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Measurement and Structural Assessment of Circular Economy Model: A Study of Nifty 100 Companies

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ABSTRACT: Circular Economy model of sustainable development is the self- referring mechanism which aims at extending the life of resources. The circular economy mechanism is gaining popularity across the globe and organisations have started measuring their circularity. The present study aims to develop a Comprehensive framework (CFA) for CE and assess the measurement and structural model of the CE Framework. For the purpose of the study a questionnaire was developed based on the seven pointer Likert scale and distributed across Nifty 100 Organisations. The model was measured and assessed using Smart PLS Software on the basis of 180 responses received. The CFA(Comprehensive Framework Analysis)model for CE is an integrated tool for conducting empirical investigations across organisations and countries to measure the extent of CE environment and develop a ranking framework for its implementation.

KEYWORDS: Circular economy; Comprehensive framework analysis; Smart PLS, Structural equation modeling

INTRODUCTION

The idea of circular economy is based on extending the life of resources to reduce the loss of value of the resource. This concept is operationalised by the idea of Rs such as recycle, reuse, remanufacture, redistribute etc. (Geissdoerfer et al., 2017). The increasing desire of the organisations to become sustainable and measure their sustainable activities has pressed upon the need of developing a framework for circular economy and practices as well. Until now there were many interpretations of the term, it has been referred to as "Industrial Ecology", "Cradle-Cradle", "Bio-Mimicry", "Performance Economy" (Frosch et al., 1989; Stevenson et al., 2004; Benyus, 1997; Braungart et al., 2002; Pauli, 2010; Stahel & Reday-Mulvey, 1976).However, there has been no consensus on a common framework or definition of CE. The circular economy covers all aspects of waste and resource management and individual daily activities, due to its relationship with systemic change and transitions. CE has traditionally been investigated in distinct domains and disciplines, with their own study traditions and theoretical frameworks. As a result, it is not immediately clear which approach to choose when examining the phenomena of circular economy and its application in practitioner-led innovation. The present study aims to develop a common framework for organisations to measure their circularity and its impacts. The organisations have always had a profit-centric approach. However, institutional and societal pressure to become circular and move away from the traditional "Take-make-use-dispose (TMUD)" practices. It is therefore necessary for the organisations to switch to WaRM (Waste Resource Management) practices and adopt circular practices. The study proposes a Comprehensive Framework Analysis (CFA) model to measure circular practices and their impacts. To implement any model, it is necessary to assess its reliability, validity and relationship across the constructs. The research aims to assess the model measurements and structure. For the purpose of research, a questionnaire was developed on the basis of action imperatives, drivers and enablers for CE based on the existing literature. The target population for the

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study were Nifty 100 companies. The CFA model for circular economy is the first of its kind which validates the idea of circular economy, confirms the presence of Circular practices in Indian organisations and is useful to measure their financial implications for being sustainable and circular.

The Comprehensive Framework Analysis (CFA) Model for Circular Economy

The CFA model of circular economy comprises of four major components identifies from the review of literature and themes of circular economy:

- The Action Imperatives for CE (18R Framework)
- The Levels of Measurement of CE
- The Enablers for CE
- The Implications of CE

