"Consumer innovativeness scale": Adaptation and validation with undergraduate students

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Abstract: This research aimed to adapt and validate Goldsmith and Hofacker's scale of Consumer Innovativeness. We employed a cross-cultural adaptation and assessment of the instrument's psychometric properties from the original scale, including content validity, face validity, semantic validity, and statistical analysis with exploratory and confirmatory factor analysis. The sample consisted of 318 participants. We present a six-item validated scale for application with undergraduate students in several scenarios of innovativeness of consumption, adapted and validated theoretically and empirically. The results showed satisfactory evidence of the scale's validity and reliability. The validation with undergraduate students can be considered a limitation of the study, while the broad scope of application of scale can foster posterior research on consumer innovativeness. The results presented are the first validated version of Goldsmith and Hofacker for undergraduate students in Portuguese as far as we are concerned.

Keywords: scale adaptation; scale validation; innovation; exploratory factorial analysis (EFA); confirmatory factorial analysis (CFA).

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1. Introduction

The diffusion and adoption of technology, being technology or innovation understood here as the application of scientific or other knowledge to practical tasks by orderly systems involving people and organizations, productive skills, living things, and machines (Dusek, 2007), is not a new or exclusive theme in contemporary society. Its study or analysis can be applied to any period of history, encompassing different situations and needs.

From the invention of the steam engine, the presence of technology in modern and contemporary societies has broadly defined relations and means of production, the development of organizations, and the allocation of roles to the individual within society relating to the competence necessary to conceive innovation and the material and institutional conditions to carry it out.

Innovation is one of the critical issues in business and management research. It has been the subject of numerous studies (Kaushik and Rahman, 2014), and many studies on innovation focus on organizational innovations, new product characteristics, and consumers' responses to such innovations from an active (innovativeness) or a passive perspective (acceptance).

Different factors condition the diffusion and consequent adoption of innovations and technologies since it is up to the individual to interact and transform the innovation into something present and valuable, in the sense of being used and belonging to the set of resources available to carry out their daily activities, validating thus innovation within its social system.

From his rural sociology studies, Everett Rogers (2003) developed a theoretical model on the diffusion of innovations in 1962 that has become classic since then, with more than 100 thousand citations since its publication. Although the Diffusion of Innovations (DOI) model is a hypothetical construction, it laid the foundation for how they assess the stage at which an innovation is within a given social system and how the members of that system relate and interact with technology, defining concepts such as innovators, early adopters, among others.

Over the latter 60 years, different research instruments were developed and adapted to evaluate the process of adoption/acceptance/rejection technology from model DOI theorists, TRA (English *Theory of reasoned Action*), TPB (English *Theory of Planned Behavior*), and TAM (from the English *Technology Acceptance Model*), with most of them incorporating new moderating variables to the original models, generating greater complexity for data collection and highlighting only the operational aspects perceived in this process.

Although the models presented were developed in the second half of the 20th century, elaborate theories about the decision process goes back to the 20th century.

John Dewey (1910/1991) identified five logically distinct steps regarding how a given problem or situation is solved. Thus, from (a) a perceived difficulty and (b) its definition and location, we start to look for (c) suggestions for possible solutions and (d) reason about the implications of these suggestions for (e) an observation more detailed and experimentation that leads us to the acceptance or rejection of the suggested suggestion, which in short is the conclusion of the reasoning process.

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In a manner analogous to that shown in the model are theoretical, steps concerning the solution of a problem or situation, as proposed by Dewey (1910/1991), are related to the phases of the decision-innovation models and decision processes of the individuals, since that present similarity and congruence and among themselves.

While Rogers' (2003) model begins with the conjunction of primary conditions, understood as the previous practices, the perceived problems and needs, the innovations, and the norms of the social system, and ends with the confirmation, evaluation, and terms of adoption continuous late adoption, discontinuity, or continuous rejection, for Dewey (1910 /1991) that exists at the beginning and end of each process is the observation. Either initially to define the nature of the problem or the difficulty to be dealt with, or at the end, to test the validity of the conjectured propositions.

In Rogers model (2003), the emphasis is on the action or the adoption itself. In that case, Dewey's approach (1910 /1991) emphasizes the cognitive processes involved in this cycle of thought, through inference reasoning, or suggestion from an explanation or solution to develop a theoretical basis and its implications the direction.

