MODELING ENTREPRENEURIAL INTENT AS A PREDICTOR OF FRUGAL INNOVATION IN UNIVERSITY STUDENTS

MODELAGEM DA INTENÇÃO EMPREENDEDORA COMO PREDITORA DA INOVAÇÃO FRUGAL EM ESTUDANTES UNIVERSITÁRIOS

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ABSTRACT

This study aimed to analyze the influence of entrepreneurial intention on the frugal innovation dimensions: open innovation, sustainable innovation, cost innovation and product innovation, in the university context under the students' perception. The quantitative approach and structural equation modeling was used for a sample of 694 undergraduate students at a Brazilian university. The analyzes confirmed a positive relationship between entrepreneurial intention and open innovation (H_1); entrepreneurial intention and sustainable innovation (H_2); entrepreneurial intention and cost innovation (H_3); entrepreneurial intention and product innovation (H_4). Thus, it was found that the relationship between entrepreneurial intention and frugal innovation is useful to demonstrate the degree that the student intends to undertake in a future moment, guided by the low cost technologies process, listed in new social and institutional structures, which insert quality products and services, using fewer resources. As limitations, it is considered the lack of behavioral studies on the intention to undertake innovations, mainly in frugal innovations. Finally, it is recommended to carry out theoretical studies that contribute to the conceptualization, terminologies and attributes of frugal innovations.

Keywords: Entrepreneurial intention; innovation; undergraduate student; structural equation modeling.

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RESUMO

Este estudo teve como objetivo analisar a influência da intenção empreendedora nas dimensões de inovação frugal: inovação aberta, inovação sustentável, inovação de custos e inovação de produtos, no contexto universitário sob a percepção de alunos de graduação. Utilizou-se a abordagem quantitativa e modelagem de equações estruturais para uma amostra de 694 estudantes de graduação em uma universidade brasileira. As análises confirmaram uma relação positiva entre a intenção empreendedora e a inovação aberta (H1); intenção empreendedora e inovação sustentável (H2); intenção empreendedora e inovação em custo (H3); intenção empreendedora e inovação de produtos (H4). Assim, constatou-se que a relação intenção empreendedora com inovação frugal é útil para demonstrar o grau que o estudante tem a firme intenção de empreender em um momento futuro, direcionado pelo processo de tecnologias de baixo custo, elencadas a novas estruturas sociais e institucionais, que inserem produtos e serviços de qualidade, utilizando menos recursos. Enquanto limitações, considera-se a falta de estudos comportamentais sobre a intenção de empreender em inovações, principalmente em inovações frugais. Por fim, recomenda-se a realização de estudos teóricos que contribuam para a conceituação, terminologias e atributos de inovações frugais.

Palavras-chave: Intenção empreendedora; inovação; estudantes de graduação; modelagem de equação estrutural.

1 INTRODUCTION

Entrepreneurship began to be discussed scientifically by economists Richard Cantillon (1755), Jean Baptiste Say (1803) and Joseph Schumpeter (1949), however, it was only after the 1960s that the entrepreneur's behavior gained focus, advocated by behavioral researchers. McClelland in his research in 1961, 1965a, 1965b pointed out that the entrepreneur's behavior is complex and that economic factors alone would not be able to explain it.

Ruppenthal and Cimadon (2012, p. 138) claim that "entrepreneurship, as a business area, seeks to understand how opportunities arise to create something new". In this way, to create new, that is, for the development of new solutions in products, services or processes, that serve the market and generate value, organizations from different countries have adopted innovation (GRÜTZMANN; ZAMBALDE; BARMEJO, 2019).

Innovation "is the implementation of a new or significantly improved product (good or service), or a process, or a new marketing method, or a new organizational method in business practices, in the organization of the workplace or in external relations" (OECD, 2018, p. 55). In this way, Feldemann et al. (2019, p. 197) point out that "the recognition and celebration of innovation in emerging markets can also inspire people, especially the next generation of managers and entrepreneurs".

Different authors point out that in developed or developing countries, governments, private organizations and universities are responsible for investing efforts to stimulate new entrepreneurs (ETZKOWITZ, 2013; LIMA et al., 2015; WEGNER et al., 2020). Therefore, it is understood that the university, by providing entrepreneurial education, encourages entrepreneurship and contributes to economic and social well-being. Thus, Wegner et al. (2020, p. 308) point out that "the underlying assumption behind this change in mission is that, offering education and support, universities can directly influence individuals, in their perception of self-efficacy and intention to start a new business. In other words, if before the point of convergence of educational institutions was the production and dissemination of knowledge, with the new mission, universi-

ties need to promote and encourage the entrepreneurial training of their students

Thus, to analyze and predict a subject's entrepreneurial intention in relation to the creation of a new business, Liñan and Chen (2009), Moriano et al. (2012) and Oliveira (2016) point out that the Entrepreneurial Intention Questionnaire (EIQ) has been applied in different countries and works to analyze and predict entrepreneurial intent from an integrative and ecosystemic perspective of the person and their context. The authors state that EI is the cognition that conducts and guides the entrepreneur's action for the creation and development of a business.

Considering that entrepreneurial intention is an effort to create new businesses, products, services and processes, this study has the following question: in college education students, the entrepreneurial intention dimension proposed by Liñán and Chen (2009) and Thompson (2009) confirms itself as a predictor of the four dimensions of innovation, cost, sustainability, openness and product?

Thus, the objective of this study was to test the relationship between the entrepreneurial intention dimension proposed by Liñán and Chen (2009) and Thompson (2009) with the open innovation dimensions (ALBURUB; LEE, 2012), sustainable innovation (CHEN; LAI; WEN, 2006), innovation in cost (AFONSO et Al., 2008) and, product innovation (GUNDAY et al., 2011), using the model of structural equations. The set of these four types of innovations, conceptually directed the study by Silva (2018), building the nomenclature of Frugal Innovation.

Thus, considering the proposed objective, this study is structured in five chapters. The first deals with this introduction to the theme and the study objective, while the second presents a literature review of entrepreneurial intent and open, cost, sustainable and product innovations. The third chapter is about the presentation of the methodological path used to directing the research. And, in the fourth chapter the results found are discussed. Then, the final considerations of this study are presented.