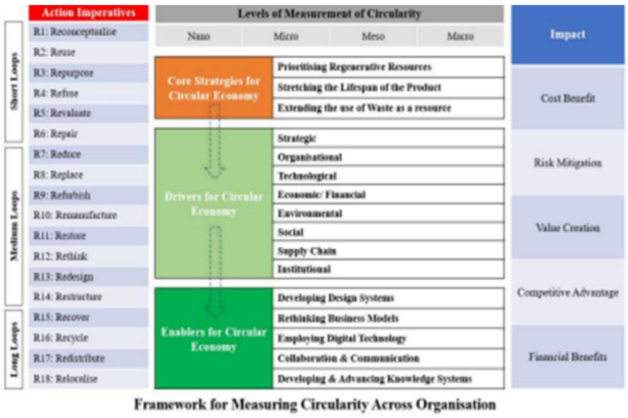

Figure 1: Comprehensive Framework Analysis (CFA) Model for Circular Economy

The Action Imperatives for CE

The Action Imperatives for CE are the resource life extension strategies that should be practised by the organisations in order to become circular. (Kirchherr et al., 2017) has expanded the 10R and 5R frameworks to include 18R Action Imperatives, which will aid the transition to circular systems. This 18R circularity framework may be used at several intervention levels, such as national, regional, sectoral, company, product, and process, to move the circular economy forward. The methods that will create conditions and eliminate barriers for smooth transition are known as circularity action imperatives. The study proposes an 18R framework of circular transition, synthesising the previously existing 10R and 5R Frameworks provided by Bocken. According to experts, these "action imperatives" might be the most important parts, consisting of "what the producers truly need to do to obtain the most impact from circularity?"

The short loops (R1-R6) such as Refuse, Reuse, Repair, Re-Conceptualise, Re-evaluate, replace occur near the commercial and non-commercial players involved in prolonging a product's life duration. These are intimately tied to consumers and are linked to the perception of a need for lower input utilisation in production and consumption. The medium long loops (R7-R14) of value retention such as Refurbish, Remanufacture, Repurpose, Rethink, Restore, Restructure, Redesign, reduce commercial business activities and procedures in the product life cycle frequently drive these. These terms are frequently misunderstood and used interchangeably. The third group of long value retention loops (R15-R18) such as Recover, Recycle, Re-distribute, Re-localise these are activities that are already well-organised, such as recycling and energy recovery. These activities, while less desirable, might serve as drives for shorter loops. This is the area on which the government's recent initiatives have concentrated (Thayer, 2003).

The Levels of Measurement of CE

The CFA framework model for circularity can be measured at four levels namely nano, micro, meson and macro wherein the nano level signifies the resource, component, products or processes and is the lowest level in the order. The organisations can measure their inputs and outputs and their company portfolio at micro and meson levels respectively. At the macro level the organisations can report their financial outcomes and organisational growth and circularity can become a GDP component for the future. Organizations can also go a step ahead in measuring their Operational efficiency, sustainability performance and value creation from circular.

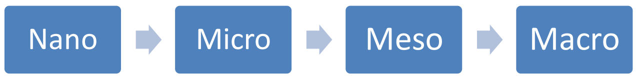

Figure 2: Levels of Measurement of Circular Economy

The Enablers for CE

The enablers for are the drivers that will enable a smooth transition to circular economy supported by resource life extending strategies. These comprise of Institutional factors which include egal and Regulatory environmental framework, Economic factors which have the potential for improving cost efficiency , profitability , revenue streams and competitiveness, Environmental factors which are relating to climate change and global warming , over consumption of energy and resources , scarcity of resources, environmental safety, Organizational factors which relate to strategic concerns for Brand reputation and social responsibility, Social factors like Global pressure towards greening and healthier practices from community, competitors and society ,Supply chain factors such as Communication and collaboration of the environment with the customers / suppliers , collaborators and technological factors that support the design and architecture of the 18R Framework.

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The Implications of CE

The development of a framework for assessing circularity was motivated by the fact that it not only unites the concept of circularity across organisations, but also aids them in externally defending their accomplishments. Organisations may also monitor the effect of their circular operations and manage the risks connected with traditional business models at the same time. According to the literature on circularity, it focuses more on economic and environmental implications than social ones. However, the financial, economic, and social elements of circularity must all be measured equally, since merely considering the money aspect might result in higher environmental and social burden. At the same time, all important aspects should be considered, as well as the flexibility with which they are used across different industries. This will entail both internal and external communication of cyclic performance. Finally, the framework for assessing circular economy should be based on natural, human, and social capitals (IIRC, 2018), and it should be successful in fostering a circular mentality from top to bottom (WBCSD, 2018)

OBJECTIVES OF THE STUDY

The present study aims has the following research objectives:

- To assess the measurement model for proposed CFA (Comprehensive Framework Analysis)
- To assess the structural model for proposed CFA (Comprehensive Framework Analysis)

RESEARCH METHODOLOGY

For the purpose of the study the constructs were examined and modelled as either reflecting or formative on past literature recommendations. The study is based on exploratory research and based on the literature review and the field study findings, a complex theoretical and measurement model has been built. Finally, PLS emerged as the best method for analysing this data. Structural equation modeling (SEM) is a multivariate statistical technique that allows researchers to estimate and test causal relationships. The software used in this research is Smart PLS.

