IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN:2278-487X, p-ISSN: 2319-7668. Volume 25, Issue 9. Ser. 6 (September. 2023), PP 18-30
www.iosrjournals.org

Frugal Innovation And Its Dimensions: Evidence In The Academic Context

Denise Adriana Johann[1], Luis Felipe Dias Lopes[2],
Sirlene Aparecida Takeda Bresciani[3], Andrieli de Fátima Paz Nunes[4],
Erik William Pereira[5], Maria do Socorro Silva Mesquita[6], Ricardo Alberti[7],
Cláudia Aline de Souza Ramser[8], Claudete Correa Dos Santos[9]

[1]*(Postgraduate Program in Administration / Federal University of Santa Maria, Brazil*
[2]*(Department of Administrative Sciences / Postgraduate Program in Administration / Federal University of Santa Maria, Brazil)*
[3]*(Doctor in Administration / Federal University of Santa Maria, Brazil)*
[4]*(Postgraduate Program in Administration / Federal University of Santa Maria, Brazil)*
[5]*(Postgraduate Program in Administration / University Vale of Itajaí-Univali, Brazil)*
[6]*(Master in Administration / Federal University of Ceará, Brazil)*
[7]*(Doctor in Rural Extension / Federal University of Santa Maria, Brazil*
[8]*(Postgraduate Program in Administration / Federal University of Santa Maria, Brazil)*
[9]*(Master in Administration / University Vale of Itajaí-Univali, Brazil)*

Abstract:
Purpose: *This study aimed to analyze frugal innovation and its dimensions (open innovation, sustainable innovation, cost innovation and product innovation) in the view of undergraduate students.*
Materials and Methods: *A quantitative approach and structural equation modeling was carried out with a sample of 462 Brazilian students.*
Results: *The analyzes confirmed and validated all proposed hypotheses as accepted with a direct and positive relationship between all dimensions of the model, being open innovation and sustainable innovation (H1), open innovation and product innovation (H2), open innovation and innovation of cost (H3), sustainable innovation and product innovation (H4), sustainable innovation and cost innovation (H5), and cost innovation and product innovation (H6). The students' perception in the context of frugal innovation stood out in the relationship of open innovation with sustainable innovation and obtained the most significant degree (0.680), since several studies have associated open innovation management practices with the innovative and sustainable performance of organizations.*
Conclusions: *The results showed that the model is useful to demonstrate the link of open innovation with the other innovation predictors of frugal innovation, thus directing the processes during the creation of the product or service. The implications of this study would be useful to understand the behavior of undergraduate students in relation to frugal innovation, as these are the labor delivered to society, managers in front of organizations or entrepreneurs inserted in the market economy.*
Keywords*: Innovation; Frugal innovation; Graduate students; Structural equation modeling.*

Date of Submission: 16-09-2023 Date of Acceptance: 26-09-2023

I. Introduction

Innovation is desired by organizations in all countries and began to be scientifically discussed by the economists Richard Cantillon (1755), Jean Baptiste Say (1803), Joseph Schumpeter (1949), and McClelland (1965) because, in addition to being associated with a competitive advantage, it can reduce costs and increase profits. Research has proven that innovation is an essential factor for the sustainability of small and medium enterprises (Kmieciak et al., 2012), and other authors corroborate that innovation is responsible for the organizations' performance, which is proven through the positive correlation between innovation and performance (Sulistyo & Siyamtinah, 2016).

The Organization for Economic Cooperation and Development (OECD, 2018), aligned in stimulating economic progress and world trade, believes that innovation is not necessarily creating a new product or service, thus expanding the concept to a new marketing method or organizational process in business practices and/or significantly improved workplace organization. Miocevic and Morgan (2018) noted that market sensing capabilities are essential to promote an organization's ability to recognize and exploit opportunities, thereby increasing business growth. The value of innovation observed in the analyzed organizations points to higher growth levels than companies with lower innovation capabilities (Miocevic & Morgan, 2018).

Allied to these factors regarding innovation value, Kunamaneni (2018) demonstrated the concern with the accelerated growth of the planet's population and the challenges found in all production chains. Hence, innovation by providing high quality and low-cost technology, disrupting sectors, has come to be studied by various nations as technology can reduce costs (RAO, 2017). Given this scenario, in the era of technological advancement and among the different types of innovations, frugal innovations are on the agenda of different industries, operations managers, and business academics (Pansera, 2018; Tiwari et al., 2017). According to Soni and Krishnan (2014), the concept originated in emerging economies that sought to develop products and services that met market needs and ensured access to unserved consumers, thereby filling this gap. Khan (2016) signaled that frugal innovations are on the path to becoming the key to the future of innovation management and will have the ability to provide new directions for organizations.

Agarwal and Brem (2017) reported that the frugal view goes beyond focusing on products or services and classifies it as a state of mind or even a way of life. Moreover, some researchers recognize this emerging innovation as a reverse economy and describe several attributes, including significantly lower costs, ease of use, limited resources, and low impact on the environment (Weyrauch & Herstatt, 2017).

According to The Economist (2010) and Von Zedtwitz et al. (2015), developing or developed nations, enriched with knowledge, have begun to pay attention to Frugal Innovation (FI) since they are challenged by some kind of frugality (Govindarajan & Trinble, 2012). On the one hand, some nations still analyze frugal innovation, while on the other hand, studies have shown that frugal products participate in several other markets and signal that there is no doubt that academic research plays an important role in constructing a theoretical and empirical framework related to the theme given that critical studies have accelerated multiple sectors of the production chain (Weiss & Cattaneo, 2017). Given the above, fundamentally, companies' innovation will lead to better economic performance and higher growth, thus generating more jobs and higher wages (Fatema & Islam, 2020).

According to AlMulhim (2021), research concerning the role of internal and external sources of knowledge in frugal innovation has increased in the last decade, albeit limited to only identifying knowledge sources in organizational practices. Therefore, to analyze and understand this theme with a lens that can fill gaps in the market, one must go beyond serving the pyramid base, promoting competitive advantage by producing more with less, and contributing to further understanding sustainable innovation.

Considering that frugal innovation leverages efforts to create new businesses, products, services, and processes, this study proposes the following question: in graduate students, is open innovation directly and positively related to the three dimensions of innovations (cost, sustainability, and product), being predictors of product innovation?

Hence, this study aimed to test the relationship between the dimensions that make up frugal innovation (Silva, 2018; Lopes et al., 2020), being open innovation (Alburub & Lee, 2012), sustainable innovation (Chen et al., 2006), cost innovation (AFONSO et al., 2008), and product innovation as proposed by Gunday et al. (2011) using the model of structural equations to measure the relationships. The set of these four types of innovations conceptually directed the studies of Silva (2018) and Lopes et al. (2020), leading to the term frugal innovation.

II. Theoretical Review

Frugal Innovation

Organizations that focus on understanding frugal innovation obtained via internal and external sources are better prepared to face sustainability challenges, develop their capabilities, and maintain efficiency for maximum productivity while also employing fewer resources (Almulhim, 2021). Terwiesch and Ulrich (2009) explained that innovations can be developed and evidenced broadly and systematically and not just be limited to generating shareholder value (i.e., economic value). In the authors' view, product and service innovations must contribute to social welfare, environmental protection, and improve the organization's image; thus, existing technologies and market knowledge are the starting point for innovation.