2 THEORETICAL REVIEW
2.1 ENTREPRENEURIAL INTENT

The 'intention' stems from Medieval Latin "*intentio*", that comes from Arabic *maʿnā*, evidencing itself as meaning or thought. In 1874 intentionality was seen as a component of consciousness, that is, conscious acts. Therefore, in 1974 the need to differentiate the behavior considered simple from the actions taken as subjective was emphasized, that is, those of which the individual refers meaning according to his thought (BRADDON, 2001). In this way, intentions are the path to motivation, resulting in the behavior and how much it will dedicate itself to this behavior to be practiced (AJZEN, 1991).

In Ajzen's (1991) model, Theory of Planned Behavior, he states that intentions are the path to motivation, resulting in behavior and how much he will dedicate himself to this behavior to be practiced. Prior to Ajzen's model (1991), researchers Shapero and Sokol (1982) and Shapero (1984) in their model, benefited by social psychology (LIÑÁN; FAYOLLE, 2015) point out that when the individual chooses to undertake, it results from an event or sudden change in the routine in which it is inserted, that is, it depends on a personally credible opportunity (WEGNER et al., 2020).

In their study, Guerreiro, Rialp and Urbano (2008), highlight the empirical evolution of the entrepreneurial intention main models used by researchers on the theme in the 1980s and 1990s, namely: Shapero and Sokol (1982) Entrepreneurial Event Model; models from Ajzen's Theory of Planned Behavior (1991); Attitude towards Entrepreneurial Orientation by Robinson et al (1991); Basic Model of Intent by Krueger and Carsrud (1993); Krueger and Brazeal's Potential

Entrepreneurial Model (1994); and Davidsson's model (1995).

Seeking to map international scientific production on entrepreneurial intention, Sousa et al. (2019) found 813 publications in the Scopus database, from 1993 to 2018. The analyzes showed that Liñán and Fayolle are the authors who most published on the subject, with the number of 13 and 11 publications during the period. Regarding the works with the greatest impact, considering the number of citations received by other studies published in journals indexed in Scopus, the work entitled Competing models of entrepreneurial intentions, by authors Krueger, Reilly and Carsrud (2000), received 1,292 citations, thus, it is considered the publication with the greatest impact. Already, with 861 citations, there is the study entitled Does entrepreneurial self-efficacy distinguist entrepreneurs fron manangers ?, by authors Chen, Greene and Krick (1998).

Entrepreneurial intention is conceptualized as the effort directed by the individual in the process of creating or innovating products and services, processes or enterprises. The factors that motivate this individual are characterized as intention. They are as parameters, which allow to interpret the desires or the effort developed by the individual so that the behavior is practiced, that is, when the individual decides to undertake he is having a planned behavior that, previously, was only an intention (AJZEN, 1991; DAVIDSSON, 1995).

Other authors explain that the entrepreneurial intention is the individual's conscience that occurs before the action is actually carried out, which is responsible for leading the conscience when undertaking (SHOOK; PRIEM; MCGEE, 2003). Therefore, the entrepreneurial intention is made up of individuals who have entrepreneurial conviction and, also, carry out actions linked to the creation of an organization (THOMPSON, 2009).

Entrepreneurial intention is qualified as a result of the perception of control over behavior (covered capacity to consolidate organizational behavior); attitude about behavior (observation of entrepreneurial behavior, also, of positive or negative degree assessment by the individual); and subjective and social norms (third party perception about being an entrepreneur, motivation level to undertake and the support of society to achieve entrepreneurial behavior) (KOE et al., 2012; LIMA et al., 2015). In this sense, Koe et al. (2012) argue that the effectiveness of the entrepreneurial intention forms the planned behavior, therefore, it is necessary that its antecedents are studied and understood.

2.2 INNOVATION

Ceretta, Reis and Rocha (2016, p. 434) emphasize that innovation plays an important role in the competitiveness of companies and countries. In this sense, they affirm that "this theme presents growing evidence both in the organizational context and in the academic and scientific context", therefore, different currents treat the theme according to the epistemological genesis. Zanadrea et al. (2015, p. 2) emphasize that innovation is essential for organizational success and consequently contributes to the development of countries, in this sense, different contexts, require different innovations. The authors claim that for the purpose of "explaining industrialized economies in emerging countries, several theories have emerged such as 'reverse innovations', 'disruptive innovations', 'cost innovations', 'frugal innovations' and 'jugaad' Therefore, these theories refer to the concept of redesigning and developing products and processes at minimal cost, according to the specific needs of each region.

Bhatty and Ventresca (2013, p. 3) state that "the concept of frugal innovation is not new. But the way individuals and companies think about its practice and impact has increased". Thus, they point out that, historically, different countries and organizations and their individuals

have practiced or practice actions or some form of frugal innovation. In this sense, they point out that "the increase in global austerity, changing the nature of global competition from companies in emerging markets, and advances in enabling technologies such as mobile, cloud and digital means that there is a renewed global interest and relevance of frugal innovation".

Thus, FI's objective is to create the new one with less resources, using appropriate technologies to develop quality products and services, with low cost, that meet customer expectations, guided by sustainability. Therefore, this type of innovation proposes to 'do more with less, for more people' (KNORRINGA et al., 2016; PRABHU; JAIN, 2015; RADJOU; EUCHNER, 2016; WEYRAUCH; HERSTATT, 2017). Therefore, in the next sections we will discuss open innovation, sustainability, cost and product innovations.

2.2.1 Open Innovation

Chesbrough (2006, p. 2) points out that "open innovation is a paradigm, which presupposes that companies can use external and internal ideas, in addition to internal and external paths to the market, as they seek to improve their technology". In this way, knowledge and partnerships can be sought internally and in other companies, industries, government, universities, research centers and consumers.

In the publication entitled 'open innovation management: challenges and perspectives', the authors Alburub and Lee (2012, p. 130) present a case study carried out with 85 South Korean companies, which aimed to "analyze the state of open innovation in South Korea, highlighting the current challenges and possible mechanisms to overcome the limitations of open innovation theory, such as the ambiguity of the concept and the modality". Thus, in the analyzes "they measure the degree (frequency) of cooperation with external partners, such as customers, suppliers and universities, based on the following variables, highlighted in Chart 1.