The fundamental purpose of this stage is to evaluate the assumptions related to the reliability and validity of the structural measurement model. SEM was utilized since it was the best statistical approach for our investigation. SEM, a second-generation data processing tool, can analyse measurement characteristics and a structural model at the same time. According to Barclay (1995), there are several advantages to utilizing a SEM, including the capacity to assess measurement aspects of constructs in diverse theoretical contexts and the ability to deal directly with measurement error. The tool of measurement was questionnaire which was developed using the Likert scale responses. The scales were a seven-pointer starting from 1 to 7, with 1 being strongly agree and 7 being strongly disagree. The target population of the study were the employees at all levels of Nifty 100 companies.

FINDINGS

A total of 180 responses were received from the targeted group of population. The first stage of analysis was assessing the measurement model.

Stage 1: Assessment of Measurement Model

In the first stage the convergent and discriminant validity of the reflective items were investigated in order to assess the instrument's measuring properties. Fornell and Larcker's recommendations were followed while evaluating item dependability, internal consistency, and AVE (1981). One construct's congruent validity is defined by its most closely related aspects. To the extent that the notion's components are intertwined, the concept has convergent validity. Coefficient of reliability was also computed to measure the consistency of the indicators and reliability of the questionnaires. Table 1 summarizes the scales used for the measurement of variables, the number of items along with the values of Cronbach's alpha. The values of Cronbach's Alpha clearly exhibit validity and reliability as all the values are above 0.5 which is the specified threshold limit. Composite reliability measures the internal consistency in the items of scale like Cronbach's alpha (Netemeyer, 2003).Item loadings are used to determine each item's weight. Table 5.3 shows the item loadings in more detail. Loadings and their accompanying constructs are interrelated. Therefore, maintaining low loading items would lessen the construct's relationship (Nunnally 1978). It is possible that the low loadings are the consequence of a lack of precision in the terminology used (Hulland 1999). Calculating item dependability also considers the quantity of random mistake for each construct. The more random faults there are, the shorter the item loading time will be. Because of this, it is possible to identify and delete the items in a certain architecture that might lead to an increase in random errors (Fornell and Lacker 1981).

Discriminant validity determines how distinct the constructs are from one other. AVE and cross-loading matrix are two analytical methods used in this evaluation (Barclay et al., 1995).The first condition is that the square roots of the AVE must be computed and shown in the main diagonal of Table 6.5 to fulfil the discriminant validity standards. The goals were achieved.

Researchers' AVE-threshold values range from 0.5 to 1.0. (Fornell and Larcker,1981). Table 6.5 shows that all the AVE values are more than 0.5, as shown by the results. Financial cost (FC) has the greatest value of 0.852, while Stakeholder pressure has the lowest value

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of 0.515. The findings show that the construct's components are all interconnected and trustworthy.

It is evident from the resources that 70.1% of people are moderately satisfied with online shopping whereas 21% are neutral about their satisfaction from online shopping, no one is dissatisfied with online shopping.

Table 1: Measuring Internal Consistency and Composite reliability

Variables	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Financial Performance	0.977	0.978	0.978	0.62
Economic/ Financial indicators _	0.895	0.898	0.927	0.761
Environment indicators _	0.922	0.923	0.941	0.763
Institutional indicators_	0.886	0.899	0.921	0.746
Organizational Indicators	0.947	0.949	0.96	0.826
Other Factors _	0.953	0.954	0.966	0.877
R's	0.973	0.974	0.975	0.684
Social indicators_	0.939	0.941	0.956	0.846
Strategic Indicators_	0.925	0.933	0.94	0.691

