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Article

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Open and Distance Learning (ODL) : Traditional or Frugal Innovation?

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ABSTRACT New information and communication technologies (ICTs) are contributing to the advancement and popularization of distance learning, and its use by educational institutions is accelerating. Some characteristics of distance learning are remarkable, such as its quantity, scalability, ability to serve many students at the same time, scope, lower costs, and so on. Some of these characteristics refer to a type of innovation called frugal, which is the ability to "do better with fewer resources for more people", that is, create significantly more value and minimize the use of resources. The objective of this research was to analyze the characteristics of distance learning through the theoretical lens of frugal innovation using the conceptual model of frugal innovation. The characteristics listed in the Rossetto model were researched qualitatively and quantitatively to obtain a solid conclusion, as this model uses a scale to identify and measure frugal innovation. The Rossetto model was developed and tested using the results of five collections of data from three different countries (Brazil, the United States of America, and India), with the entire development and refinement processes being subjected to an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA). The final validation of the scale was based on data from 1130 companies. The mixed (qualitative and quantitative) methodological procedures were used to analyze the data obtained from the field research. The qualitative analysis consisted of verifying the characteristics of frugal innovation through Rossetto's conceptual model, and exploratory factor analysis was chosen for the quantitative analysis. Ten of the characteristics of the model sought, analyzed in three dimensions, identified, and strongly indicated that ODL can be considered as a frugal innovation, convincing and confirming that ODL has as main characteristics of the FI such as cost reduction, focus on essential functionalities and improved performance in relation to face-to-face teaching and thus, highlighting that the main value created is to do better with fewer resources than traditional teaching for a greater number of students served.

KEY WORDS: open and distance education, ODL, AFE, frugal innovation.

JEL Classification: O33.

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1. Introduction

Open and distance learning (ODL) is a modality that is changing all forms of teaching and learning, including face-to-face instruction, and they are beginning to use more and more blended methodologies, easing the need for physical presence, reorganizing spaces and times, media, language accommodation, and their related processes (Moran, 2015).

New information and communication technologies (ICTs) are contributing to the advancement and popularization of distance learning and accelerating its use by educational institutions. Some

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characteristics of distance learning are remarkable, such as its quantity, scalability, ability to serve many students at the same time, scope, lower cost, and so on.

Some of these characteristics refer to a type of innovation called frugal. According to Prabhu (2017), frugal innovation is the ability to do better with fewer resources for more people, that is, create significantly more value and minimize the use of resources. Rossetto (2018) -related frugal innovation has been gaining space and attention from researchers and managers, primarily because it is a competitive alternative in times of crisis and increasingly scarce resources.

Understanding the effects of ODL in relation to face-to-face education is important for two reasons: (a) ODL managers can use this information to make decisions about how to act; and (b) as the main characteristics of ODL are its cost and quality, understanding its performance can help to determine the real reasons people have chosen it.

After analyzing the definitions of frugal innovation, a literature review was carried out to examine the main aspects (discussed in Section 2) of the works of Mourtzis et al. (2017), Rinn and Erharter (2014), Roland Berger Strategy Consultants (2013), Winterhoff et al. (2014), Mourzis (2018), Mourtzis et al. (2019), Bhatti, (2012), and Rossetto (2018). Thus, the objective of this research was to analyze the characteristics of ODL through the theoretical lens of frugal innovation using a conceptual model with ten characteristics in three dimensions (frugal functionality, frugal cost, and frugal ecosystem) created by Rossetto (2018).

After analyzing the definitions of frugal innovation, a literature review was carried out to examine the main aspects (discussed in Section 2) as a new business model where low cost solutions, high value for the customer (Mourtzis et al., 2017) and reduce the complexity and total costs of a product's life cycle (Roland Berger Strategy Consultants, 2013); the basis is the implementation of regional customer requirements constraints on globally distributed products (Rinn and Erharter, 2014); FI explores the concept of intelligent use of resources to develop highly functional products (Winterhoff et al., 2014); another characteristic is to make it easier for manufacturers to expand their potential target markets with products and modules that can be combined in order to meet the requirements of different markets without compromising functionality or quality (Mourtzis, 2018); the main attributes of FI are robust, easy to use, growing, accessible and local (Mourtzis et al., 2019); FI is focused on three basic aspects: substantial cost reductions, focus on fundamental functionality and an optimized performance due to the restrictions (Mourtzis et al., 2019; Bhatti, 2012) and frugal innovation is the ability to 'do better with less resources for more people' (Prabhu, 2017).

Thus, the objective of this research was to analyze the characteristics of open and distance learning through the theoretical lens of frugal innovation using a conceptual model with ten features in three dimensions (costs reductions, core function and frugal ecosystem) created by Rossetto (2018).

The characteristics listed in the Rossetto (2018) model were researched qualitatively and quantitatively to obtain a solid conclusion as this model uses a scale to identify and measure frugal innovation and was developed and tested using the results of five collections of data from three different countries (Brazil, the United States of America, and India). The entire development and refinement processes were subjected to an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA), and the final validation of the scale was based on data from 1130 companies. Other models were researched, but none of them proposed a scale that met all the requirements for this research.

In Section 2, we present our literature review and the concept of frugal innovation (FI). In Section 3, the adopted methodology is presented, and in Section 4, our analysis and its results are shown. In Section 5, the research conclusions are addressed.

2. Literature Review

2.1. Innovation

Since the beginning of the 20th century, a common research theme has been the object of study, and the part of the theory of economic development elaborated upon by Schumpeter through the capitalist model at the beginning

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of the industrial revolution, when the author differentiated between invention and innovation, Freeman attributes to Schumpeter and stated as follows: "an invention is an idea, sketch, or model for a new or improved artifact, product, process, or system. An innovation, in the economic sense, is only complete when there is a commercial transaction involving an invention and thus generating wealth" (Freeman, 1974, p. 22).

Innovation has been a goal of different types of organizations, and so in each reality, aspects of innovation must be observed in order to promote it or eliminate the barriers that can make it difficult.

In the study by Vallina-Hernandez et al. (2022), there is an interesting discussion on innovation, but it is related to internationalization and value chain activities in Chile.

According to Carvalho et al. (2011), companies should seek innovation to increase their performance and obtain gains resulting from competitive advantages. Innovation can provide:

- increased demand for products and services with the creation of new markets, clear differentiation from competitors, and increased perceived quality
- better defense of an organization's competitive position through products and services, with a high degree of difficulty for potential imitators
- cost reductions with better efficiency in production and management processes
- expansion of margins, with products and services having high added value that allows them to have a differentiated premium price
- increased competence for innovation arising from the practice of launching innovative products and services, which leads a company to increase its skill, volume of knowledge, and attitude towards innovation, and over time, with additional training, better and faster market launches can occur

Claver-Cortés et al. (2016) considered that innovation can be measured in a broader sense to verify whether a company has innovated or modernized products, processes, organizational practices, or commercial strategies.