Chart 1 - Open Innovation dimension items

Open Innovation – OI
1. Obtaining a right to exploit technologies (intellectual property; patent, copyright or trademarks) by paying royalties to external partners;   2. 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;   3. 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;   5. Revealing internal technologies without immediate financial rewards with indirect benefits for the company.

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

Considering that "open innovation is the use of knowledge inputs and outputs with the purpose of accelerating internal innovation and expanding markets for external innovation" (CHESBROUGH, 2006, p. 2), the following hypothesis is presented:

H_1: Entrepreneurial intention directly and positively influences open innovation.

2.2.2 Innovation in Sustainability

Pinsky and Kruglianskas (2017, p. 109) explain that "the concept of innovation oriented towards sustainability is comprehensive and receives several names in the literature, such as sustainable, green, eco or environmental innovation. However, they point out that in general, "the-

ories address innovation from the perspective of new or modified products, services, production and management processes, which offer environmental benefits" (PINSKI et al., 2015, p. 232).

Chen, Lai and Wen (2006), in their study, aim to explore whether the performance of green product innovation and green process innovation has brought positive effects to the competitive advantage of companies in Taiwan. They argue that "the adoption of proactive strategies in corporate environmental management can also help companies to develop new market opportunities and increase competitive advantage, in addition to preventing the company from facing environmental protests or penalties (CHEN; LAI; WEN, 2006, p. 332). Thus, data collection involved sending 600 questionnaires to production, marketing, R&D managers and, environmental protection departments, from different companies in Taiwan. The instrument used contained 4 items related to green innovation and 8 items for measuring companies' competitive advantage performance. The green innovation items are described in Chart 2.

Chart 2 - Sustainable Innovation dimension items

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

Source: Chen, Lai e Wen (2006, p. 334).

Considering that sustainable innovation contributes to innovations that mainly bring solutions to environmental issues, it is still recognized as a differentiation strategy in the correct and rational use of inputs, with lower cost and less environmental risk and for consumers, in line with stakeholders' expectations, the following hypothesis is presented:

H_2: Entrepreneurial intention directly and positively influences sustainable innovation.

2.2.3 Cost Innovation

Afonso et al. (2008) argue that reducing the time and cost of New Product Development (NPD), can create relative advantages in market share, profit and long-term competitiveness, especially during the first stage, that is, in the production phase, before making the product available on the market. As a result, by applying NPD as a strategy, organizations can take advantage of pioneering spirit, with higher prices and customer loyalty.

The study developed by the authors follows research that addresses NPD Cost, Target Costing (TC) and Reduction of lead time for product development - TtM (time-to-market), with the objective of testing factors and variables that are associated with organizational skills to minimize time and cost (AFONSO et al., 2008). Chart 3 shows the items considered in the authors' study.

Chart 3 - Cost Innovation Items

Cost Innovation – CI

1. 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;
2. 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;
3. During the process of developing new products, the attributes of the product are considered to be very expensive when compared to the value assigned by the customer are reduced/eliminated (for example, packages, warranty, after-sales service);
4. The company generally negotiates changes in product design and/or functionality with suppliers and customers to achieve a predetermined cost of the product;
5. 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;
6. During the process of developing new products, the company seeks to surpass competitors that design competitive products in price, functionality and quality
7. Comparing with competitors, this company has a higher level of use of targeting techniques in the process of developing new products.

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

Considering that innovating in cost means doing 'more with less', maintaining quality and performance, the following hypothesis is presented:

H_3: Entrepreneurial intention directly and positively influences cost innovation.

2.2.4 Product Innovation

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). Gunday et al. (2011) consider the Oslo Manual as the main source for describing, identifying and classifying innovations in organizations. Thus, the aim of the study was to explore innovations and their effects on company performance, examining product, process, marketing and organizational innovations, as well as production performance, market performance and financial performance.

They emphasize that the literature on innovation does not reveal the conclusion on what type of innovation can provide a greater or lesser impact on the performance of a company. Thus, Gunday et al. (2011, p. 663) argue that "innovations that influence each other and need to be implemented together", therefore, they measure the relationships between the four types of innovations. Chart 4 shows the items used in the authors' research.

Chart 4 - Product innovation dimension items

Product Innovation – PI
1. Increase in manufacturing quality in components and materials of current products/services;
2. Decrease in manufacturing costs for components and materials of current products/services,
3. Development of new products/services for current products/services, leading to greater ease of use for customers and better customer satisfaction;
4. Development of new products/services with technical specifications and features totally different from the current ones;
5. Development of new products/services with components and materials totally different from the current ones.

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

Whereas product innovation "is a difficult process, driven by advances in technology, changing customer needs, shortening product life cycles and increasing global competition" (GUNDAY et al., 2011, p. 672), the following hypothesis is presented:

H_4: Entrepreneurial intention directly and positively influences product innovation.

3 METHODOLOGY

According to Hair Jr. et al. (2009), it is necessary to carry out the quantification of variables. Therefore, these need to be transformed subject to empirical observation and measurement (GIL, 1999). As a result, the dimensions entrepreneurial intention and open innovation, innovation in sustainability, innovation in costs and innovation in products were measured based on research instruments already validated in Brazil.

The Entrepreneurial Intention Questionnaire (EIQ) is composed of the Liñán and Chen (2009) and Thompson (2009) model's variables. In Brazil, the models were validated by different authors, but for this study we opted to partially use the instrument validated by Almeida (2013), that is, 09 statements were used, composed of two endogenous EI constructs, answered with a Likert scale 5 points, ranging from "strongly disagree" (1) to "strongly agree" (5).

Open innovation (ALBURUB; LEE, 2012), sustainable innovation (CHEN; LAI; WEN, 2006), cost innovation (AFONSO et al., 2008). And product innovation (GUNDAY et al., 2011) are endogenous constructs of frugal innovation, an instrument 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, the first on organizational capacities and the second on modes of innovation within the organization. Thus, the author points out that frugal innovation is a strategy that combines cost efficiency and innovation and can also contribute to the management of non-renewable environmental resources. Thus, in this study the instrument used is composed of 18 statements, adapted to the context of university students and answered with a scale *Likert* 5 points, ranging from "strongly disagree" (1) to "strongly agree" (5).