Table 2: Fornell Larcker Test for Discriminant Validity

Column1	Financial Performance Impacts	Economic / Financial indicators	Environment indicators	Institutional indicators	Organizational Indicators	Other Factors	R's	Social indicators	Strategic Indicators	Supply Chain indicators
Financial Performance Impacts	0.787									
Economic/ Financial indicators _	0.781	0.872								
Environment indicators _	0.768	0.775	0.873							
Institutional indicators_	0.771	0.803	0.784	0.864						
Organizational Indicators	0.758	0.780	0.785	0.767	0.909					
Other Factors _	0.716	0.605	0.624	0.576	0.649	0.936				
R's	0.598	0.517	0.562	0.539	0.534	0.440	0.827			
Social indicators_	0.785	0.782	0.768	0.767	0.745	0.584	0.548	0.920		
Strategic Indicators_	0.733	0.758	0.752	0.759	0.780	0.556	0.555	0.754	0.831	

Table 3: HTMT Test for Discriminant Validity

Variables	Financial Performance Impacts _	Economic/ Financial indicators _	Environment indicators _	Institutional indicators _	Organizational Indicators	Other Factors _	R's	Social indicators_	Strategic Indicators_	Supply Chain indicators _
Economic/ Financial indicators _	0.831									
Environment indicators _	0.806	0.85								
Institutional indicators_	0.810	0.892	0.863							

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Organizational Indicators	0.784	0.848	0.84	0.835						
Other Factors _	0.743	0.655	0.665	0.621	0.682					
R's	0.606	0.548	0.591	0.574	0.553	0.455				
Social indicators_	0.818	0.850	0.824	0.831	0.791	0.617	0.569			
Strategic Indicators_	0.758	0.827	0.812	0.835	0.833	0.595	0.575	0.805		
Supply Chain indicators _	0.841	0.778	0.806	0.812	0.767	0.730	0.565	0.825	0.782	

The findings from the assessment of measurement model suggest the factors loadings satisfied the threshold of greater than 0.708. The Average Variance Extracted satisfied the threshold of greater than 0.50. Composite reliability was between 0.70 to 0.95 and the HTMT values were greater than 0.85. As a result, the suggested conceptual model was supposed to be acceptable, with confirmation of adequate reliability, convergent validity, and discriminant validity and the verification of the research model. It has been confirmed that the measurement model was valid and reliable. Therefore, the goals were achieved and the construct's components are all interconnected and trustworthy. Also, the reliability and validity of the model is established.

The next step was to measure the Inner Structural Model outcomes. This included observing the model's predictive relevancy and the relationships between the constructs. The coefficient of determination (R^2), T-statistic value and P Values.

Stage 2: Assessment of Structural Model

Endogenous construct variation may be used to assess the predictive power of a proposed model. The significance of the anticipated correlations was determined using path coefficients and t-values. To evaluate statistical significance between constructs, Hanlon (2001) recommends PLS since it does not need data to be normalised before the analysis. Gefen, Straub, and Boudreau (2000) provided two non-parametric methods for assessing correlations between constructs: 'bootstrap' and 'jack-knife'. Because of the complexity of this inquiry, "bootstrap" was chosen. This approach provides both a t-value and an R^2 value, which is advantageous. In terms of statistical significance, it is the same as a t-test. Using the R^2 value, we may draw similar conclusions as we would with the results of multiple regression. Endogenous construct variance is estimated using this value. In this manner, the model's explanatory ability and the proposed model may be evaluated. Having an R^2 value of 1 is the biggest, although it is quite uncommon. The size of the structural model R^2 may be determined by comparing it to comparable studies in relevant empirical research if the study setting is not too distinct. In addition, the size of the sample and the number of predictive variables is considered when evaluating the updated R^2. As of 2017, (Hair and co-authors, 2017).

The model's explanatory power was assessed using the coefficient of determination (R^2) of endogenous constructs (Santosa, Wei, and Chan 2005). In the opinion of Falk and Miller, R^2 should at least be 0.10. (1992). The coefficient of determination measures the overall effect size and variance explained in the endogenous construct for the structural model and is thus a measure of the model's predictive accuracy. In this study, the inner path model was **0.793** for the Financial Performance Impact endogenous latent construct. This indicates that the ten independent constructs substantially explain 79.3% of the variance in the Financial Performance impact, meaning that about 79.30% of the change in the Impact on the Financial Performance was due to ten latent constructs in the model. According to Henseler et al. 2009, an R^2 value of 0.75 is considered substantial, an R^2value of 50 is regarded as moderate, and an R^2 value of 0.26 is considered as weak. Hence, the R^2 value in this study was substantial.