According to Ortigueira-Sánchez et al. (2022), innovation is a source of value creation for firms and plays a key role in national competitiveness and productivity and innovation creates firm value through the introduction of new technologies and the exploitation of new markets.

In this article, we focus on Frugal Innovation which is explained in the next section

2.2. Frugal Innovation (FI)

The concept of frugal innovation is new, and scholars and authors have described several definitions for this topic. According to Hossain (2018), there is no clear awareness of the concept of frugal innovation. Furthermore, no research in the literature on frugal innovation has emphatically stated the root of the term. Zeschky et al. (2011) contributed to the first journal article on frugal innovation, found in the Web of Science database.

The definitions of FI that were found in articles are described in Table 1.

There are further interesting publications on FI. For example, Hossain et al. (2016) presented FI as a scarce resource solution (i.e., product, service, process, or business model) that is designed and implemented despite financial, technological, material, or other resource constraints in which the result is significantly cheaper than competitive offerings (if available) and good enough to meet basic customer needs that would otherwise remain underserved. This definition is a translation of the authors' definition of FI.

Hossain et al. (2022) developed a framework for FI to identify its antecedents, mediators, and consequences. Their framework promised a holistic perspective for FI by linking these identified factors to the concept of sustainability. The study positioned the consequences of FI in relation to the three pillars of sustainability: economy, society, and the environment.

The article by Ru-Zhue et al. (2022) addressed a part of FI, that is, they discussed an issue related to the technological aspects of innovation related to cost and value creation of canned and instant food export companies in Thailand. The research staff delivered 278 questionnaires for these companies and received 63 completed questionnaires.

Pellin et al. (2022) sought to identify incubator managers' understanding of and perspectives on the phenomenon of frugal innovation in their

Table 1
Definitions of Frugal Innovation

Definition	Author(s)
Frugal innovation introduces a new business model where a low-cost, high-value customer solution must be designed and delivered.	Mourtzis et al. (2017)
The foundation of frugal innovation is in the implementation of regional customer requirement constraints on globally distributed products by changing some modular product features.	Rinn and Erharter (2014)
The concept of frugal innovation introduces a new business model that aims to reduce the complexity and total lifecycle costs of a product by providing high value and targeted and affordable solutions for customers in different, and possibly divergent, markets.	Roland Berger Strategy Consultants (2013)
Frugal innovation explores the concept of the intelligent use of resources in order to develop highly functional products that can be tailored to meet the specific requirements of different markets which may have different consumer purchasing powers, with an optimal cost and quality per case.	Winterhoff et al. (2014)
Frugal innovation not only aims to support emerging economies, but also to facilitate manufacturers in expanding their potential target markets by designing and manufacturing products and product modules that can be combined in a way that fits the requirements of various markets, without compromising functionality or quality. Thus, it is important to expand the application of economic directives in various aspects of manufacturing and support it with the right tools to allow for the connection between the market and the manufacturer.	Mourtzis (2018)
The two basic challenges that companies aspiring to operate in emerging markets face are: the low purchasing power of most potential customers and resource constraints (Bhatti, 2012).	Bhatti, (2012)
Frugal innovation is focused on three basic aspects: substantial cost reductions, a focus on fundamental functionality, and an optimized performance given the constraints.	Mourtzis et al. (2019) Bhatti, (2012)
Frugal innovation enables socially and environmentally responsible economic development through products and services that combine accessibility, sustainability, and quality.	Mourtzis et al. (2019)
Frugal innovation is the ability to 'do better with less resources for more people', i.e., to create significantly more value while minimizing the use of resources	Prabhu, (2017).

respective institutions. Thus, their study allowed incubator managers to understand the aspects involving FI so that they could develop strategic actions for their incubators based on these aspects.

The work by Shivdas et al. (2021) also used a questionnaire, provided to 121 companies from different areas, followed by qualitative and quantitative analyses. This study used an exploratory factor analysis (EFA) and then a combinatory factor analysis (CFA), but it did not address the definition of FIC (FI capabilities) according to Rossetto (2018).

The article by Winkler et al. (2020) addressed FI in developed markets and adopted a criterion from

Weyrauch (2016) to evaluate a model, while our proposal used Rossetto's (2018) definition of FI.

The work by Velananda et al. (2022) showed applications of frugal innovation in a global context.

Some authors refer to business models such as Mourtzis et al. (2017) and Roland Berger Strategy Consultants (2013) and innovation in the business model is described as the model's ability to transform itself, with innovation included as an element that characterizes the business model itself (Rocha et al., 2018).

There are also several bibliometric works that show the evolution of scientific production related to an IF theme, such as the works by Tatum and Russo (2020), Dima et al. (2022), and Fernandes et al. (2020).

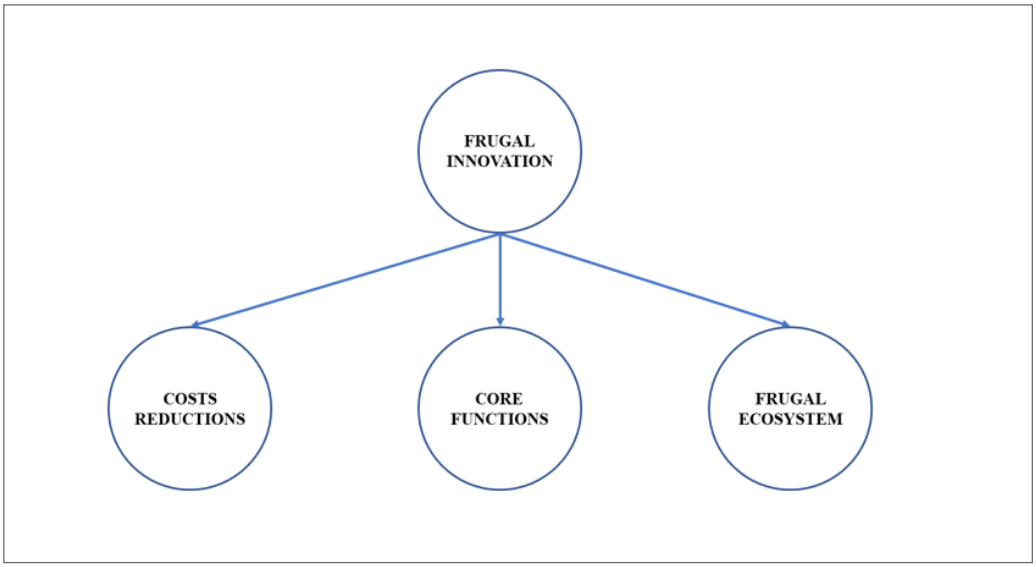
Rossetto et al. (2017) presented a new scale for measuring frugal innovation using three dimensions: frugal functionality, frugal cost, and frugal ecosystem. Rossetto (2018) proposed the following definition of FI: "Frugal innovation consists of creating an attractive value proposition for the selected target audience, focusing on the essential features and performance of the offer, thus minimizing the use of material, financial resources and organizational along the value chain. It provides a substantial reduction in usage and/or ownership costs while meeting or even exceeding prescribed quality standards, without losing sight of the pursuit of creating a frugal ecosystem."

