A LOOK AT COMPLEXITY INPROJECTS: RETHINKING FOR CIRCULARITY IN SUPPLY CHAINS

[1]MARIA MERCEDES, [2]BERNAL CERQUERA

PhD Student, University EAN, Street 79 #11- 45 Bogotá - Colombia
E-mail: mbernalc560@universidadean.edu.co

Abstract - The circular economy activities today are increasingly important in societies, promoting sustainable consumption and stimulating organizations to close their production cycles, in such a way that there is a transformation of a linear economy where processes are culminated with the elimination of waste, to a circular economy that is regenerative and restorative from the design. This is not an easy task, therefore it requires a commitment from the leaders of the companies who must structure different projects that are often characterized by their complexity[1]. The objective of this study is to know if there is a relationship between the variables of complex projects with the variables of circular economy. A survey-type instrument was applied to a non-probabilistic sample of 36 companies in the Colombian food industry to evaluate the study variables. A principal component analysis and a bivariate and multivariate parametric analysis were carried out to test their relationships. The results showed that the variables Ambiguity, Human behaviors, time, and cost positively affected the circular economy variables such as green purchases and recycling, while the other circular economy variables did not present a significant effect. However, a contradictory relationship was observed between the behavior of the system and the circular networks. The results suggest that, although companies in the food industry may be willing to adopt sustainable consumption because they consider it important to work for the environment when considering green purchasing and recycling, there is still a contradictory impact between connectivity, dependency and dynamic systems of the organizations regarding the link with circular clusters. It is necessary to establish action plans for this in order to better embrace circularity in organizations and in this way not only economic benefits but also social and environmental benefits that are aligned with sustainable development can be obtained.

Keywords - Circular Economy, Supply Chain Management, Complexity, Sustainability.

I. INTRODUCTION

In today's supply chains, one of the most challenging aspects is how quickly things change. Every day there are changes in the industries related to new technologies that are implemented, new suppliers that are part of the stakeholders, new processes, new regulations, new competitors, reduction of product life cycles and new customers who are the axis main of any chain. This is why it is necessary to have a good project management that guarantees the due transformation of the supply chains, counting on coordinated activities that help them stay current in the market, fully meeting their proposed goals in the short, medium and long term.

When projects have a connotation that involves uncertainty and the unpredictable in the situations they must handle; and the interested people who are around them manifest some problems such as inconveniences in communication to such an extent that they hinder the proper development of a project[5]; and if there are many parts that must be connected and interrelated within the dynamics of a system, each with its own particularity, then we are talking about complex projects. That is why it can be said that they differ from traditional projects due to their particular characteristics in terms of their management in time, dimensions, budget, size, and tools that are needed for a better development in an organization[6].

In reference to a circular economy perspective, the need to recover the material that enters the system to be transformed is visualized in a supply chain and that in a linear economy at the end of its process is discarded, while what is wanted with the circular economy is that this material is not lost in this last stage, but that it re-enters the production cycle in such a way that its reintegration into the system is useful[7].

Then it can be said that it is a proposal for a regenerative economic model, where the end-of-life concept is replaced by the restoration of resources. That is why this kind of economy is a way to achieve environmental and economic sustainability objectives, these being essential in the current management of the supply chain[4], [2].

The methodology of this research has a descriptive, correlational, and explanatory quantitative approach, where a measurement instrument and statistical techniques are used to determine the validity of the data. Then, the methodological framework is approached where each of the steps to arrive at the construction of the model are exposed, considering the essential elements that are required in each one of them. Afterwards, a review of the results is made with the help of figures that allow better visualization of said results extracted from the statistical program R. Followed by discussions of the results, conclusions and bibliographic references consulted.

