Meeting the Circular Economy Agenda: Supporting Tools for a New Strategic Design Practice

Rumo aos desafios da economia circular: Ferramentas de apoio a uma nova estratégia na prática de design

Camocho, D. Vicente, J. Ferreira, A.

UNIDCOM/IADE - IADE, Universidade Europeia
UBI - Universidade da Beira Interior
UNIDCOM/IADE - IADE, Universidade Europeia

ABSTRACT: The circular economy is a new strategic concept to meet society's needs in a more efficient and sustainable manner based in decoupling the economic growth and welfare from the increase in the consumption of natural resources. It implies the transition from the traditional linear model to a more innovative and circular approach in the development of the economy by designing new products, new services, and new systems, supported, in most cases, by the re-thinking and creation of new business models.

Designers and product developers have an important and crucial role to achieve a successful and wide implementation of the concept which has to be accepted and applied in practice by businesses along the whole value chain and meet the current and future needs of consumers and the society.

Currently, several methods, principles, practices, tools, training initiatives, and many resources are being developed globally as a result of the wide exploitation of the concept, but there is still a large gap between what is available to companies and designers, and what is applied in practice on product and service development.

This paper reflects part of the PhD research project under development by the authors which is based on the promotion of the design practice within Circular Economy. It explores the results of the review of circularity tools available that can be used by design professionals to systematize and guide their development process. The analysis will support the development of a toolkit and guidelines oriented for the practical implementation of the circular economy in the development of innovative and efficient products and services. (Camocho, Ferreira, & Vicente, 2018).

KEYWORDS: Circular Economy, Design Tools, Design Practices and Principles, Innovation, Sustainability.

RESUMO: A economia circular é um novo conceito estratégico que visa responder às necessidades da sociedade de uma forma mais eficiente e sustentável que se baseia na dissociação entre crescimento económico e bem-estar do aumento do consumo de recursos naturais. Esta transição, do modelo linear tradicional para uma abordagem mais inovadora e circular no desenvolvimento da economia implica o desenvolvimento de novos produtos, novos serviços e novos sistemas, apoiados, na maioria dos casos, no repensar e na criação de novos modelos de negócio.

Os designers e os responsáveis pelo desenvolvimento de produtos têm um papel importante e crucial para alcançar uma implementação ampla e bem-sucedida do conceito. Este deve ser aceite e aplicado na prática pelas empresas ao longo de toda a cadeia de valor atendendo às necessidades atuais e futuras dos consumidores e da sociedade.

Atualmente, vários métodos, princípios, práticas, ferramentas, iniciativas de formação e outros recursos têm sido desenvolvidos globalmente como resultado da ampla exploração do conceito, no entanto, ainda existe uma grande lacuna entre o que está disponível para empresas e designers e o que é aplicado na prática no desenvolvimento de produtos e serviços.

Este artigo reflete parte do projeto de investigação de doutoramento em desenvolvimento pelos autores, o qual se baseia na promoção da prática de design no âmbito da Economia Circular. Explora os resultados da revisão de ferramentas de circularidade disponíveis que podem ser aplicadas pelos profissionais de design na sistematização e orientação do processo de desenvolvimento. Esta análise irá apoiar o desenvolvimento de um conjunto de ferramentas e orientações para a implementação prática da economia circular no desenvolvimento de produtos e serviços mais inovadores e mais eficientes. (Camocho, Ferreira & Vicente, 2018).

PALAVRAS-CHAVE: Economia circular, Ferramentas de design, Práticas e princípios de design, Inovação, Sustentabilidade.

1. Introduction

Changes are taking place worldwide in business strategy and industries face increasing pressure from economic crises, resource scarcity, and pollution (De 0los Rios & Charnley, 2017). The Circular Economy approach to the development of the society is seen as a potential solution to attain a sustainable future by increasing prosperity while reducing the critical dependence on primary materials and energy (Ellen MacArthur Foundation, 2015). The concept is receiving increasing attention worldwide as a way to overcome the current production and consumption models based in so-called “linear economy” or “take, make and dispose model” that depletes natural resources and destroys ecosystems. In the past, during many decades, designers and other professionals have been working to achieve sustainability in the development process, aiming to increase the efficiency and innovation exploring several approaches, from cleaner production, eco-design, design for sustainability through product services systems, however, despite several good examples, mainly linked to niche markets with low added value (Ferreira, Ana M.,2003), the results were far from been globalized and integrated widely in the society. Nowadays, Circular Economy claims to be a new path to achieve sustainability and welfare, promoted strongly by governments, research institutions, academia, associations, and many other stakeholders.

