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VALIDATION OF THE MEASUREMENT SCALE FOR THE CIRCULAR ECONOMY: A PROPOSAL BASED ON THE PRECEPTS OF INNOVATION

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ABSTRACT

Objective: This article is a research report that is part of a study that aims to build a measuring scale for circular economy business models based on the precepts of innovation and validation of the structural model. The report presented consists of the pre-validation of the research instrument, adopted as the stage of development and validation of the final scale of the research.

Method: The validation of the research instrument is part of the procedures adopted for refining and enabling the presentation of the final scale. The theoretical research analysis model consists of four constructs (Innovation, Resource Recovery, Circular Economy Business Models and Value Proposition), for which four questionnaires were created with a pool of 149 initial items.

Originality/Relevance: The relevance for carrying out the study is associated with the need to expand knowledge about the field of circular economy, based on valid and reliable metrics. The initiatives advance towards measuring circular economy indicators. However, the issue of constructing measurement scales remains obscure and subject to different concepts, which do not always converge. Therefore, this study bears a conceptual, theoretical and scientific advance in this field, by proposing the construction of a wide measuring scale in circular economy.

Results: The scale was applied to companies in the service sector. The questionnaire items were generated from systematic literature reviews focusing on circular economy, innovation and sustainability. 149 initial scale items were generated, distributed among the dimensions Business Models of Circular Economy, Resource Recovery, Innovation and Value Proposition. From the exploratory factor analysis, 48 scale items that did not present satisfactory factor loading were excluded. The questionnaires were applied to a total sample of 223 respondents, distributed into four groups.

Theoretical/methodological contributions: This article contributes to the field of circular economy and innovation by proposing the construction and validation of a measuring scale for circular economy and innovation. In a search performed in the Scopus, Web of Science, ScienceDirect, Emerald, Google Scholar, Wiley Online Library, Sage, Springer, Taylor and Francis and JSTOR databases, the existence of studies on the validation of scales in circular economy was revealed. The development of academic works in gray literature, including national and international dissertations and theses, with searches operated in the Google Scholar databases and in the Brazilian Digital Library of Theses and Dissertations, also did not allow us to identify works with the configuration of scale validation in circular economy in the broad sense.

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VALIDAÇÃO DE ESCALA PARA MENSURAÇÃO DO NÍVEL DE ADOÇÃO DE ECONOMIA CIRCULAR NAS EMPRESAS

RESUMO

Objetivo: O presente artigo é um relatório de pesquisa que faz parte de estudo que tem por objetivo a construção de escala de mensuração de modelos de negócios de economia circular pautada nos preceitos da inovação e validação do modelo estrutural. O relatório apresentado consiste na pré-validação do instrumento de pesquisa, adotado como estágio de desenvolvimento e validação da escala final da pesquisa.

Método: A validação do instrumento de pesquisa faz parte dos procedimentos adotados para refinamento e viabilização da apresentação da escala final. O modelo teórico de análise da pesquisa consiste em quatro constructos (Inovação, Recuperação de Recursos, Modelos de Negócios de Economia Circular e Proposição de Valor), para os quais criaram-se quatro questionários com um pool de 149 itens iniciais.

Originalidade/Relevância: A pertinência para realização do estudo, está associada a necessidade de expansão do conhecimento sobre o campo da economia circular, a partir de métricas válidas e confiáveis. As iniciativas avançam rumo à mensuração de indicadores de economia circular. Contudo, o tema da construção de escalas de mensuração permanece obscuro e sujeito a diferentes conceituações, nem sempre convergentes. Portanto, este estudo comporta justificativa conceitual, teórica e avanço científico neste campo, ao propor a construção de uma escala de mensuração ampla em economia circular.

Resultados: A escala foi aplicada em empresas do setor de serviços. Os itens do questionário foram gerados a partir de revisões sistemáticas de literatura com foco em economia circular, inovação e sustentabilida de. Foram gerados 149 itens de escala iniciais, distribuídos entre as dimensões Modelos de Negócios de Economia Circular, Recuperação de Recursos, Inovação e Proposição de Valor. Da análise fatorial exploratória, foram excluídos 48 itens de escala que não apresentaram carga fatorial satisfatória. Os questionários foram aplicados a uma amostra total de 223 respondentes, distribuídos em quatro grupos.

Contribuições teóricas/metodológicas: O presente artigo contribui para o campo da economia circular e da inovação ao propor a construção e validação de uma escala de mensuração para a economia circular e a inovação. Em busca executada nas bases Scopus, Web of Science, ScienceDirect, Emerald, Google Scholar, Wiley Online Library, Sage, Springer, Taylor and Francis e JSTOR, revelou-se a existência de estudos sobre validação de escalas em economia circular. O desenvolvimento de trabalhos acadêmicos de literatura cinzenta, incluindo dissertações e teses nacionais e internacionais, com buscas operadas nas bases Google Scholar e na Biblioteca Digital Brasileira de Teses e Dissertações, também não nos permitiu identificar trabalhos com a configuração de validação de escala em economia circular no sentido amplo.

Palavras-chave: Economia Circular, Inovação, Construção de Escala de Mensuração, Validação de Escala de Mensuração.