The expansion of emerging markets and consumerism and the need for affordable development have signaled the need for changes and innovations in production processes, products, and services. Therefore, frugal innovation, which was a term used to initially discuss forms of meeting the needs of consumers with financial limitations (i.e., to offer opportunities to non-affluent customers), has expanded to developed markets as a strategy for competitive improvement (Hossain, 2018). According to Silva (2018), frugal innovation aims to create something new with fewer resources while using the appropriate technologies to develop low-cost and high-quality products and services that meet the needs and expectations of consumers; in addition, these innovations need to be guided by sustainability. In this sense, it is possible to state that this type of innovation implies doing more with less and for more people (Knorringa et al., 2016; Radjou & Euchner, 2016; Weyrauch & Hersttatt, 2017), that is, the goal is to make the product or service accessible to consumers with limited financial resources.

Rosseto et al. (2017, p. 7) pointed out that frugal innovation consists of creating a value proposition that is attractive to the target audience, focusing on the functionalities and performance of core factors, minimizing material, financial, and organizational resources throughout the value chain. Bhatty and Ventresca (2013) described that the concept of frugal innovation is not new and that its terminology is recent; in fact, this innovation can also be defined as reverse innovation, creative improvisation, "jugaad innovation," and inclusive innovation, although other terminologies may still emerge as frugal innovation has been gaining popularity in research.

There is a consensus among authors that frugal innovation is still unexplored and requires much more practical analysis (Almulhim, 2021; Koerich; Cancellier, 2019; Silva, 2018).

Koerich and Cancellier (2019) reported that frugal innovation is considered a relevant topic in social and academic discourse; therefore, they signal the importance of developing research instruments and their application in empirical studies.

Frugal Innovation Tools

Regarding validated instruments, the literature review demonstrated the validation of three frugal innovation scales (Rosseto et al., 2017; Silva, 2018; Bresciani et al., 2020). The first instrument proposed by Rosseto et al. (2017) was aimed at measuring the level of frugality achieved by the organization and applied using 5- and 7-point Likert scales composed of three dimensions: i) substantial cost reduction, with three items; ii) creation of a frugal ecosystem, with three items; iii) concentration on core functionalities and performance, with three items. Notably, the authors reported that this instrument could be applied in any company, regardless of its size, type of product, service, or industry.

The scale proposed by Silva et al. (2018) is conceptualized as a meta-construct of open, cost, sustainability, and product innovations in which each dimension contributes to the understanding of frugal innovation, being: open innovation (OI) (Abulrub & Lee, 2012), sustainable innovation (SI) (Chen, 2008), cost innovation (CI) (Afonso et al., 2008), and product innovation (PI) (Gunday et al., 2011). In their study, the authors applied a questionnaire with a 5-point Likert scale and an instrument of organizational capabilities with the following dimensions: production, technological, human capital, and marketing capabilities to the organizational context.

Lastly, the frugal innovation metric validated in the Brazilian organizational context by Silva et al. (2020) was validated in the university context and under undergraduate students' perception by Lopes et al. (2020). The authors analyzed the influence of entrepreneurial intention on the dimensions of frugal innovation. For the frugal innovation scale, the following dimensions were applied: OI (Abulrub & Lee, 2012), SI (Chen, 2008), CI (Afonso et al., 2008), and PI (Gunday et al., 2011), while the entrepreneurial intention scale used two dimensions of entrepreneurial intention, being the first with six items as proposed by Liñán and Chen (2009) and the second with three items as proposed by Thompson (2009). The instrument was applied with a 5-point Likert scale ranging from strongly disagree to strongly agree.

Open innovation

The items validated by Silva (2018) and Lopes et al. (2020) from Abulrub and Lee (2012, p. 132) are shown in Table1.

Table I. Open innovation dimension items

Open Innovation - OI
Obtaining a right to exploit technologies (intellectual property, patent, copyright, or trademarks) by paying royalties to external partners;
Sale of internal technologies (intellectual property, patents, copyrights, or trademarks) to the market to make better use of them in the industry where the company operates or in another;
Joint development of technologies with external partners, such as universities or other companies; 4. Involve customers in innovation processes (market research to verify their needs or product development based on customer specifications and modifications;
Revealing internal technologies without immediate financial rewards with indirect benefits for the company.

Source: Abulrub and Lee (2012, p. 132).

It can be inferred that open innovation is an important competitive strategy in some industries and results from the generation and use of ideas inside and out of the organizations with the use of knowledge inputs and outputs to accelerate internal innovation and expand external innovation markets (Chesbrough, 2007). Therefore, open innovation can be considered a determinant of the successful realization of the production process to achieve sustainable production, and research findings show that open innovation has a strong effect on achieving cleaner production (Rumanti et al., 2021). With this view, the following hypotheses are proposed:

H_1: Open innovation is related to product innovation;
H_2: Open innovation is related to cost innovation;
H_3: Open innovation is related to sustainable innovation.

Sustainable innovation

Pinsky and Kruglianskas (2017, p. 232) explained that theories approach innovation from the perspective of new or modified products, services, production, and management processes, which offer environmental benefits. Chen et al. (2006, p. 232) aimed to explore whether green innovation in product and green innovation produced positive effects on the competitive advantage of the companies surveyed. The authors emphasized that adopting proactive strategies in corporate environmental management can not only prevent companies from facing environmentalist protests or penalties, but also help them develop new market opportunities and increase competitive advantage.

Moreover, the authors' data collection involved sending 600 questionnaires to managers of production, marketing, R&D, and environmental protection departments of different Taiwanese companies. The instrument applied contained four items related to green innovation and eight items to measure the performance of the companies' competitive advantage (Chen et al., 2006). The items are described in Table 2.

Table II. Sustainable innovation dimension items

Sustainable innovation - SI
The company's manufacturing process effectively reduces the emission of hazardous substances or waste;
The company's manufacturing process recycles waste and emissions that allow them to be treated and reused;
The company's manufacturing process reduces the consumption of water, electricity, coal, or oil;
The company's manufacturing process reduces the use of raw materials.

Source: Chen et al. (2006, p. 334).

Considering that sustainable innovation contributes with innovations that mainly bring solutions to environmental issues and is recognized as a differentiation strategy in the correct and rational use of inputs, lower costs, lower environmental and consumer risks, and together with the stackholders' expectations, the following hypotheses are proposed:

H_4: Sustainable innovation is related to product innovation;
H_5: Sustainable innovation is related to cost innovation.

Cost innovation and product innovation

Afonso et al. (2008) argued that reducing the time and cost of New Product Development (NPD) can create relative advantages in market share, profits, and competitiveness in the long term, especially during the first stage (i.e., the production phase), before making the product available on the market. Given this, the study of these authors follows other studies that address NPD costs, target costing, and the reduction of lead time for product development (time-to-market) to test factors and variables associated with organizational skills to minimize time and costs. The items considered in the authors' study are listed in Table 3.