The completion of stage 2 was with the t-statistics and p-value analysis of the hypotheses developed based on relationships of the constructs.

Table 4: The T-statistic and P-values

Hypothesis	T Statistics (|O/STDEV|)	P Values	Results
Impact of Economic/ Financial indicators _ -> Financial Performance Impacts _	1.325	0.185	InSig
Impact of Environment indicators _ -> Financial Performance Impacts	0.548	0.584	InSig
Impact of Institutional indicators_ -> Financial Performance Impacts	1.093	0.274	InSig
Impact of Organizational Indicators -> Financial Performance Impacts	0.331	0.741	InSig
Impact of Other Factors _ -> Financial Performance Impacts	3.149	0.002	Sig

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Impact of R's -> Financial Performance Impacts	2.176	0.030	Sig
Impact of R's -> Economic/ Financial indicators _	7.320	0.000	Sig
Impact of R's -> Environment indicators _	7.757	0.000	Sig
Impact of R's -> Institutional indicators_	7.486	0.000	Sig
Impact of R's -> Organizational Indicators	6.965	0.000	Sig
Impact of R's -> Other Factors _	5.694	0.000	Sig
Impact of R's -> Social indicators_	7.682	0.000	Sig
Impact of R's -> Strategic Indicators_	7.307	0.000	Sig
Impact of R's -> Supply Chain indicators _	7.304	0.000	Sig
Impact of R's -> Technological Indicators	7.518	0.000	Sig
Impact of Social indicators_ -> Financial Performance Impacts	1.617	0.106	InSig
Impact of Strategic Indicators_ -> Financial Performance Impacts	0.275	0.783	InSig
Impact of Supply Chain indicators _ -> Financial Performance Impacts	2.552	0.011	Sig
Impact of Technological Indicators -> Financial Performance Impacts	0.508	0.611	InSig

It is evident from the analysis that R's have revealed significant impact on all facets including Economic/ Financial indicators, Environment indicators, Institutional indicators, Organizational Indicators, Social indicators, Strategic Indicators, Supply Chain indicators and Technological Indicators. The results also show that the institutional, technological, Organisational, supply chain indicators have no direct influence on the financial performance of the Organisations.

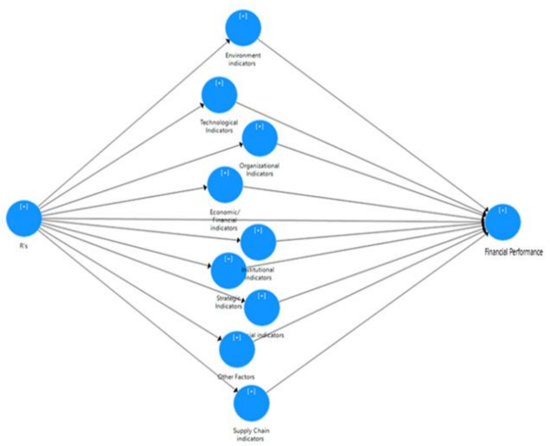

Figure 2: PLS Model for direct relationships

DISCUSSION AND IMPLICATIONS

The purpose of this study was to develop a Comprehensive framework model for measurement of circularity at all levels in the organisations and the society. Keeping this in mind the CFA model for circular economy was built based on the action imperatives, drivers and impact factors derived from the study of existing literature. For any model to be implemented, it has to be reliable and valid . The study of 180 respondents across Nifty Companies confirmed the validity and reliability of the model for circular economy. This model can be used as a tool for measuring circularity and the financial impacts of the circular practices of organisations. The study also reveals that the resource extending strategies i.e., the 18R Framework is necessary for designing and implementation of circular activities. Without the presence of 18Rs in the organisations their drivers will not have any positive cost impacts. Further, the CFA model and its results are suited to country specific practices and norms. The questionnaire was close ended which is a possible limitation of the research. The CFA Model for circularity can emerge as a tool not only for organisational analysis but also for cross-country studies. This tool can be further expanded to incorporate environmental and social impacts of circular practices.

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