This new economic model that aims to work in closed circuits, catalyzed by innovation along the entire value chain, is promoted as an alternative solution to minimize resource consumption and energy losses (Ministério do Ambiente, n.d.) and designers should have the skills, knowledge and the tools to leverage this process (Vicente, 2012).

Today, designers and product development teams face new challenges in their daily practice. The design is recognized as a catalyst to transition from the traditional model of take-make-dispose to achieve a more restorative, regenerative and circular economy(Moreno, De los Rios, Rowe, & Charnley, 2016) and the design of products and services in a smarter and innovative way, extending their useful lives and adjust the function of such products and services within the system will be crucial to the achieve the transition to circularity (European Environment Agency, 2017).

The design practice relies on methods and tools. The evolution of the design profession and the solutions proposed by designers to solve the problems and needs of the society is linked, at some extent, to the evolution of the tools available to designers, (Vasantha G., 2014)(Vicente, 2011). The tools designers use, which have a significant impact on the development process, are changing constantly, new tools appear frequently, especially in the digital environments (Witkowski, 2017), however, and although tools related to circular economy are starting to appear, it seems that in most of the cases, designers are integrating circular economy strategies in an ad-hoc way, without the support, guidance, and validation of tools at different stages of the process. The paper presents part of the research under development which aims to help the transition to a more sustainable and circular economy through design. It explores the results of an in-deep review of circular economy tools available that can be used by designers and product developers to systematize and guide the development process of industrial products and services.

The design practice has a crucial role in defining the characteristics of the products and services that fulfil the needs of society and their impacts in the life cycle are defined in the design and development phase. In order to promote an efficient design and the practice of design, it is important to understand how designers can have a positive and successful impact in this process.

1.1. Circular Economy

The transition to a more sustainable way of design, produce and consume is a crucial objective for the development of our society (Bhamra & Lofthouse, 2007; Braungart & McDonough, 2009; Manzini & Vezzoli, 2010; MARGOLIN, 2014). In 2015 the European Commission adopted an ambitious Circular Economy Package (European Commission, 2015) to help European businesses and consumers to make the transition to a stronger and more Circular Economy where resources are used in a more sustainable way. The proposed actions will contribute to "closing the loop" of product lifecycles through greater recycling and re-use and bring benefits for both the environment and the economy. The plans will extract the maximum value and use of all raw materials, products, and waste, fostering energy savings and reducing greenhouse gas emissions. The proposals cover the full lifecycle: from production and consumption to waste management and the market for secondary raw materials.

In December 2017 the National action plan for the circular economy was published by the Portuguese Council of Ministers (PAEC, 2017). The plan is part of the strategy to be followed up to 2020 and aims to redefine the concept of end-of-life of the linear economy, based on the production and elimination of waste, focusing on the concepts of reuse, repair, and renovation of materials and energy.

It is a strategic model of growth and investment based on efficiency and value of resources and minimization of environmental impacts. This is a document aligned with Portugal's international commitments, such as the Paris Agreement, the Sustainable Development Goals, and the European Union.

We can find in literature many definitions of circular economy. The concept has been widely explored and each author or each project tends to develop a definition that best suits their interests. This proliferation and diversity of definitions do not help in the communication and practical implementation of circular economy by businesses.

One of the most known and spread definition is the one developed by the Ellen MacArthur Foundation. However, many others were published. In 2017, an article analyzed 114 definitions of circular economy and concluded that there is not one coherent understanding or definition of circular economy (Kirchherr et al., 2017), and from 2017 till now, many other definitions were developed.