Based on this definition, Rossetto (2018) created a conceptual model of FI, which we understand to be the most adequate for our context, and it is shown in Figure 1.

Thus, we present the definition of "substantial cost reduction" as a dimension that brings together the items that seek to measure efforts to offer high value products with the rearrangement of organizational resources to provide significant cost reductions in the operational and organizational processes, with the intent to transfer this savings to the final consumer.

We present the definition of "focus on essential functionality" as a dimension that brings together

Figure 1
A Conceptual Model of FI



Source: Rossetto (2018).

the items that offer the essential functionality of the products, rather than additional functionality, and that are designed to be easy to use and offer durability to the end consumer, that is, items that are not easily spoiled.

In this way, we present the definition of "Frugal Ecosystem" as a dimension that brings together items that offer efficient and effective solutions to the socio-environmental needs of customers and that provide environmental sustainability and offer partnerships with local companies in their operational processes.

The frugal measurement model with ten items and three dimensions is shown in Figure 2.

2.3. Open and Distance Learning (ODL)

Open and distance learning (ODL) in Brazil was created and developed through private initiatives and government decrees, and it followed a trajectory that followed the introduction and growth of each technology in the country (Gomes, 2013). With the creation of the Department of Open and Distance Learning of the Ministry of Education in 1995, ODL has been evolving as information and communication technologies (ICT) have been improving. After eleven years, this evolution began to erupt, having peaked in 2017 due to the change in the regulatory framework for open and distance learning (Schimiguel et al., 2020)

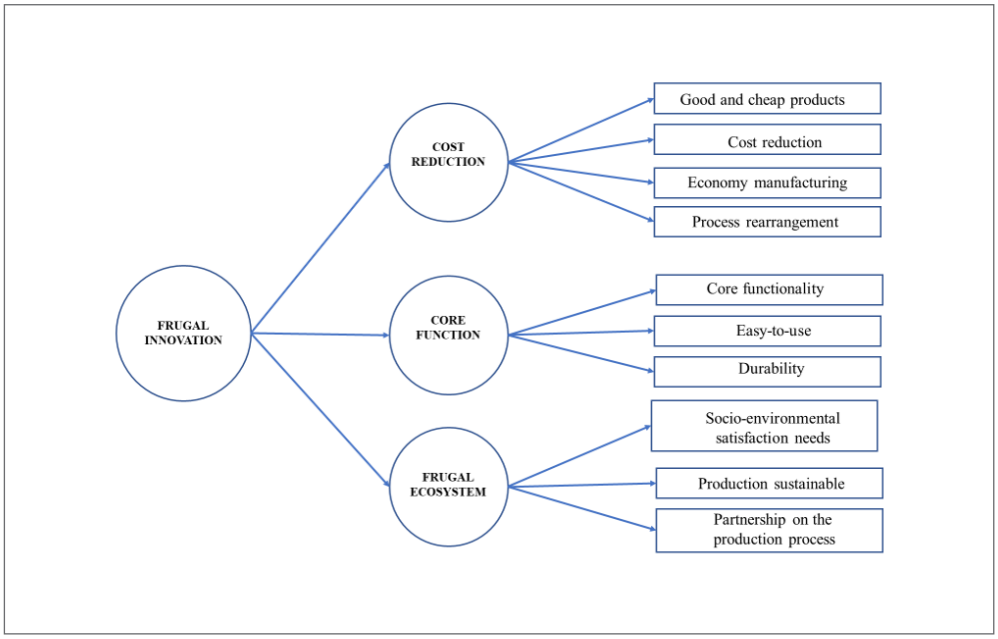
According to Mugnol (2009), open and distance learning is presented as a teaching modality that accompanied the development of the Brazilian educational system, and since 1996, it has received significant support from the federal government, which, through the Ministry of Education, has encouraged its growth in both the public and private spheres.

Belloni (2002) understood that the open and distance learning phenomenon, understood here as part of a broader educational innovation process, is the integration of new information and communication technologies in educational processes.

The very concept of distance is changing, such as the relationships of time and space, due to the incredible possibilities of distance communication

Figure 2

The Frugal Measurement Model



Source: Rossetto (2018).

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that telecommunications technologies offer. The concept of interactivity also carries great ambiguity, oscillating between a more precise sense of technical virtuality and a broader sense of interaction between subjects, mediated by machines (Belloni, 2002).

According to Gomes (2013), open and distance learning has been an ally of successive governments which have used it as an economically viable way of expanding access to overcome the latent educational gap in different regions of the country. The discourse of the democratization of education has sometimes transformed it into a fetish for a nearly magical solution to educational problems, and lately, open and distance learning has also played an important role in the expansion of private higher education as it has been used to considerably expand the number of students, lower costs, and maximize profits.

Rezende and Dias (2010) stated that what distinguishes distance learning from the face-to-face modality is, effectively, its circumstance: the physical distance between the student and his teacher. However, it should be noted that in the face-to-face modality, if there is no physical distance, there are also other types of distances in the teacher–student relationship: the distance of language, the distance of goals, objectives, and so on. On the other hand, the great effort that some educators have made in an attempt to minimize these distances in face-to-face education is remarkable. Thus, it appears that one could conclude that one of the main objectives of the educational act, whether in the face-to-face or distance modalities, is to minimize distance.

Each experience carried out, whether in person or at a distance, has its specificities and requires a teacher to adapt to their proposal. According to Vidal and Maia (2010), the dynamics and pedagogical approach of a teacher in a face-to-face context differs from one who works in distance learning in many aspects, such as:

- the degree of presence
- the rigidity of the time allocated to the development of each class
- the form of interactivity, knowledge construction, and content presentation
- the mechanisms used to maintain student interest and motivation

Distance learning is increasingly complex because it is growing in all fields, with different models, alongside the rapid evolution of networks and technological mobility and the scope of digital communication systems. The characteristics of this mass model are its quantity, scalability, ability to service to many at the same time, national and international coverage, interest as product for a majority of learners, current status as well-dimensioned and accepted, low price, and strong fundraising and marketing actions (Moran, 2015).