One of the main criticisms of the DOI model is that the diffusion and adoption of technology are treated as temporal concepts, which directly relates these processes to the time of adoption, preventing the development of measurement of innovation and its ideal types. (Midgley & Dowling, 197 8; Goldsmith & Hofacker, 1991; Flynn & Goldsmith, 1993; Gatignon & Robertson, 1985; Flynn & Goldsmith, 1999; Compagni, Mele, & Ravasi, 2015; Zolkepli & Kamarulzaman; 2015)

To remove the temporal bias and allow the measurement of the independent form construct without the complete mastery of a type of innovation, Goldsmith, and Hofacker (1991) built and validated a research instrument in the form of a structured and self-administered questionnaire.

After several data collections for validation, the final version of the instrument consists of 6 items, in the form of statements (3 in the positive and 3 in the negative), which must be answered on a 5-point Likert scale, varying from "totally disagree" to "totally agree," allowing the type of innovation to be suitable for the questionnaire.

Another essential point of the *Consumer Innovativeness* scale is that it is not specific, and it can be contextualized following the domain that which one wishes to evaluate the construct. In the original version, the scale was tested in the following contexts: (1) with students: rock records, visiting record stores and magazine subscriptions about music, fashion designers, and (2) overall public: clothes and appliances.

Consumer Innovativeness

Despite extensive research on consumer innovativeness, the literature does not contain a parsimonious construct that has been validated for use across countries, demographics, and categories. Tellis et al. (2011), in a literature review, identified three main research streams on consumer innovativeness studies: (a) measurement of innovativeness, (b) relationship between innovativeness and new product adoption or other behavioral constructs, and (c) antecedents of innovativeness, including personal and demographic characteristics.

New avenues of research have been opened by including sustainability concepts into consumer innovativeness attitudes, as proposed by Flores and Jansson (2021) on shared e-scooters, being innovativeness a higher driver of technology adoption than green perception, similar to Esfahani and Reynolds (2021), that found consumer innovativeness as an innate innovativeness trait, with differences in the influence of each motivational aspect of consumer innovativeness on innovation adoption.

As indicated by Vandecasteele and Geuen (2010), several researchers have tried to predict consumers' innovative buying behavior using different scales intended to measure innovativeness as a personality trait, and the criticism of such rankings goes to the limited scope employed like consumer–product relationship or domain-specific innovativeness, supposed to be constant over time.

According to the extant literature revised, no adaptation and validation of Goldsmith and Hofacker's scale were performed to accommodate technology as a broader concept, rather than specific as Kim and Ho (2021) for the wearable healthcare technology, Pal et al. (2021) on smart-homes and Internet of Things (IoT), smartwatch adoption intention (Böllen, 2020) to smart thermostats (Mamonov and Koufaris, 2020).

The emergence of new adopters of innovation

In this age of Internet and communication technology, retailing has become a dynamic industry, partly because consumers have become increasingly technology-dependent as society exchanges information through smartphones, laptops, and multi-touch tablets, and retailing employs various innovative technologies to improve the consumer shopping experience (Priporas et al., 2017). At the same time, age became an essential factor in differentiating consumers' categories and their expectations as consumers.

In this regard, Aimeen et al. (2021) have identified several areas for future research under six categories: rethinking consumer behavior models; behavioral differences among different generations of consumers; consumer interaction with automated services; ethics, privacy, and the black box; consumer security concerns; and consumer interaction with new-age technologies during and after a significant global crisis.

As an example of new consumer behavior models, Mehra et al. (2021) investigated the increase in mobile application downloads, especially by young consumers in India. These findings are similar to those found by Dorie and Loranger (2020), as significant differences between the generations in the average purchase amounts via (1) mobile phone, (2) tablet, (3) computer, (4) social media, (5) brick-and-mortar.

Also, online buying has increased to a great extent in recent years, and there has been an enormous growth in business to customer (B2C) and electronic commerce (e-commerce), which eventually has made a

significant contribution to consumer behavior research (Chakabrorty and Balakrishnan, 2017). Similarly, Chang (2017), studying wearable smart devices, identified a significant trend in high-tech markets, among which smart glasses were generating significant interest.