Within the KATCH_e EU funded Project (KATCH_e, 2019) focusing on the reinforcement of the skills and competences in the field of product-service development for the circular economy and sustainability, the consortium, building on several definitions and concepts from the main key players on circular economy developed a definition that is the definition adopted in the current research by the authors:

> *“Circular economy is a system that is restorative and regenerative by intention and design, which maximizes ecosystem functioning and human well-being with the aim of accomplishing sustainable development.*
>
> *It replaces the end-of-life concept with closing, slowing and narrowing the resource flows in production, distribution and consumption processes, extracting economic value and usefulness of materials, equipment, andgoods for the longest possible time, in cycles energized by renewable sources. It is enabled by design, innovation, new business, and organizational models and responsible production and consumption”.*

2. Design For Circular Economy

The design plays a key role in the definition of the profile of products and services, and a more sustainable way of design, produce, and consume is a crucial objective for the development of the society (Bhamra & Lofthouse, 2007; Braungart & McDonough, 2009; Manzini & Vezzoli, 2010; MARGOLIN, 2014).

To develop innovative, efficient and sustainable products, the designers should be able to translate the needs from several actors in the value chain. The needs of the users who will buy and consume the products, the ones from the business, who will develop, produce and place them on the market and the ones from Society, who will indirectly benefit or suffer with the sustainability impacts of the products

Product design directly influences the way a value chain will be managed and building circular and sustainable value chains inevitably imply a fundamental change in the design practice (centre, 2013; Camocho, 2018; De los Rios, 2017). New methods and effective design-oriented tools are needed to support and promote the transition to a circular economy. Designing products in a smarter and innovative way, extending their useful lives and changing the role of such products within the system is crucial to the achievement of a transition to circularity (Camocho et al., 2018; European Environment Agency, 2017) from a society that has been actively seduced by the over-consumption of new and better goods and services, leading to massive consumption of natural resource and the generation of waste and emissions, (Medkova & Fifield, 2016) and this had been promoted globally by industries through design.

The transition to circular economy is not only a design issue but design has a massive role. The potential for design to influence and impact the way that we produce, consume and dispose of products is huge. The Portuguese National action plan to circular economy includes concrete actions to promote the transition to a circular economy and in these the design plays a crucial role (PAEC 2017).

The design practice in circular economy can be seen as more complex, requiring changes in the way of thinking and conduction projects focusing on a shift from product-based solutions to system-based or function-based approaches (RSA. 2014).

Designers need to align their development process with the concept of circular economy in order to replace the conventional end-of-life concept in which the materials and components of a product are disposed after the fulfilling of the function by closing, slowing and narrowing the resource flows in production, distribution and consumption processes (Bocken, 2016) by applying several strategies in the development process.

As for strategies to achieve circularity, several approaches in the literature that are related to design were identified. As an example, the Ellen MacArthur Foundation proposes 3 main principles: (Ellen MacArthur Foundation, 2015)

1. Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows,
2. Optimize resource yields by circulating products, components, and materials in use at the highest utility at all times in both technical and biological cycles,
3. Foster system effectiveness by revealing and designing out negative externalities.

These three principles are then translated into the ReSOLVE framework which considers six actions that should be considered in the design process (table 1).

Table 1 — ReSOLVE Framework, Ellen MacArthur Foundation

Regenerate	Shift to renewable energy and materials; Reclaim, retain, and restore the health of ecosystems; Return recovered biological resources to the biosphere
Share	Share assets (e.g. cars, rooms, appliances); Reuse/second hand; Prolong life through maintenance, design for durability, upgradability, etc.
Optimize	Increase performance/efficiency of the product; Remove waste in production and supply chain; Leverage big data, automation, remote sensing and steering
Loop	Remanufacture products or components; Recycle materials; Digest anaerobically; Extract biochemicals from organic waste
Virtualise	Books, music, travel, online shopping, autonomous vehicles, etc.
Exchange	Replace old with advanced non-renewable materials; Apply new technologies; Choose new product/service (e.g. multimodal transport)

Source: Growth Within, adapted

3. Methodology

The literature review under development aims to identify which tools are available to designers and their adequacy to the design practice for circular economy, having in mind the principle of circular economy and the needs of the design process.

The results of the search resulted in a collection of relevant academic and non-academic resources that are available to be implemented by designers.