Table III. Cost innovation items

Cost Innovation - CI
For the development of new products, it is common to calculate the desirable production cost of the new product using the following formula: maximum allowed cost = potential market price - expected margin for that product;
During the design process of a new product, many changes are made to the product so as not to exceed a predetermined maximum production cost;
During the process of developing new products, the attributes of the product are considered to be very expensive compared to the value assigned by the customer are reduced/eliminated (e.g., packages, warranty, after-sales service);
The company generally negotiates changes in product design and/or functionality with suppliers and customers to achieve a predetermined cost of the product;
During the process of developing new products, the company tries to add additional resources or functionality to the product if it is not possible to offer a lower price than the competitors;
During the process of developing new products, the company seeks to surpass competitors that design competitive products in price, functionality, and quality.

Source: Afonso et al. (2008, p. 567).

Product and service innovation includes significant improvements in technical specifications, components and materials, embedded software, ease of use, or other functional characteristics (OECD, 2018, p. 56). Under this concept, Gunday et al. (2011) explored innovations and their effects on company performance by examining the product, process, marketing, and organizational innovations as well as production, market, and financial performance and reported that the innovation literature does not reach a conclusion regarding which type of innovation provides a greater or lesser impact on a company's performance. Given this scenario, the authors argued that innovations influence each other and must be implemented together; therefore, they measured the relationships in the four types of innovations (Gunday et al., 2011, p. 663). The items used in the authors' study are presented in Table 4.

Table IV. Production innovation items

Product Innovation - PI
Increased manufacturing quality in components and materials of current products/services;
Decreased manufacturing costs for components and materials of current products/services;
Development of new products/services for current products/services, leading to greater ease of use for customers and higher customer satisfaction;
Development of new products/services with technical specifications and features completely different from the current ones;
Development of new products/services with components and materials completely different from the current ones.

Source: Gunday et al. (2011, p. 672).

Considering that product innovation is critical driver and driven by technological advances, acting as a bridge carrying positive impacts of process innovations to innovative performance, making changing customer needs, making shorter product life cycles, and increasing global competition (Gunday et al., 2011, p. 672). Nevertheless, Hall (2011) concluded that product innovation has a significant positive impact on companies' revenue productivity (i.e., their costs). Given the research described herein concerning cost innovation and product innovation, the following hypothesis is proposed:

H_6: Cost innovation is related to product innovation.

III. Methodology

For the research, According to Hair et al. (2009), it is necessary to operationalize the quantification of variables, which must be transformed into variables that can be empirically observed and measured (Gil, 1999). As a result, the dimensions of open innovation, sustainable innovation, cost innovation, and product innovation were measured based on research instruments already validated in Brazil. The instrument of Silva (2018) was employed, which was validated in the university context by Lopes et al. (2020). Eighteen statements composed of one exogenous construct Open Innovation (OI) and three endogenous constructs Sustainable Innovation (SI), Product Innovation (PI) and Cost Innovation (CI) were applied and answered using a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

Open innovation (Alburub & Lee, 2012) is the exogenous construct proposed in the model, whereas sustainable innovation (Chen et al., 2006), cost innovation (Afonso et al., 2008), and product innovation (Gunday et al., 2011) are endogenous constructs of frugal innovation, as validated by Silva (2018). In his study, the author used an instrument composed of demographic questions about companies and respondents and a questionnaire divided into two blocks: organizational capabilities and modes of innovation within the organization).

Hence, the instrument used herein is composed of 18 statements adapted for the context of university students and answered using a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The sample was defined as non-probabilistic by convenience and with a population of 3801 graduate students from the Federal University of Santa Maria (UFSM). Questionnaires were sent online to all students enrolled in graduate courses, and 462 questionnaires were answered and used for this study.

Next, variance-based structural equation modeling (Partial Least Squares - Structural Equation Modeling; PLS-SEM) was chosen. The PLS-SEM approach focuses on maximizing the explained variance of the endogenous dimensions; thus, structural equation modeling is considered a powerful tool due to its versatility in helping confirm existing relationships among multiple variables (Hair et al., 2014).

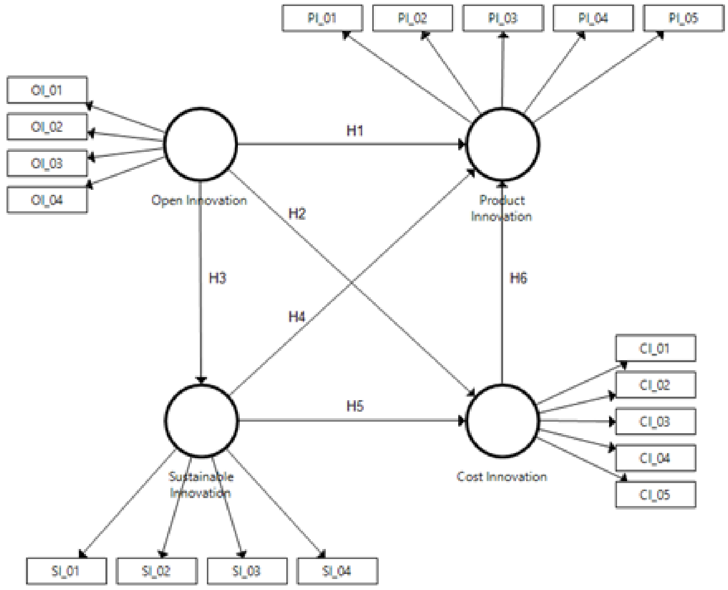
Open innovation was used as an independent variable as it causes fluctuations in the other variables of the model. The innovation literature considers open innovation as one of the most important constructs and consequences of other innovations, in addition to sustainable development through initiation, accessibility, building bridges, and finding unique solutions to problems through mutual dialogue and reciprocity (Sexana, 2015).

Therefore, this interaction of interaction should facilitate sustainable and inclusive development through open innovation, making this criterion of theoretical relevance. Predictive analysis includes open innovation in this model as a predictor of the other innovations that make up frugal innovation through PLS analysis to build a structural model (Chin, 1998). The exogenous variable values are not explained by the model and are assumed as a result (Faria & Santos, 2000).

IV. Results

Through exploratory survey research, 462 valid questionnaires were obtained from students of different graduate courses. The socio-demographic data show that 239 (51.73%) are men and 223 (48.07%) are women, and the age group with the highest participation is 26 to 35 years old, with 249 participants (53.90%). Regarding marital status, 300 (64.94%) of the participants declared to be single, of which 225 respondents (48.70%) were pursuing their doctoral studies. Upon summarizing the participants' data, we analyzed the measurement diagram and its relationships between latent variables and their respective variables observed (Figure 1).

Figure 1. Frugal innovation measurement model



Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

According to Figure 1, the measurement model presents four hypotheses that connect the five latent variables to the 14 observed variables (OV's) and 4 latent variables (LV's), being the independent variable. Sustainable innovation, product innovation, and cost innovation are the dependent variables of the model proposed herein. Three stages were used to analyze the collected data. In the first structure analysis, with the data processed in the SmartPLS® software, the factor loadings of all variables were verified to assess internal consistency and construct validity (convergent validity and discriminant validity). The data showed that the validity of the loadings referring to the constructs was close to 0.70, which did not make it necessary to exclude any variable. Hair et al. (2009) stated that factor loadings between latent and manifest variables are considered acceptable values above 0.70.