VALIDACIÓN DE LA ESCALA DE MEDIDA PARA LA ECONOMÍA CIRCULAR: UNA PROPUESTA BASADA EN LOS PRECEPTOS DE LA INNOVACIÓN

RESUMEN

Objetivo: Este artículo es un informe de investigación que forma parte de un estudio que tiene como objetivo construir una escala de medición de modelos de negocio de economía circular basada en los preceptos de innovación y validación del modelo estructural. El informe presentado consiste en la prevalidación del instrumento de investigación, adoptado como etapa de desarrollo y validación de la escala final de la investigación.

Método: La validación del instrumento de investigación forma parte de los procedimientos adoptados para perfeccionar y posibilitar la presentación de la escala final. El modelo de análisis de la investigación teórica consta de cuatro constructos (Innovación, Recuperación de Recursos, Modelos de Negocio de Economía Circular y Propuesta de Valor), para lo cual se elaboraron cuatro cuestionarios con un pool de 149 ítems iniciales.

Originalidad / Relevancia: La relevancia para la realización del estudio está asociada a la necesidad de ampliar el conocimiento sobre el campo de la economía circular, en base a métricas válidas y confiables. Las iniciativas avanzan hacia la medición de indicadores de economía circular. Sin embargo, el tema de la construcción de escalas

de medición sigue siendo oscuro y sujeto a diferentes conceptos, que no siempre convergen. Por tanto, este estudio supone un avance conceptual, teórico y científico en este campo, al proponer la construcción de una amplia escala de medición en economía circular.

Resultados: La escala se aplicó a empresas del sector servicios. Los ítems del cuestionario se generaron a partir de revisiones bibliográficas sistemáticas centradas en la economía circular, la innovación y la sostenibilidad. Se generaron 149 ítems de escala inicial, distribuidos entre las dimensiones Modelos de Negocio de Economía Circular, Recuperación de Recursos, Innovación y Propuesta de Valor. Del análisis factorial exploratorio se excluyeron 48 ítems de la escala que no presentaron carga factorial satisfactoria. Los cuestionarios se aplicaron a una muestra total de 223 encuestados, distribuidos en cuatro grupos.

Aportes teóricos / metodológicos: Este artículo contribuye al campo de la economía circular y la innovación proponiendo la construcción y validación de una escala de medición para la economía circular y la innovación. En una búsqueda realizada en las bases de datos Scopus, Web of Science, ScienceDirect, Emerald, Google Scholar, Wiley Online Library, Sage, Springer, Taylor y Francis y JSTOR, se reveló la existencia de estudios sobre la validación de escalas en economía circular. El desarrollo de trabajos académicos en literatura gris, incluyendo disertaciones y tesis nacionales e internacionales, con búsquedas operadas en las bases de datos de Google Scholar y en la Biblioteca Digital Brasileña de Tesis y Disertaciones, tampoco permitió identificar trabajos con la configuración de validación de escala. en economía circular en sentido amplio.

Palabras clave: Economía Circular, Innovación, Construcción de Escalas de Medición, Validación de Escalas de Medición.

1. INTRODUCTION

The Circular Economy (CE) is an economic model that aims to retain the value of resources through conscious and optimized use, made possible by the extension of utility through use, by the reduction and elimination of outputs and losses in production cycles. It is an alternative to the traditional or conventional production system, in which the resource is only useful during consumption and becomes an environmental liability soon after its use ends (Geissdoerfer et al., 2017). The logic present in the circular economy approach involves closing production cycles (Linder et al., 2020), evaluating the life cycle of products (Lonca et al., 2018) and efficient use of resources and energy (Di Maio et al., 2017). The value embedded in products, parts and materials during their production is retained at the highest value for as long as possible. Extending the use of resources reduces the extraction of new raw materials from nature and adds value through use. This contrasts and contrasts with linear business models, in which the value of products is added upstream during manufacturing and retailing but loses value downstream after a single-use phase (Priyadarshini & Chirakkuzhyil Abhilash, 2020).

Achieving greater balance and more efficiency in the operationalization of practical actions aimed at sustainability are promoted by the circular economy (Corona et al., 2019, Linder et al., 2020). The transition to closing the production cycle is conditioned by the intensity of innovation in the economy. Innovation is needed to explore and implement your strategies. Fostering the adoption of its principles involves the evolution of new green markets, consumer

behavior and awareness, environmental and industrial policies, as well as the demand for regenerative and sustainable systems over time (Edmondson, Kern, & Rogge, 2019). In this context, it is considered that the extension of the useful life of resources can be reinforced by the concentration of innovative activities in the field of CE.

Advances in practices, strategies, behavior change and the institution of policies for the circular economy must be mapped through the formation of indicators, metrics and analysis parameters (Linder et al., 2020). Strengthening the field involves the task of building theoretical and empirical considerations that allow designing and validating measurement models (Asokan, Yarime, & Onuki, 2019). In this sense, the construction of measurement instruments for empirical assessments provides the basis for the development of theoretical constructs that present the necessary validity and reliability requirements.