Within the current study, only the tools that indicate their relevance to circular economy were selected. Despite the fact that many sustainability and eco-design tools are available in diverse platforms (online, software's, board games, etc) and that their application in circular economy project is relevant (as an example LCA software like SimaPro), the study considers mainly those that were developed and disseminated claiming to be oriented to circular economy.

To perform the analysis of the tools, besides the general information such as the identification, editor/publisher, author, source, availability and short description, a set of variables were used to access the potential for application by designers.

The variables were the following:

— The aim of the tool

— Scope - Circular economy; Eco-design, Design for sustainability, LCA, etc

— Assessment indicators/strategies - how the tool is applied? Which indicators or strategies are applied?

— Life cycle perspective – indication if the tool has an LC perspective or if only focus on a specific stage

— The influence on the design process - How can the tool influence the design?

— The influence in the business model - Can the tool and the results influence the business model?

— Type of inputs - Qualitative or Quantitative

— Inputs - Which inputs are needed to use/apply the tools

— Level of complexity - Level complexity in using the tool by design professionals

— Sectoral focus - sectoral, to which sector the tool is applicable or if it has a generic approach

— Expected results – which type of results are attained with the tool

— Pros and cons – Analysis of the main Pros and cons of the tool related to the design practice in the development of circular products and services

In the next chapter, the authors present seven tools that were analyzed within the research project under development according to the variables explained above. These resources address circularity aspects to develop new products and services and can be applied by design professionals.

4. Tools

4.1. Circularity Check

The Circularity Check developed by Ecopreneur, Wesustain, and MVO is a free tool to assist companies to become sustainable and circular or resource-efficient. The tool is primarily intended as an instrument for self-evaluation by companies, based on a questionnaire with about 60 questions that determines a circularity score for a specific product and/or service.

The checklist consists of a free questionnaire that can be filled out online covering five main indicators: Design, procurement, and manufacturing; delivery, use, recovery, and sustainability and the outcome is a total score on circularity (0-100%) and partial scores on the five indicators (0-100%) showing the overall strengths and weaknesses for the product or service.

The tool calculates the score and presents it in a few graphs, and by analyzing and answering the questions, and the scores on each indicator, the design team should identify potential ideas to improve and redesign the product or service (Ecopreneur).

4.2. Circular Economy Toolkit

The Circular Economy Toolkit is a free online resource for businesses to find Circular Economy opportunities.

The tool is based on a set of 33 questions related to the strategies and by answering, the analysis will result in the indication of the improvement of potential strategies: Design, Manufacture and Distribute; Repair/Maintenance of the product; Reuse/Redistribution of the product; Remanufacturing/ Refurbishment of product or part; Products as a Service; and Product Recycling at end of life. Besides the assessment features, the tools provide useful information in each strategy.

Based on a simple and user-friendly structure, the results cover the life cycle stages and highlights the potential in each one, and by analyzing the questions and results, the user can identify ideas to improve the product under analysis (circular economy toolkit).

4.3. Material Circularity Indicator

The Material Circularity Indicator (MCI), developed by Ellen MacArthur Foundation and Granta Design, is a tool aiming to measure how restorative the material flows of a product or company are.

By comparing to a similar industry-average product, the MCI for a product measures the extent to which linear flow has been minimized and the restorative flow maximized for its component materials, and how long and intensively the product is used. The tool is built from a combination of three product characteristics: the raw material used in production, the unrecoverable waste that is attributed to the product, and a utility factor that accounts for the length and intensity of the product's use.

The tool is easy to fill in with a user-friendly interface and useful to demonstrate the circularity level of a specific product.

The indicators may be used by designers to analyze a reference product or service and the assessment of potential changes in new designs, as well as for internal reporting, procurement decisions, and the evaluation or rating of companies (Ellen McArthur).

4.4. KATCH_e tools (KATCH_e 2019)

Within the EU research project KATCH_e - Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education, several tools were developed to support a transition to a circular economy.

The following four tools are the ones with a higher potential to be applied in the design practice from the above-mentioned research project under development.

4.5. KATCH-Up Board game

This tool is based on a creativity board game and aims to create an idea-value of a new product/service according to the needs of the users and to define the most appropriate circularity design strategies and business models to launch the product/service into the market. The objective of this game is to stimulate the users to generate valuable ideas from a business challenge, applying circular design and circular business strategies.