A population of 3,573 undergraduate students, enrolled from the fourth phase on the Management, Accounting, Economic Sciences, Civil Engineering and Electrical Engineering courses, which is the total of all the enrollments taken in the courses offered by the State University of Mato Grosso - UNEMAT, in the period 2019/1. In the first phase of the research, 22 students (pilot sample) from the sixth phase of the Management course were invited, in order to complete the questionnaire and point out flaws and suggestions for adjusting the model. After adjusting for the university context, 761 printed questionnaires were applied in courses already cited, of which 67 were excluded, thus 694 were used for this study. It is observed that this sample meets the criteria proposed by Hair Jr. et al (2009), which defines the minimum sample of 5x the number of questions with likert scale. In the case of this research, at least 135 students.

As for ethical aspects, this study was approved by the Research Ethics Committee (REC) of UFSM, with registration nº. 12457019.1.000. REC is recognized by the Research Ethics Commission (CONEP) and respects the National Health Council (NHC), more specifically, resolution 196/96, which makes the ethical regulation of research on human beings in Brazil (BRASIL, 1996).

Then, we opted for the techniques of Partial Least Squares Structural Equation Modeling – PLS-SEM. The PLS-SEM approach focuses on maximizing the explained variance of endogenous dimensions, thus, structural equation modeling is considered a powerful tool because of its versatility in facilitating the confirmation of existing relationships between multiple variables (HAIR Jr.; GABRIEL; PATEL, 2014).

4 SEARCH RESULTS

From the valid responses, the sociodemographic data show that 372 (53.60%) are women and 322 (46.40%) are men. The age group with the highest participation is 17 to 22 years

old, being 318 (45.82%). Regarding individual income, 365 (52.59%) participants receive from R$ 1,000.00 to R$ 2,500.00 per month, of which 341 (49.10%) are employed in private companies.

Summarizing the data of the participants, we proceed to analyze the measurement diagram and its relationships between latent variables and their respective observed variables, shown in Figure 1.

Figure 1 - Measurement model Entrepreneurial Intention - Open Innovation, Sustainable Innovation, Cost Innovation and Product Innovation.
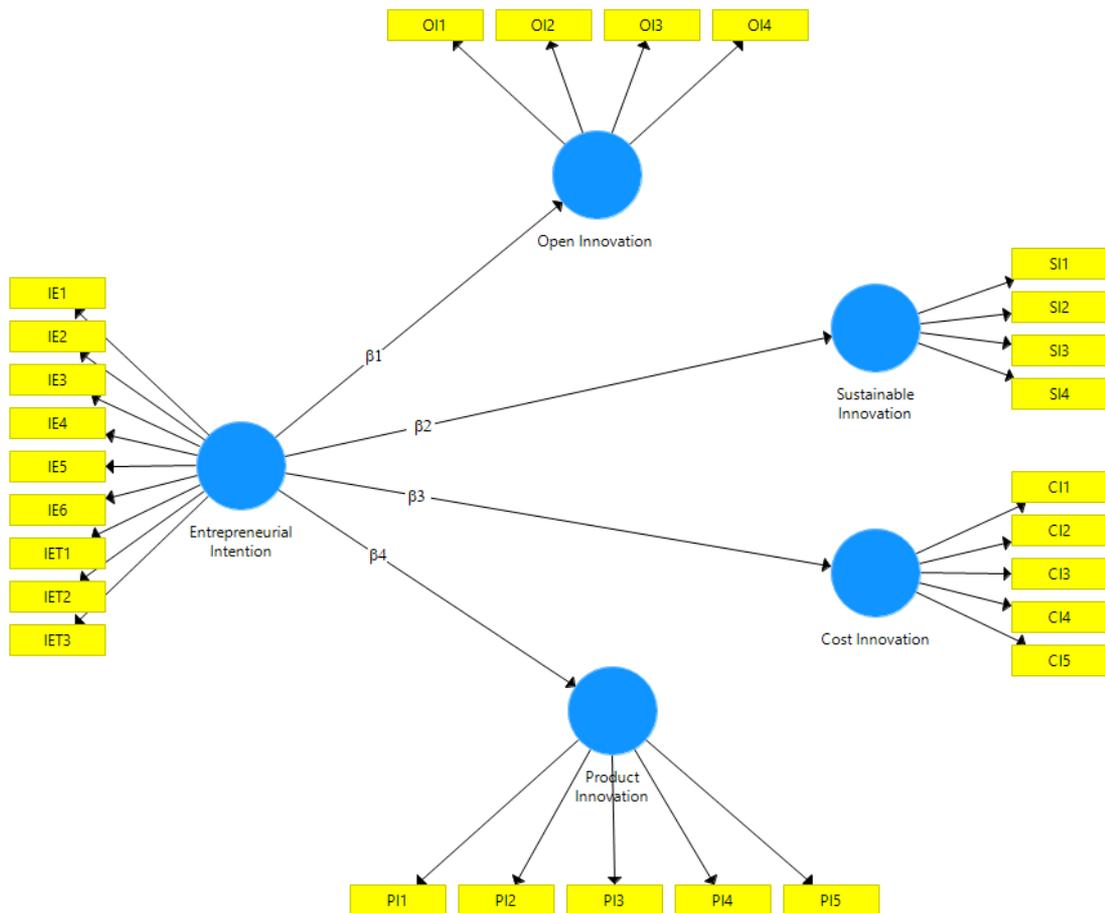
Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

As shown in Figure 1, it is observed that the measurement model presents four hypotheses (represented by the beta coefficients) that connect the five latent variables (LV's) – dimensions to the 27 observed variables (OV's) – indicators.

In the first stage, with the data processed in SmartPLS® v. 3.3.2, the factorial loads of all variables were verified, the result demonstrated the validity of the loads related to constructs close to 0.70, thus, it is not necessary to exclude any variable of the present study. Hair Jr. et al. (2009) state that the factor loads between the latent and the manifest variables are considered acceptable values higher than 0.70.

For the second stage, convergent validity tests were adopted reliability, internal consistency (α) and composite reliability(ρ_c) and Average Variance Extracted (AVE). At Table 1, it can

be seen that the results meet the requirements for obtaining values higher than 0.70 and not greater than 0.95 for internal consistency (Cronbach Alpha and Composite reliability), and values higher than 0.50 for AVE, as they score Hair Jr. et al. (2005).