Jedrzejczyk and Brzezinski (2021) addressed the importance of social media in relation to the image of educational institutions. Caring for the image and building it consciously are becoming general practices in schools. The role played by marketing communications in the process of shaping this image is subjected to increased virtualization due to progressing digital transformation. Thus, the role of distance education can also be modeled by social media.

3. Methodology

In this research, we chose to use a mixed (quantitative and qualitative) methodological procedure to analyze the data obtained in our field research. The qualitative analysis consisted of verifying the characteristics of frugal innovation through Rossetto's conceptual model (2018).

Exploratory factor analysis was chosen for the quantitative analysis because, according to Matos and Rodrigues (2019), factor analysis (FA) is used to investigate latent patterns or relationships for a large number of variables and determine whether the information can be boiled down to a smaller set of factors.

3.1. Data

The survey data were collected from 14 to 22 July 2021 through Google forms, and ten questions were prepared according to Rossetto's conceptual model of frugal innovation (2018). The answers were closed on a scale of five levels, ranging from totally disagree to totally agree.

3.2. Discrete Statistics

Table 2 shows the descriptive statistics for each variable. In the first column, we can see that nine variables

had means greater than 2.5, that is, for the respondents, the variables good and cheap, final price, operating costs, resources, functionalities, ease of use, partnerships, social needs, and sustainability were better in open and distance learning than they were in face-to-face education. Final price and operating cost were the most significant variables for the respondents, and quality was the variable with the lowest average, that is, respondents stated that the quality of distance learning was lower than that of face-to-face education.

3.3. Sample Size

According to Matos and Rodrigues (2019), the minimum sample size to adjust an FA depends on the number of variables being analyzed, and the higher this number, the more data that must be collected, as more parameters will need to be estimated. Hair et al. (2009) suggested a sample of 100 or more observations, and Matos and Rodrigues (2019) stated that other authors have recommended having at least five times more observations than the number of variables analyzed, with a ratio of ten to one being ideal. Our sample had 217 observations and 10 variables, and thus, it met the requirements mentioned above.

3.4. Correlation

FA makes sense only if the variables analyzed are highly correlated with each other. Once the measurement level of the variables and the type of appropriate correlation have been defined, before starting the analyses, the correlation matrix must be verified (Matos and Rodrigues, 2019). Field et al. (2012) suggested that most matrix entries should be above 0.3. If some variables have many correlations below this value, they are candidates to be excluded from the analyses. Figure 3 shows that a majority of the correlations in our study were above 0.3.

3.5. Bartlett's Sphericity Test

The first step of the AFE implementation was to verify whether the application of the technique was valid for the chosen variables. For this, two evaluation methods are commonly used: the Bartlett sphericity test and the Kaiser–Meyer–Olkin (KMO) criterion.

First, we calculated Bartlett's test of sphericity, which showed a value of $\chi 2 = 813.0139$, with 45 degrees of freedom and a p-value of $1.576502x10\text{-}141 < 0.001$. These values presented by the test, along with the null hypothesis, indicated that the sample correlation matrix was not an identity matrix and that the application of the AFE was appropriate.

3.6. KMO

We performed another data adequacy test using the Kaiser–Meyer–Olkin measure of sampling adequacy, or

Table 2
Discrete Statistics

Variable	Average	Median	Standard deviation	Maximum	Minimum
good and cheap	3.56	4.00	1.25	5.00	1.00
final price	4.19	5.00	1.11	5.00	1.00
operational costs	4.54	5.00	0.85	5.00	1.00
resources	3.58	4.00	1.33	5.00	1.00
functionalities	3.76	4.00	1.25	5.00	1.00
facilities of use	3.22	4.00	1.31	5.00	1.00
quality	2.22	2.00	1.20	5.00	1.00
social needs	3.10	3.00	1.36	5.00	1.00
sustainability	2.90	3.00	1.31	5.00	1.00
partnerships	2.84	3.00	1.34	5.00	1.00

Source: research data.

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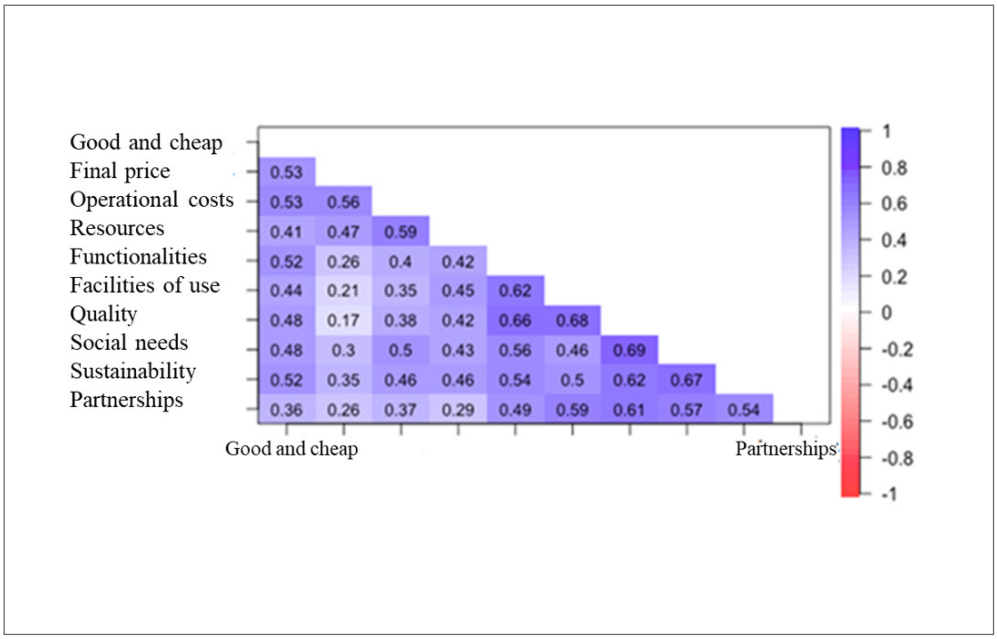
Figure 2
Correlation Matrix



Source: research data

KMO, where values less than 0.5 are considered unacceptable, values between 0.5 and 0.7 are considered mediocre, values between 0.7 and 0.8 are considered good, and values greater than 0.8 and 0.9 are considered excellent. Therefore, the KMO we obtained was suitable for the application of factor analysis, and the measure of adequacy for each item of the questionnaire is shown in Table 3.

The KMO Tests indicated that the sample sizes were adequate for both the overall test and for each variable individually. All values were above 0.84 and the acceptable sample adequacy measure (MAA) was greater than 0.5 (Pereira, 1999).