The study portrayed acceptable convergent validity as the average variance extracted (AVE) of all its first-order reflective constructs (open innovation, sustainable innovation, product innovation, and cost innovation), with values exceeding .50, while the factor loadings of all items were above 0.70 (Hair et al., 2017). These findings corroborate Chin (1998), who considered acceptable factor loadings ranging from 0.50 to 0.70 and that the measurement criteria (Cronbach's alpha - α, composite reliability (CR) and Average Variance Extracted - AVE) are above the minimum tolerated value.

As listed in Table 5, the internal consistency and convergent validity data meet the requirements of obtaining > 0.50 values for VME and 0.70 to 0.95 for internal consistency (Cronbach's alpha; α) and composite reliability, as described by Hair et al. (2017).

Table V. Cronbach's alpha, composite reliability, and AVE for the model

Constructs	ronbach's alpha (α)	omposite Reliability (CR)	VME
ıovation (OI)	0.844	0.895	0.681
ple Innovation (SI)	0.939	0.956	0.846
nnovation (PI)	0.951	0.963	0.837
ovation (CI)	0.925	0.944	0.770

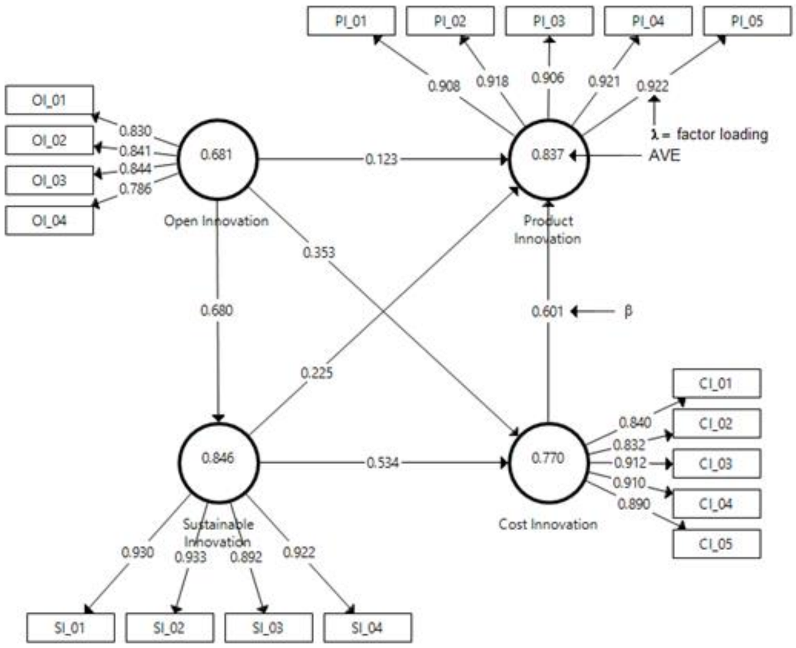
Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

The initial results proved to be satisfactory (Table 5). The second stage, after ensuring Internal Consistency (IC) and Convergent Validity (CV), consisted of observing the values of Cronbach's alpha (α) and composite reliability (CR) (RINGLE et al., 2014). Values of α and CR between 0.60 to 0.70 are considered adequate in exploratory research, and 0.70 to 0.95 are considered satisfactory (Hair et al., 2017). By analyzing Table 1, it was possible to observe that the model fit in a manner compatible with the parameters suggested by

Chin (1998) for CV: VME > 0.50, CR and $\alpha > 0.70$. The result of discriminant validity was also satisfactory after adjusting the model.

After recognizing the interrelationships arising from the variables and structuring the path measurement model (Figure 2), with the results referring to the four constructs in hand, the path model provides the factor loadings between the indicators and constructs.

Figure 2. Frugal innovation path model



Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

By using the path diagram, it is possible to describe the structural equations (Table 6).

Table VI. Initial path diagram for the model

Endogenous constructs	=	**Exogenous constructs**	+	**Error**
PI	=	β_1 OI + β_2 SI + β_3 CI	+	ε_{PI}
SI	=	β_4 OI	+	ε_{SI}
CI	=	β_5 OI + β_6 SI	+	ε_{CI}

Source: Survey data based on Hair et al. (2014).

In the second step, we used the Discriminant Validity (DV) of the Structural Equation Modeling (SEM), as the DV indicates whether the dimensions or latent variables are independent of each other (Hair et al., 2014). Cross factor loadings and Fornell and Larcker (1981) criterion was used to compare the square roots of the AVE values of each dimension with the Pearson's correlations matrix between the constructs. The result found from the square roots of the AVE must be greater than the correlations between the dimensions.

According to the data in Table 7, the factor loadings of the VO's in the LV's are always greater than in the other constructs, thus confirming that the model has DV according to the criterion of Chin (1998).

Table VII. Method of analysis of cross factor loadings

Indicators (OV's)	Constructs (LV's)			
	OI	**CI**	**PI**	**SI**
OI_01	**0,830**	0,513	0,532	0,556
OI_02	**0,841**	0,638	0,617	0,574
OI_03	**0,844**	0,640	0,626	0,539
OI_04	**0,786**	0,564	0,550	0,576
CI_01	0,581	**0,840**	0,678	0,714
CI_02	0,585	**0,832**	0,644	0,617
CI_03	0,670	**0,912**	0,778	0,690
CI_04	0,653	**0,910**	0,825	0,698
CI_05	0,648	**0,890**	0,842	0,678
PI_01	0,648	0,819	**0,908**	0,698
PI_02	0,655	0,817	**0,918**	0,709
PI_03	0,631	0,763	**0,906**	0,740
PI_04	0,655	0,781	**0,921**	0,697
PI_05	0,642	0,767	**0,922**	0,697
SI_01	0,645	0,698	0,698	**0,930**
SI_02	0,634	0,702	0,696	**0,933**
SI_03	0,638	0,714	0,748	**0,892**
SI_04	0,581	0,734	0,702	**0,922**

Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

The results listed in Table 7 confirm the cross-factorial loading analysis, as all values were well above the recommended limits. According to Fornell and Larcker (1981), factor loadings greater than 0.6 and higher loading values per line (bold) in the source LV's. What is more, Ringle et al. (2014) reported that the dimension is the only variable with characteristics that are not representative of others.

Discriminant validity can be understood as the finding that the factor loadings of each observed variable (indicator) are grouped into their respective dimensions or LV's (Ringle et al., 2014). The results found are in accordance with Fornell-Larcker and Heterotrait-Monotrait Ratio (HTMT) criteria (Table 4).

Table VIII. Fornell-Larcker and HTMT criteria

Constructs	$\sqrt{AVE}$	Pearson's Correlation Matrix			
		OI	**SI**	**PI**	**CI**
Open Innovation (OI)	0.825	1.000	0.680	0.706	0.716
Sustainable Innovation (SI)	0.920		1.000	0.774	0.774
Product Innovation (PI)	0.915			1.000	0.863
Cost Innovation (CI)	0.877				1.000
		HTMT Criterion*			
Sustainable Innovation (SI)		0.820			
Product Innovation (PI)		0.836	0.862		
Cost Innovation (CI)		0.861	0.874	0.940	

*UL = Upper Limit (97.5% confidence interval)
Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

The results found indicate the extent to which the LVs are independent of each other, thus confirming the DV of each dimension (Hair et al., 2017). Table 8 shows the confirmation of the Fornell-Larcker Criterion, where on the diagonal, they present the square roots of the VME and the correlations between the dimensions in the other cells, to confirm the criterion, $\sqrt{AVE} > r_{ij},\ i \neq j$. As for the HTMT criterion, the results meet the criterion's requirement, that is, the $UL(HTMT)_{97.5\%} < 1$. According to the notes of Chin (1998), we used the observation of the cross loading, observing the indicators with higher factor loadings on their respective LV than in the others, confirming the DV of each dimension (Table 4).