Table 1 – Cronbach alpha, composite reliability and AVE for model EI-FI

Dimensions endogenous	Cronbach's Alpha (α)	Composite Reliability (ρC)	Average Variance Extracted (AVE)
Open Innovation (OI)	0.847	0.896	0.693
Sustainable Innovation (SI)	0.890	0.923	0.749
Cost Innovation (CI)	0.862	0.901	0.645
Product Innovation (PI)	0.897	0.924	0.708
Entrepreneurial Intention (EI)	0.949	0.955	0.713

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

Thus, it evidences Table 1 that the initial results were satisfactory. The second stage, after ensuring convergent validity (CV), was to observe the values of internal consistency Cronbach alpha (α) and composite reliability (ρ_c) (RINGLE et al., 2014).

Alpha values and composite reliability from 0.60 to 0.70 are considered adequate in exploratory research and values from 0.70 to 0.90 are considered satisfactory (Hair Jr et al., 2016). Thus, when analyzing the Table it was observed that the model adjusted in a way compatible with the parameters suggested by Chin (1996) respectively for: convergent validity (AVE > 0.50); Cronbach's alpha and composite reliability (values > 0.70). The result of the 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 of the Entrepreneurial Intention Scale and the Frugal Innovation Scale, the path model provides the results of the factor loads between indicators and constructs.

Figure 2 - Path model of the Entrepreneurial Intention dimension with the Frugal Innovation dimensions (EI-FI)
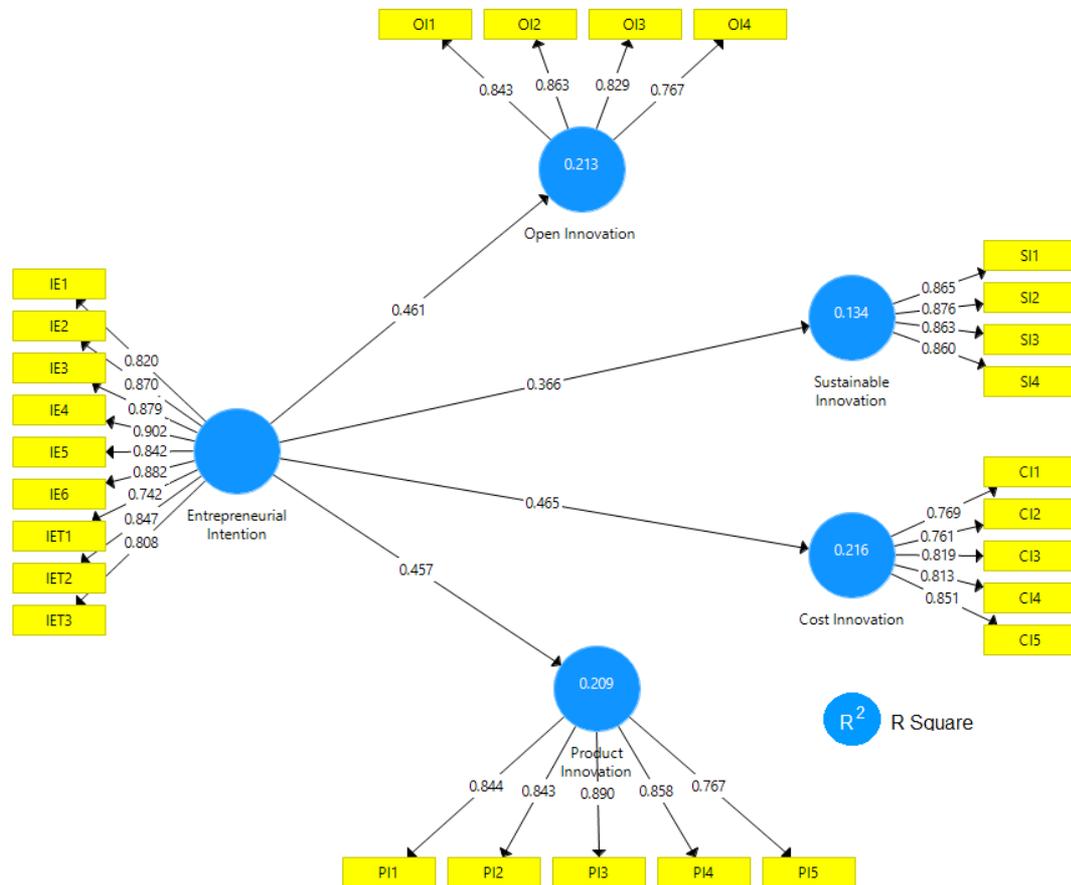
Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

Through the path diagram, it is possible to describe the structural equations, according to the Table 2.

Table 2 - Path diagram for the model EI-FI

Dimensions endogenous	=	Dimension exogenous	+	Error
OI	=	β_1 EI	+	ε_{OI}
SI	=	β_2 EI	+	ε_{SI}
CI	=	β_3 EI	+	ε_{CI}
PI	=	β_4 EI	+	ε_{PI}

Source: survey data (2019).

In the third stage, the evaluation of the discriminant validity (DV) of SEM, according Hair et al. (2014) a DV it is an indicator that the latent dimensions or variables are independent of each other. In this sense, the criterion of Fornell and Larcker (1981) was used where the square roots of the values of the AVE's each dimension with the Pearson correlation between the dimensions (or Latent Variables - LV's). The result found from the square roots of the AVE's must be greater than the correlations between dimensions.

According to Ringle, Silva and Bido (2014), the dimension is the only variable that carries characteristics that are not representative of others, according to the results presented in Table 3 it appears that the factorial loads of Observed Variables (OV's) of Latente Variables (LV's) originals

are always larger than in another, thus realizing that the model has discriminant validity by Chin's criterion (1998).

