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The typology of 60R circular economy principles and strategic orientation of their application in business

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ABSTRACT

The circular economy is one of the recent concepts promoted as the pathway for further green and sustainable development, yet entrepreneurs and managers lack the knowledge on implementing circular economy principles. Assuming the multi-dimensional and systemic character of the circular economy, this article provides a road map of 60R circular economy principles that can be adopted in any company to create a positive economic, environmental, and social impact. This set of circular economy principles allows the existing performance of companies within environmental regeneration to be assessed, and identifies possible improvements to business circularity. Identifying additional "R" principles could lead to increased synergy or complementarity between them. These 60R circular economy principles are classified in four groups - reduce, reuse, recycle and reverse logistics. The proposed list of CE principles provides a useful framework for business managers to structure potential tasks and develop strategies for CE implementation and serve as a roadmap for researchers to extend existing research on CE principles. This study is based on the systematic literature review critically examining 148 articles and providing a comprehensive and profound overview of circular economy principles to be considered by business practitioners and entrepreneurs. Previously, CE principles are researched in environmental sciences, engineering, and energy. This article contributes to the existing knowledge gap and builds new knowledge on the discipline of business management, as publications in these fields are scarce. The study highlights the significance of reverse logistics and calls for extensive research on how companies can incorporate material or product returns into their business models or strategies, which is a critical research question for future studies.

1. Introduction

The Circular Economy (further - CE) imposes new challenges on entrepreneurs, how to balance interests of the business growth, and a positive environmental impact. The CE promotes sustainable consumption and for businesses that may indicate wrongly perceived signals of the necessity to reduce the quantity of products produced and sold. The CE is an opposite approach to the linear economy; yet the CE stimulates entrepreneurs to think about changing business practices, strategic aims, and perceived values. The CE highlights the necessity to find new revenue streams and develop business model innovations, allowing the creation of a positive environmental impact and an increase in social, as well economic value or profit.

The CE requires holistic changes (Evans et al., 2017) within the company activities. The CE may affect the strategic choices of company, its business model, and the business processes. We can distinguish circular-driven business start-ups with green or environmentally-friendly business ideas. At the same time, there are companies that are gradually transforming and searching for new solutions to adopt CE principles (Cirule and Uvarova, 2022). For both types of enterprises, circularly born and gradually transforming, CE principles are important to streamline the circular business approach.

The Ellen Macarthur Foundation, as the initial organisation defining the CE concept, explained more broadly the nature of material circulation flows, linking it with 3R principles - reduce, reuse and recycle. The Ellen Macarthur Foundation explained the reverse flows of materials

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which can occur in several cycles or "cascades" in cross-industry interactions (EMF, 2013). The Ellen Macarthur Foundation defends the opinion that companies integrating the CE principles compose an economic system that promotes the introduction of new operating principles and strategies in the company itself and its cooperation networks, the supply and value chains (EMF, 2013).

Previous studies propose 3R principles as the main actions of the circulation of materials (Ranta et al., 2018), the guiding directions (Geng et al., 2012) or prospects (Ghisellini et al., 2016) for companies when considering gradual changes towards the CE. These 3R principles are based on the waste pyramid hierarchy (Ghisellini et al., 2016; Kirchherr et al., 2017) and suggest the reasonable consumption of resources (Su et al., 2013) and proper treatment of waste or leftovers from the production (Giordano et al., 2020).

In addition to these initial 3R principles, practitioners and researchers tend to explore and define new CE principles (Reike et al., 2018), creatively continuing the linguistic game with the definition of new "R" principles, such as redeployment and remanufacturing, redesign and repurpose (Benton et al., 2014; Vermeulen et al., 2018).

Academic society has not agreed on the exact designation of these principles; also, perpetuating confusion between such terms as circular or circularity strategies (Alamerew et al., 2020; Blomsma et al., 2019), circular actions (EMF, 2015), circular practices (Bassi and Dias, 2019), CE approaches (Mestre and Cooper, 2017), CE tools (Yang et al., 2022) and others. This indicates an existing knowledge gap and the need to clarify CE principles and their relationship with the strategic choices and business models (Kirchherr et al., 2017; Morseletto, 2020; Yang et al., 2022).

Meanwhile, European companies are meeting the increasing green pressure triggered by the European green deal strategy (European Commission, 2019). Entrepreneurs and managers are forced to reconsider their strategies and the sustainable value creation (European Commission, 2022; Orazalin et al., 2023) to comply with the upcoming taxonomy requirements to report on ESG; namely, the environmental, social and good governance performance of companies (Imperiale et al., 2023; Kotsantonis and Serafeim, 2019).

Entrepreneurs lack the experience, knowledge, and practical tools to implement CE principles in the company and monitor positive environmental performance (Cirule and Uvarova, 2022; Uvarova et al., 2020). More importantly, without experiencing business benefits and economic returns, companies are not philanthropically motivated to think about creating positive environmental value (Porter, 2021).

A tendency can be observed whereby policy and development planners declaratively define sustainability and CE goals or expectations (Circle Economy, 2022; World Economic Forum and SAP, Qualtrics, 2021). Lazarevic and Valve (2017) consider that this goal-setting is not followed by practical solutions and tools for practitioners and organisations on how to implement the CE and create the necessary changes.

It is necessary to define and explain CE principles that show financial and non-financial benefits to companies, thus showing new opportunities for companies to create shared value. The creation of shared value means that a company pursues the generation of revenue in a way that provides not just financial returns, but also creates social and environmental benefits (Kramer and Pfitzer, 2016). The creation of shared value allows a balancing of the economic, environmental, and social value creation as part of the business model (Porter, 2021) and is ensured through sustainable business model innovations (Ritala et al., 2018).

The existing literature demonstrates a deficiency in uniform terminology and categorisation of CE principles suitable for implementation in companies (Morseletto, 2020; Reike et al., 2018). These researchers share common opinion and emphasize the importance of adopting new strategies and business models that promote circularity in corporations. The promotion of the business shift towards a circular economy is also actively advocated by European institutions and other global organisations (European Commission, 2019; Mhatre et al., 2021). The European Commission's pledge to promote circularity in businesses is projected to intensify (European Commission, 2022), urging companies to explore appropriate strategies, business models, and associated innovations (Bocken et al., 2022). The process of transitioning to a circular economy is increasingly influenced by the changing values and behaviour of society and consumers (OECD, 2018a).

Considering the above, this study will explore the following questions:

RQ1: What are the CE principles that can be adopted by companies and how can these principles be classified?
RQ2: What are the perspectives of the principles of CE and how are they related to the strategy and business models of companies?

These questions will be investigated using research methods such as a systematic literature review, comparative analysis and focus group discussions of entrepreneurs, and academic staff.

This publication will firstly outline the general conceptual framework and perspectives for implementing CE principles in companies. Subsequently, a detailed examination of the various meanings and characteristics of CE principles, activities, and strategies will follow. The study will then analyse common issues and significant differences in CE principles, activities, and strategies. Finally, the impact of these concepts on companies will be discussed, and potential managerial prospects for adopting CE principles within companies will be presented. Conclusions and future research directions will be identified at the end of the article.

The study aims to contribute to a better understanding of the perspectives on how and what types of CE principles can be adopted by companies to improve their circularity and environmentally-friendly business performance.

2. The research process and methods

The research process contains several stages and methods that are illustrated in Fig. 1. Primarily, the research process is based on a critical literature analysis, but at the final stage of the research, additional methods are used to verify the obtained results and deepen the discussion.

The systematic literature review comprises three distinct steps and is conducted based on certain principles suggested by previous researchers (Snyder, 2019; Tranfield et al., 2003). These principles include a transparent and traceable process, with a clear sequence of review steps, ensuring scientific and replicable outcomes. Relevant data metrics and software tools are utilised for data analysis purposes.

In the initial stage, the literature was screened to establish the research gap, primary research questions, and limitations. Subsequently, in the second stage, publications were obtained from the SCOPUS database, based on pre-defined selection criteria and specific keywords used in two search strings (as shown in Table 1). The bibliometric analyses were performed using the metadata of the selected publications.

The final step involved an in-depth literature review of the most pertinent articles. The review was limited to articles published between 2011 and 2022, based on pre-defined search criteria and limitations as shown in Table 1. While examining the most relevant publications, we applied the snowball principle (Wohlin, 2014) to widen the scope of the literature. This approach involved exploring additional sources of literature beyond the specified time frame, including articles cited or referenced in the initially-reviewed articles in the comprehensive pull of articles for the in-depth literature review.

The research process and methods were designed to ensure the validity and the reliability of this research (MacDonell et al., 2010). The research framework was designed based on the key concepts identified during the initial screening of the literature. The precise protocol with the selection criteria and keywords and phrases were defined and followed. We applied the theory triangulation by conceptualising main research gaps, specified key theoretical concepts and interpreted them in

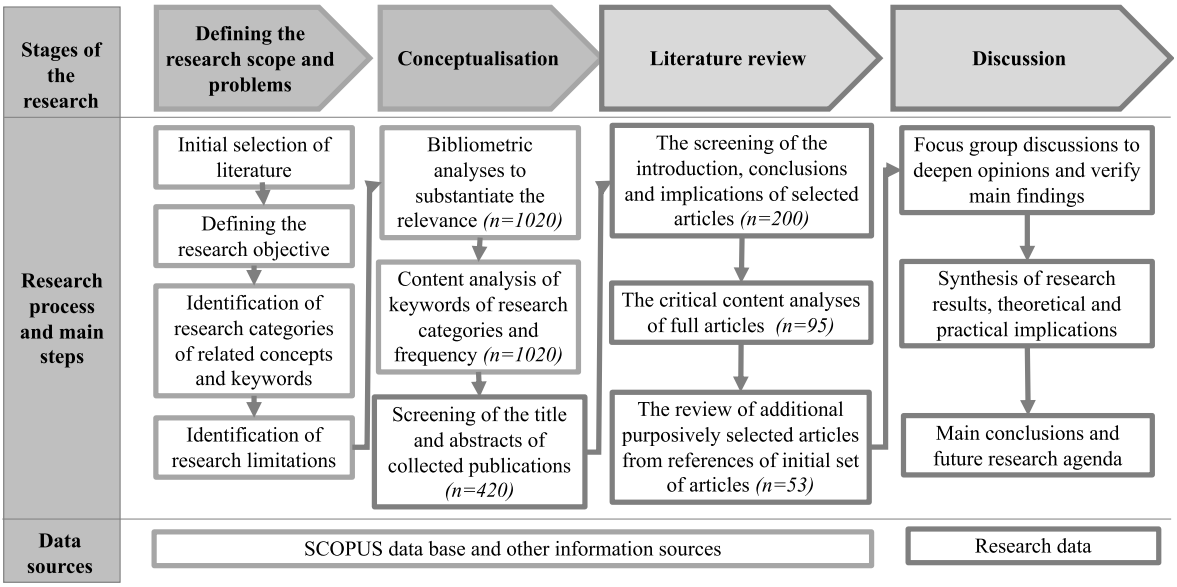

Fig. 1. The research process and methods, created by the authors.