In the third step and after confirming the DV of each dimension, the structural model was analyzed. Hair et al. (2017) pointed out that the structural model can be measured by several methods, including collinearity analysis (Variance Inflation Factor - VIF), predictive relevance assessment of Q^2, significance level of R^2, effect size f^2, and evaluation of the significance and relevance of the betas of the structural model (Student's t-test). The VIF indicates whether there is a potential collinearity problem in the model (Table 9).

Table IX. Variance Inflation Factor - multicollinearity analysis for the model dimensions

Exogenous Constructs	Endogenous Constructs		
	SI	PI	CI
novation (OP)	1.000	2.233	1.858
ble Innovation (SI)	---	2.716	1.858
ovation (CI)	---	3.003	---

Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

In the model, all VIF values were below 5, thus attending to the non-existence of strong correlations between the dimensions and showing no collinearity problems. The VIF is a measure of the degree to which the other independent variables explain each independent variable. The higher the VIF, the more severe the multicollinearity. The results showed that the VIF of the constructs ranged from 1.000 to 3.003, indicating that multicollinearity was not an issue. In addition, the main loadings for each construct were significantly higher than the others, which again indicated that multicollinearity was not a problem. According to Kutner et al. (2004), the general rule accepted for the existence of multicollinearity is that the VIFs are greater than ten or the tolerance value is below 0.10.

Moreover, following the precepts of Ringle et al. (2014), the model's predictive power and the usefulness of each LV were evaluated through the predictive validity indicators (Q^2), as shown in Table 10.

Table X. Predictive relevance of the model

Endogenous Constructs	SSO	SSE	$Q^2 = 1 - \frac{SSE}{SSO}$
novation (OI)	1,852.00	1,135.70	0.387
Innovation (SI)	2,315.00	817.28	0.647
ovation (CI)	2,315.00	1,135.59	0.509

Note: SSO: Sum of Square Observations; and SSE: Sum of Squared Errors.
Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

The results showed that the model exhibited predictive property by processing Q^2 values above zero (SI = 0.387, CI = 0.509, and PI = 0.647), highlighting product innovation with the highest degree of predictive property. Then, we analyzed the effect size (f^2) using the Blindfolding module (Table 11), in which the quality of the adjusted model and the search for the variance of the endogenous dimensions are explained by the structural model and Pearson's coefficients (R^2) (Ringle et al., 2014). According to the authors, the reference values for the analysis of the R^2 follow the parameters suggested by Cohen (1988) adapted by Lopes et al. (2020): 0.02 to 0.075 small effect, 0.076 to 0.19 medium effect, and > 0.19 large effect. The effect size (f^2) or Cohen's indicator (Table 11) assesses how useful the dimension is for the model fit. The value is obtained by including and excluding dimensions in the model (one by one). Hair et al. (2017) adapted by Lopes et al. (2020) considered the values of 0.02 to 0.075 weak effect, 0.076 to 0.225 moderate effect, and > 0.225 strong effect.

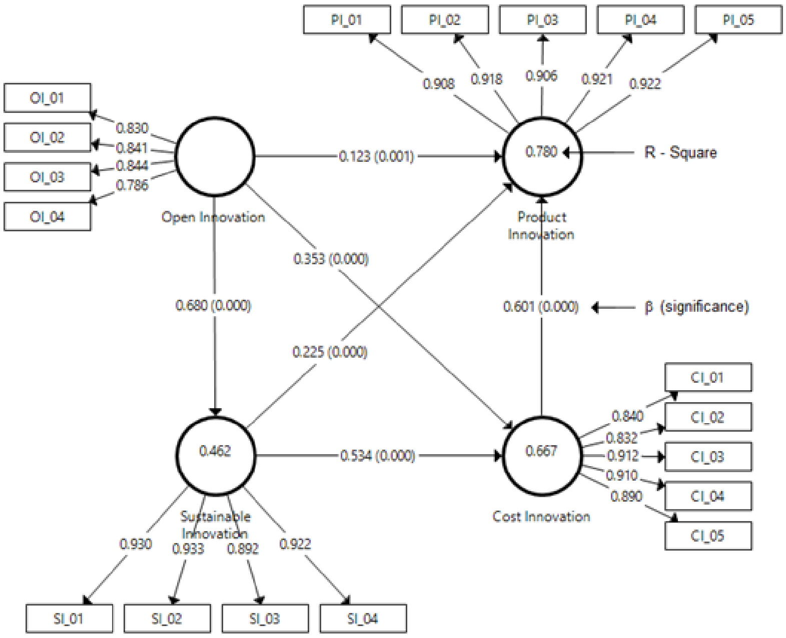
Table XI. Effects between dimensions (f^2) and explanation coefficient (R^2)

Exogenous Constructs	Endogenous Constructs (f^2)		
	SI	PI	CI
novation (OP)	0.858 (0.000)	0.031 (0.119)	0.202 (0.000)
ble Innovation (SI)	---	0.085 (0.010)	0.462 (0.000)
ovation (CI)	---	0.546 (0.000)	---
R^2	0.462 (0.000)	0.780 (0.000)	0.667 (0.000)

Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

The model presents a non-significant (f^2) effect (OI → PI), two moderate effects (SI → PI and OI → CI) and the other strong effects (OI → SI, CI → PI and SI → CI). As for R^2, the Frugal Innovation model is explained by 78.0% of Product Innovation, 66.7% of Cost Innovation and 46.2% of Sustainable Innovation. Thus, the final path model of the relationships between the dimensions is illustrated in Figure 3.

Figure 3. Final path model of the frugal innovation dimension



Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

The final model in Figure 3 presents the items referring to each dimension after the model validation steps; in this way, this study concludes that the model is empirically supported and its dimensions have significant relationships. The values of all the fit indices confirm the excellent fit of the structural model. The final path diagram for the model is presented in Table 12.

Table XII. Final path diagram for the model

Endogenous constructs	=	Exogenous constructs	+	Error
PI	=	0.123 OI + 0.225 SI + 0.601 CI	+	ε_{PI}
SI	=	0.680 OI	+	ε_{SI}
CI	=	0.353 OI + 0.534 SI	+	ε_{CI}

Source: Survey data based on Hair et al. (2014).

Next, the Student t-test values were also calculated, which according to Hair et al. (2005), one must test the causal relationship between two dimensions using Student's t-test to verify whether it is significant or not in order for the beta coefficient to be significant or not. The relationships between the dimensions are listed Table 13.