Table 3 - Discriminant validity analysis using the Fornell-Larker (F-L) method and HTMT for the reflective measurement model EI-FI

Dimensions		Pearson's Correlation Matrix (F-L)				
		OI	SI	CI	PI	EI
OI	**0.819**	1.000				
SI	**0.852**	0.484	1.000			
CI	**0.802**	0.500	0.626	1.000		
PI	**0.826**	0.510	0.646	0.712	1.000	
EI	**0.843**	0.498	0.396	0.452	0.462	1.000
UL* (HTMT) 97.5%						
OI						
SI		0.577				
CI		0.608	0.745			
PI		0.619	0.774	0.925		
EI		0.570	0.463	0.576	0.558	

* Upper Limit

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

For Henseler, Ringle and Sarstedt (2015) the Heterotrait-Monotrait Ratio of Correlations (HTMT) is calculated by the equation:

$$HTMT_{ij} = \frac{\frac{1}{K_i K_j} \sum_{g=1}^{K_i} \sum_{h=1}^{K_j} r_{i_g \cdot j_h}}{\sqrt{\frac{2}{K_i(K_i - 1)} \sum_{g=1}^{K_i - 1} \sum_{h=g+1}^{K_i} r_{i_g \cdot i_h} \cdot \frac{2}{K_j(K_j - 1)} \sum_{g=1}^{K_j - 1} \sum_{h=g+1}^{K_j} r_{j_g \cdot j_h}}}$$

where:

$r_{i_g \cdot j_h}$ is Pearson's Correlation;
Ki is the number of indicators of VL's i; and
Kj is the number of indicators of VL's j.

The discriminant validity can be understood as the finding that the factor loads of each observed variable (indicator) are grouped in their respective dimensions or latent variables (RINGLE; SILVA; BIDO, 2014). Thus, the results found indicate how independent the latent variables are from each other, confirming the discriminating validity of each dimension. (HAIR Jr. et al., 2016). In Table 3, confirmation of the Fornell-Larker Criterion was observed, where presents the square roots of the AVE's and in the other cells the correlations between the dimensions, where to confirm the criterion a $\sqrt{AVE's} > r_{i_g j_h}$, for $i_g \neq j_h$. The criterion of HTMT (*Heterotrait-Monotrait Ratio*) the results meet the criterion requirement, that is, the UL (HTMT)$_{97,5\%}$ < 1,00, confirming its significance by method bootstrapping, using 5,000 subsamples.

As noted by Chin (1998), the observation of cross loading, observing the indicators with higher factor loads in their respective latent variables than in others, confirming the discriminating validity of each dimension (Table 4).

Table 4 - Values of the crossed factor loads of the observed variables in relation to the latent variables for the EI-FI model

Variables	Dimensions				
	OI	SI	CI	PI	IE
OI1	**0.843**	0.356	0.358	0.384	0.355
OI2	**0.863**	0.444	0.489	0.504	0.484
OI3	**0.829**	0.346	0.361	0.371	0.319
OI4	**0.767**	0.307	0.317	0.332	0.325
SI1	0.376	**0.865**	0.464	0.479	0.270
SI2	0.388	**0.876**	0.513	0.552	0.301
SI3	0.419	**0.863**	0.603	0.643	0.387
SI4	0.356	**0.860**	0.495	0.550	0.280
CI1	0.328	**0.445**	0.769	0.555	0.375
CI2	0.371	0.440	**0.761**	0.574	0.336
CI3	0.432	0.521	**0.819**	0.666	0.356
CI4	0.335	0.489	**0.813**	0.640	0.343
CI5	0.426	0.538	**0.851**	0.725	0.441
PI1	0.422	0.583	0.672	**0.844**	0.417
PI2	0.418	0.510	0.677	**0.843**	0.372
PI3	0.429	0.594	0.720	**0.890**	0.426
PI4	0.424	0.562	0.670	**0.858**	0.383
PI5	0.381	0.479	0.577	**0.767**	0.309
IE1	0.398	0.312	0.375	0.392	**0.820**
IE2	0.422	0.326	0.402	0.400	**0.870**
IE3	0.418	0.347	0.441	0.451	**0.879**
IE4	0.450	0.341	0.421	0.400	**0.902**
IE5	0.383	0.316	0.384	0.376	**0.842**
IE6	0.404	0.341	0.445	0.432	**0.882**
IET1	0.297	0.252	0.342	0.335	**0.742**
IET2	0.358	0.275	0.346	0.338	**0.847**
IET3	0.350	0.246	0.358	0.321	**0.808**

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

In the fourth stage, after confirming the discriminant validity of each dimension, the structural model is analyzed. In this sense, Hair Jr. et al. (2017) point out that the evaluation of the structural model can be measured by the collinearity analysis (Variance Inflation Factor - VIF); significance level of R^2; and by assessing predictive relevance Q^2; and finally, evaluation of the significance and relevance of the betas of the structural model (Student test). In this sense, the Variance Inflation Factor – VIF indicates whether there is a potential collinearity problem in the model (Table 5).

Table 5 - VIF values for model dimensions EI-FI

Exogenous Dimension	Endogenous Dimension			
	OI	SI	CI	PI
EI	1.000	1.000	1.000	1.000

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

It is observed in the model that all values of VIF < 5, given the lack of strong correlations between dimensions, so there are no collinearity problems.

In the next stage, Pearson's explanation coefficients (R^2) were analyzed for the adjusted model quality and sought the variance of the endogenous dimensions explained by the structural model (RINGLE; SILVA; BIDO, 2014). According to the authors, the reference values for R^2 analysis follow the parameters suggested by Cohen: 2% small effect, 13% medium effect and 26% large effect.

Table 6 - Explanation coefficient R^2 and $R^2_{adjusted}$ for the model EI-FI

Endogenous Dimension	R2 (p-value)	R2adjusted (p-value)
Open Innovation (OI)	0.213(0.000)	0.211 (0.000)
Sustainable Innovation (SI)	0.132 (0.000)	0.132 (0.000)
Cost Innovation (CI)	0.215 (0.000)	0.215 (0.000)
Product Innovation (PI)	0.207 (0.000)	0.207 (0.000)

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

The values de R^2 and $R^2_{adjusted}$ have been confirmed significantly by method bootstrapping, using 5,000 subsamples. In both endogenous latent variables (OI, SI, CI and PI), an average explanatory power was admitted, considering an effect greater than 13,2%. The convergent and discriminant validities were verified, as well as the reliability of the reflective measurement models and the average explanatory power of the endogenous latent variables by the exogenous variable ($0.13 < R^2 < 0.27$), the analysis of the measurement model was started.