4. Results and Analysis

4.1. Exploratory Factor Analysis

To debug the dataset, we performed an exploratory factor analysis to verify the suitability of the 10 items for capturing the three dimensions.

According to the Kaiser criterion (an eigenvalue of greater than 1), we must retain two factors. According to the criterion of accumulated variance (a level of 60% of the accumulated variance), we also retain two factors, as they are able to explain 66% of the data variability. Therefore, the explanatory power of the model is adequate. Finally, by the slope diagram (the Scree test), this number could be up to five factors (an inflection point, which is when the individual variance curve of each factor becomes horizontal or suffers an abrupt drop) (Figure 4). This is because, as a general rule, the Scree test results for at least one, and sometimes two or three factors, are more than the Kaiser criterion (eigenvalue of >1) (Hair et al., 2009).

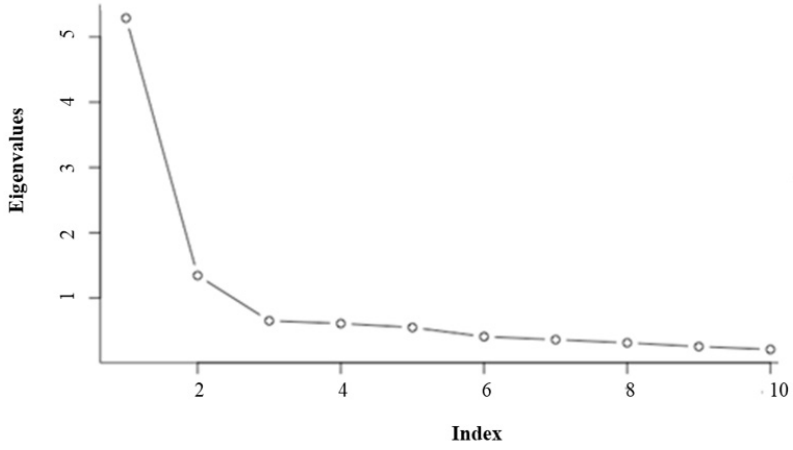
The exploratory factor analysis showed that the data were adequate for the analysis, with a KMO of 0.88, a Bartlett's sphericity test resulting in $\chi^2(45; N = 217) = 813.0139$, and a p-value of < 0.001. The parallel analysis suggested the extraction of two factors. However, two factors had eigenvalues greater than one, with the first factor explaining 32% of the data variance and the second factor explaining 17%. Additionally, for the adequacy indices, the scale presented the following statistics: $\chi^2(26 , N = 217) = 813.0139$, $p < 0.001$; TLI = 0.945; and RMSEA = 0.065 (90% CI 0.037 0.093).

Table 3
Adequacy Measure for each Questionnaire Item

General	**0.88**
good and cheap	0.9
final price	0.79
operational costs	0.84
resources	0.88
functionalities	0.92
facilities of use	0.85
quality	0.88
social needs	0.88
sustainability	0.92
partnerships	0.88

Source: research data.

Figure 4
Scree Plot



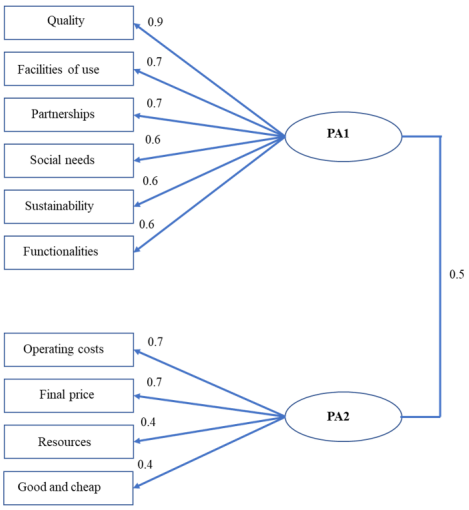
Source: research data

4.2. Qualitative Analysis

The answers to the questionnaires were analyzed according to the conceptual model of FI by Rossetto (2018), and the dimensions proposed in the model were used to guide the analyses.

The "cost reduction" dimension brings together the items that seek to measure efforts to offer products considered to be of good value with the rearrangement of organizational resources to provide significant cost reductions in the operational and organizational process, with the intent to transfer these savings to the final consumer

Figure 5
Factor Loadings



Source: research data

(Rossetto, 2018).

The first question was whether open and distance learning is "good and cheap" because, according to Mourtzis (2017), frugal innovation introduces a new business model in which solutions have low costs and high value for the customer. Figure 6 shows the responses of the respondents, and most respondents agreed with Mourtzis (2017), while as 66.8% of the responses were in full and partial agreement.

Respondents considered that the value proposed by open and distance learning was significant in relation to traditional courses, while still offering savings in mobility, meal, and time costs.

Another question was whether there was a significant price reduction with a monthly fee. According to Mourtzis et al. (2019) and Bhatti (2012), a substantial cost reduction is one of the basic aspects of frugal innovation, and Roland Berger Strategy Consultants (2013) stated that frugal innovation reduces the total lifecycle costs of a product. Figure 7 shows the responses of respondents, and we can see that 82.9% of the respondents fully or partially agreed with the question, including the respondents said that the main advantage of open and distance learning is its monthly fee. Monthly fees for open and distance learning are lower than monthly fees for traditional courses, providing a 30-50% reduction.

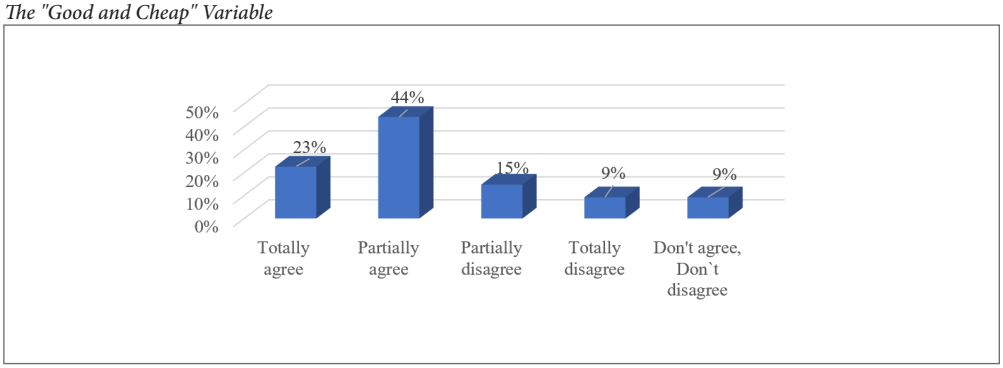
According to Gomes (2013), open and distance learning has been an ally of successive governments, each of which has used it as an economically viable way of expanding access to overcome the latent educational gap in various regions of the country.