Table 1
The criteria applied for the selection of the literature.

Criteria	Description
Language	English
Availability	Available on-line as the full text
Relevance of keywords	1) circular economy AND 3R 2) circular economy AND reduce AND reuse AND recycle
Coverage and variety	Cover different publishers and authors
The timeframe limit on the search	1) The main timeframe is from 2011 to 2022* (*first three quarters of 2022) 2) Additional literature resources (beyond the search timeframe) have been purposively selected from references of the initially selected literature, particularly, to examine previous theoretical concepts

Source: created by authors

relation to the results. During the literature review we explored key concepts, describing and comparing previously identified characteristics of related concepts. The main highlights from previous research were analysed in the context of the CE principles.

The definition and classification of CE principles involved a systematic literature review to identify these principles. Then this process contained creative contribution from the focus group discussions. Two in-person focus group discussions were conducted with around 20 professionals and researchers specialising in the circular economy, sustainability and business management (Fig. 2).

In the first focus group discussion experts verified the coding system and categories of CE principles revealed from the literature review. In this discussion, the formulation of certain CE principles was clarified, better reflecting the "re-" prefix trend. Experts emphasized the importance of creating four distinct groups of CE principles – #R1 reuse, #R2 reduce, #R3 recycle and #R4 reverse logistics. The on-line whiteboard (MIRO.com) was used for the visual and interactive facilitation of discussions on assigning CE principles to the respective group. Recommendations of experts were incorporated into the classification model of CE principles.

The 2nd focus group discussion supplemented with design thinking and ideation techniques were utilised to determine perspectives on how CE principles can intervene in a company's business model and strategies. These discussions ensured a broader range of opinions and enhanced the reliability of the findings presented in this article.

Additionally, three focus group discussions were held during online circular economy seminars for entrepreneurs and practitioners of the circular economy. In total, approximately 150 participants representing entrepreneurs, circular economy professionals and enthusiasts

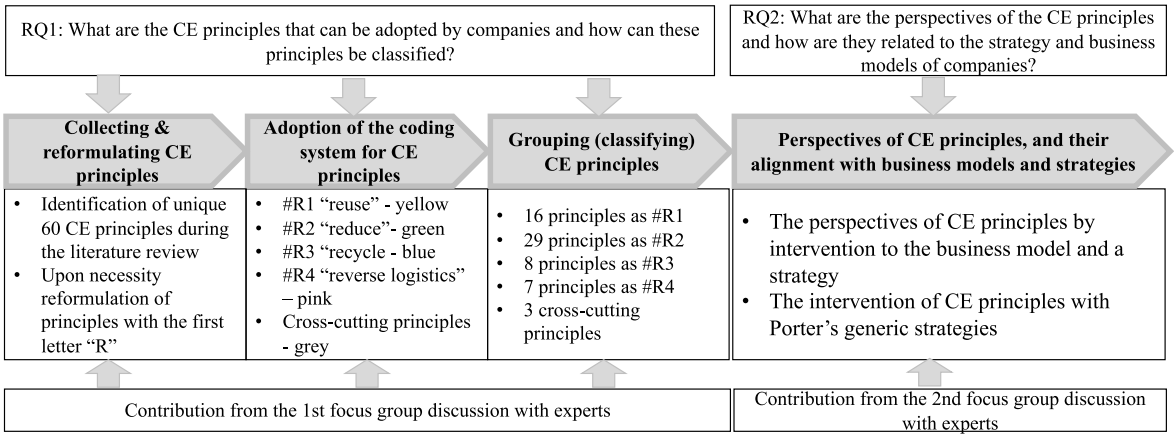

Fig. 2. The process of definition and classification of CE principles.

participated in these three focus group discussions. Interactive tools were utilised to facilitate the discussions and obtain feedback from the participants, such as an express survey pool to determine the most recognised circular economy principles, break-out discussions within smaller groups to collect feedback on the potential classification and types of CE principles, and open discussions in larger groups on the interpretation of CE principles and their alignment with business models and strategies within companies. These tools were employed to organise the discussions and gather comprehensive feedback from the participants. Following this, one distinct in-person focus group discussion was arranged with business management students who were instructed to utilise the 60R CE principles in case studies of specific companies. The students were asked to provide their opinions regarding the feasibility and clarity of the 60R principles, while assessing the circularity progress of the companies. These last four focus group discussions aided in formulating implications for managers.

3. Results of the literature review

3.1. The theoretical framework and the bibliometric analyses

The initial bibliographic analyses were carried out to substantiate the scope and a wider theoretical background of this research. For the analysis of the CE principles, publications with the highest citation index were selected in the SCOPUS database. Additional references were purposefully added to the pool of analysed articles, which allowed a wider analysis of studies to be conducted; also, by various international and professional organisations. In the SCOPUS database, publications were collected using two search streams each having the precise definition of search criteria and keywords (see Table 2).

According to bibliometric analyses, the academic discussions related to CE principles are mainly concentrated in the fields of environmental sciences, engineering, and energy. Although some studies have approached these issues from a business management and economic perspective, the number of scientific publications in these fields is considerably lower than in the aforementioned fields. This highlights the importance of conducting further research on these topics from a strategic management and business perspective, which could generate new insights for managers and entrepreneurs in adapting and developing business strategies, new business models supporting the transition towards the CE.

Fig. 3 highlights the novelty and actual relevance of this topic. Discussions on this topic have been increasing for the last three or four years; this might be influenced by stronger commitments assumed by European countries towards green development, pushing entrepreneurs and companies to reconsider their business approach. Such green pressure is also motivating the academic community to explain the implementation of CE principles in more detail and more precisely, as well as to study the benefits of companies so far, and the motivation to create a positive impact on the environment.

The content analysis was conducted using VOSviewer on publications selected from the SCOPUS database based on their title, abstract, and keywords. This software helped to visualise the most frequently used keywords and phrases in these publications. VOSviewer provides the visualisation of clusters with interrelated keywords or phrases using the text mining functionality from the full text of articles. The size of letters indicates the frequency of mentions of particular keywords, with larger letters representing more frequent words. The analyses of the co-occurrence of keywords provide an insight into interrelated concepts and indicates the most important issues to be investigated further in detail, as well as leading to essential findings (Philbin et al., 2022).

Fig. 4 demonstrates five clusters of interrelated keywords or phrases gained from the 1st search stream ("circular economy" and 3R) of the literature.

The initial set of chosen publications reveal that a cluster of keywords, depicted in purple, pertains to the 3R principles, although the keywords in this cluster are grouped based on issues related to construction and the demolition waste. This may indicate that the 3R principles have been applied more so far in the context of engineering, supplementing previously acquired findings.

However, the visualized clusters also show indications of other CE principles. In the red cluster the words are grouped around one of the 3R principles - "reduce". Issues related to the "reduce" principle such as raw materials and the life cycle assessment are included in this cluster. The life cycle assessment method is essential in analysing the usefulness of materials and their reduction possibilities. The cluster also highlights the agricultural sector, which is linked to the production of raw materials and indicates the important potential for implementing the reduce principle in the future. The presence of certain keywords such as the utilisation of natural resources and the imperative to limit non-renewable resources in this cluster supports the connection between agriculture and the implementation of the reduce principle. The research on the application of the reduce principle in agriculture could serve as a model for other industries to follow. This particular cluster of keywords and phrases depicts scholarly discourse concerning the responsible consumption and the possible influence of customers in promoting circular principles within companies.

The blue cluster indicates the discussion about the generation of waste and recycling possibilities. It also indicates the stakeholder perspective, assuming the necessity of cooperation between private and public sectors. The green cluster stresses a current research area related to the challenges and benefits of companies striving for the implementation of CE and cleaner production.

Based on Fig. 4, it can be inferred that there is a relatively low level of discussion about the implementation of the reuse principle and its associated processes. While the green cluster emphasises design approaches, the academic discussion related to it is not sufficiently extensive and meaningful. Moving forward, it is crucial to activate the adoption of CE principles that incentivize businesses to adopt eco-design approaches.

Further research on the utilisation of design thinking methodologies would be significant in facilitating the implementation of CE principles that prolong the usage of products, enable modifications in the functionality and application of utilised products, and establish novel

Table 2
The search streams of the literature sources, most published authors and disciplines, the number of articles.

Search streams and selection keywords	Number of articles	The most published authors and a number of articles of each author	Most represented research areas/ disciplines and a number of articles of each discipline
1st search stream: TITLE-ABS-KEY "circular economy" AND 3R	476	Garza-Reyes, J.A. (5); Geng, Y. (5); Ghisellini, P. (5); Rada, E.C. (5); Ulgiati, S. (5); Bassi, F.(4); Charef, R.(4); Cioca, L.I.(4); Karaca, F. (4); Ragazzi, M. (4)	Environmental science (318) Engineering (193) Energy (157) Business, management and accounting (126) Social sciences (91) Economics (65) Computer sciences (38)
2nd search stream: TITLE-ABS-KEY "circular economy" AND reduce AND reuse AND recycle	544	Kant R. (6 publications); Klemeš, J.J. (6); Lahane S. (6); Varbanov, P.S. (6); Wang, Q. (5); Yuan, X. (6); Kurniawan, T.A. (4); Piekarski, C.M. (4); Salvador, R. (4); Aarikka-Stenroos, L. (4)	Environmental science (306) Engineering (213) Energy (159) Business, management and accounting (143) Social sciences (87) Computer sciences (47) Economics (43)

Source: created by the authors based on the bibliometric analyses.

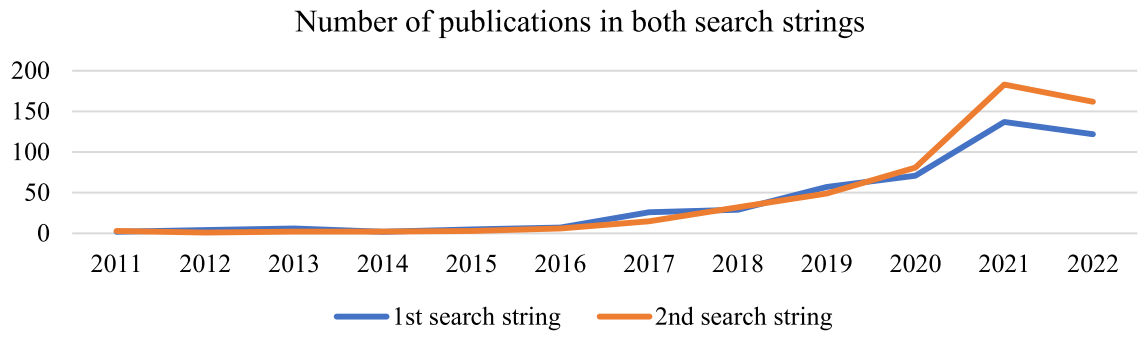

Fig. 3. Number of publications published each year from 2011 to 2022* (*first three quarters of 2022), created by the authors based on the SCOPUS data base.