Still, following the precepts of Ringle, Silva and Bido (2014), the predictive power of the model and the utility of each latent variable were evaluated, through predictive validity indicators (Q^2), obtained by *Blindfolding* method from SmartPLS® and the size of the effect (f^2), confirmed significantly by method bootstrapping, using 5,000 subsamples, demonstrated in Tables 7 and 8.

Table 7 – Predictive validity (Q^2) of the model EI-FI

Latent Variables	SQO	SQE	
Open Innovation (OI)	2,776.00	2,394.44	0.137
Sustainable Innovation (SI)	2,776.00	2,512.67	0.095
Cost Innovation (CI)	3,470.00	2,999.09	0.136
Product Innovation (PI)	3,470.00	2,970.61	0.144

SQO = sum of observed squares; SQE = sum of squares of errors

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

The results showed that the model presented predictive property when processing values Q^2 higher than zero OI ($Q^2 = 0.137$); OC ($Q^2 = 0.095$, OS ($Q^2 = 0.136$ e OP ($Q^2 = 0.144$).

The effect size (f^2) or Cohen's indicator (Table 8) assesses how useful the dimension is for adjusting the model. The value is obtained by including and excluding dimensions in the model (one by one). Hair Jr et al (2016) consider values 0.02, 0.15 and 0.35 small, medium and large, respectively.

Table 8 - Effect size f^2 for the model EI-FI

Dimension exogenous	Endogenous Dimension			
	OI	SI	CI	PI
EI	0.270 (0.000)	0.154 (0.000)	0.276 (0.000)	0.264 (0.000)

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

The values f^2 presented values considered average for the four dimensions OI = 0.270 (medium); SI = 0.154 (medium), CI = 0.276 (medium) and PI = 0.264 (medium), thus, the dimensions open innovation, sustainable innovation, cost innovation and product innovation are considered to have medium effect dimensions for the construction of the model.

After the adjustments related to the predictive value and the effect size of the model, the path coefficient of the proposed model was calculated, which are: between EI and OI (0.461), between EI and SI (0.366), between EI and CI (0.465) and between EI and PI (0.457). In this way, Figure 3 shows the final paths model of the relationships between the dimensions.

Figure 3 - Final path model of the Entrepreneurial Intention dimension with the Open, Sustainable Innovation, in Cost and in Product dimensions.
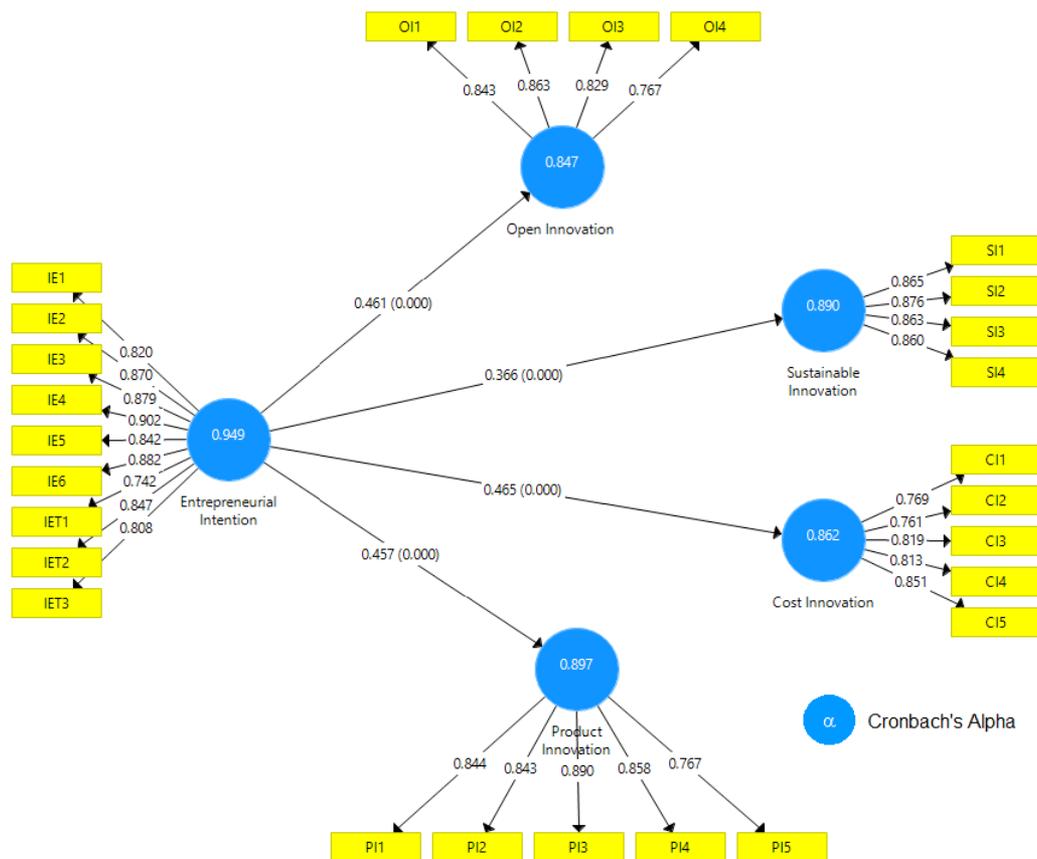
Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

Figure 3 of the final model presents the items referring to each dimension after the model's validation steps. Thus, the present study concludes that the model is empirically supported and its dimensions have significant relationships.

Following, the T statistics values, that according to Hair Jr. et al. (2005), one should test the causal relationship between two dimensions, using the Student t test to verify whether it is significant or not so that the structural coefficient (β) is significant or not.

Table 9 – Hypotheses and relationships between latent variables in the model EI-FI

Hypotheses		Relationship		β	S. D.*	T Statistic ($|β / S. D.|$)	p - value	Situation
		Exoge-nous	→ Endo-genous					
H_1	Entrepreneurial intention directly and positively influences open innovation	EI	→ OI	0.461	0.033	13.970	0.000	Accept
H_2	Entrepreneurial intention directly and positively influences sustainable innovation	EI	→ SI	0.366	0.036	10.167	0.000	Accept
H_3	Entrepreneurial intention directly and positively influences cost innovation	EI	→ CI	0.465	0.032	14.441	0.000	Accept
H_4	Entrepreneurial intention directly and positively influences product innovation	EI	→ PI	0.457	0.033	13.848	0.000	Accept

*S. D. = Satandart Desviation

Source: SmartPLS® software, v. 3.3.2 (RINGLE; WENDE; BECKER, 2015).