II. RESULTS

Taking as a fundamental basis for the study, the report of the Superintendency of Companies of the 1000 largest companies in Colombia, where the results of their financial information are presented as of December 31, 2019, and being this a reliable source to validate the business strengthening thanks to the operational results regarding the income, profits and profitability of the same, the companies classified within the manufacturing sector were taken, registering 299 in total. After making a new filter of that total, the record of 36 of them referring to the food industry was extracted. These companies are characterized by being companies from the departments of Valle, Bogotá, Antioquia, Cundinamarca, Córdoba, Caldas, Atlántico, Quindío, Cauca and Santander, whose operating income that is recorded ranges from a value of $ 1,771,701,513 to 162,300,049 in thousands of Colombian pesos.

36 interviews were applied to leaders with management positions and from the project and planning areas, who answered the questions of the instrument elaborated for this study, built from the themes that are addressed in this research such as complex projects and circular economy in supply chains, based on in-depth literary review and own research. Through telephone interviews to avoid biases and achieve the highest levels of response among the managers of the organizations, the information from the instrument was collected and subsequently encoded in a template prepared for this purpose. These data were entered into the SPSS software to determine their reliability using Cronbach's alpha. Through this statistical procedure, it was possible to estimate the reliability of a test, evaluating its internal consistency of a group of items (Cervantes, 2005). The estimated coefficient yielded a value of 0.84, which exceeded 0.8. Therefore, the instrument applied to organizations was adequate and demonstrated that it has the necessary reliability to continue with the statistical analyzes.

After verifying the reliability of the questionnaire, the data template was loaded into the R program in order to initiate a statistical analysis of the correlation matrix between variables. For this, the research was divided into two groups of variables. The first group was made up of variables corresponding to complex projects. This in order to search for bivariate correlations within each of the groups.Subsequently, the principal component analysis that is displayed in Figure 1 was carried out.

The principal component analysis aims to adequately represent the greatest amount of information with a smaller number of variables, constructed as linear combinations of the original variables. The principal components technique is due to Hotelling and due to technological advances, it was added to the set of methods with the greatest impact in scientific research, although its origins lie in the orthogonal adjustments by least squares introduced by K. Pearson. Its usefulness can be observed in two ways:

- It allows to represent optimally in a space of reduced dimension observations of a much larger general p-dimensional space. In this sense, this technique constitutes the first step to identify the possible latent variables observed directly in the general information.

- It allows transforming the original variables, generally correlated, into new unrelated variables, facilitating the interpretation of the data.

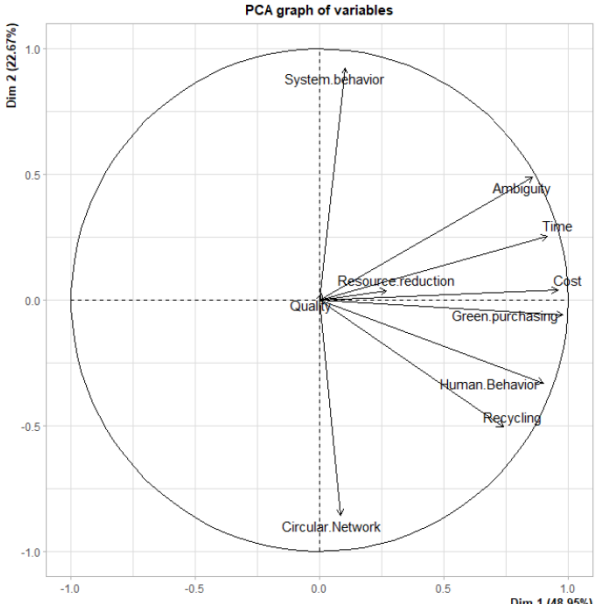

Figure 1: Principal component analysis.

It can be seen from Figure 1, that most of the research variables are exposed within the first dimension of the graph with a weight of 48.95% between them and directed in the same direction, thus indicating the formation of a new factor that collects most of the information. While 22.67% is the equivalent weight for the variables located in the second quadrant, heading inversely with respect to the Circular Network variable. The vectors representing Green Purchasing, Cost, Time, Ambiguity, are displayed quite close to each other, which is why it is stated that there is a correlation between these variables, in the same way as time, risk and scope.

Regarding the Quality and Resource Reduction variable, they do not present significant relationships due to their behavior in the graph.