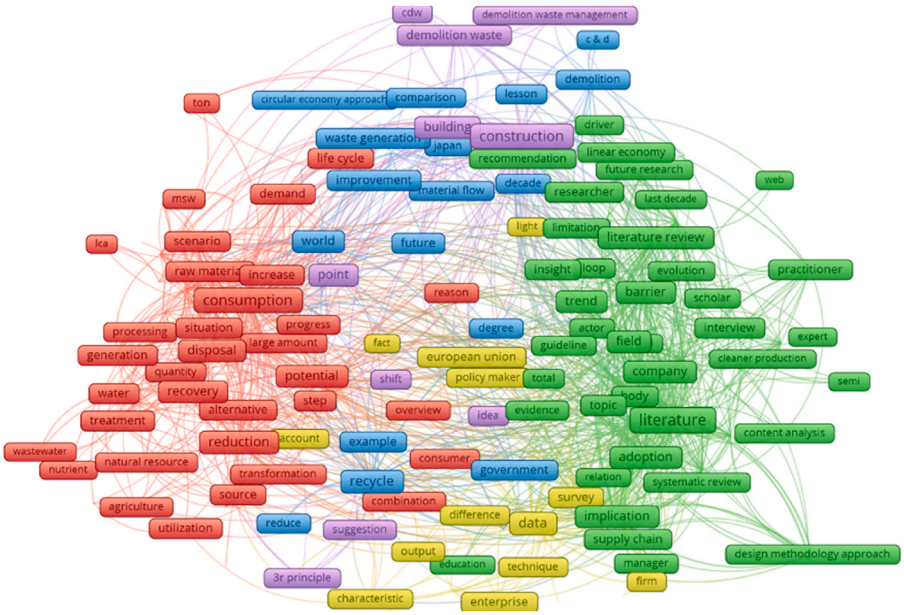

Fig. 4. The network visualisation of the co-occurrence of keywords “circular economy and 3R, created by the authors with VOSviewer.

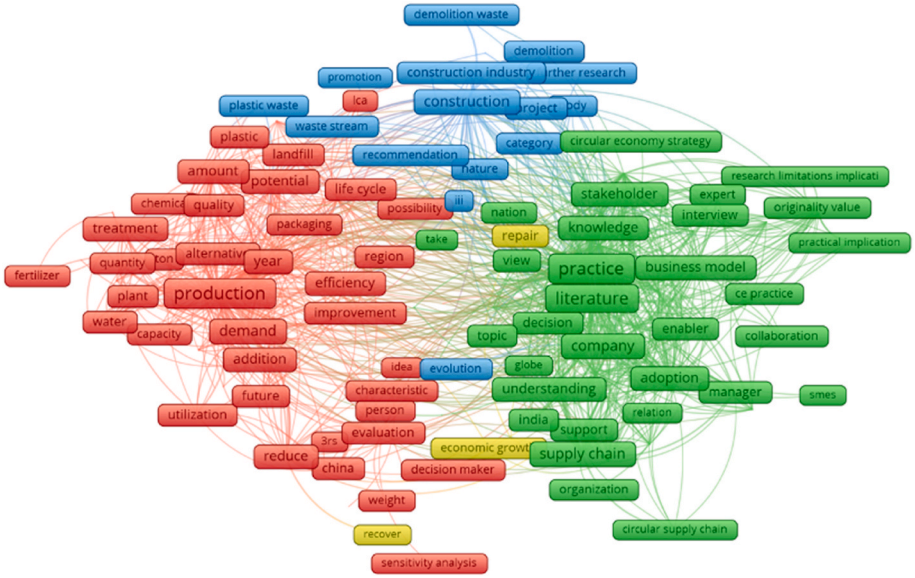

Fig. 5. The network visualisation of co-occurrence of keywords “circular economy”, reduce, reuse and recycle, created by the authors with VOSviewer.

business models offering services instead of the purchasing of product ownership, thereby promoting the circulation of a smaller quantity of products in the economy. In-depth analysis of such methodologies could provide valuable insights into the ways in which businesses can operate more sustainably, and thereby contribute to the transition towards a circular economy.

The findings depicted in Fig. 4 emphasize the significance of supply chains in achieving circularity through the creation of closed or narrow material loops. Nonetheless, the analysis does not acknowledge the fourth group of CE principles, namely, reverse logistics.

The absence of the fourth group of CE principles, reverse logistics, emphasises the novel character of this analysis and highlights the necessity for more comprehensive examinations on how companies can assimilate the return flow of materials, packaging, or end-of-life products into their circular business models or strategies. This constitutes a crucial research inquiry for scholars in the future to address reverse logistics as important group CE principles.

Fig. 5 demonstrates the main clusters of the second search stream and the interrelations of the keywords or phrases provided.

The content analysis of articles from the second search stream observes the intensive academic discussion on the initially-mentioned 3R principles and opportunities, challenges, and the necessary prerequisites for companies to create a positive environmental impact. This figure provides support for various aspects of the findings presented in the previous figure. Also, a significant range of questions is related to material flows and reasonable use of materials during the life cycle of products, as well as further use of waste in recycling. This group of literature also shows the importance of supply chains in the implementation of CE principles.

The academic literature frequently discusses circular business models and strategies, yet there is a need for greater distinction and clarification regarding the level of impact that CE principles hold on strategic and business model levels within organisations. The evaluation demonstrates that CE principles have different degrees of influence, with certain aspects linked to modifications in the operational level of business procedures that impact the business model and encourage innovation. The reference to strategies emphasises the continued importance of investigating the alignment of CE principles with business strategies. The content analysis lacks sufficient reflection on the varying levels of company strategies, which is an important aspect of the business and strategic management research perspective. This research investigates how CE principles can be integrated into generic strategies at the organizational level, expanding the knowledge into the intersection of business strategies and contributing CE principles.

These results support the importance of the chosen research scope and identify areas that warrant further investigation explored in later sections, particularly from the viewpoint of business and strategic management. This study supports the classification of CE principles into four distinct categories, which includes 3R principles as well as the addition of a fourth group called “reverse logistics".

Additionally, the analysis identifies and emphasises the gaps that were identified during the initial literature screening more accurately. From a methodological perspective, this content analysis plays a crucial role in this study by identifying and drawing attention to relevant issues and artifacts that need to be further explored. This reinforces the importance of addressing these gaps through thorough literature analyses, as outlined in subsequent sections. This analysis shows the multidimensional nature of CE principles, justifying the need to explore the development of concepts related to CE principles over the past decade.

3.2. Theoretical concepts and research perspectives related to the principles of circular economy

The concept of the CE can be seen on several levels. It is important to distinguish CE issues at a national level that can be referred as the macro level, the industry or regional level named as the meso level, and the micro level considering the CE adoption on the organisation or a company level (Uvarova et al., 2020). This research has a focus on the micro level scrutinising CE principles that can be embraced by businesses.

Research on the CE at the micro or an enterprise level has intensified more in the last 5–7 years mainly in two directions. One research direction analyses the practices carried out to increase the circularity of companies (Bocken and Ritala, 2021; Veleva and Bodkin, 2018), impacts or opportunities derived from the circular activities (Yu et al., 2022) and related challenges (Grafström and Aasma, 2021; Uvarova et al., 2020).

The second direction is associated with circular business models (Bocken and Geradts, 2022) and the value chain, which includes value proposition, value creation, value delivery and value capture, aligned with the CE principles (Geissdoerfer et al., 2017; Ranta et al., 2018). Additionally, international organisations (OECD, 2018a) and scholars (N. M. P. Bocken et al., 2016; Geissdoerfer et al., 2020) have put forward several classifications of circular business models that are pertinent to the CE principles, and offer guidance to entrepreneurs willing to become more circular.

The CE principles appear more like a guiding road map or practices for companies to make a positive contribution to the environment and the development of the CE (Ranta et al., 2018). Unlike business models, the principles of the CE can be of different scales and have different effects, either on the company’s strategy or the business model.

When describing the principles of ESG (Environmental, Social, Good Governance), the OECD emphasises that the principles are not legally binding, but rather concise, clearly defined, accessible and comprehensible steps or tasks for any organisation to develop their own initiatives, strategies, or action plans for intended changes (OECD, 2015). This clarification can be relevant to the development of CE principles.

The selected publications are further used for the content analysis of the selected publications in relation to the CE principles. Although the CE 3R principles were used and explained even before 2011, the literature within the framework of this study was selected for the time period from 2011, when the CE concept began to develop. The analysis of the literature initially selected shows the connection of CE principles with other earlier described theoretical concepts, which have had an impact on the further definition and application of these principles. Therefore, in further content analysis, the additional literature resources (beyond the search timeframe 2011–2022) have been purposively selected from references of the initially selected literature.

The literature review shows an active interest of leading research and higher education institutions to study more deeply issues related to the implementation of the CE in companies.

The Porter Hypothesis confirmed that the implementation of strict environmental requirements for companies promotes innovation and improves efficiency (Porter and Van der Linde, 1995). Porter advocated the opinion that positive environmental contribution encourages companies to introduce and develop new technologies, thus promoting the increase of the competitiveness of companies (Porter and Van der Linde, 1995). These findings indicate the significant impact of the CE on the development of various innovations in the company, such as product innovation, value proposition innovation, business model innovation, as well as innovation at an industry or ecosystem level (Konietzko et al., 2020a).

The development and implementation of the CE at the company level has been influenced by the service or functional economy (Stahel, 2005), which envisaged a change in the business mindset from the product sales-purchase process to the development of services providing the possibilities of using the products without the need to own these products. This further contributed to the development of the product-service system based on offering a product as a service. In turn, this is one of the principles or ways of implementing the CE in companies (Costa et al., 2018; Suárez-Eiroa et al., 2019).

The literature review leads to the various existing theories rather than a single theory or author that influenced the development of CE

principles (listed in Table 3).

The eco-design concept and the product life cycle approach have yielded several guiding principles for modelling the manufacturing process (McAloone and Evans, 1996), implementing recycling technologies to foster a resource-saving economy and resource recycling (Mizuki et al., 1996), promoting eco-efficiency, driving voluntary green transitions within companies, and fostering the growth of the green business movement (Newton and Harte, 1997).

The concept of environmentally-responsible production and inclusion of the environmental issues in the TQEM (Total Quality Environmental Management) quality standards have been setting the bases for further CE principles and the business contribution to the positive environment impact (Handfield et al., 2001). At the beginning of this century the comprehension and application of the corporate social responsibility (Lindgreen and Swaen, 2010) and corporate sustainability strategies (Lo and Sheu, 2007) were actively advanced by augmenting the knowledge about sustainable and transparent supply chains, and the advantages of responsible and traceable resources. This forms the groundwork of the CE principles that advocate the minimization of hazardous or toxic materials and resources of unknown origin.

