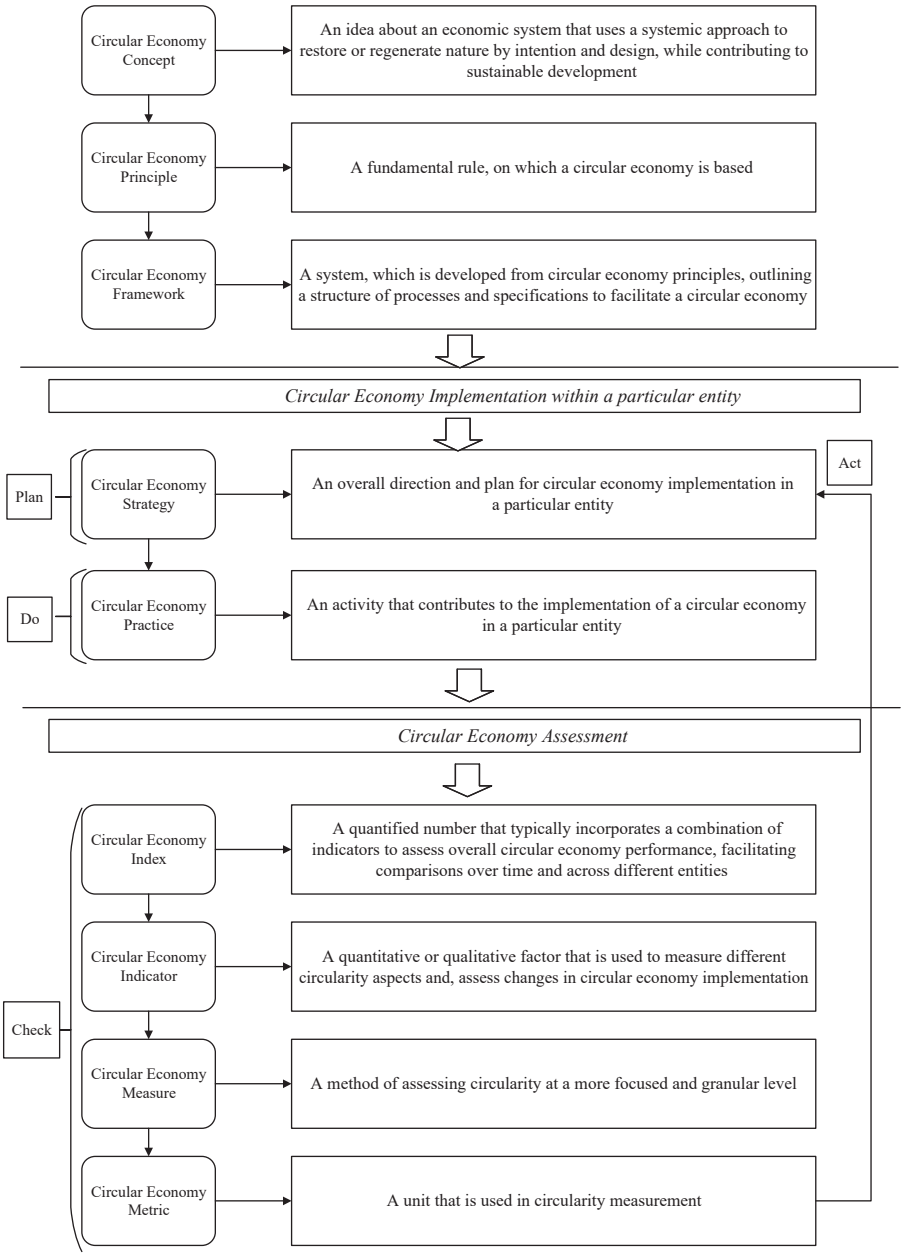

Figure 2. Taxonomy of circular economy terminologies. Source: Authors' own work

The proposed taxonomy includes nine frequently misused terminologies in implementing and assessing CE and follows a hierarchical arrangement. It begins with the broader term CE concept and is narrowed down to philosophical terms like CE principles and CE frameworks. Thereafter, the taxonomy is diverted towards CE

implementation within a particular entity and followed up by the assessment of CE implementation. In addition to the hierarchical arrangement, the definitions for each term, which were derived from the above discussions are provided. There was one main change from the conceptual taxonomy to the final taxonomy. Expert 05 highlighted that the "CE index" should come before the "CE indicator" as the index combines several indicators. The authors had noticed the same from the literature and agreed with the expert's opinion. Accordingly, the term "CE index" is moved up in the taxonomy.