The literature on circularity metrics provides ways to build scientific knowledge on the topic, propose ways to improve and advance, survey the weaknesses and inconsistencies of the models, among others (Brink, Hengeveld, & Tobi, 2020). The metrics already developed list practices that can potentially be used to measure circularity from their conceptual framework. Recent reviews expand the possibilities for developing new metrics by exploring their methodological and theoretical characteristics, direction and weaknesses (Kuzma et al., 2021). The review by Kalmykova, Sadagopan and Rosado (2017) analyzed different approaches to the circular economy and its principles in order to develop tools for the implementation and evaluation of circular strategies applicable in different segments of the value chain. Corona et al. (2019) mapped methodological aspects of product and service metrics and assessed their alignment with the concept of sustainability for providing recommendations. Moraga et al. (2019) proposed a classification to categorize the indicators according to the strategies and scope of measurement in technological cycles. Fellner and Lederer (2020) address the recycling rate as a metric to measure and promote the circular economy in a practical way. Kravchenko, Pigosso and McAloone (2020) proposed a framework for measuring sustainability performance to support practices and strategies for decision-making focused on circular economy and sustainability.

The relevance of carrying out the study is associated with the need to expand knowledge about the field of circular economy, based on valid and reliable metrics. Initiatives advance towards measuring circular economy indicators (Corona et al., 2019; Reid & Rout, 2020), however, the issue of constructing measurement scales remains obscure and subject to different conceptualizations, not always converging (Das, 2017). Therefore, this study bears a conceptual, theoretical and scientific advance in this field, by proposing the construction of a

wide measuring scale in circular economy. In a search performed in the Scopus, Web of Science, ScienceDirect, Emerald, Google Scholar, Wiley Online Library, Sage, Springer, Taylor and Francis and JSTOR databases, the existence of studies on the validation of scales in circular economy was revealed. The development of academic works in gray literature, including national and international dissertations and theses, with searches operated in the Google Scholar databases and in the Brazilian Digital Library of Theses and Dissertations, also did not allow us to identify works with the configuration of scale validation in circular economy in the broad sense.

The objective of the article is to build a measuring scale for circular economy business models based on the precepts of innovation and to validate a structural model. The report presented consists of the pre-validation of the research instrument, adopted as the stage of development and validation of the final scale of the research. The validation of the research instrument is part of the procedures adopted for refining and enabling the presentation of the final scale, as proposed by the protocol by Costa (2011), adopted as a methodological guide. The theoretical research analysis model consists of four constructs (Innovation, Resource Recovery, Circular Economy Business Models and Value Proposition), for which four questionnaires were created with a pool of 149 initial items. The results reported in this study refer to factor analysis and scale refinement, as reported in the methodological procedures.

The study is structured in sections. In addition to the introduction, the second section contains a theoretical framework for the research. The third section describes the research procedures. The fourth section presents the results of the factor analysis. The fifth section discusses the main results of the study. The sixth section concludes the study.

2. MEASUREMENT SCALE FOR CIRCULAR ECONOMY

The circular economy is by nature a restorative and regenerative model, which aims to maximize utility and maintain active resources in production cycles, a concept disseminated by the Ellen Macarthur Foundation (EMF). Its fundamental principles are based on preserving and improving the use of natural capital, optimizing the utility and yield of resources and promoting the effectiveness of production systems (EMF, 2015). The gradual transformation of the production logic from the conventional model to a circular and sustainable model, which directly consists of reducing the consumption of virgin resources, maintaining resources in production systems, adding value through use, closing and narrowing resource cycles with a focus in extending its usefulness (Geissdoerfer et al., 2017).

The value creation structure in a circular business model can be defined as a function of the offer of a product or service that is designed, produced or provided based on a circular value creation strategy (Nussholz, 2018). The added value in the product, component or material can be obtained from the preservation of the economic and environmental value generated by actions focused on initiatives to reduce the consumption of resources and energy. In this case, the offer of added value occurs from circular practices that lead to improved efficiency in the use of resources in flows and closed circuits. The value added from the initiatives of different companies in the production chain can be redistributed in the form of value (Genovese et al., 2017).

The innovation in the way value is created and distributed also extends to the market, especially regarding the aspect of identifying customer segments that demand a certain product offer (Mentink, 2014). Customers with high environmental awareness or who have a preference for durable products, or another type of product/service/business model aligned with the circular economy, can compose a market to be explored to create viability and adherence to the offer (Mesa, González-Quiroga, & Maury, 2020). It is necessary that the relationship with the customer enables the weakening of obstacles not only related to sales and consumption, but also to the reverse logistics of products and components after use, to feed the remanufacturing and reconditioning resource chain (Guldmann & Huulgaard, 2020).

Innovative business models, in the context of the circular economy, are driven by economic and environmental performance. Collaborative businesses, which allow access to use instead of ownership, fulfill their useful function to the end user while increasing the possibility of use through the efficiency of the resources used. This meets the demand for performance without compromising a considerable volume that will sit idle when not in use. Process modifications involve new ideas and innovation to implement transformations in material flows, energy recovery and create product life cycles in line with the principle of recovery, regeneration and reuse (Mentink, 2014). The need for essentially innovative business models that reconfigure the conventional economy is stimulated.