Scholars (N. Bocken et al., 2016; Bocken and Ritala, 2021) propose examining the CE principles through the lens of material or resource usage, based primarily on the circular material flow model introduced by the Ellen MacArthur Foundation (EMF, 2013). One of these principles involves narrowing down the material flow to enhance the efficient use of raw materials and other resources, thereby aligning with the "reduce" principle. The second principle focuses on slowing down material flows by designing products with longer lifetimes, thus reinforcing the "reuse" or "use longer" principles. The final principle entails closing material flows by recycling or reusing materials (N. Bocken et al., 2016; Bocken and Ritala, 2021).

Notwithstanding, comprehending the purpose behind each of the suggested concepts concerning narrowing, slowing, or closing the material flow is somewhat challenging without further elucidation. Nonetheless, the 3R principles - reduce, reuse, and recycle - more explicitly convey their significance and are connected to specific objectives aimed at ameliorating ecological concerns (Reike et al., 2018).

A number of researchers have studied the implementation of CE principles in companies by industries or business sectors, for example, in the agricultural sector (Zhu et al., 2013), in the processing industry (Lieder and Rashid, 2016), in the field of plastic waste and its recycling (Huysman et al., 2017), in the field of construction (Ghisellini et al., 2018; Jin et al., 2019), in the textile and leather processing industry (Franco, 2017; Moktadir et al., 2020). These researchers emphasize that the adoption of CE principles may be different in each sector, but it is essential to analyse and summarize the practices and experiences implemented in the sectors.

In addition, scholars have compared the adoption of CE principles by sectors in European SMEs considering the age, size and country of these SMEs (Bassi and Guidolin, 2021). A Flash Eurobarometer 456 survey "SMEs, resource efficiency and green markets" (Eurobarometer, 2018) can be highlighted, in which 13,117 SMEs from 28 European countries were surveyed in 2017 about the implementation of eight CE principles and their further implementation in the business. This type of survey is an essential and important tool to assess to what extent and what type of CE principles are implemented by companies that are less understood and implemented. It also gives an opportunity to identify where additional incentives are needed to fuel more active adoption of CE principles.

This highlights the importance of such type of surveys and justifies the need to perform such studies systematically and regularly, instead of a one-time flash measurement. In response to the assumption expressed by the OECD that the circular economy is a growing niche whose volume cannot be accurately determined (OECD, 2018a), such a regular survey could be a kind of barometer or measurement that determines the volume of the circular economy in the overall national economy (Bassi and

Table 3
Theoretical concepts related to the adoption of CE principles in companies.

The theoretical concept	Contribution to the knowledge on CE principles	Scholars, references
Limits to growth	• Saving resources and efficiency of resources	Meadows et al. (1972)
Regenerative design	• Eco-design, resilient and adaptive design that emulates the processes and functions of the natural ecosystem • Pro-active contribution to environmental regeneration	John T. Lyle (Stahel, 2008)
Performance and function economies	• Sell product as a service, • Product – service system	Walter Stahel (Stahel, 1997, 2008)
Product – service system	• Rent, lease or other services • Customers pay for the use of a product rather than owning it	Annarelli et al. (2016)
Collaborative consumption and sharing economy	• Sharing of resources, assets, goods or products between individuals, organisations, communities • Commercial and non-commercial platforms ensuring collaboration and sharing options	R. Botsman, R. Rogers (Botsman and Rogers, 2010)
Cradle to cradle	• Designing and producing products that facilitate the recycling or regeneration of used products or their parts • Design for recycling or disassembly • Closed-loop production	Michael Braungart, William McDonough (McDonough and Braungart, 2002)
Industrial ecology	• Engineering of industrial process with minimised negative environmental impacts and stimulated resource efficiency • Closed loop production • Reuse and recycle, waste as valuable resource	Thomas E. Graedel (Graedel, 1996) Roland Clift (Clift, 2001)
Biomimicry	• Inspiration from nature and imitation of natural materials • Sustainable innovations aligning with natural ecosystem	Janine Benyus (Benyus, 1997)
Natural capitalism	• Natural ecosystem services • Restoring natural capital (natural resources)	Amory Lovins (Hawken et al., 2013)
Blue economy	• Sustainable use of marine or ocean resources • Sustainable fisheries, coastal and economic development respecting the marine ecosystem and biodiversity	Gunter Pauli (Pauli, 2010)
Bioeconomy	• Use of renewable resources • Bio-based materials and organic products • Biotechnologies	OECD (OECD, 2018b)
Green economy	• Economic growth balanced with the reduction of environmental risks • Pro-environmental values and attitudes • Clean and environmentally-friendly technologies	OECD (OECD, 2011)
Shared value creation	• Generation of economic value (a profit) simultaneously creating social or environmental benefits • Social or environmental value creation as part of a business model	Michael E.Porter (Porter, 2021; Porter and Kramer, 2011)
Corporate social responsibility	• Voluntary actions of companies to create positive social and environmental impact	Lindgreen and Swaen (2010)

(continued on next page)

Table 3 (*continued*)

The theoretical concept	Contribution to the knowledge on CE principles	Scholars, references
	• A broader responsibility of businesses to society and the environment beyond the financial performance • Transparency and accountability in business operations	
Stakeholder approach	• Considering needs of various stakeholders in business decisions • Balancing interests of various stakeholders rather than just shareholders	Edward R. Freeman (Kujala et al., 2019)
Extended producer responsibility	• Producers' responsibility towards waste - collection, recycling or appropriate disposal of used products or packaging • Managing environmental impacts throughout the entire life cycle of production and design of products that are easier to recycle and reuse	Walls (2006)

Source: created by the authors.

Costa, 2022).

The Eurobarometer survey data reveals that a large part of European SMEs have not considered implementing CE principles (Bassi and Dias, 2019). This is an essential signal for researchers, policy makers, educational institutions, and practitioners on the necessity to explain and promote the knowledge on the CE principles and their implementation experience. This analysis showed significant trends and differences regarding the existing practices and willingness of companies to implement CE principles (see Fig. 6). This analysis indicates that companies more widely recognize and practice CE principles related to resource saving and efficient utilisation, and are concerned about the waste disposal and possible costs associated with these activities.

The disinterest by SMEs to CE principles related to recycling can be associated with the limited access to funding and other pitfalls related to development of new technologies, thus strongly influencing the technical feasibility and financial viability to adopt these CE principles. Insufficiently developed understanding, experience, motivation, forms of trust-building and cooperation for the industrial symbiosis may further hinder the use of waste and residue from production. The multi-stakeholder cooperation on the ecosystem level is a strong driver for implementing CE principles (Velter et al., 2022).

The possibilities to adopt CE principles related to reuse and re-design of products for an extended lifecycle often require business model innovations (Konietzko et al., 2020a). Lack of knowledge and experience about business models, value creation and capturing through business model innovations could be one of the obstacles to implementing reuse related CE principles, especially in SMEs (Uvarova et al., 2020; Uvarova and Vitola, 2019) This leads to the discussion extended in the next section regarding the intervention of CE principles to business processes, business models and strategy.

3.3. The definition and evolution of the principles of circular economy

The academic community does not have a universally-accepted definition or a single theoretical concept of the CE principles. However, common terms utilised include CE principles (Ghisellini et al., 2016), advanced sustainability capabilities or circular strategies (Blomsma et al., 2019), CE activities (Katz-Gerro and López Sintas, 2018), target areas (Morseletto, 2020), CE arrangements or challenges (Korhonen et al., 2018) and others.

The review of existing studies covers different perspectives of CE principles, such as waste treatment, product design, the value chain perspective, the eco-design and production process, recycling, or the secondary use of resources. This demonstrates that the theoretical concepts previously examined have been further operationalised in CE principles. Appendix A presents a comprehensive outline of the research articles scrutinised in this study. The tabular format of this appendix illustrates the progression of academic discourse in the past decade, indicating the broadening of this area of study and the diverse range of perspectives since the introduction of the circular economy concept. This tabulated presentation offers a comprehensive chronological portrayal of the evolution of CE principles, providing an overview of novel research directions and contextual settings pertaining to the adoption of CE principles in business operations. The table incorporates the scholars and their studies reviewed in this literature analysis, and thus encompasses the dynamics of CE principles identified, as well as well as emerging trends and revelations.

In the 10 years following 2011, the 3R principles - reduce, reuse, and recycle - were fundamentally discussed by scholars, mostly in relation to the topic of waste management. These considerations were crucial for initiating further theoretical advancement on the adoption of the CE in companies. The academic community agreed that 3R principles represent a novel model of sustainable and recycling economies (Hu et al., 2011). Although the terminology and concepts differ, researchers share a relatively similar understanding of the nature and terms of 3R, namely - reduce, reuse and recycle, that indicate three CE principles (Bag et al., 2021; Benton et al., 2014; Kirchherr et al., 2017).

This also leads to criticism of the comparatively narrow scope of 3R principles and opened discussions in the academic community about the necessity to clarify and define more CE principles (Geng et al., 2012). Numerous scholars have attempted to expand upon the original 3R principles and have introduced various additional principles. However, there is no agreement on the exact terms, with each scholar offering their own definitions while retaining the letter R as a common element. For example, some scholars have proposed 10R principles, including refuse, rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, and recovery (Bag et al., 2021; Morseletto, 2020) while

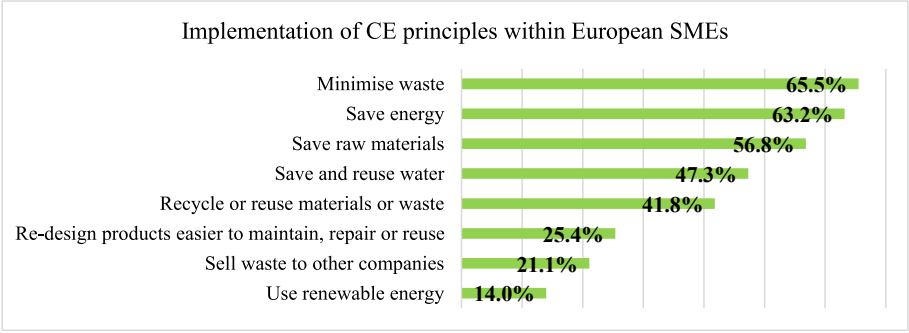

Fig. 6. The adoption of specific CE principles by European SMEs, created by the authors based on data retrieved from (Bassi and Costa, 2022).

others have formulated them as refuse, reduce, resell or reuse, repair, refurbish, remanufacture, repurpose, recycle, recover, and re-mine (Vermeulen et al., 2018). One can be concluded that R-type words associatively fit into resource loops and cascades of the CE (EMF, 2013), because when translated from Latin, it means "again" and "back" (Reike et al., 2018).