The authors have also considered the ISO's "Plan-Do-Check-Act (PDCA)" model in preparing the taxonomy. The term "CE strategy" fulfils the requirement of a "plan" to implement CE in an organisation, and the term "CE practice" aligns with "do" following the plan. The assessment-related terminologies will "check" and monitor the progress of the organisation's progress toward CE and report results. Finally, the results from the assessment will "act" as a feedback mechanism for an organisation to improve its circularity performances.

4.3 Practical examples from the construction industry

Four example scenarios from the construction industry are elaborated in Table 3 to improve the understanding of the proposed hierarchy in the CE taxonomy. Corresponding to the discussions in Sections 4.1.1 and 4.1.2, the CE concept, CE principles and CE frameworks are at a philosophical level and commonly applied terminologies in any context. Therefore, those have not been considered for providing entity-specific examples. Starting from the term "strategy", a construction organisation has been selected as the entity to describe the examples across the implementation and assessment sections of the taxonomy. Four main themes, i.e. material, waste, energy and emission of CE, have been considered in providing examples.

5. Conclusions

The study aimed to propose a taxonomy of CE terminologies to mitigate issues related to misusing those in academic and industry contexts. To compare dictionary definitions and definitions in the global standards of various CE-related terminologies, the study used a comparative analysis methodology. Accordingly, consolidated definitions were derived for each term and a conceptual hierarchical arrangement of the terminologies was identified and validated through expert opinions to finalise the definitions and the CE taxonomy. The findings of the study revealed that the majority of CE terminologies are inappropriately used in the literature with regards to their theoretical meaning and many occasions were identified where these terminologies are misused.

The developed taxonomy would directly contribute to the existing body of knowledge and answer the prevailing issue of misusing terminologies in the CE literature. Since the developed definitions capture the available literature and practical aspects together, the reliability is high. Researchers, government or non-government organisations specifically focusing on the policy development for CE in the construction sector could use the definitions derived in this study. From an industry point of view, the taxonomy would assist in the proper implementation of CE within the construction industry, as it demarcates each step that needs to be considered during implementation and assessment. It is recommended to follow the hierarchical order given in the taxonomy to gather information and properly plan the CE implementation process within a particular entity. The examples given in Table 3 also provide guidance on how each term can be interpreted in the construction context. Even though the examples are provided from the construction industry, the developed taxonomy could be used in any industry following similar approach and practical applications, as shown in Table 3. Further research is needed to identify any refinements required when applying this taxonomy to other industries.

Table 3. Explanation of the proposed CE taxonomy using examples from the construction industry

Terminology	Final definition	Examples Example 1 material	Example 2 waste	Example 3 energy	Example 4 emission
Circular economy strategy	An overall direction and plan for circular economy implementation in a particular entity	Incorporating alternative material sources into new construction	Efficiently managing demolished materials	Using renewable energy sources	Tracking the embodied carbon emission
Circular economy practice	An activity that contributes to the implementation of a circular economy in a particular entity	Reusing materials in new construction activities	Identifying and recycling possible materials	Using solar power for electricity generation	Using embodied carbon calculating techniques
Circular economy index	A quantified number that typically incorporates a combination of indicators to assess overall circular economy performance, facilitating comparisons over time and across different entities	The amount of reused material used out of the total weight/ volume of the material	The recyclability value of the material	The amount of solar usage out of the total electricity consumption	The number of projects that implemented embodied carbon calculating techniques out of the total projects completed per year
Circular economy indicator	A quantitative or qualitative factor that is used to measure different circularity aspects and, assess changes in circular economy implementation	Material	Waste	Energy	Emission
Circular economy measure	A method of assessing circularity at a more focused and granular level	Amount of reusable materials	Recyclability of the demolished material	Amount of solar-generated electricity consumption	Degree of using embodied carbon calculating technique for construction projects
Circular economy metric	A unit that is used in circularity measurement	Percentage/ Mass/Volume	Percentage/ Mass/Volume	Percentage/ kWh	Percentage/ number

Source(s): Authors' own work

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