According to the data presented in Table 9, the relationships values between the VL are above the reference value 1.96, considering the significance level adopted of 5%, that is, the dimensions are significantly related (HAIR Jr, et al., 2017; WONG, 2013; RINGLE, SILVA, BIDO; 2014). The values found were: EI → OI ($t_{cal.}$ = 13,970), EI → SI ($t_{cal.}$ = 10,167), EI → CI ($t_{cal.}$ = 14,441), EI → PI ($t_{cal.}$ = 13.848). Therefore, all the hypotheses proposed in the model were accepted.

After the evaluation of the adjustment quality model was concluded, it was found through the analysis that the path coefficients of the adjusted model, interpreted as the regression betas (β's), concluding that the Entrepreneurial Intention (EI) relations with the Open Innovation (OI), Sustainable Innovation (SI), Cost Innovation (CI) and Product Innovation (PI) dimensions are significant ($t_{cal.}$ > 1.96 and p < 0.05) which led to the acceptance of all hypotheses (H_1, H_2, H_3 e H_4).

The analyzes confirmed the positive relationship between entrepreneurial intention and open innovation (H_1), sustainable innovation (H_2), cost innovation (H_3) and product innovation (H_4). Thus, the first hypothesis proposes that the entrepreneurial intention directly and positively influences open innovation. According to the data described, the path coefficient of the relationship between EI and OI is significant, with a beta of 0.461 and p of 0.000.

The second hypothesis, the entrepreneurial intention directly and positively influences sustainable innovation, being supported by a beta = 0.366 (p = 0.000). The third hypothesis presented in the study (H_3) which analyzes the direct and positive influence of entrepreneurial intention on cost innovation, the hypothesis is supported by a value of beta = 0.465 (p = 0.000). In fact, cost innovation is the most impacted dimension by entrepreneurial intent. And finally, the last hypothesis (H_4) relating entrepreneurial intention to product innovation, was supported by a β = 0,457 (p = 0,000).

5 FINAL CONSIDERATIONS

The aim of this study was to test the relationship between the entrepreneurial intention dimension proposed by Liñán and Chen (2009) and Thompson (2009) with the dimensions of open innovation (ALBURUB; LEE, 2012), sustainable innovation (CHEN; LAI; WEN, 2006), cost innovation (AFONSO et. al, 2008) and, product innovation (GUNDAY et al, 2011), using the struc-

tural equation model. The four endogenous dimensions of innovation form the frugal innovation model proposed by Silva (2018). Thus, the study was developed from the process of joining the EIE scale and adapting the EIF scale to the context of higher education students.

The results indicate that the mediation model met the criteria of convergent and discriminant validity for all assumptions. In addition, the results showed the reliability of the dimensions ranging from 0.80 to 0.93, indicating that all values were within the acceptable scale. The analyzes confirmed that all relations are positive between the exogenous dimension (entrepreneurial intention) and the endogenous dimensions: open innovation (H_1); entrepreneurial intention and sustainable innovation (H_2); entrepreneurial intention and cost innovation (H_3); entrepreneurial intention and product innovation (H_4).

It was also found that the greatest statistical significance was between entrepreneurial intention (EI) and cost innovation (CI), in which the t value of the relationship (EI ⮕ CI; $t_{cal.}$ = 14.441) was higher than 1.96 (tabulated t-value), which indicated a level of significance less than 0.05. The path coefficient or standardized regression coefficient (β) of this relationship (EI ⮕ IC) indicated that the variation of a unit in the intention to undertake (EI) is capable of influencing a variation of 0.465 in cost innovation (CI). The convergent validity, the discriminant validity and the quality of the adjusted model were verified, accepting all hypotheses, confirming the explanatory power of the model, where it can be said that the proposed model is reliable and has predictive validity.

In this sense, the modeling proved to be efficient and confirmatory to identify the students' intention to undertake innovations with frugal characteristics. Emphasizing, Thompson (2009, p. 675) defines entrepreneurial intention "as a self-recognized conviction by a person who intends to establish a new enterprise and consciously plans to do so at some point in the future". Almeida (2013) states that the EI demonstrates the degree that the individual has the firm intention of opening a company, in a future moment.

Soomro and Shah (2015) point out that entrepreneurship generates economic growth and serves as a vehicle for innovation, therefore, entrepreneurship education is important to develop and foster the individual's mentality and skills. In this sense, it is concluded that the EI-FI scales are useful to demonstrate the degree that the student has the firm intention to undertake in a future moment, guided by the low cost technologies (CI) process, which are anchored in new social structures and institutional (OI), which insert quality products and services (PI), using fewer resources (SI). Thus, it is stated that these instruments are useful both in academia and in the business area, for the development of a frugal business mentality, focused on solving problems of customers at the base of the pyramid.

As a possible limitation of the research, the lack of behavioral studies on the intention to undertake innovations, mainly in frugal innovations. Another limitation is related to the low amount of publications and discussions on openess, cost, sustainability and product innovations, mainly due to the different terminologies used and discussions of attributes, which may or may not be considered frugal innovations.

Finally, considering the importance of entrepreneurial behavior formation regarding to the development of frugal innovations, it is recommended to carry out theoretical studies that contribute to the conceptualization of the theme. Still, it is suggested that other researchers develop other research with Brazilian and foreign university students, but also in other contexts, with the aim of broadening the discussions to understand frugal innovation in the context of the entrepreneur.

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Contribution of authors

Contribution	Authors					
	1	2	3	4	5	6
1. Definition of research problem	√	√	√	√	√	√
2. Development of hypotheses or research questions (empirical studies)	√	√	√	√	√	
3. Development of theoretical propositions (theoretical work)						
4. Theoretical foundation / Literature review		√	√	√	√	√
5. Definition of methodological procedures	√	√	√	√	√	√
6. Data collection		√				
7. Statistical analysis	√					
8. Analysis and interpretation of data	√	√	√	√	√	√
9. Critical revision of the manuscript	√	√	√	√	√	√
10. Manuscript writing	√	√	√			
11. Other (please specify)						