Innovation initiatives in business models can be centered on different aspects of circular economy principles and different associated practices, such as product durability, product life extension design, extension of resource usefulness in production cycles, reduction or elimination of production waste, recycling approaches, among others (Nussholz, 2018; Bocken et al., 2019; Pieroni, McAloone, & Pigosso, 2019). The initiatives result in different degrees of innovation, from the addition of an isolated activity to close cycles to generalized transformations that encompass various elements of the business model (Bocken et al., 2019).

The actions implemented are conditioned by the focus of innovation, which can be aimed at reconfiguring an already established company, creating entirely innovative business models, or even in a new business area of a mature company (Geissdoerfer et al., 2017) . The articulation of the construct of circular economy business models, innovation, resource recovery and value generation for businesses is precisely in line with the logic of circular transition via systematic transformation of production and consumption, in which value is created for businesses by changing the way resources are used.

Monitoring the development of the circular economy through indicators allows evaluating decision-making and establishing priorities to be implemented in the long term (European Commission, 2018). The political implication of measuring its effects influences the positioning of companies and allows governments to favor its implementation based on the association with observed results (Völker, Kovacic, & Strand, 2020). Indicators can be integrated into decision-making methodologies to facilitate their implementation (Geng et al., 2012). The clear identification of how indicators can be applied and how their results can be converted into support for decision making must be explicit and easy to elaborate. It is possible to establish combinations of metrics to obtain a more complete understanding and can fill gaps in the assessment of specific contexts, as long as there is no overlap or conflict regarding the visualization of results (Parchomenko et al., 2019; Corona et al., 2019.

The measurement indicator, in the form of a measurement scale, allows assigning value or number to events in order to quantify and qualify attributes. The performance in obtaining data is related to the validity and reliability of the measurement instrument. The precise articulation between the constructs and their arrangement in the theoretical reference model contributes to the instrument's assertiveness as to its interface with the observed reality (Kim, Ritchie, & McCormick, 2010). The elements that make up the scale must be refined in order to generate analysis dimensions that are clean of factors unrelated or misaligned to the theme. In this sense, the quality of a scale's responses, regardless of the field for which it is intended, can be evaluated based on the intended use and the accuracy of the concept measured by the instrument.

The proposition of a new measurement instrument does not guarantee that it has been properly validated (Turner & Zolin, 2012). Its properties must be evaluated and refined before definitive application (Straub & Gefen, 2004). The literature presents several possibilities of protocols that can be used as guidelines for the procedures and tests to be performed (Churchill, 1979; DeVellis, 2003; Hinkin, Tracey, & Enz, 1997; Netemeyer, Bearden, & Sharma, 2003; Hair et al. ., 2009). Especially in the field of circular economy, in which theoretical

consolidation is sought (Kravchenko, Pigosso, & McAloone, 2019), the consistency of argumentation and method are considered essential for advancing and proposing promising paths (Reid & Rout, 2020).

3. METHOD

The protocol adopted in the construction and validation of the scale is derived from the scale development paradigm prescribed by Costa (2011). The elaboration stages comprise defined stages for development based on validity and reliability criteria in order to propose a useful and methodologically adequate metric. According to the proposed protocol, the development of the scale goes through 10 stages, ranging from the definition of the theoretical construct to the presentation of the final scale. The stages already overcome include: i) articulation and definition of the theoretical construct (literature review, definition of the theoretical model and constructs); ii) generation of initial scale items (development of initial scale, face and content validation); iii) decision on initial items (decision on initial validation responses, rectification of inconsistent aspects); iv) elaboration of the initial research instrument (based on the literature review and initial validation); v) first sampling / pilot project (scale application and initial return to scale); and vi) scale purification (exploratory factor analysis and exclusion of uncharged items). The next stages to be followed comprise the second sampling for data generation, scale purification, re-measurement of instrument validity and reliability, and final scale, with recommendations.

The initial pool of items consists of 149 scale items, distributed among the constructs Innovation (33 items), Circular Economy Business Models (35 items), Resource Recovery (52 items) and Value Proposition (29 items). Scale items are derived from systematic reviews focusing on innovation, circular economy and building scales in the field of sustainability. To measure the Innovation dimension, the items were created to assess the constructs Product Innovation, Process Innovation, Technological Innovation, Organizational Innovation, and Marketing Innovation. The measurement of the Circular Economy Business Models dimension was measured from the constructs Regenerate, Share, Optimize, Cycle, Virtualize and Exchange, as proposed by the ReSOLVE Framework (EMF, 2015). The measurement of the Resource Recovery dimension was measured by the constructs Refusal, Reduction, Reuse/Resale, Repair, Renovation/Reconditioning, Remanufacture, Reuse with new function or purpose, Recycling, Energy Recovery and Re-extraction of resources, according to 10 R Principles proposed by Reike, Vermeulen and Witjes (2018). The Value Proposition dimension

was measured by the constructs Value Creation, Value Delivery and Value Capture, according to Ibarra, Ganzarain and Igartua (2020).