In this way, the objectives of this study were to culturally adapt and evaluate the psychometric properties of the "*Consumer Innovativeness*" scale for the population of undergraduate students, which even now represents a gap with the repertoire of internationally and employed scales that have been adapted and validated to a specific audience.

2. Method

The study was conducted in two phases, phase 1 to adapt the instrument culturally and phase 2 to assess the adapted instrument's psychometric properties.

2.1 Phase 1 - the cultural adaptation of the instrument
For the cultural adaptation of the "*Consumer Innovativeness*" scale, the items in the final version were translated and retranslated according to the procedures proposed by Behling and Law (2000) and Hair et al. (2019a), as there were no substantial differences between the versions after the first round of translations and retranslations, the procedure was considered valid, and the analysis of the test content was started.

Judges analyzed the test content, experts in the field, scholars with experience in quantitative methods, construction of scales and indicators, and attitude research (Pasquali, 2007; Hair et al., 2019a).

2.1.1 Participants
Thirty-two subjects participated, fifteen students from undergraduate courses at a public university and seventeen students from undergraduate studies at a private university, with an average age of 20.7 years (SD = 2.1), 55% being female.

2.1.2 instrument
The translated and retranslated version of the *Consumer Innovativeness instrument* with validation by the judges was used for the semantic analysis of the items made by subjects picked from the population itself for which the test is suited.

2.1.3 Procedures
Participants were asked to answer the instrument, point out difficulties in understanding the statement, and suggest changes in the instrument's structure. As a result of the semantic analysis, the scale items were changed to be presented in their positive form, thus emphasizing innovative behavior and the request for changing the scale from 7 to 5 points.

2.2 Phase 2 - evaluation of the psychometric properties of the scale

2.2.1 Participants
Three hundred thirty-seven respondents participated in this phase, students of undergraduate courses from public and private universities in the State of São Paulo, Brazil. The latter were asked to answer the questionnaire during the classes. In addition to the six items in the questionnaire, the following sociodemographic data were collected: gender, age, and type of Higher Education Institution (HEI).

Of the 318 valid questionnaires, 54.4% of the respondents were female. The average age was 23.19 years (SD = 5.1 years), with 72.3% of students from private universities. Participants were guaranteed anonymity in the responses, and there was no personal identification record. In this context, valid questionnaires were those that reported no missing data.

3. Results

3.1 Data analysis
Descriptive statistics of all study variables were performed, considering that it is an ordinal scale (of the *Likert* type), the adherence of the data to the univariate normality distributions (Komolgorov-*Smirnov* or KS test), bivariate (Doornik-*Hansen* test), and multivariate (*Omnibus Test* by *Doornik and Hansen)* was also verified, with non-normal data being observed.

The statistical packages used in the data analysis were jamovi 1.2.27 and SmartPLS 2.0 M3.

No averages or standard deviation of responses were calculated, given the non-parametric nature of the data and the typical nature of the scale, ordinal in its construction, which, according to Stevens (1946), only allows the calculation of medians and frequencies.

In the analysis of the scores added to the scale, theoretically comprised between 6 and 30, values from 6 to 29 were found within the sample of 318 respondents. The mean score was 12.78 (SD = 4.477), the median 12, with the first quartile (Q1) equal to 9 and the third (Q3) equal to 16.

Unlike developing a scale from scratch, Exploratory Factor Analysis (EFA) is the recommended procedure for reducing/eliminating, and maintaining items on the scale.

Netemeyer, Bearden, and Sharma (2003) suggest the use of Confirmatory Factor Analysis (CFA) to test hypotheses a *priori* about the relationship of a set of items with their respective factors and is indicated as a procedure that followed the EFA, which was the approach used by Goldsmith and Hofacker (1991) in the development of the original instrument.

In this procedure (CFA), the internal consistency is assessed by two reliability indicators, Cronbach's alpha (as the lower bound) and composite reliability (or Dillon-Goldstein's rho, as the upper bound). Convergent validity is measured by the average variance extracted (AVE), a measure equivalent to a construct's commonality (Hair et al., 2019b).

Both procedures (EFA and CFA) were carried out to assess the adapted scale's psychometric properties, ensuring that all criteria recommended by the literature were verified.

To run an EFA is necessary to check the factorization capacity of data evaluated by two criteria: Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity test.