Most of the researchers understand these concepts as methods, tasks or actions that companies should take, not as strategies in the sense of organizational management theories defined by P.Drucker or J.G.March (Drucker, 2013; Starbuck, 2013) or the generic strategies defined by Porter (1985). However, these CE principles are closely related to the strategic choices or a standpoint (Ferasso et al., 2020) of any company. Also, CE principles represent strategic means of generic strategies (Murray, 1988; Porter, 1985) explaining or indicating what companies can do to develop the CE.

In addition, some CE principles are interconnected, and more often implemented in companies than others; for example, reducing waste and energy consumption is more often considered by companies. Less often, companies switch to the use of renewable energy resources or transform products and services according to the eco-design or circular design principles (Katz-Gerro and López Sintas, 2018) or re-purpose the functional use and the value proposition of used products (Zink et al., 2014).

3.4. Classification of 60R CE principles

Academics affirm that, irrespective of the number of Rs employed (3R, 4R, 5R, etc.), the R principles serve as the primary foundation for classifying or categorising the circular economy (CE) principles (Reike et al., 2018). Although there is currently no widely accepted classification or consistent interpretation of R-based CE principles, 3R CE principles receive the most attention from scholars and reveal the most distinct hierarchy and interrelationships (Reike et al., 2018).

The 38R principles (Reike et al., 2018) is an exhaustive list previously collected in a single and unified form. Also, the contribution by Mhatre and co-authors is noticeable with an extended list of 45 CE principles and indicating their relevance to particular sectors (Mhatre et al., 2021).

Based on the previous knowledge, we have collected additional principles found in the literature, clarified, or defined during the focus group discussions. Thus, our proposed number of CE principles symbolically reach 60Rs. In this study, when creating a list of 60R CE principles, it was assumed to continue the creative way of defining these principles with the first letter R. During the literature analysis, some principles were identified that did not have a name starting with the letter "R" and they were reformulated accordingly during the first focus group discussion.

Since the number of CE principles has reached 60, this number is difficult for the human mind to grasp. So, it is worth creating general groups of principles based on the 3R principles (reduce, reuse, recycle), because their meaning, the sequence and the hierarchy of their implementation is easier to understand and commonly agreed. Based on the content analysis, four categories of CE principles were proposed. Besides the initial 3R groups of principles an additional (4th) group "reverse logistics" has been introduced. This group covers such CE principles as the deposit system for the returning of packaging (bottles) or the platform-based new business models providing take-back and re-sell possibilities of used products or their packaging.

During the first focus group discussion experts categorised the listed CE principles into four groups. In addition, experts suggested that some principles may be relevant to multiple groups and should thus be labelled as cross-cutting. This process involved a creative and interactive exercise where each group of CE principles was represented with a unique colour, such as yellow for #R1 "reuse", green for #R2 "reduce", blue for #R3 "recycle", and pink for #R4 "reverse logistics". The cross-cutting CE principles were designated with the grey colour. The group of experts utilised an online whiteboard to allocate a distinct colour to each CE principle, indicating its association with a particular group. Consequently, the 60 CE principles were allocated into the following groups: #R1 "reduce" had 16 CE principles, #R2 "reuse" had 29 CE principles, #R3 "recycle" had 8 CE principles, #R4 "reverse logistics" had 7 CE principles, and 3 principles were designated as cross-cutting. These results are presented below (Fig. 7).

While 3Rs are commonly agreed as reduce, reuse, and recycle principles, the other Rs are defined differently and vary, regardless of the number of these principles. The number of R principles can be expanded and explained in more detail if they simply show the actions that companies should take rather than philosophically continuing the linguistic game of finding new "R …" words.

It should be considered that such game with R-words will be applicable only in English. While adapting and translating these CE principles into different languages the definition of principles may not use R letters. The most important in the list of R principles is to maintain meaningful understanding of each CE principle that it can really provide new ideas for any company willing to become circular. At the same time, it should be recognised that for the further enumeration and compilation of the CE principles, it is not essential to stick to words that begin with the letter R. This reveals from previous studies (Mhatre et al., 2021), where the meaning and significance of some CE principles can be more clearly described with other words, without creating a restriction of the letter R.

It is also necessary to continue the investigation of the specifics, range, and explanation of these principles in relation to specific industries or business fields (Mhatre et al., 2021). Researchers confirm this, for example, highlighting the need to define a wider range of CE principles in the construction and demolition sectors (Ghisellini et al., 2018).

Exploring and discovering novel "R" CE principles is a stimulating pursuit that may be employed by academics or practitioners to gain new notions for CE principles, examine business methods and generate additional theoretical deductions regarding drivers, benefits and challenges associated with embracing CE principles.

The process of discovering novel "R" CE principles offers a compelling and imaginative ideation activity for corporate stakeholders and practitioners to foster the creation of applicable and viable CE principles that cater to their organisation's specific needs. The search for new "R" CE principles can also function as an engaging linguistic exercise, heightening employees' and managers' understanding and consciousness regarding the CE. It may also encourage employees to empathize with self-generated circular concepts and recognize their significance in implementing such practices.

Several authors have proposed a list of 10R principles, which are simple to present, understand and memorise without additional explanation. Most importantly, these 10R principles should be the first milestones or strategic points for managers to consider the implementation of the CE in a business. Yet, in future studies, it is necessary to reach a common consensus on the precise list of 10R principles. Later these can be used as a good starting base for providing detailed clarification and examples for business managers and practitioners.

The more R principles appear, the more synergy, interdependence or complementarity exists between these principles (Morseletto, 2020). While the proposed list of CE principles is not exhaustive, it can provide a useful framework for business managers to develop strategies for implementing the CE in their organisations. It is not necessary to assign a precise numerical code to each "R" principle due to the evolving nature and expanding number of CE principles. Instead, the list can be used as a roadmap for entrepreneurs as a basis for generating ideas and further research by scholars.

The list of CE principles must be open to new ideas, knowledge co-creation and sharing. These CE principles must encourage any company to adopt principles from the existing list or define new principles customized to the specifics of their business.

In order to achieve a more comprehensive and effective

Fig. 7. 60R CE principles, created by the authors.

environmental value creation process, it may be necessary to implement certain CE principles in a specific order, ensuring their incorporation as a part of the business model and revenue streams. For example, when implementing the reselling of used products, it is crucial to consider the reverse logistics involved in taking these products back from customers, as well as potentially implementing a reward system to incentivize customers to return their used products.

4. Discussion

4.1. The intervention of CE principles adopted by companies

The literature review shows that high importance within the knowledge of the circular economy is related to sustainable and circular business models as a new opportunity for the environmental value creation in companies (N. Bocken et al., 2016; Bocken et al., 2018; Geissdoerfer et al., 2020; Stubbs and Cocklin, 2008). Academic discussions about sustainable and circular business models have been fuelled by the researchers' interest to analyse the nature and archetypes of business models. On the other hand, researchers analysing the implementation of CE principles use the term strategies for the implementation of the circular economy within a business (Alamerew et al., 2020; Blomsma et al., 2019), which other researchers define as activities or practices (Bassi and Dias, 2019). Accordingly, it causes confusion about how the concepts of CE principles intervene the business model and the business strategy. This leads to the necessity to clarify the concept of a business model and a strategy exploited further in this study.

Zott and Amitt as one of founders of the business model's definition, described the theoretical nature of business models and emphasized that a business model helps to reconsider business processes from a systemic perspective, rather than focusing on individual business functions or processes (Zott and Amit, 2010). Osterwalder clarified that a business model is a business architecture describing how the company will make profits, create and capture the value (Osterwalder, 2004).

Massa with co-authors highlight the multi-faceted nature of a business model and propose that the concept of a business model can be understood as an attribute of a company, a cognitive scheme, or a conceptual visual presentation, explaining activities performed by the company to create and capture a value. It also provides innovation opportunities on another scale, for instance, the value proposition innovation and innovative business models (Massa et al., 2017).

Authors have a common understanding with other researchers (Massa et al., 2017) that a business model is the description or the architecture of logics as to how an existing or intended business unit gains revenues, creates value, and exploits other elements of the value chain.

Osterwalder has highlighted the difference between a business model and a business strategy. According to Osterwalder, the business model draws a picture of the value creation and capturing and main elements necessary or associated with the value chain at this exact moment; the strategy deals with defining strategic ambitions for the longer perspective and the aims and values of the business. This researcher separates the functional level of business processes and functions (Osterwalder, 2004). However, this approach can be both conceptually and pragmatically challenged as the business model arguably covers day-to-day business activities, procedures and functions and should therefore not be separated from the business model. Strategic planning involves the articulation of an organization's vision, mission and objectives and the identification of the most appropriate strategy to achieve them (Fig. 8).

The viability of the circular business models depends on the opportunities for value creation and value capturing. Researchers emphasize that in order to promote the viability of adoption of CE principles it is necessary to create an attractive value proposition for the owners of waste and surplus materials so that the company has access to such resources from their owners (Veleva and Bodkin, 2018).

CE principles can be implemented differently in each company, depending on the products, the industry, and the company's specifics. Therefore, there is no uniform approach on how to adapt these principles in companies. The matrix illustrated below (see Fig. 9) can be a basis to envision and plan the adoption of CE principles in any company. As regards the intervention of CE principles, we have distinguished between those that affect a company's business model and those that

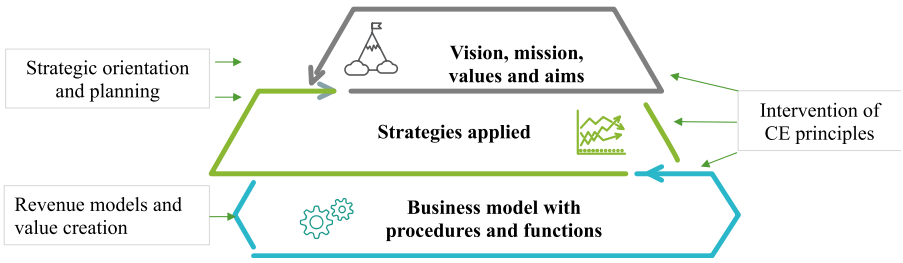

Fig. 8. The place of the business model in the hierarchy of company management, created by the authors.