The items went through a face and construct validation process, through expert evaluation. Each questionnaire was reviewed by 10 experts or more, all researchers and scholars with expertise in the themes of affect to constructs. From the experts' analysis, changes and corrections were made according to the suggestions, in order to align with its main purpose.

The initial scale was applied for validation and the first round of exploratory factor analysis in companies in the service sector. The questionnaires were sent via e-mail and other various forms of destination, in the months of June and July 2021. The sample consists of 223 respondents, 52 for the Circular Economy Business Model questionnaire, 55 for Resource Recovery, 57 for Innovation and 59 for Value Proposition. The questionnaire included questions rated on a 7-point Likert scale (1 - not comfortable with answering/does not know the subject, 2 - not adopting, 3 - early adoption stage, 4 - intermediate stage of adoption, 5 - advanced stage of adoption adoption, 6 - full adoption, 7 - practice fully adopted in the company for more than a year). Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS Statistics), version 26.

4. RESULTS

The EFA was used to delineate the adequacy of the questionnaire items. The Kaiser-Meyer-Olkin (KMO) test and Bartlett's sphericity test were used to determine sample adequacy and data adequacy for factor analysis. The KMO coefficient oscillates between zero and one. A coefficient of 0.7 or higher indicates that the correlation between the data is adequate for factor analysis. Bartlett's test also examines the hypothesis that the observed correlation matrix is related to a community of uncorrelated items. The significance of this test indicates the correlation of the items and their suitability for factor analysis. If $p < 0.001$, the null hypothesis is rejected and the test is considered significant. Values are shown in Table 01.

Table 1. Adaptation of the Model

	KMO Test	Bartlett's Sphericity Test
Circular Economy Business Models	0,754	0,001
Resource Recovery	0,746	0,001
Innovation	0,759	0,001
Value Proposition	0,782	0,001

Source: Research Data.

After confirming the suitability of the data for the factor analysis, the Varimax rotation was used to obtain significant factors. The results of the factor analysis were taken for the four questionnaires. Data are presented in Table 2.

Table 2. Eigenvalues and Factor Variance

Circular Economy Business Models			
Explanation of Variance	Cumulative of Variance Explanation	Eigenvalue	Factor
10,599	13,998	2,650	1
7,818	23,791	1,954	2
7,488	31,737	1,872	3
7,199	38,810	1,800	4
7,154	45,735	1,788	5
7,004	52,070	1,751	6
6,969	57,779	1,742	7
6,893	63,072	1,723	8
5,626	67,922	1,407	9
5,610	72,360	1,403	10
Resource Recovery			
Explanation of Variance	Cumulative of Variance Explanation	Eigenvalue	Factor
6,786	19,389	6,786	1
3,919	30,584	3,919	2
2,832	38,675	2,832	3
2,637	46,210	2,637	4
2,271	52,699	2,271	5
1,879	58,068	1,879	6
1,559	62,521	1,559	7
1,364	66,418	1,364	8
1,225	69,919	1,225	9
1,120	73,120	1,120	10
1,090	76,235	1,090	11
Innovation			
Explanation of Variance	Cumulative of Variance Explanation	Eigenvalue	Factor
11,409	18,005	2,738	1
10,094	28,898	2,423	2
9,583	37,382	2,300	3
8,602	44,891	2,064	4
8,093	51,938	1,942	5
7,954	58,209	1,909	6
6,386	63,517	1,533	7
6,119	68,239	1,469	8
Value Proposition			
Explanation of Variance	Cumulative of Variance Explanation	Eigenvalue	Factor
12,596	12,596	4,692	1
11,420	24,016	2,004	2
7,938	31,954	1,777	3
7,259	39,213	1,549	4
6,749	45,963	1,363	5
6,335	52,298	1,320	6
6,092	58,389	1,249	7
5,976	64,366	1,157	8
5,856	70,222	1,042	9

Source: Research Data.

Os resultados indicam que, cumulativamente, os fatores com autovalores superiores a um explicam, em todos os casos, mais que 50% da variância. Foram excluídos do modelo, gradativamente, os fatores com carga fatorial abaixo de 0,5. Nesse processo, da dimensão Modelos de Negócios de Economia Circular excluiu-se 10 itens de questionário, que resultou num modelo com 42 itens de escala. Da dimensão Recuperação de Recursos excluiu-se 23 itens de questionário, com saldo de 32 itens de escala. Da dimensão Inovação, 9 itens não tiveram carga suficiente. A exclusão resultou em 48 itens de escala válidos. Por fim, da dimensão Proposição de valor, 6 itens não obtiveram carga suficiente, resultando no saldo de 53 itens de escala. No total, 48 itens foram excluídos a partir da análise fatorial exploratória. A relação de itens e cargas são apresentados na Tabela 3.