The discourse of teaching democratization has at times become a fetish for a nearly magical solution to educational problems, and lately, open and distance learning has played an important role in the expansion of private higher education as it has been used to considerably expand the number of students, lower costs, and maximize profits. Figure 8 shows the results of the question of whether open and distance learning brings savings in operating resources, and 92.2% of the respondents believed that it does.

For the respondents, the fact that open and distance learning reaches a large audience without distance limits due to the resources offered by technolo-

Figure 6

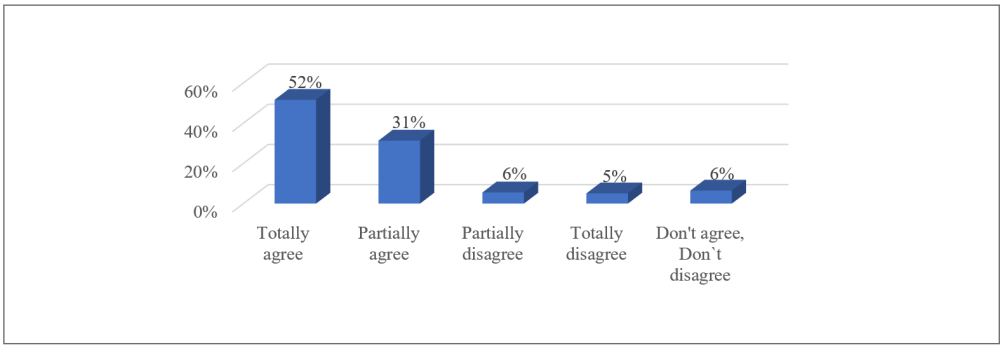
The "Good and Cheap" Variable



Source: research data

Figure 7

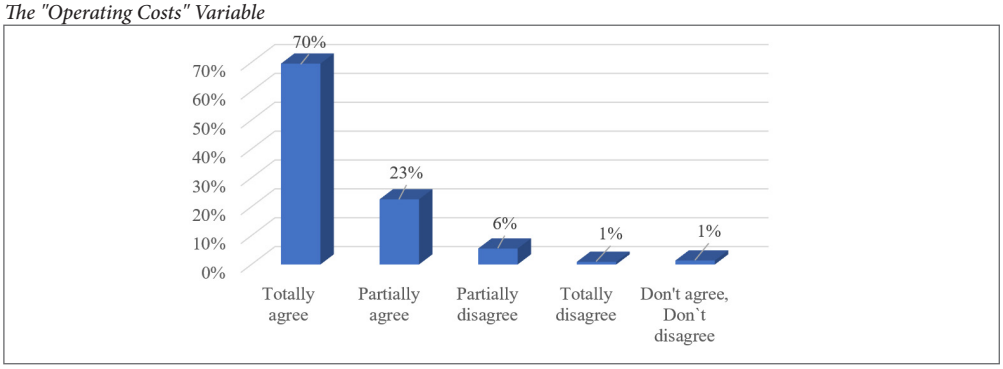
The "Final Price" Variable



Source: research data

Figure 8

The "Operating Costs" Variable



Source: research data

gies, thereby allowing a larger number of students to enroll in courses, that is, having a capacity for scalability without increasing technological and operational resources, creates the illusion that its costs are much lower than traditional modalities' costs.

In this question, unlike the previous one, it was found that open and distance learning offers savings for resources such as computers, books, classrooms, and so on. Rossetto (2018) considered that frugal innovation minimizes the use of material and financial and organizational resources throughout the value chain, and according to Prabhu (2017), frugal innovation is the ability to "do better with fewer resources for more people", that is, it creates significantly more value and minimizes the use of resources. Figure 9 shows that 68.3% of the respondents partially or fully agreed that open and distance learning offers savings in terms of resources.

For the respondents, open and distance learning offers a reduction in resources because students do not physically go to colleges or universities, and academic resources such as books, handouts, classes, and teachers are more accessible through technology and thus are not required to be physically produced or fabricated.

In analyzing the answers to the questions in the "cost reduction" dimension, a significant reduction in costs in the operational and organizational processes was perceived as the main value of open and distance learning, particularly the concept that open and distance learning is "good and cheap". Respondents perceived that the gains were not only economical (in the form of reduced monthly fees), they also stated that the main value proposition was that they could study during the time available, not wasting time on mobility, and that they could have the same quality as traditional courses.

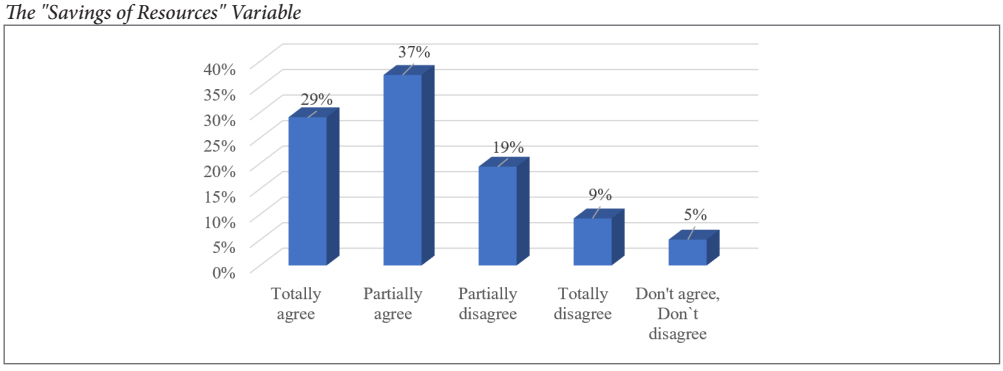
The second dimension of FI brings together the items that offer essential product functionality, rather than additional functionality, with items that are designed to be easy to use and that offer durability to the final consumer, that is, they do not spoil easily (Rossetto, 2018).

Open and distance learning users were asked if this modality offered more features such as chat capability, forums, recorded classes, and so on. Mourtzis (2018) considered that frugal innovation not only aims to support emerging economies, but also to facilitate manufacturers in expanding their potential target markets and designing and manufacturing products and product modules that can be combined to fit the requirements of various markets without compromising functionality or quality. Mourtzis et al. (2019) and Bhatti (2012) defined elements that focus on fundamental functionalities as one of the basic aspects of FI. Figure 10 shows the results of our respondents, and 73.2% confirmed that the modality offers more features.