	Dim.1	ctr	cos2	Dim.2	ctr	cos2	Dim.3	ctr	cos2
Time	0.926	17.725	0.857	-0.262	3.027	0.069	0.226	8.732	0.051
Cost	0.963	19.189	0.928	-0.045	0.089	0.002	0.259	11.507	0.067
Human.Behavior	0.891	16.400	0.793	0.332	4.850	0.110	-0.172	5.085	0.030
System.behavior	0.088	0.159	0.008	-0.921	37.393	0.847	0.108	2.010	0.012
Ambiguity	0.852	15.019	0.727	-0.491	10.619	0.241	-0.101	1.735	0.010
Circular.Network	0.077	0.124	0.006	0.861	32.716	0.741	0.462	36.615	0.214
Green.purchasing	0.987	20.146	0.974	0.052	0.119	0.003	0.063	0.674	0.004
Recycling	0.737	11.238	0.544	0.504	11.187	0.254	-0.443	33.642	0.196

Figure 2: Results of the dimensions and percentage contributions of principal components

Based on the results of the principal components analysis that can be seen in Figure 2, a composite indicator is constructed with the data extracted from dimension 1 for each variable. The values presented in the indicator show the relative weight of each of them.

Composite indicator= 0.926 * Time + 0.963 * Cost +0.891 * Human Behavior + 0.088 * System Behavior + 0.852 * Ambiguity + 0.077 * Circular Network + 0.987 * Green Purchasing + 0.737 * Recycling.

This indicator allows a joint measurement of the analyzed variables, obtaining weights in accordance with the observed variability.

Each of the variables in the indicator has a percentage that supports its behavior of the vector that represents them in the Principal Components graph.

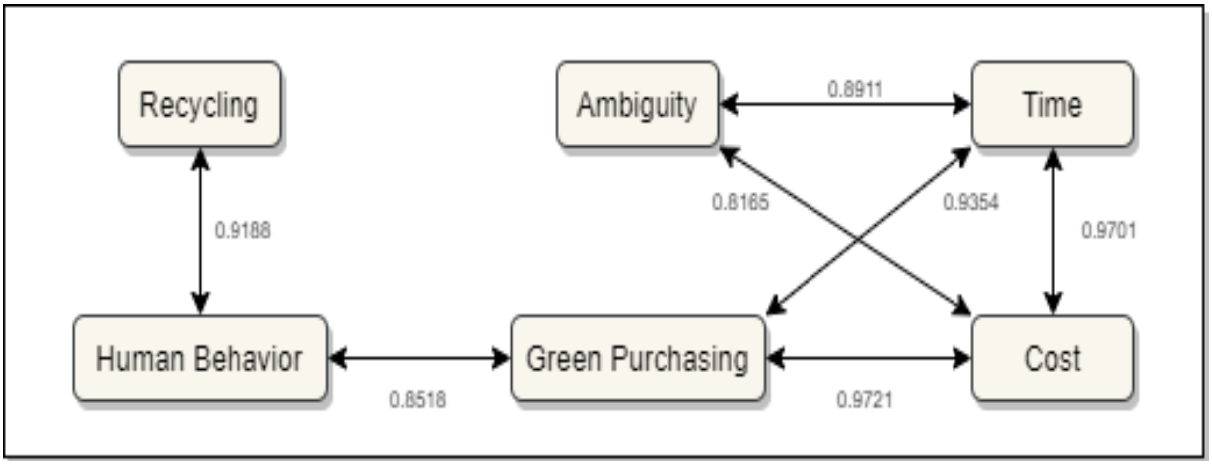

Figure 3: Pearson correlations between variables.

Figure 3 shows a close relationship between the variables Green Purchasing and cost since they have a Pearson correlation value of 0.921, a very close relationship is also seen between the variable Cost and Time, as well as the variable Human Behavior and Recycling. Other relationships but with a lower Pearson correlation value but which is significant, are the relationships between the variables Ambiguity and Time, Ambiguity and Cost and Green Purchasing with Human Behavior.