Table 3. Final exploratory model with factor loadings and reliability measure

Circular Economy Business Models (Cronbach's Alpha 0.712)

	Regenerate	
MNEC_REG03	Our products/services are always designed to enable post-use regeneration, that is, capacity for reuse, dematerialization and reintroduction in new production processes.	0,525
MNEC_REG04	Our products/services are never designed to retain post-use value, so that they can serve as raw materials to manufacture new products.	0,545
MNEC_REG06	We always promote waste management in a way that allows the regeneration of what can be used.	0,580
	Share	
MNEC_COMP01	We never share the use of equipment, machines or vehicles with other companies.	0,517
MNEC_COMP02	We never share physical space (stock, commercial room, among others) with other companies.	0,671
MNEC_COMP03	Our company always promotes training of employees in partnership with other companies or commercial partners.	0,584
MNEC_COMP04	We always use equipment, machines or facilities that have already been used by other companies.	0,460
	Optimize	
MNEC_OT01	Our company is always looking to increase the performance and efficiency of our products and services.	0,882
MNEC_OT02	Whenever possible, our company avoids generating waste during the production/sales process.	0,882
MNEC_OT03	We always use technology-based information/monitoring systems to verify our performance.	0,475
MNEC_OT05	We always use technologies that help in the efficient use of resources and reduce waste.	0,573
	Cycle	
MNEC_CIC01	Our company always takes advantage of the economic opportunities generated by the recovery and reuse of materials.	0,845
MNEC_CIC02	Our company never avoids premature disposal of parts or components.	0,705
MNEC_CIC03	Our company is fully articulated with suppliers to encourage the return of useful materials to the manufacturing stage.	0,751
MNEC_CIC04	Our company never avoids disposing of useless materials or components as waste.	0,511
	Virtualize	
MNEC_VT01	Our company always offers virtual/digital versions of products that are physically sold in other companies.	0,562
MNEC_VT02	Our company always prefers to keep its administrative processes in virtual form than to work with printed materials.	0,555
MNEC_VT03	We always prioritize the use of telecommunications/communication technology resources to reduce the use of offices, travel and other administrative expenses.	0,881
MNEC_VT04	Our online sales volume exceeds sales in physical stores.	0,741

MNEC_VT05	Products, equipment or supplies used for internal consumption in our company are always purchased online.	0,659
	Exchange	
MNEC_TC01	Our company always replaces non-renewable materials with renewable products/components.	0,488
MNEC_TC04	We never seek to replace obsolete technologies/equipment with others that generate less waste.	0,341
MNEC_TC05	We always seek to replace obsolete technologies/equipment with others that provide greater economic efficiency.	0,710
MNEC_TC06	We always encourage the exchange of traditional products/services for others that are more durable/efficient for the consumer.	0,822
	Resource Recovery (Cronbach's Alpha 0.706)	
	Refusal	
RR_REC01	Our company always avoids the consumption of products/resources whenever possible.	0,674
RR_REC02	Our company always refuses the consumption of products/resources whenever possible.	0,649
RR_REC03	We seek not to consume resources whenever possible.	0,494
RR_REC04	Our company always refuses to use materials with harmful components.	0,458
RR_REC05	Our company always refuses to sell materials with harmful components.	0,450
	Reduction	
RR_RED01	Our company never encourages the reduction of resource/product consumption.	0,410
RR_RED02	Our company never adopts internal practices to reduce consumption of products/resources.	0,502
RR_RED04	We always encourage the reduction of resource consumption as a way to eliminate the generation of waste.	0,521
RR_RED05	We always encourage our customers to use the products purchased for longer.	0,429
	Reuse/Resale	
RR_REU01	Our company never sells reused products.	0,593
RR_REU02	Our company always resells products originating from merchandise returns, even if at a more affordable price.	0,687
RR_REU05	We always encourage the consumption of reused products for our customers	0,544
	Repair	
RR_REP02	We always recreate products after minor repairs keeping their original function/purpose.	0,627
RR_REP03	Our company never offers periodic/planned repairs on products sold to our customers as an extension of their useful life.	0,495
RR_REP04	Our company never offers corrective repairs to the products sold to our customers.	0,545
RR_REP05	Our company always repairs products for later sale.	0,670
	Renovation/Refurbishment	
RR_REN02	Our company always improves the performance of products to extend their useful life and later sell.	0,423
RR_REN03	We never offer refurbished products to our customers.	0,430
RR_REN04	Our company never offers products with components that have been replaced/repaired for sale.	0,646
RR_REN05	We always encourage the reconditioning of products with functional defects as an alternative to disposal.	0,509
	Remanufacture	
RR_REM02	We never offer products that have gone through a process of disassembly, verification and cleaning.	0,600
RR_REM04	Our company never sells products that have undergone a reprocessing procedure.	0,725
RR_REM05	We always encourage product remanufacturing as an alternative process to disposal.	0,587
	Reuse with new function or purpose	
RR_REUF03	We never offer products with reused components.	0,379
RR_REUF04	Our company always reuses its products to meet new demands.	0,519
RR_REUF05	We always encourage reuse as a way to repurpose products to prevent their disposal.	0,505
	Recycling	
RR_RECI01	Our company always promotes the processing/separation of materials for recycling.	0,528
RR_RECI02	Our company never sells products made from recycled materials/components.	0,423