Table XIII. Validation of the structural coefficients and their respective hypotheses

Hyp.	Exogenous Constructs	□	Endogenous Constructs	□'s	SD	T-test (|□ / SD|)	p-values
H_1	OI	□	PI	0.123	0.039	3.15	0.002
H_2	OI	□	CI	0.353	0.041	8.53	0.000
H_3	OI	□	SI	0.680	0.029	23.30	0.000
H_4	SI	□	PI	0.225	0.042	5.29	0.000
H_5	SI	□	CI	0.534	0.040	13.50	0.000
H_6	CI	□	PI	0.601	0.046	13.19	0.000

SD = Stardart Desviation

Source: SmartPLS® Software, v. 4.0.8.5 (Ringle et al., 2022).

According to the data in Table 9, the values of the relationships between the LV are above the reference value of 1.96 while considering the adopted significance level of 5% (i.e., the dimensions relate significantly) (Hair et al., 2017; Wong, 2013; Ringle et al., 2014). The values found were: OI → PI (t_{cal} = 3.15), OI → CI (t_{cal} =

8.53), OI → SI (t_{cal} = 23.30), SI → PI (t_{cal} = 5.29), SI →CI (t_{cal} = 13.50), and CI → PI (t_{cal} = 13.19). Thus, all the hypotheses proposed in the model were significant and accepted.

Upon evaluating the model adjustment quality through the path coefficients analysis of the adjusted model and interpreted as the beta coefficients (β) of the regression, it is concluded that the relationships of frugal innovation: OI, SI, CI, and PI are significant ($t > 1.96$ and $p < 0.05$), which led to the acceptance of all hypotheses (H_1, H_2, H_3, H_4, H_5, and H_6).

The path coefficients (β's) explain how strong the effect of one construct is on the other; thus, open innovation exerts the most significant effect of the model in sustainable innovation (0.680 degrees). The analyses confirmed the positive relationship between all hypotheses. Hence, the first hypothesis proposes that open innovation directly and positively influences sustainable innovation. As the data described, the path coefficient of the relationship between OI and SI is the most significant. The results confirm that open innovation, sustainable innovation and cost innovation impact in production innovation in 78%, open innovation and sustainable innovation impact in cost innovation in 66.7% and open innovation impact in sustainable innovation in 46.2%.

IV. Conclusions

This study aimed to test the relationship between the dimensions of frugal innovation, which is composed of the dimensions of open innovation (Alburub & Lee, 2012), sustainable innovation (Chen et al., 2006), cost innovation (Afonso et al., 2008), and product innovation (Gunday et al., 2011), using the structural equations model. The exogenous open innovation dimension and the three endogenous innovation dimensions form the frugal innovation model proposed by Silva (2018) in the organizational context, as validated and adapted by Lopes et al. (2020) for the context of higher education students.

For the proposed model, open innovation relates directly and positively to the other innovations; with this, it corroborates Bogers et al. (2018), which indicates the openness of companies to external sources of knowledge as an important driver of innovation performance. Our findings also indicate that the model met the criteria for convergent and discriminant validity for all assumptions. Furthermore, the results showed that the reliability of the dimensions ranged from 0.80 to 0.93, indicating that all values were within the acceptable range. Furthermore, the analyses confirmed that all relationships are positive between the exogenous (OI) and endogenous dimensions (sustainable, cost, and production).

It was also found that the highest statistical significance was between open innovation and sustainable innovation, as the t-value of the relationship (OI → SI; t_{cal} = 23.299) was greater than 1.96 (tabulated t-value), which indicated a 0.05 significance level. The path coefficient or standardized regression coefficient (β) of this relationship (OI → SI) indicated that a one-unit change in open innovation could influence a 0.680 change in sustainable innovation.

Convergent validity, discriminant validity, and quality of the adjusted model were verified, leading all hypotheses to be validated and confirming the model's explanatory power, where it can be stated that the proposed model is reliable and presents predictive validity.

Given the above, the modeling proved to be efficient and confirmatory to identify graduate students' perception in open innovation, sustainable innovation, product innovation, and cost innovation (i.e., the innovations that form frugal innovation). Therefore, the proposed model is explained in 78% by product innovation, 67% by cost innovation, and 46% by sustainable innovation. It is concluded that frugal innovation, in this proposed model, is mostly explained by product innovation with a percentage of almost 80%, thus highlighting how much product innovation can explain frugal innovation.

In this sense, the model studied reflects how graduate students recognize frugal innovation and concludes that they first perceive the relationship of open innovation with sustainable innovation, followed by the relationship of cost innovation with product innovation, and sustainable relationship with cost innovation. The estimation and evaluation of the model under study allowed us to conclude that the proposed theoretical model is satisfactory. The quality of the model is good, noting that the indices of reliability, validity, and adjustment for the latent construct (open innovation) in relation to the dependent constructs (sustainable innovation, product innovation, and cost innovation) have higher values than those recommended (Hair et al., 2009).

Several limitations to this study include the lack of instruments that make up frugal innovation and the development of theoretical and empirical studies that can contribute to disseminating this type of innovation, given the urgency of rethinking the forms of production and use of natural resources. It is suggested that other researchers replicate this study in other universities with Brazilian and international students and other contexts to broaden the discussions and better understand frugal innovation in the context of other innovations, their relationships, and their interrelationships.

Acknowledgments

This research was funded by the following Brazilian research agencies: National Council for Scientific and Technological Development (CNPq), Coordination for the Improvement of Higher Education Personnel (CAPES) and Research Support Foundation of the State of RS (FAPERGS).

References

[1]. Afonso, P.; Nunes, M.; Paisana, A.; Braga, A. (2008). The Influence Of Time-To-MarketAnd Target Costing In The New Product Development Success. International Journal Of Production Economics, V. 115, P. 559-568. Https://Doi.Org/10.1016/J.Ijpe.2008.07.003.

[2]. Agarwal, N.; Brem, A. (2017). The Frugal Innovation Case Of Solar-Powered Automated Teller Machines (Atms) Of Vortex Engineering In India. Journal Of EntrepreneurshipAnd Innovation In Emerging Economies, 3(2). 115-126. Https://Doi.Org/10.1177/2393957517717895.

[3]. Abulrub, A. H. G.; Lee, J. (2012). Open Innovation Management: Challenges And Prospects. Procedia-Social And Behavioral Sciences, 41, 130-138. Https://Doi.Org/10.1016/J.Sbspro.2012.04.017.

[4]. Almulhim, A. F. (2021). The Role Of Internal And External Sources Of Knowledge On Frugal Innovation: Moderating Role Of Innovation Capabilities. International Journal Of Innovation Science, 13(3), 341-363. Https://Doi.Org/10.1108/IJIS-09-2020-0130.

[5]. Bhatti, Y. A.; Ventresca, M. (2013). How Can 'Frugal Innovation'be Conceptualized? Available At SSRN 2203552. Https://Doi.Org/10.2139/Ssrn.2203552.

[6]. Bogers, M.; Foss, N. J.; Lyngsie, J. (2018). The "Human Side" Of Open Innovation: The Role Of Employee Diversity In Firm-Level Openness. Research Policy, 47(1), 218-231. Https://Doi.Org/10.1016/J.Respol.2017.10.012.

[7]. Cantillon, R. (1997). Essai Sur La Nature Du Commerce En Général. Ined.