Taking into account the behaviors between the variables shown in the Principal Components Figure, and also the results of the Pearson correlations, a reduction of variables is carried out since the variables quality and Resource Reduction do not present significance due to the size of their vector represented in the graph, for this reason they are not considered in the principal components analysis but they are considered in the study. This can be seen in Figure 4.

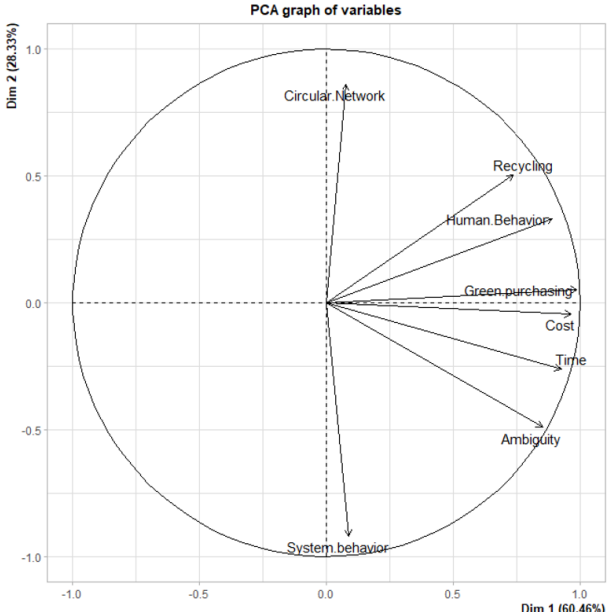

Figure 4: Principal component analysis with variable reduction

Figures 5 and 6 show the relationships between variables with their respective Pearson correlation value for the quadrant indicated in the Principal Components graph.

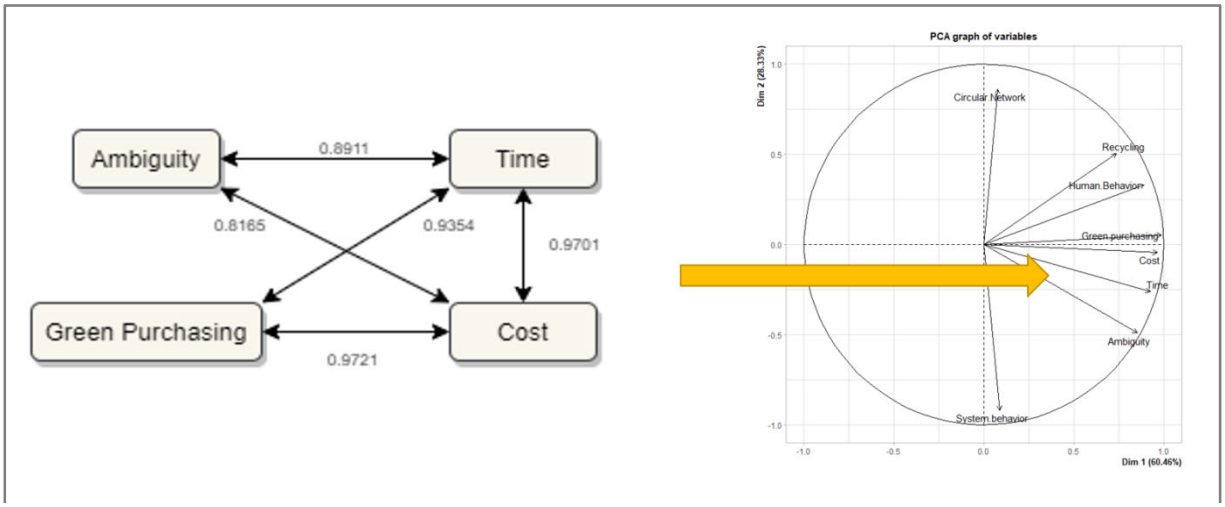

Figure 5: Pearson correlations between bivariate relationships of the lower right quadrant of Principal Components.