RR_RECI03	We always try not to contaminate/dispose of products in order to facilitate the recycling process.	0,566
RR_RECI05	We always encourage recycling as a way to reduce waste generation in our company.	0,580
	Innovation (Cronbach's Alpha 0.779)	
	Product Innovation	
IN_PROD01	Our company produces/sells original products/services.	0,521
IN_PROD02	Our company produces/sells innovative products/services.	0,484
IN_PROD03	Our company never uses new products to enter markets.	0,478
IN_PROD05	We are always looking to develop products/services for specific audiences.	0,687
IN_PROD07	We fully emphasize the development of specific products/services.	0,625
IN_PROD09	We always improve old products/services.	0,659
IN_PROD010	We always increase the quality of new products/services.	0,538
	Process Innovation	
IN_PROC01	Our company always develops new operational processes to meet different demands.	0,478
IN_PROC02	Our company always innovates by introducing new processes.	0,521
IN_PROC04	We fully trust in the innovation capacity applied to our company's processes.	0,602
IN_PROC05	We never use process innovation to improve our productivity.	0,620
	Tecnologic innovation	
IN_TEC01	Our company never replaces obsolete products.	0,495
IN_TEC03	We are fully aware of the most advanced technologies within our segment.	0,646
IN_TEC04	Our company develops/improves programs to reduce production/sales cost.	0,512
IN_TEC05	We never integrate management activities into our company's operations.	0,535
	Organizational Innovation	
IN_ORG01	We always ensure that our employees have a high level of freedom to propose new ideas.	0,614
IN_ORG02	We never encourage our employees to try new ways to solve problems.	0,586
IN_ORG03	Decision-making in our company is always centered on the manager.	0,516
IN_ORG04	We never make changes to our employees' tasks/roles.	0,419
	Marketing Innovation	
IN_MKT01	Our company is always actively seeking out innovative marketing ideas.	0,607
IN_MKT02	We never deal with innovative distribution methods for our consumer markets.	0,455
IN_MKT04	We never explore markets that could potentially increase demand for our products/services.	0,506
IN_MKT05	We never develop new channels for promoting our products/services.	0,624
	Value Proposition (Cronbach's Alpha 0.712)	
	Value creation	
PV_CRI02	We always use new technologies to improve our relationship with people.	0,780
PV_CRI03	We always use new technologies to reduce material consumption.	0,437
PV_CRI04	Our company never uses new equipment whenever possible to reduce waste generation.	0,699
PV_CRI06	Our structures are modified whenever necessary to make the best use of available resources.	0,560
PV_CRI07	We never seek to form new partnerships to improve the use of our resources.	0,559
PV_CRI08	We always encourage the creation of value with our employees based on practices to reduce material expenses.	0,806
PV_CRI09	We always encourage the creation of value with our commercial partners based on practices that reduce material expenses.	0,872
PV_CRI010	We are always looking to form new relationship networks to optimize the creation of value in the company.	0,701
PV_CRI011	The acquisition of new capabilities is always encouraged to improve the use we make of our resources.	0,717
PV_CRI012	The acquisition of new skills is always encouraged to improve the use we make of our resources.	0,749
PV_CRI013	We never encourage the adoption of new production/sales methods to create new value.	0,512
PV_CRI014	We never seek to develop new business practices to encourage the creation of value in our products/services.	0,352
	Value delivery	
PV_ENT01	Our company is always looking to propose new offers of services/products to generate value.	0,760
PV_ENT02	Our company is always looking for new customers to improve value delivery.	0,518

PV_ENT03	We never explore new market segments to deliver value to customers.	0,447
PV_ENT04	Our company is always looking for new distribution channels to increase the value delivered to its customers.	0,432
PV_ENT05	We always encourage the formation of new relationships with customers as a way to deliver value.	0,658
PV_ENT07	We always develop new products/services to deliver greater value to our customers.	0,759
PV_ENT08	Our production/sales support activities are never constantly revised/improved to provide greater value to customers.	0,772
	Capture value	
PV_CAP04	We never create new pricing methods for our products/services.	0,732
PV_CAP05	We are always exploring new methods of inserting products/services into the consumer market.	0,369
PV_CAP06	We are always exploring new sales channels to insert products/services into the consumer market.	0,709
PV_CAP07	Our company always encourages that new methods of relationships with our employees are adopted to capture value.	0,827

Source: Research Data.

5. DISCUSSION

The relationship between the constructs of innovation, circular economy business models and resource recovery can be interpreted from the possibility of creating, delivering and capturing value in business models. Innovation aims to incorporate new forms, processes, services, products to contexts in which a company operates. The offer of the new aims to promote incremental, disruptive or radical changes, which lead to obtaining an advantage or improvement in relation to the previously established situation. In the context of resource utility, value maximization occurs when the product is in full use. Until the resource is transformed into a product, there is a process of transformation and aggregation and value. After consumption ends, the value attributed to the product decreases. In the context of the conventional or linear economy, the end of use implies the destination of the product to the landfill with the consequent extinction of the value.

In the context of the circular economy, the end of use implies the adoption of successive processes that aim to preserve the value of the product and reincorporate it in the production and consumption cycle. This can occur from different resource recovery principles. Through recycling, remanufacturing or reuse, products and resources are reinserted at different stages of the production process, depending on the reuse possibilities. The objective is to prevent the resource from turning into garbage and completely losing its value.