[8]. Chen, Y. S.; Lai, S. B.; Wen, C. T. (2006). The Influence Of Green Innovation Performance On Corporate Advantage In Taiwan. Journal Of Business Ethics, 67, 331-339. Https://Doi.Org/10.1007/S10551-006-9025-5.

[9]. Chesbrough, H. W. (2007). Why Companies Should Have Open Business Models. MIT Sloan Management Review. Available In: Https://Sloanreview.Mit.Edu/Article/Why-Companies-Should-Have-Open-Business-Models/.

[10]. Chin, W. W. (1995). Partial Least Squares Is To LISREL As Principal Components Analysis Is To Common Factor Analysis. Technology Studies, 2(2), 315-319.

[11]. Economist, T. (2010). The Power Of Disrupt: Business Innovations From Emerging Markets Will Change The Rich World Too. The Eonomist, 395, 16-18.

[12]. Enkel, E. Heil, S. Hengstler, M.; Wirth, H. (2017). Exploratory And Exploitative Innovation: To What Extent Do The Dimensions Of Individual Level Absorptive Capacity Contribute? Technovation, 60, 29-38. Https://Doi.Org/10.1016/J.Technovation.2016.08.002.

[13]. Eggers, F.; O'Dwyer, M.; Kraus, S.; Vallaster, C.; Güldenberg, S. (2013). The Impact Of Brand Authenticity On Brand Trust And SME Growth: A CEO Perspective. Journal Of World Business, 48(3), 340-348. Https://Doi.Org/10.1016/J.Jwb.2012.07.018.

[14]. Farias, S. A. D.; Santos, R. D. C. (2000). Modelagem De Equações Estruturais E Satisfação Do Consumidor: Uma Investigação Teórica E Prática. Revista De Administração Contemporânea, 4, 107-132. Https://Doi.Org/10.1590/S1415-65552000000300007.

[15]. Fornell, C.; Larcker, D. F. (1981). Evaluating Structural Equation Models With Unobservable Variables And Measurement Error. Journal Of Marketing Research, 18(1), 39-50. Https://Doi.Org/10.1177/002224378101800104.

[16]. Gil, A. Métodos E Técnicas De Pesquisa Social. (1999). 5. Ed. São Paulo: Atlas.

[17]. Govindarajan, V.; Trimble, C. (2012). Reverse Innovation – Is It In Your StrategicPlan? Ontario: Leadership Excellence.

[18]. Gunday, G.; Ulusoy, G.; Kilic, K.; Alpkan, L. (2011). Effects Of Innovation Types On Firm Performance. International Journal Of Production Economics, 133(2), 662-676. Https://Doi.Org/10.1016/J.Ijpe.2011.05.014.

[19]. Hall, B. H. (2011). Innovation And Productivity (No. W17178). National Bureau Of Economic Research. Https://Doi.Org/10.3386/W17178.

[20]. Hair, J. F.; Anderson, R. E.; Tatham, R. L.; Black, W. C. (2005). Análise Multivariada De Dados. 5. Ed. Porto Alegre: Bookman.

[21]. Hair, J. F.; Black, W. C.; Babin, B. J.; Anderson, R. E.; Tatham, R. L. (2009). Análise Multivariada De Dados. 6. Ed. Porto Alegre: Bookman.

[22]. Hair, J. F.; Gabriel, M. L. D. S.; Patel, V. K. (2014). Modelagem De Equações Estruturais Baseada Em Covariância (CB-SEM) Com O AMOS: Orientações Sobre A SuaAplicação Como Uma Ferramenta De Pesquisa De Marketing. Revista Brasileira De Marketing, V. 13, N. 2, P. 44-55. Available In: Https://Www.Redalyc.Org/Pdf/4717/471747340003.Pdf.

[23]. Hair, J. F.; Hult, G. T. M.; Ringle, C.; Sarstedt, M. (2017). A Primer On Partialleast Squares Structural Equation Modeling (PLS-SEM). 2. Ed. Thousand Oaks: Sage.

[24]. Hossain, M. (2018). Frugal Innovation: A Review And Research Agenda. Journal Of Cleaner Production, 182, 926-936. Https://Doi.Org 10.1016/J.Jclepro.2018.02.091.

[25]. Fatema, F.; Islam, M. M. (2020). Driving Forces Of Marine Fisheries And Seafood Export Of Bangladesh: Augmented Gravity Model Approach. Asian Journal Of Economic Modelling, 8(2), 106-122. Available In: Https//Archive.Aessweb.Com/Index.Php/5009/Article/View/357/658.

[26]. Khan, R. (2016). How Frugal Innovation Promotes Social Sustainability. Sustainability, 8(10), 1034. Https://Doi.Org/10.3390/Su8101034.

[27]. Kmieciak, R.; Michna, A.; Meczynska, A. (2012). Innovativeness, Empowerment And IT Capability: Evidence From Smes. Industrial Management & Data Systems, 112(5), 707-728. Https://Doi.Org/10.1108/02635571211232280.

[28]. Knorringa, P.; Peša, I.; Leliveld, A.; Van Beers, C. (2016). Frugal Innovation And Development: Aides Or Adversaries? The European Journal Of Development Research, 28, 143-153. Https://Doi.Org/10.1057/Ejdr.2016.3

[29]. Koerich, G. V.; Cancellier, E. L. P. L. (2019). Inovação Frugal: Origens, Evolução E Perspectivas Futuras. Cadernos Ebape. Br, 17, 1079-1093. Https://Doi.Org/10.1590/1679-395174424.

[30]. Kunamaneni, S. (2019). Challenges In Moving From Incremental To Radical Low-Cost Innovation In Emerging And Transition Countries: Institutional Perspectives Based On Rechargeable Battery Innovation In China And Point-Of-Use Water Purification Innovation In India. International Journal Of Innovation Management, 23(03), 1950028. Https://Doi.Org/10.1142/S1363919619500282

[31]. Lopes, L. F.; Bresciani, S. A. T.; Johann, D. A.; Moura, G., Almeida, D.; Teixeira, C. E. (2020). Modeling Entrepreneurial Intent As A Predictor Of Frugal Innovation InUniversity Students. Revista De Administração Da UFSM, 13(3), 643-663. Https://Doi.Org/10.5902/19834659 43879.

[32]. Lopes, L. F. D.; Chaves, B. M.; Fabricio, A.; Almeida, D. M.; Obregon, S. L.; Lima, M. P.; Silva, W. V.; Camargo, M. E.; Veiga, C. P.; Moura, G. L.; Silva, L. S. C. V.; Costa, V. M. F. (2020). International Journal Of Environmental Research And Public Health, 17(11), 3874. Https://Doi.Org/10.3390/Ijerph17113874.

[33]. Mcclelland, D. C. (1965). N Achievement And Entrepreneurship: A Longitudinal Study. Journal Of Personality And Social Psychology, 1(4), 389. Https://Doi.Org/10.1037/H0021956.

[34]. Miocevic, D., & Morgan, R. E. (2018). Operational Capabilities And Entrepreneurial Opportunities In Emerging Market Firms: Explaining Exporting SME Growth. International Marketing Review, 35(2), 320-341. Https://Doi.Org/10.1108/IMR-12-2015-0270.

[35]. OECD / Eurostat, Oslo Manual (2018). Guidelines For Collecting, Reporting And Using Data On Innovation, 4th Ed., The Measurement Of Scientific, Technological And Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg.