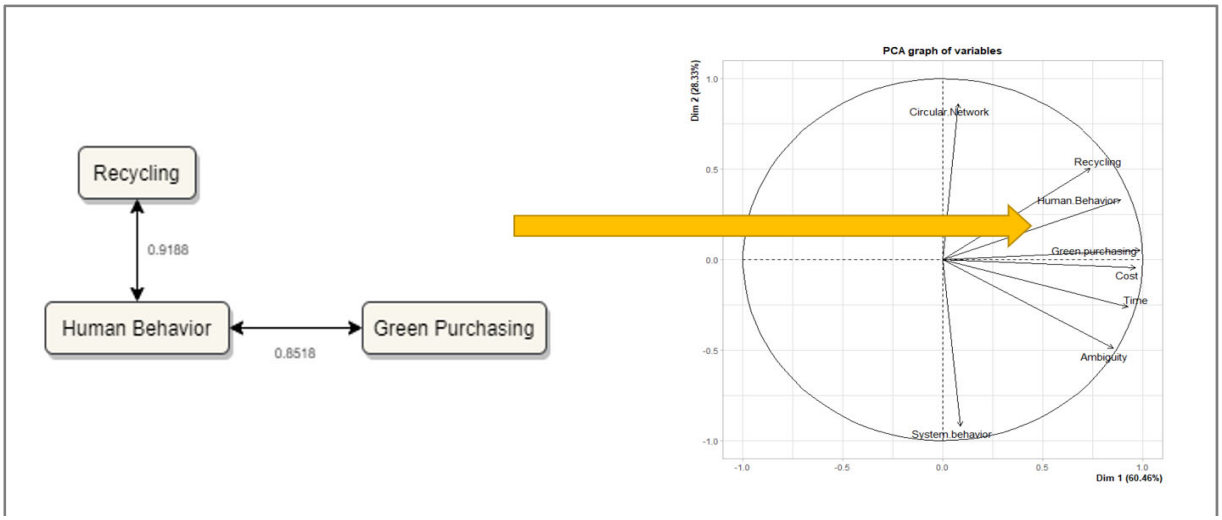

Figure 6: Pearson correlations between bivariate relationships of the first quadrant of Principal Components

After the bivariate and multivariate analysis, a model is proposed in which the complexity variables of a project are taken into account, together with the circular economy variables, as can be seen in Figure 7.

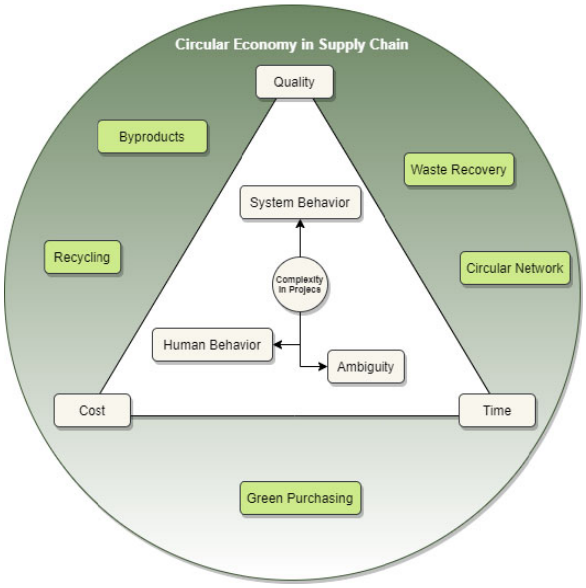

Figure 7: Proposed integrative model of complex projects and circular economy

Finally, in Figure 8, the proposed model with the variables of circular economy and complex projects resulting from the data of this research is presented. From a circular economy perspective, organizations are adopting green purchases, and designing recyclable products, but they need to work on reducing resources and generating by-products, associated with the circular economy. This denotes an incipient handling of circularity within their supply chains. It is necessary to adopt action plans to give greater coverage to the different dimensions that the circular economy covers.