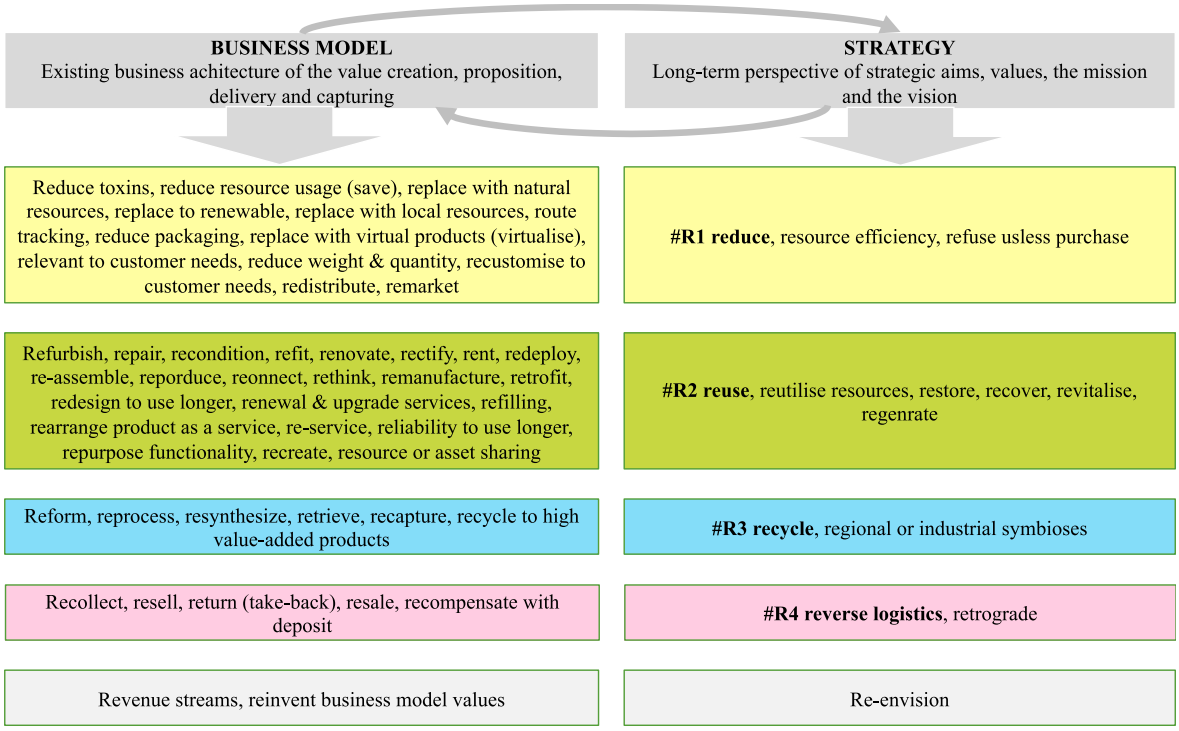

Fig. 9. The matrix of the division of CE principles by intervention to the business model and a strategy, created by the authors.

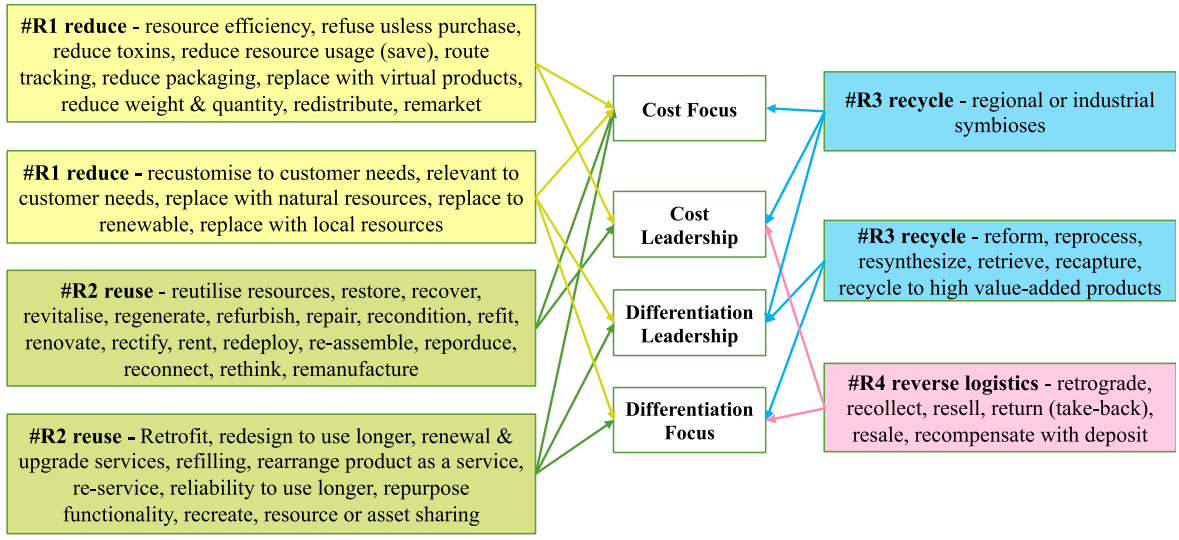

Fig. 10. The intervention of CE principles with Porter's generic strategies, created by the authors.

influence its overall strategy.

It is crucial for each company to evaluate how the selected CE principles impact their business planning and operations. CE principles that lead to immediate changes in value creation or revenue generation may relate to the business model, while those aligned with long-term strategic objectives are more closely related to overall strategy.

Yet, this is not a simple question and further research on the strategy aspects are needed, mainly considering that companies can have different strategies and they can be at several levels. To demonstrate the complexity of the strategy approach we exploited the concept of Porter's generic strategies (Porter, 1985) and tried to group CE principles according to intervention to each type of generic strategy (Fig. 10).

Porter has proposed four generic strategies. The cost leadership strategy is oriented on the minimization of costs in such acquiring possibility to sell products at a lower price. This strategy is intended to broader or mass-market segments and aims to achieve competitive advantages through the resource and cost savings, and utilizing the economies of scale (Murray, 1988). The CE principles oriented to resource savings and increasing resource efficiency under the "#R1 reduce" group of CE principles. In addition, some CE principles facilitate the economies of scale under "#R2 reuse" group of CE principles, for instance, sharing, re-using of resources or parts of products for re-manufacturing.

The second generic strategy is the differentiation which is intended for the creation and offering of unique products or services (Murray, 1988). The third group of CE principles (#R3 recycle) provides promising opportunities for producing innovative and high value – added products because of the up-cycling. There are a number of industries demonstrating innovative products produced from recycled materials and applied in the mass markets, for instance, in the milk processing (Uvarova et al., 2020a) or the production of rubber products from recycled end-life tyres (Uvarova et al., 2020b).

The third strategy has two sub-strategies "Cost Focus" and "Differentiation Focus". What distinguishes these sub-strategies from the previous ones is that these strategies focus on a niche market, where a company applies competitive advantages of lower prices or differentiation advantages by offering a unique product in a narrow segment of customers (Murray, 1988). The literature reveals the green value proposition is considered as the niche market, although it has a growing tendency (OECD, 2018a). Assuming this, most of CE principles promoting the sustainable consumption, reuse of products and extending their life-cycle can be considered as the value proposition for the niche market and thus contributing to one of "Focus" strategies.

In addition, the literature also mentions supporting principles or functions that simultaneously refer to several of the CE principles, such as eco-design (Karlsson and Luttropp, 2006) or circular design (EMF, 2013), life cycle assessment (Finnveden et al., 2009).

Kalmykova with co-authors found that the adoption of CE principles in the company depends on the levels of their implementation distinguishing three levels: 1) in the company's planning or policy documents, 2) in research and development (R&D) processes; 3) in the introduction of the product into the market or in the commercialization stage (Kalmykova et al., 2018). This echoes Bocken and Ritala's findings that CE principles can be integrated into the company's innovation process, which should be considered as an important additional level (Bocken and Ritala, 2021).

In recent years, researchers have increasingly been emphasizing the system approach to the implementation of the CE principles in the company, suggesting that the implementation of the CE in the company should be seen in interaction with the components in the wider system. Suárez-Eiroa with co-authors emphasized the need to educate stakeholders about the circular design and the CE, as the adoption of CE principles affects communication and cooperation with various external stakeholders, such as customers and suppliers, cooperation partners and other interested parties (Suárez-Eiroa et al., 2019).

Researchers stress that it is the personnel policy which stimulates the CE that is rarely used and implemented in companies, because contrary to the principles and values of sustainability policy employees are mostly rewarded based on the performance of a better and larger production or sales plan, not about the implementation of specific CE principles in companies (Veleva and Bodkin, 2018). The analyses of the information, big data and process are the essential elements of such systemic changes as the transition to the CE. This requires regular monitoring, analyses of product sales and demand by customer groups, traceability of material flows and the origin, product logistics within the supply chain, and other factors. Such information may provide indications on the potential tipping points where to start the adoption of the CE principles. The importance of the accumulation of data and information has also been mentioned by other researchers (Konietzko et al., 2020b).

This leads to the conclusion that adoption of CE principles is of a multi-dimensional nature. CE principles vertically integrates on various decision-making levels related to the company' strategy and the business model. CE principles can encounter simple tasks requiring minor changes in the behaviour of employees and can be simply adopted in a rather short time. This could be a common decision by a company to save some energy resources by limiting the exploitation of an elevator and motivating employees to use the stairs instead. In contrast, this can be a mid-term plan of the improvement of the energy efficiency within the production plant. In such a case it may require a change of technological equipment or technologies to more energy efficient options, the modernisation of the lightning system and other activities. These types of interventions will be more investment, efforts, and time-consuming initiatives. From the business model perspective some CE principles may require the introduction of new business models, new revenue streams and thus influencing all elements of the value creation, proposition, delivery and capturing. An example of such CE principles may include the introduction of the sharing business model or the product as a service business model (Boons and Bocken, 2018; Han et al., 2022).

4.2. The industry perspectives on economic and environmental impacts of CE principles

The preceding analysis provides an insight into the potential economic advantages that the integration of CE principles into various strategies can offer. These economic benefits encompass decreased costs through more optimal and efficient resource utilisation, improved treatment and reduction of risks.

The implementation of CE principles also creates opportunities to expand turnover and operational volumes through the introduction of novel products, revenue streams, and business models. This viewpoint is supported by other scholars who recognize the advantages of implementing circular economy practices at various levels of innovation (Konietzko et al., 2020b). The application of CE principles not only enhances the services provided by a company but also has a direct impact on its viability, cash flow, and revenue streams, resulting in stable and predictable financial outcomes.

The efforts to adopt each of CE principles can be communicated to stakeholders such as cooperation partners, customers, investors, and financial institutions, and this information can improve the company's reputation and external communication. As customers increasingly prioritize sustainability and environmental values, these factors have become key market trends that companies should incorporate into their operations and their communication (OECD, 2018a).

During the focus group discussions, participants engaged in an interactive dialogue using a theory of change approach (Funnell and Rogers, 2011) to explore the potential benefits, challenges, and drawbacks of implementing CE principles in the company. The benefits and drawbacks have been pre-defined based on previous research (Uvarova et al., 2020). Six potential benefits and drawbacks have been identified and assessed in terms of their significance for the group of CE principles

to which they belong using the Delphi method (Okoli and Pawlowski, 2004). The evaluation scale ranges from 1 to 5, where 1 represents a low level and 5 represents a high level. It is used to determine the extent to which a particular group of CE principles produces the intended benefits or poses challenges and repercussions.