[36]. Pansera, M. (2013). Frugality, Grassroots And Inclusiveness: New Challenges For Mainstream Innovation Theories. African Journal Of Science, Technology, Innovation And Development, 5(6), 469-478. Available In: Https://Hdl.Handle.Net/10520/EJC150311.

[37]. Pérez, J. A. H.; Geldes, C.; Kunc, M. H.; Flores, A. (2019). New Approach To The Innovation Process In Emerging Economies: The Manufacturing Sector Case In Chile And Peru. Technovation, 79, 35-55. Https://Doi.Org/10.1016/J.Technovation.2018.02.012

[38]. Pinsky, V. C.; Moretti, S. L. A.; Kruglianskas, I.; Plonski, G. A. (2015). Inovação Sustentável: Uma Perspectiva Comparada Da Literatura Internacional E Nacional. RAI Revista De Administração E Inovação, 12(3), 226-250. Https://Doi.Org/10.11606/Rai.V12i3.101486.

[39]. Pinsky, V.; Krugliankas, I. (2017). Inovação Tecnológica Para A Sustentabilidade: Aprendizados De Sucessos E Fracassos. Estudos Avançados, 31, 107-126. Https://Doi.Org/10.1590/S0103-40142017.3190008.

[40]. Purcarea, I., Del Mar. B. E., M.; Apetrei, A. (2013). Innovation And Knowledge Creation: Perspectives On The Smes Sector. Management Decision, 51(5), 1096-1107. Https://Doi.Org/10.1108/MD-08-2012-0590.

[41]. Radjou, N.; Euchner, J. (2016). The Principles Of Frugal Innovation: An Interview With Navi Radjou: Navi Radjou Talks With Jim Euchner About Jugaad And Frugal Innovation And Their Place In Corporate R&D. Research-Technology Management, 59(4), 13-20. Https://Doi.Org/10.1080/08956308.2016.1185339.

[42]. Rao, B. C. (2013). How Disruptive Is Frugal? Technology In Society, 35(1), 65-73. Https://Doi.Org/10.1016/J.Techsoc.2013.03.003.

[43]. Ringle, C. M.; Silva, D.; Bido, D. S. (2014). Modelagem De Equações Estruturais Com Utilização Do Smartpls. Remark-Revista Brasileira De Marketing, 13(2), 56-73. Https://Doi.Org/10.5585/Remark.V13i2.2717.

[44]. Ringle, C. M.; Wende, S.; Becker, J. M. (2022). Smartpls 4. Smartpls Gmbh, Boenningstedt.

[45]. Rosseto, D. E.; Borini, F. M.; Bernardes, R. C.; Frankwick, G. L. (2017). A New Scale For Measuring Frugal Innovation: The First Stageof Development Of A MeasurementTool. In Anais VI SINGEP, São Paulo.

[46]. Rumanti, A. A.; Sunaryo, I.; Wiratmadja, I. I.; Irianto, D. (2021). Cleaner Production Through Open Innovation In Indonesian Batik Small And Medium Enterprises (SME). The TQM Journal, 33(6), 1347-1372. Https://Doi.Org/10.1108/TQM-04-2020-0086.

[47]. Say, J. B. (1855). A Treatise On Political Economy, Trans. Clement Biddle. Philadephia:Lippincott, Grambo & Co.

[48]. Schumpeter, J. (1949). Economic Theory And Entrepreneurial History. Change And The Entrepreneur: Postulates And Patterns Of Entrepreneurial History, Cambridge-Mass:Harvard University Press, P. 63-84.

[49]. Saxena, S. (2015). Dialogue Between The Formal And The Informal Sector In Open Innovations At The Grassroots' Level. Humanomics, 31(1), 104-117. Https://Doi.Org/10.1108/H-05-2013-003.5

[50]. Silva, I. M. (2018). Capacidades Organizacionais Para A Inovação Frugal. São Paulo, 2018, 166 F. Tese (Doutorado Em Administração) – Universidade De São Paulo.

[51]. Silva, S. B. S. (2018). Inovação Frugal À Luz Dos Princípios Da Jugaad: Estudo De MúltiplosCasos Em Mpes. São Cristovão, 163f. Dissertação (Mestrado Em Administração) – Universidade Federal De Sergipe,

[52]. Silva, I. M.; Borini, F.; Oliveira, M.; Quan, X.; Von Zedtwitz, M. (2020). An Indirect Metric Of Frugal Innovation From Product, Open, Cost And Sustainable InnovationScales. In: A. J. Mcmurray And G. A. De Walls (Eds.). Frugal Innovation – A Global Research Companion. Routledge: London. Chapter 15, P. 241-247.

[53]. Soni, P.; Krishnan, R. T. (2014). Frugal Innovation: Aligning Theory, Practice, And Public Policy. Journal Of Indian Business Research, 6(1), 29-47. Https://Doi.Org/10.1108/JIBR-03-2013-0025.

[54]. Sulistyo, H. S. (2016). Innovation Capability Of Smes Through Entrepreneurship, Marketing Capability, Relational Capital And Empowerment. Asia Pacific Management Review, 21(4), 196-203. Https://Doi.Org/10.1016/J.Apmrv.2016.02.002.

[55]. Terwiesch, C.; Boston, K. U. (2010). Innovation Tournaments: Creating And Selecting Exceptional Opportunities. Book Reviews, 27, 616-622.

[56]. Tiwari, R.; Herstatt, C. (2012). India-A Lead Market For Frugal Innovations? Extending TheLead Market Theory To Emerging Economies. TIM/TUHH Working Paper, N. 67.

[57]. Thompson, E. R. (2009). Individual Entrepreneurial Intent: Construct Clarification And Development Of An Internationally Reliable Metric. Entrepreneurship Theory And Practice, 33(3), 669-694. Https://Doi.Org10.1111/J.1540-6520.2009.00321.X.

[58]. Tomoyose, F. H.; Santos, I. C. D.; Faria, A. C. D. (2019). The Influence Of Open Innovation On Domestic Sales In Brazilian Industry: An Analysis Of The Innovation Survey 2014 Based On Structural Equation Modeling. BBR. Brazilian Business Review, 16, 222-238. Https://Doi.Org/10.15728/Bbr.2019.16.3.2.

[59]. Von Zedtwitz, M.; Corsi, S.; Søberg, P. V.; Frega, R. (2015). A Typology Of Reverse Innovation. Journal Of Product Innovation Management, 32(1), 12-28. Https://Doi.Org/10.1111/Jpim.12181.

[60]. Weyrauch, T.; Herstatt, C. (2017). What Is Frugal Innovation? Three Defining Criteria. Journal Of Frugal Innovation, 2(1), 1-17. Https://Doi.Org/10.1186/S40669-016-0005-Y.

[61]. Weiss, M.; Cattaneo, C. (2017). Degrowth–Taking Stock And Reviewing An Emerging Academic Paradigm. Ecological Economics, 137, 220-230. Https://Doi.Org/10.1016/J.Ecolecon.2017.01.014.

[62]. Wunker, S.; Luo Law, J. (2018). Costovation: Innovation That Gives Your CustomersWhat They Want – And Nothing More, Newyork: Harpercollins Leadership.