The respondents reported that the main resources

Figure 9

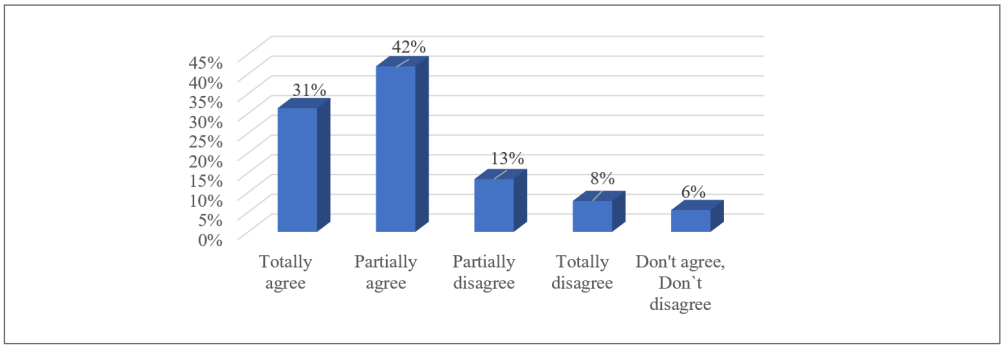
The "Savings of Resources" Variable



Source: research data

Figure 10

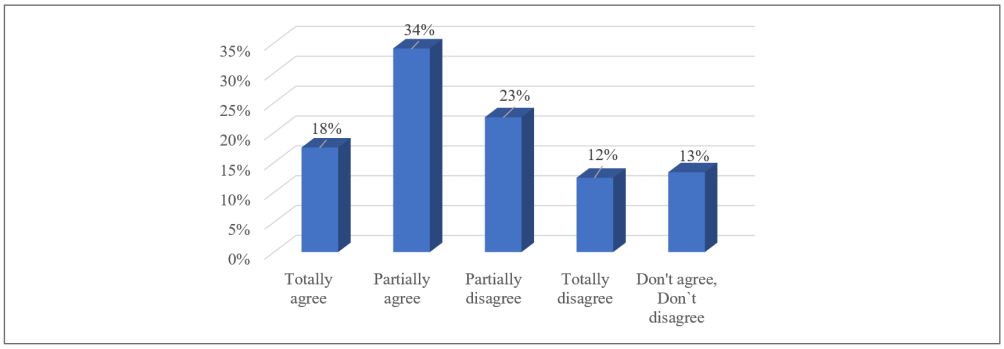
The "Features" Variable



Source: research data

Figure 11

The "Facilities" Variable



Source: research data

such as chat capability, forums, and recorded classes are offered by the modality, as was questioned, and also that the technological platforms used offer additional features such as an online library and academic services.

Winterhoff et al. (2014) considered that frugal innovation explores the concept of the intelligent use of resources to develop highly functional products that can be adjusted to meet the specific requirements of different markets—which may have different consumer purchasing powers—at great cost and quality by case. Based on this definition, our respondents were asked if open and distance learning offers greater facilities in relation to on-site education, and most respondents (51.6%) indicated that they partially or totally agreed, as seen in Figure 11.

The interviewees considered that distance learning offers some facilities in relation to traditional education, but it primarily enables the democratization of education since barriers—demographic and temporal, and cultural and social—are broken, thereby allowing access to a much larger and more varied audience.

The discussion about product quality due to frugal innovation is significant, and Winterhoff et al. (2014) considered that the FI must have products with great cost and quality per case, while Mourtzis (2018) considered that the FI must design and manufacture products and product modules that can be combined to fit the requirements of various markets without compromising on functionality or quality. Users of open and

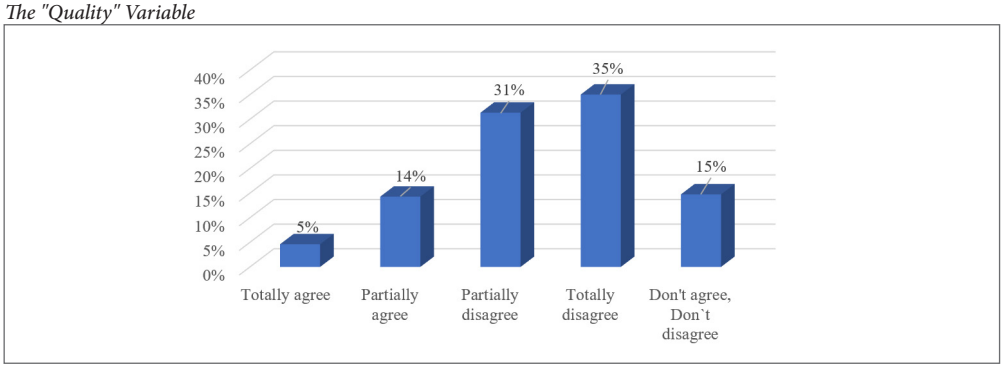
distance learning were asked if this modality has better quality than face-to-face education, and the majority (66.3%) answered that they totally or partially disagreed, as seen in Figure 12.

Despite all the technological resources used by open and distance learning, the respondents considered that the quality was worse than that of traditional courses. This perception of most respondents may be due to the fact that open and distance learning is newer in Brazil, and most respondents received their education through traditional courses, where the presence of a teacher is essential and the teaching–learning process is conducted differently than it is in open and distance learning, where the process is student-led.

The analysis of the questions about the second dimension showed that open and distance learning offers the essential and additional functionalities, it was designed to be easy to use, and it does not offer better quality than face-to-face education because the ODL modality is new and respondents have always studied using a face-to-face educational modality.

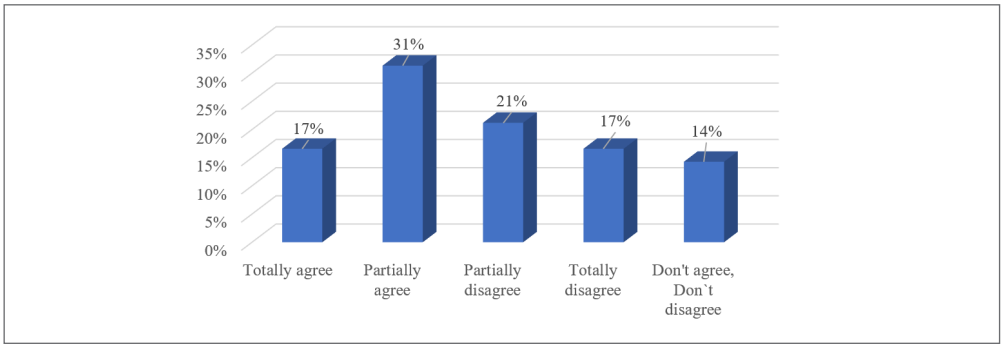
The third dimension is the "Frugal Ecosystem" which brings together items that offer efficient and effective solutions to the social and environmental needs of customers, provides environmental sustainability in its operational processes, and offers partnerships with

Figure 12
The "Quality" Variable



Source: research data

Figure 13
The "Social Needs" Variable



Source: research data

local companies in its operational processes.