Based on six basic steps: a) Defining the problem context; b) Way to the solution-focused in the circular economy strategies that can be applied, c) Idea creation, with the development of a solution to meet the needs of the challenge; d) Business model, defining the most appropriate business model; e) Market launch, to define how the solution can be placed on the market and f) Presentation of the results of the exercise, the game acts as a guide to get an idea about an innovative product-service or to solve a real business problem and generate improvement opportunities.

4.6. KATCH_e CE Strategist

This tool helps the user to identify for a specific product in a specific context, Circular Business Opportunities and provide ideas and inspiration along the process of defining a Circular Business Model.

The tool starts with an assessment of a product or business to identify circularity strategies that fit best to the predefined circular business strategies.

After assessing the opportunities, the tool proposes several strategies to choose from and shows a definition of each strategy, providing existing business examples and shows how the strategies are connected to specific Design Strategies. The final step is a definition of the Circular Business Model using an adapted version of the Business Model Canvas framework. The Canvas, describing the business model highlights the implications and effects of circular models and guides the user towards circularity.

4.7. KATCH_e CE Designer

The CE Designer is a semi-quantitative tool for prioritization, assessment and idea finding of circular solutions for product and/or service design. It consists in a checklist structure organized in 8 strategies that address the most relevant issues a design team needs to consider in the development process of new products or services to support the transition to a more circular society.

The tool, in the first step, starts by asking the user to reflect on each strategy, their adequacy, and relevance for the project under development. In the next phase, the user evaluates the profile of the reference product in each strategy according to a set of predefined criteria. This step has two objectives, the first is the assessment of the reference products, identifying the hotspots in the product which can be improved, and secondly, by answering the questions in each criterion, the user can identify improvement opportunities that can be implemented in the project.

The identification of the hotspots and opportunities are useful resources to be used as background information to brainstorming sessions and development activities.

In the third phase, the tool is used to compare the reference situation with the new concepts or new products /services resulting from the project.

The tool is simple to be used by designers and development teams and the process and results allow the development of new and innovative circular solutions.

4.8. KATCH_e Circular Economy Journey

The tool aims to help the players to assess the overall Product / Service / System journey, in the three stages (uphill, top hill and downhill) according to several factors: materials, producers, stakeholders, and users.

Through a visual canvas, the tool consists in a visual representation of the journey, it aims to identify the touchpoints between the factors identified, providing a model for analysis and identification of opportunities to optimize the journey and to enhance the closing of the loops to develop a more circular solution for a specific problem.

Being a physical tool composed by a printed canvas, cards, pins and colour threads, the tool promotes innovation, discussion and brainstorming in creativity sessions.

5. Conclusions

Designers have at their disposal numerous tools oriented to support the development of sustainability and eco-design projects, both qualitative and quantitative tools with different levels of complexity, costs, orientation, typologies of results, among others. These tools have been extensively developed, but their use is not as wide as expected and most designers and development teams have not used them in practice in a systematic way.
Currently, the concept of circular economy is gaining attention worldwide and being widely disseminated at various levels of society, and tools with a specific orientation towards the development of circular products and services are beginning to appear.
In order to ensure that the products and services developed are indeed circular, it is necessary to apply several methods and tools that support the development, validation, and communication of their circularity aspects. In order to become widely used tools, it is necessary that these combine the perspectives of circularity with the needs of the design practice.

The seven tools presented address the challenge of integrating circularity in design, however, due to the nature of the tools, which are not mature yet, their characteristics and the needs of the design practice, there is still the need to develop an efficient and innovative tool or a toolkit to support the design of innovative circular products and services. These new or redesigned tools must address the design practice and supply efficient results perceived by all stakeholders as an added value to design projects showing clearly the benefits of their utilization.

6. Further Research

The identification, test, and analysis of circularity tools will continue along the project and other relevant activities will be developed such as the analysis of the designers and product developers' perceptions, methods, and approaches on the development of circular products in order to understand how designers translate the user and business needs in product development. The identification of which methodologies and tools are applied in practice by designers and which are the needs, barriers and drivers in their adoption in product/service development will promote the development of the efficient resources to support the transition to circular economy through design.

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