The concepts presented are the basis for defining the study's analysis model. Constructs are associated with the broad themes of circular economy, innovation and business models. The innovation typologies represent different manifestations and gradations of innovation, focusing on complementary aspects in relation to the analysis model. Incremental innovation aims to improve existing processes, technologies, products and services. Radical innovation anticipates

and influences the emergence of new meanings for products and services. Disruptive innovation promotes consistent advances in disrupting markets for business. Open innovation is translated by the incorporation of internal and external knowledge to the company with the establishment of new paths for the markets. The different types of innovation are ways to make circular economy business models viable, especially in terms of resource recovery processes.

Resource recovery in the model is represented by the 10 R Principles of the circular economy. The structure hierarchically describes the Resource Value Retention Operations. The 10 R's are established as a function of the priority of resource value retention, broken down from R0 to R9 in the highest to lowest priority level (Reike, Vermeulen, & Witjes, 2018). The short cycles (R0 to R3) describe Refusal (R0), Reduction (R1), Reuse/Resale (R2) and Repair (R3). These principles are considered a priority because they provide shorter cycles and closer to consumption. The average cycles (R4 to R6) consider Renewal (R4), Remanufacture (R5) and Reuse with new function (R6). They are operated by business activities with indirect links to consumers. The long cycles (R7 to R9) describe Recycling (R7), Energy Recovery (R8) and Resource Re-extraction (R9). Long cycles focus on traditional waste management activities, with a concentration on recycling operations (Reike, Vermeulen, & Witjes, 2018). The different possibilities for recovering resources are the principles inherent in the circular economy that make it possible to extend the value of the product and the usefulness of the resources. Due to these principles and the innovation in its different manifestations and scope, the business models are oriented towards the circular economy.

Circular economy business models aim to create, deliver and capture environmental, social and economic value by incorporating principles that provide smarter solutions to companies, society and the environment than can be achieved by conventional businesses. Through the recovery of resources and innovation in business models, the company generates the capacity to deal with constant market changes and availability of resources. The innovation of the business model for the circular economy aims to create new products, services, businesses, processes, structures, among others, in line with the principles of the circular economy. At each level of implementation via the circular economy, resources or components are brought back into production in recovery cycles. For materials originating from recycling, the cycle leads to the beginning of the process, as reprocessing and dematerialization of components is necessary. In the case of resale or reuse, the cycle takes you back to the sale stage. In any initiative, the resource is put into flow to ensure continuous value creation.

From the innovation and recovery of resources in circular economy business models, different possibilities for reinserting the material, product or component in the production and

consumption cycle are operated to extend its value. Innovation acts in the creation of the new and the insertion of circular economy principles and resource recovery condition the creation, delivery and capture of value. New value is created, delivered and captured in circular business models from possibilities of extension of use. In this way, with each new value creation proposition, the production and utility cycles of resources are closed.

In procedural terms, the methodological process that involves the creation of the scale must describe which rules were used or which protocol was followed so that the replicability of the study is guaranteed. The use of integrated and mixed methods brings the researcher closer to a more assertive answer about the studied phenomenon. With the use of appropriate techniques and following the elaboration protocol, the researcher can direct greater effort towards the theoretical articulation that guides the study. To improve the scale refinement results, the following criteria can be adopted: (i) use integrated and mixed methods to increase the external validity of the scales, (ii) expand the use of qualitative methods for initial scale construction, (iii) use more refined scale refinement techniques, (iv) revalidate scale items, (v) verify the influence of sociodemographic factors on the strength of relationships, (vi) integrate different validity and reliability methods, among others.

6. FINAL REMARKS

The purpose of this article is to build and validate a measuring scale for circular economy business models based on the principles of innovation and validation. It is an effort that consists of the initial application and evaluation of the behavior of the instrument built for the reduction and refinement of the instrument. The scale was applied to companies in the service sector. The questionnaire items were generated from systematic literature reviews focusing on circular economy, innovation and sustainability. A total of 149 initial scale items were generated, distributed among the dimensions Business Models of Circular Economy, Resource Recovery, Innovation and Value Proposition. From the exploratory factor analysis, 48 scale items that did not present satisfactory factor loading were excluded. The questionnaires were applied to a total sample of 223 respondents, distributed into four groups. The main weakness of the study refers to the low number of respondents. Considering the extension of the scales, it was not possible to obtain a larger number of respondents, especially with the delimitation defined only for companies in the service sector. It is proposed, as a proposal for future research, the application of the reduced questionnaire to a larger number of respondents, for a new round of validity and reliability measurement. It is recommended, in addition to the application of Exploratory Factor Analysis, also the execution of Confirmatory Factor Analysis.

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1. Definition of research problem	√	√
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3. Development of theoretical propositions (theoretical work)	√	√
4. Theoretical foundation / Literature review	√	√
5. Definition of methodological procedures	√	√
6. Data collection	√	
7. Statistical analysis	√	
8. Analysis and interpretation of data	√	√
9. Critical revision of the manuscript	√	√
10. Manuscript writing	√	√
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