Advantages and disadvantages of CE principles are shown in Fig. 11. This assessment provides an indication of a particular pattern in which each group of CE principles is associated with more benefits or challenges. These findings can delve into conducting more detailed empirical research on this matter, both for each CE principle individually and by considering characteristics of the specific industry.

This analysis suggests that the group of principles related to reuse has a lower rating of benefits and also associated with relatively low drawbacks. This may be attributed to the fact that this group of principles is not as extensively applied or comprehended among entrepreneurs, which results in a smaller amount of evidence and practice of such benefits.

There is a similar trend for the reverse logistics group when it comes to benefits, but it should be noted that this group is a novel set of principles proposed by this study. Among experts, the reverse logistics group is associated with the deposit systems for returning packaging, such as bottles, which have yielded several favourable outcomes as well as opportunities for improvements. This group would also require further in-depth empirical and conceptual research.

The Recycling group has a higher rating of drawbacks, acknowledging the resources, time, and effort required to establish the necessary technological processes. Nonetheless, empirical evidence indicates that such practices can yield considerable economic benefits for businesses (Uvarova et al., 2020a, 2020b).

This discussion holds great significance from a management perspective, as it involves the delicate balance between economic and environmental benefits. The key priority is to maintain balance, ensuring that challenges or negative impacts do not outweigh the benefits, including both economic and environmental. Therefore, it is crucial to assess the feasibility of implementing CE principles from a technical, institutional, and other pertinent aspects.

Additionally, it is vital to consider the emotional and social aspects of the implementation of each CE principle for stakeholders, such as shareholders, managers, employees, and other parties involved. If these stakeholders are committed to implementing such principles, they can offer their expertise, collaborate on creating new solutions, encourage communication and cooperation, apply their innovative skills and capabilities, and make other efforts to achieve results and mitigate potential challenges. Other scholars investigating circular business models also endorse this perspective proving the importance of the feasibility, desirability and viability (Bocken and Geradts, 2022).

Examining the environmental sustainability impacts of implementing CE principles is critical, as this represents the ultimate objective of the circular economy approach. In this regard, the study employed the grand ecological challenges or planetary boundaries framework, established by previous researchers (Kuckertz et al., 2019; Whiteman et al., 2013), to determine the contribution of each CE principle group towards mitigating these issues. This evaluation involved assessing each CE principle group on a scale of 1–5 (1 -low, 5 – high), measuring the extent to which the given group of principles influences each of the planetary boundary challenges (Fig. 12). The assessment was made during the focus group discussions, applying the Delphi method (Okoli and Pawlowski, 2004), similar as the above assessment of the economic advantages and disadvantages.

Based on the evaluations, it can be inferred that all CE principles have the potential to contribute towards addressing global sustainability challenges. The rating scale employed allows for a comparative analysis of the different principle groups, accounting for the variations in the size, scale and impact of individual companies. Each company can define the specific impact and outcomes to be attained by considering the varying performance scales and their individual size and scope of operations, or by determining industry averages. This observation has been previously made by other scholars (Lieder and Rashid, 2016).

From the assessment the recycling principles appears to have comparatively smaller impact, largely attributable to the extensive technological and production processes involved in recycling. While recycling enables the transformation of certain materials into new values and products, the process can also consume significant amounts of energy resources, produce emissions, and cause other repercussions. Nevertheless, it is worth noting that the recycling principles, while demonstrating a relatively lower impact level in the evaluation, may prove to be more impactful on a larger scale, such as at the level of a municipality or region. This is particularly true in the context of industrial symbiosis processes, which can facilitate the recycling activities and promote the efficient use of resources, thus generating positive environmental outcomes and contributing to addressing the listed grand ecological challenges.

The present assessment adopts a corporate perspective to provide insight into the potential environmental sustainability impacts when selecting any CE principle from the different groups. This assessment has the potential to offer guidance to companies in defining targeted environmental sustainability indicators within their strategic goals and strategies.

Additionally, it is noteworthy that this evaluation does not reflect on the impact of other influential factors, since most of these challenges necessitate systemic changes at the regional, national, or global level (Whiteman et al., 2013). Such modifications require the cooperation and engagement of various stakeholders in the same ecosystem. Nonetheless, the impact scales presented herein can offer reassurance and motivation

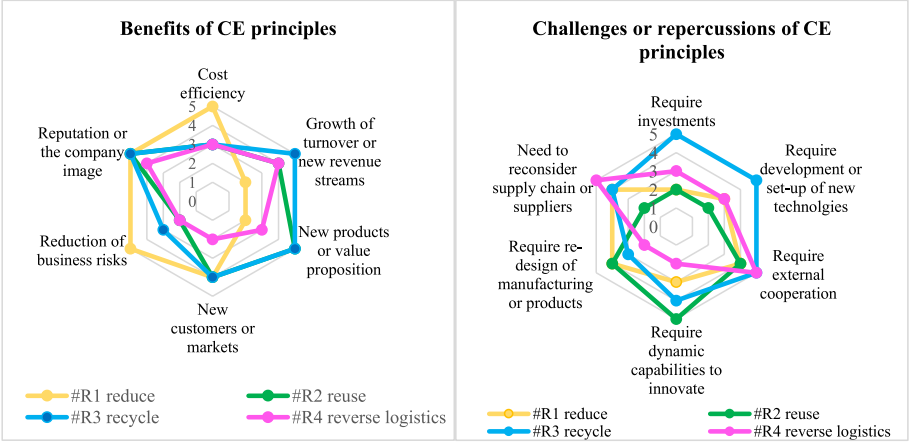

Fig. 11. The significance of benefits, challenges or repercussions depending on the group of CE principles, created by the authors.

Ecological challenges linked of the planetary boundaries	#R1 reduce	#R2 reuse	#R3 recycle	#R4 reverse logistics
Climate Change	4	4	4	4
Biodiversity loss	4	4	3	3
Ocean (water) acidification	3	3	5	5
Exhaustion of atmospheric ozone	4	3	4	4
Global freshwater over-consumption	5	3	3	3
Agricultural land use change	5	3	2	2
Nitrogen and phosphorus production	3	4	3	3
Atmospheric pollution load	3	4	4	4
Chemical pollution	5	3	4	4

Fig. 12. The impact of CE principles on mitigating the ecological limits of planetary boundaries, created by the authors.

to firms and managers, demonstrating that any measure taken towards the implementation of CE principles can yield a positive effect, albeit modest.

Furthermore, to achieve a more precise assessment of the influence of each CE principle, detailed case analyses may be employed. Such analyses enable a determination not only of the exact extent of the positive impact of each principle but also of the negative consequences associated with the specific CE principle. Researchers have previously employed similar approaches, utilizing life-cycle assessment and eco-design principles, to evaluate various CE principles (Spreafico, 2022).

4.3. Contribution to the literature

This research targeted answering the following research questions: What are the CE principles that can be adopted by companies and how can these principles be classified? What are the perspectives of the CE principles and how are they related to the strategy, business models and other business processes within companies?

This study contributes to the previous knowledge gap in the following aspects. Firstly, this study provides a systematic review of CE principles and draws an extensive list of 60 CE principles that can be implemented by companies to comply with the green and circular transition.

Secondly, this study proposes the classification of four groups of CE principles – #R1 reduce, #R2 reuse, #R3 recycle and #R4 reverse logistics. This classification is based on commonly used 3R waste hierarchy and adding the reverse logistics as the fourth group of principles.

Thirdly, this study clarifies the previous confusion of scholars between the terms and concepts of circular principles, circular activities, circular business models and circular strategies. This study analyses the intervention and relationship of CE principles with the strategy of a company, a business model and other support process on the operational level in the business management.

This study advocates the idea that it is necessary to distinguish listed CE principles from the strategies. Previously, researchers have superficially applied various terms such as circulation practices, activities, principles and even strategies, without distinguishing their essence. We tried to clarify the nature of CE principles and various perspectives of CE principles. By the construal nature, CE principles can be considered as the strategic means (Murray, 1988) that depending on the strategic aims, ambitions and expected results can intervene a strategy with a list of principles to be followed as precise tasks to be achieved in a shorter period or general business values to be followed in a longer period. Several CE principles adopted through already applied eventual incentives or systematic practices may support the implementation of the envisaged strategy, for instance the life cycle assessment or Lean (Finnveden et al., 2009; Shokri et al., 2022).

4.4. Managerial implications

The business representatives reconsider shared or sustainable value creation, which means that apart from profit and economic value creation the company needs to address social and environmental challenges (Bocken and Ritala, 2021; Porter, 2021).

The need to implement CE principles is created by growing green pressure in the external business environment that is expecting companies to create social impact for society and ensure environmental regeneration unless internal stakeholders have strong sustainability ambitions and empathy towards the adoption of the CE principles. Mostly, the concerns of the internal business environment are related to ensuring the financial viability of the business while considering shared value creation.

Researchers agree that it is necessary to continue research and collect information about CE activities in companies. The potential range of CE principles grows with the experience and new practices of companies to become more circular and environmentally friendly. The business advances with the circular experience and so new CE principles develop and set-up in already proved daily business processes or new business models. Currently, when all sides lack the knowledge and verified practices, the key towards adoption of CE principles is the experimentation and collaboration to build new experiences in implementing CE principles in companies (Bocken and Ritala, 2021; EMF, 2021).

The CE principles proposed in this study are different in terms of their complexity, technological feasibility, and financial viability. Their mutual combination, creative and flexible development of new ideas can reveal new opportunities for the development of the CE principles in the company, and more importantly, may provide new opportunities for the economic and environmental value creation.

The ability of companies to implement CE principles in their business varies. Researchers (Bocken et al., 2014; Veleva and Bodkin, 2018) have concluded that the introduction of CE principles is much more possible and easier in large companies because they have more accessible resources and infrastructure, better opportunities for implementing CE related innovations and resistance to unforeseen risks.

Newly established companies with the initial circularity ambition are more motivated and empathetic in following environmentally-friendly values and creating a positive environmental impact. However, start-ups and small companies have weaker financial capacity and higher risks related to the viability for the adoption of CE principles (Cirule and Uvarova, 2022). Newly-established and small companies can react to

external environmental factors much more flexibly and quickly and use them positively for the implementation of CE principles; on the other hand, under the influence of strong external negative factors they may not be so resistant to risks (Veleva and Bodkin, 2018). Bocken with co-authors believe that newly-established companies will react much more sensitively to changes in legal regulations related to environmental requirements or any changes in the market, thus significantly affecting the viability of the business model of these companies (Bocken et al., 2014).

Researchers are concerned about scale-up companies that may encounter the largest difficulties in implementing CE principles (Bassi and Dias, 2019). Scale-ups are struggling with issues of business expansion, sales growth and stabilisation of positive cash flow, while paying less attention to necessary changes related to the environmental value creation.