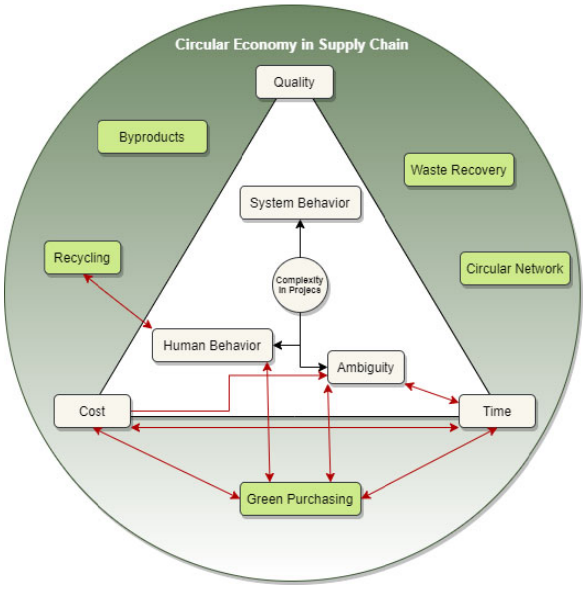

Figure 8: Integrative model with outstanding variables in the application of the research instrument

From a complex project perspective, it is evident that priority is given to Human Behavior, Ambiguity, Cost and Time, but with a lower correlation between them the quality dimensions. This is supported by the statistical analysis of multivariate correlations presented earlier in this investigation.

III. CONCLUSION

The correlations between variables of the two integrated groups at the same time allow us to infer that the supply chains of the pilot sample are working a path towards sustainability since they think about the environment as strategies such as green purchases and design of recyclable products. They also work to have economic stability by embracing strategies such as time and integration that allow generating savings by optimizing their processes in such a way that economic growth is sought. In addition, the social is implicit in the dimensions of human resources and communication and in general the work that is consolidated with all the actors of the supply chain. From the point of view of complexity in supply chains and the circular economy in turn, it is inferred that there needs to be more synchronization in the different activities that involve circularity in a company and in turn complex projects that allow reaching a certain level of understanding to be able to handle the system properly and to be able to stay current in the market.

The correlations shown in the research clearly show that the companies surveyed in the food industry are working to create a collaborative structure between all actors in the supply chain, which is essential for their respective management. Cooperation, mutual understanding and joint efforts will encourage companies to remain in the market in addition to being aligned with sustainability as long as their actions are aimed at contributing not only from an economic point of view, but also environmental and social.

This is evidenced by detecting the relevant bivariate correlations between Recycling, Green Purchasing and Human Behavior. These very relevant associations reveal the collaborative emphasis between the parts of a supply chain where a network is perceived that allows the emergence of an industrial ecosystem that aims to maintain a sustainable balance in the community.

Now, the food industry plays an important role in society and in the world economy, since it ensures important quantities of food and guarantees their quality with high standards that must be controlled. It is for this reason that complexity in this kind of manufacturing industry is implicit. The development of their products and what this entails, allows considering the dimensions of complex projects.

REFERENCES

[1] V. Anyosa,Simplifying project complexity: beyond eating the elephant in small pieces. Paper presented at PMI® Global Congress 2008—Latin America, São Paulo, Brazil. Newtown Square, PA: Project Management Institute. 2008.

[2] R. Basu,Managing Project Supply chains.GOWER. ISBN: 978-1-4094-2515-1. 2011.

[3] T, Bosona, &G, Gebresenbet,Cluster building and logistics network integration of local food supply chain. Biossystems Engineering,vol. 108, no. 4, pp.293–302, 2011.

[4] C, Meyer,&E, García, Success Factors for Supply Chain Management Projects: An Empirical Analysis, IFAC-Papers Online, ISSN 2405-8963. vol. 52, no. 13, pp.153–158, 2019.

[5] Project Management Institute PMI. A Guide to the Project Management Body of knowledge (PMBOK Guide) – Sixth Edition. Pennsylvania, USA. 2017.

[6] Project Management Institute PMI.Navigating Complexity, a practice guide. Pennsylvania, USA. 2017.

[7] C. Weetman, A circular economy handbook for business and supply chains. Koganpage. ISBN: 978 0 7494 7675 5, 2017.

★★★