Figure 13 shows the responses of the respondents to the question of whether open and distance learning meets the social and environmental needs of users. Only 47.9% of the respondents agreed (fully or partially) with the statement. As an open and distance learning user, it is very difficult to have this perception of social and environmental needs.

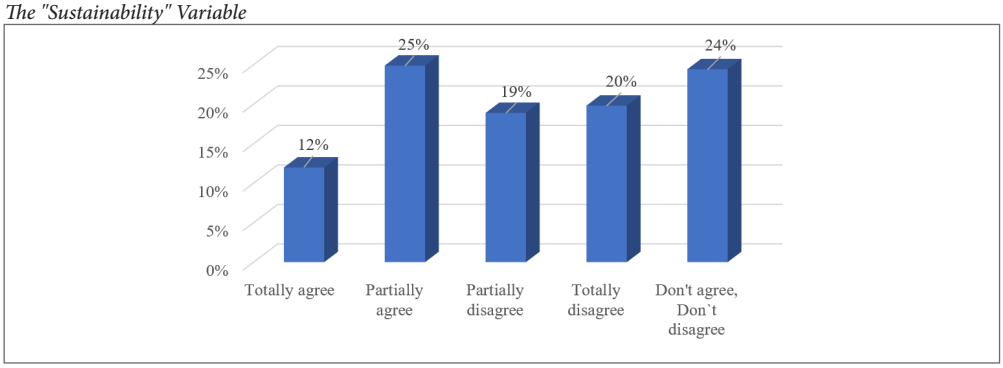
Frugal innovation allows for socially and environmentally responsible economic development through products and services that combine accessibility and sustainability (Mourtzis et al., 2019). Respondents were asked whether open and distance learning is concerned with social and environmental sustainability. Figure 14 shows the results of this question, and we emphasize that 38.7% of respondents totally or partially disagreed, while 36.9% partially or totally agreed. As an open and distance learning user, it is very difficult to have this perception of social and environmental sustainability.

The last question in the questionnaire asked respondents whether open and distance learning offers more opportunities for partnerships with local companies. Figure 15 presents the answers to this question, and 39.2% of respondents partially or totally disagreed while 34.1% totally or partially agreed. The low perception of partnerships can be explained by the fact that the perception of a partner is in the characteristic of being together, such as a friend or partner, but the e-learning modality does not offer this possibility.

The analysis of the questions about the third dimen-

Figure 14

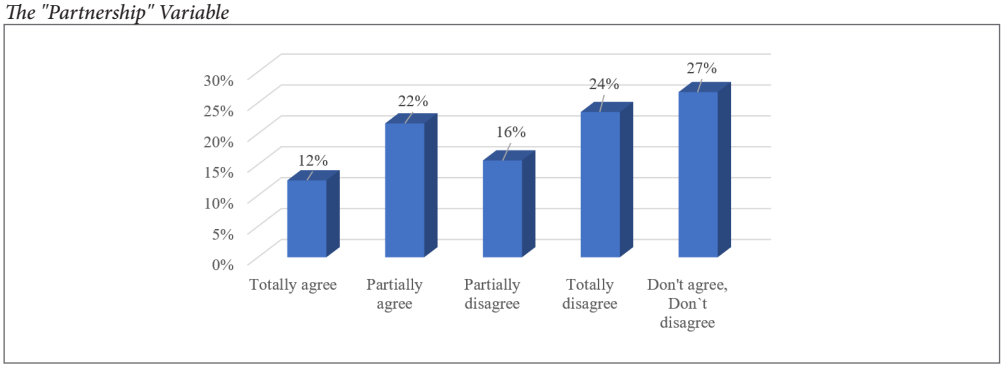
The "Sustainability" Variable



Source: research data

Figure 15

The "Partnership" Variable



Source: research data

sion showed that "Frugal Ecosystem" brings together the items that offer efficient and effective solutions to the social and environmental needs of customers, provides environmental sustainability in its operational processes, and offers partnerships with local companies in its operational processes. However, the fact that the relationship between players is virtual impairs the perception of these items.

5. Final Considerations

5.1. Conclusion

Although many authors have described various aspects of frugal innovation, our proposal was to follow in their footsteps (as seen in Figures 1 and 2) to describe our particular situation in relation to ODL. From the proposed study, it can be seen that the objective of this research was achieved, from which an exploratory factor analysis was used to debug the data and verify the adequacy of the 10 items to capture the three dimensions and the conceptual model of frugal innovation, as seen in Figures 1 and 2, to verify the characteristics of frugal innovation. Therefore, from this point of view, ODL can be considered a frugal innovation as the ten characteristics in three of the conceptual models were identified in the research.

In this context, the concept of "good and cheap" was identified in the research, with the final price and operating costs being the main characteristics mentioned while highlighting the dimension of cost reduction. On the other hand, the respondents' perception was that the quality of face-to-face education is better when compared to a distance learning modality.

It is also worth noting that, from the responses, there was no unanimity on issues related to social needs, sustainability, and partnerships, and the results were mixed in the context of the research.

Comparing the results and analyzes with the characteristics of frugal innovation faced in the literature review, we can verify that the ODL business models work with low cost solutions, high value for the customer, low complexity and reduction of the total costs of the cycle of a product's life, this can be confirmed by the monthly fees of the ODLs, which are lower than the monthly fees of face-to-face courses, in addition to saving time and financial resources for travel, meals and study materials.

Another characteristic that was observed is that any face-to-face activity such as assessments or delivery of documents is carried out regionally at the poles or offices located close to the students' homes, but these events are sporadic or scheduled for once or twice per semester. ICTs have a great contribution to the ODL model, as it makes the courses offered through digital platforms and tools more flexible and streamlined, allowing periodicity and frequent releases of new ODL products.

Answering the title question of this article, ODL can first be considered an innovation as it is a source of value creation through the introduction of new technologies and the exploration of new markets and the ODL has as main characteristics of the FI such as the cost reduction, the focus on essential functionalities and the improvement in performance in relation to face-to-face teaching, thus, highlighting that the main value created is to do more (greater number of students served) with fewer resources than traditional teaching.

5.1. Limitations and Future Research

In addition to the possible contributions made with this study, our work has a number of limitations. The first problem that deserves to be mentioned concerns the qualitative analysis because, despite having a statistical treatment, the opinions of the analyzes were in accordance with the perception of the researchers. Another limitation is that we used the Rosseto model and the study can also be performed with other theoretical models. As suggestions for future research, we can suggest a deepening or detailing of the technical characteristics of ODL and how to improve the quality of ODL, as well as increasing the research sample.

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