This indicates that in the implementation of CE principles it is essential to analyse and reconsider the financial viability, attractiveness or desirability for different stakeholders and the technical feasibility to adopt CE principles by business. Continuing with the dominant perspectives and interventions of CE principles, we suggest a new conceptual model of the infinity of the shared value creation (Fig. 13) comprising endless and significant preconditions for any business unit to consider and adopt CE principles. All these pre-conditions must be balanced. The left side of the infinity leads to values and the necessity to balance economic, environmental, and social values; the right side of the infinity reminds us that any CE principle may be adopted in any business unit if it is technically possible or feasible, and it is financially viable as we are expecting economic benefits and not just social responsibility or charity. As a final condition, there is a circularity or sustainability ambition or interest by all involved stakeholders to create a positive environmental value.

The figure illustrates crucial prerequisites or preconditions for implementing CE principles, implying a need to attain balance among them. Despite environmental and social benefits being seen as an external impact, they are still integral in creating sustainable value in a company and must be integrated into the business model. The social and environmental impact should not be regarded as an extra cost for the social responsibility but an important aspect of the company's strategy, revenue and the business model.

Companies, by nature, continue to prioritize economic benefits, but adhering to the CE principles requires a new approach and a pro-environmental mindset that evaluates environmental and social benefits alongside economic benefits. Furthermore, to achieve environmental and social impact, companies must consider the technical feasibility of implementing CE principles within their operations, as well as the institutional interest and need. Failure to respect the balance and an equal importance of elements depicted in the infinity can threaten the successful implementation of CE principles. Additionally, each CE principle should be evaluated to determine which has the greatest positive impact on achieving this balance.

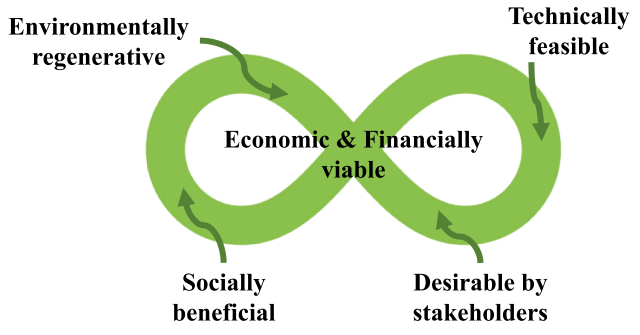

Fig. 13. Infinity of creating shared value and the adoption of CE principles, created by the authors.

This means that CE principles are changing the business nature towards socially-beneficial, environmentally-regenerative, and financially-viable businesses. While we consider the potential efforts necessary for the changes required to adopt CE principles there are a number of benefits derived from the literature that can fuel the interest of entrepreneurs and managers to introduce circular changes within companies. Some of these benefits are the possibilities to increase the innovation potential and reach market leadership by the differentiation as one of Porters generic strategies. The adoption of CE principles fuels not just product innovations but may lead to new business models or new revenue streams, or results in new opportunities in the whole ecosystem.

The adoption of CE principles opens a wide space in the improvement of the efficiency, resource and cost savings complying with Porter's cost leadership strategy. Some of the CE principles allows minimising risks, for instance related to human health when refusing to use toxins.

The adoption of the CE principles may lead to reputation improvements and better recognition in the market by applying the green branding strategy or promoting sustainability values followed by the company.

In the initial stage the adoption of CE principles may require larger short-term expenses, so it is important that non-financial benefits are planned from the beginning and communicated accordingly to all involved stakeholders and shareholders of company (Veleva and Bodkin, 2018). As the investment or financial necessity may not bring fast returns on investments, it is important to facilitate the general understanding and clear expectations of other non-financial benefits.

At the same time, the company must also create an attractive value for its customers so that they have an interest and desire to purchase a product or service created based on the principles of the CE. The ability to balance the value proposition to both sides – customers and suppliers – is critical in being able to reduce resource costs and increase cost efficiency, increased profits and profitability.

5. Conclusions, limitations, and further research

5.1. Conclusions

In this study we have presented sixty CE principles, named as 60R principles, and classified in four groups. The classification is based on the initial 3R principles of the waste pyramid as most used typology by researchers.

We propose the following four groups of CE principles - #R1 reduce, #R2 reuse, #R3 recycle and #R4 reverse logistics. If the first three groups of principles are adapted more in academic discussions, explaining the sub-principles contained in them and their interrelationship, then reverse logistics is less highlighted among researchers. However, this research confirms the essential importance of reverse logistics for the implementation of the CE in companies. Furthermore, the principles of #4R group may initiate business model innovations and changes at the ecosystem level.

In this study, 60 CE principles were defined by continuing the creative and exciting process of matching definitions of CE principles with the letter "R" at the beginning of the word. At the same time, the meaning of the letters R is minimal, what is more important is the understanding and explanation of each principle. Moreover, when these principles are adapted in different languages, it is not possible to translate these words using the letter R. The positive aspect is that R-principles are recognised among practitioners and researchers, they are passionately and creatively used to understand the nature of the CE and implementation possibilities in companies.

The adoption of CE principles may provide cost savings or risk mitigation only after several years. The CE principles of the reverse logistics group may initially require additional logistics costs for sorting or improving returned used products or materials, and only then can new

income streams be provided (EMF, 2013; Veleva and Bodkin, 2018). When adopting #R2 (reuse) or #R3 (recycle) principles it is essential to pay attention to the cost of material savings (EMF, 2013) that fuels further circularity ambition. The financial viability of the adoption of CE principles must be considered as a long-term perspective because from a short-term perspective their implementation can be resource or investment intensive. Measuring the environmental benefits and quantifying the financial benefits can be difficult, but crucial to proving the economic viability of the CE principles adopted (EMF, 2013).

A crucial issue of implementing CE principles is understanding the level of impact they have on the company's strategy or a business model. Understanding the principles of CE intervention and perspectives provides a better structure of the company's strategies or business activities for value creation, as well as making it possible to recognize the broader view of the benefits provided.

Communication about the planned and achieved economic benefits is very important in the adoption of CE principles to increase the attractiveness of the value proposition to interested stakeholders.

In addition, not only the benefits of CE principles should be studied, but also their downsides and potential negative impacts (e.g. saving materials can lead to higher CO2 emissions). The CE principle may reveal the downsides of the technical, institutional and economic feasibility of the circular economy.

5.2. Limitations and a further research avenue

This study is based on qualitative research methods, in particular the systematic literature review and other methods that ensure the triangulation principle, the validity and reliability of the research. This study does not include empirical research on the experience, performance, and future considerations of companies adopting CE principles. We have highlighted the evidence of previous research and indicated importance to conduct systematic surveys and other empirical research in this field. Such research may cover different perspectives that are indicated in the previous sections of this Article. Firstly, the geographical perspective by countries, regions, or other geographical scales. Secondly, the sectoral perspective where most of the research applies case studies and empirical analyses and broader comparisons of the performance of companies by industries would be beneficial.

The intervention of CE principles regarding the strategies has been limited to two main aspects: a company strategy with strategic aims and values, the mission and vision statements. Secondly, we exploit the concept of generic strategies of Porter (1985) and analyse the intervention of each group of CE principles to each of the four generic strategies.

In the future, researchers may explore the interrelationship between CE principles and strategies in more depth, especially considering the fact that a company may have strategies of different levels, scales, and duration.

In the future, researchers could study the benefits of CE principles, structuring them as economic, environmental, and social gains. This can widen the academic discussion about the pre-conditions of shared value creation and our proposed conceptual model of the infinity of creating shared value.

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CRediT authorship contribution statement

Inga Uvarova: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. **Dzintra Atstaja:** Conceptualization, Funding acquisition, Formal analysis, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing. **Tatjana Volkova:** Conceptualization, Formal analysis, Methodology, Validation, Writing – review & editing. **Janis Grasis:** Conceptualization, Funding acquisition, Formal analysis, Methodology, Validation, Writing – review & editing. **Iveta Ozolina-Ozola:** Conceptualization, Data curation, Formal analysis, Methodology, Software, Validation, Writing – review & editing.

Declaration of competing interest

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

Data availability

Data will be made available on request.

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Appendix A. Summary table of the literature on the evolution of CE principles

Year, authors	Emerging trends and revelations within scientific publications
2011 (Cao et al., 2011; Hu et al., 2011; Sakai et al., 2011)	**Developments in CE principles:** • 3R principles – reduce, reuse, and recycle based on the waste pyramid • From 3R to 4R adding "Recover" as a novel principles **Emerging trends and revelations:** Clarification of 3R from the company perspective
2012 (Geng et al., 2012; Ying and Li-jun, 2012)	**Emerging trends and revelations:** • 3R principles in the context of supply chains and the packaging • The importance of the industrial symbiosis • Economic effects of 3R principles
2013 (EMF, 2013; Su et al., 2013)	**Developments in CE principles:** Reverse flows of materials and waste **Emerging trends and revelations:** • 3R principles are distinguished from producers and consumers perspectives • Sharing as one of reuse possibilities

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(*continued*)

Year, authors	Emerging trends and revelations within scientific publications
2014 (Benton et al., 2014)	**Developments in CE principles:** 7R principles **Emerging trends and revelations:** • Re-manufacturing and recycling distinguished • Indications of the classification of CE principles
2015–2017 (N. M. P. Bocken et al., 2016; EMF, 2015; Geissdoerfer et al., 2017; Ghisellini et al., 2016; Mestre and Cooper, 2017; Sauvé et al., 2016)	**Developments in CE principles:** • 10R principles • Re-SOLVE framework of CE principles **Emerging trends and revelations:** • The multi-level nature of circular principles • the circular design introduced • the economic viability effects of CE principles
2018–2019 (Esmaeilian et al., 2018; Kalmykova et al., 2018; Suárez-Eiroa et al., 2019)	**Developments in CE principles:** 38R principles **Emerging trends and revelations:** • Increasing research activities from the business management perspective • Structuring of strategies, activities, or tools for the adoption of the CE in companies • The cross-functional nature of CE principles in firms
2020–2021 (Bag et al., 2021; Chen et al., 2020; Dantas et al., 2021; Konietzko et al., 2020b; Mhatre et al., 2021; Morseletto, 2020; Pohlmann et al., 2020)	**Emerging trends and revelations:** • Importance of design thinking approaches in evaluating the existing performance and generating new possibilities of adopting CE principles • Targets and indicators to evaluate the circular performance • Industry-specific applications of CE principles
2022 (Cirule and Uvarova, 2022; Han et al., 2022; Uvarova and Atstaja, 2022; Velter et al., 2022; Yang et al., 2022)	**Emerging trends and revelations:** • Balancing the quality, feasibility and financial viability in adoption of CE principles • The importance of the multi-stakeholder collaboration and the circular ecosystem

Source: created by the authors.

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