In the KMO criterion, values below 0.5 are considered unacceptable for data factoring. Values between 0.5 and 0.7 are considered mediocre, between 0.7 and 0.8 are good, above 0.8 are excellent and above 0.9 are excellent (Hair et al., 2019a).

On the other hand, Bartlett's sphericity test assesses the general significance of all correlations in a data matrix, and the test values with a significance p <0.05 indicate a matrix favorable to factorization (Damásio, 2012).

In EFA, both in orthogonal rotation (Varimax, with Kaiser normalization) and oblique rotation (Oblimin, with Kaiser normalization), the solution found was only 1 factor with the six variables.

In both cases, the Kaiser-Meyer-Olkin (KMO) measure was 0.812, with Barlett's sphericality test not significant (p <0.001), as shown in Table 1 below:

Table 1

Kaiser-Meyer-Olkin and Barlett's sphericity tests

Kaiser-Meyer-Olkin		0.812
Bartlett's sphericity test	Chi-square (approx)	547.187
	DF	15
	Sig.	.000

The total explained variance of the six variables that make up Factor 1 resulted in 50.043%, with *eigenvalues* above 1, as shown in table 2. The assumption of choosing factors to be retained in EFA with *eigenvalues* above one is also known as the Kaiser- Gutman (Kaiser, 1991), whose theoretical basis is associated with the fact that values less than 1 imply factors whose reliability, measured by the alpha coefficient, will be ≤ 0 and therefore rejected.

Table 2

Total Variance Explained

	Eigenvalues (initial)			Extraction		
Component	Total	% of Variance	Accumulated %	Total	% of Variance	% Accumulated
1	3.003	50.043	50.043	3.003	50.043	50.043

Note. Extraction method: analysis of the main components

As extracted in the EFA, the respective factor loads for each variable are shown in table 3.

Table 3

Component Matrix

	Component
	1
CI3	0.820
CI1	0.769
CI6	0.768
CI4	0.756
CI2	0.637
CI5	0.414

Note. Extraction method: principal component analysis

Like those obtained in the EFA, the CFA factorial loadings are presented in table 4 below.

Table 4

Results from Confirmatory Factor Analysis (CFA)

INDICATOR	FACTOR LOADING	INDICATOR RELIABILITY	t	p
CI1	0.762	0.581	20,442	0.000
CI6	0.763	0.582	23,746	0.000
CI2	0.642	0.412	13.951	0.000
CI3	0 811	0.658	35,466	0.000
CI4	0.754	0.569	21,393	0.000
CI5	0.444	0.197	7.350	0.000

Hair et al. (2017) recommend that factorial loads less than 0.4 must be removed in the CFA, and loadings between 0.4 and 0.7 should be maintained if their suppression does not impact the values of AVE and composite reliability.

The variables were removed, and the AVE and composite reliability values did not suffer a significant impact, opting for their maintenance. The values obtained in the CFA for internal consistency, composite reliability, and convergent validity are shown in table 5.

Table 5

Convergent validity and reliability

	AVE	Composite Reliability	Cronbach's alpha	Ordinal alpha
CI	0.552	0.881	0.841	0.910
Reference values	> 0.500	> 0.708	> 0.700	> 0.900

Despite several discussions about Ordinal alpha as proposed by Zumbo et al. (2007), Chalmers (2018) recommends its use as an estimate of the expected reliability in an alternative reality whereby continuous responses have replaced categorical responses. In this sense, the ordinal alpha coefficient was presented in Table 5.

To assess the discriminant validity, a *dummy* variable with demographics was created and inputted into the model to assess the heterotrait-monotrait ratio ($HTMT_{ratio}$), a robust measure of discriminant validity (Henseler et al., 2015) where values of $HTMT_{ratio}$ below 1 indicates discriminant validity. In our study the $HTMT_{ratio}$ achieved was 0.243.

Although computed differently, the results of the factor loadings obtained in EFA and CFA are similar and present a positive, significant, and robust correlation (Spearman's rho = 0.943, p-value < 0.001).

This finding, although not an explicit recommendation in the literature, confirms the advice of Netemeyer et al. (2003) for the use of CFA in the validation of existing scales, in addition to using the traditional approach for validation of scales (EFA) and, in both cases, the results are valid and reliable.

4. Discussion

The *Consumer Innovativeness* scale developed by Ronal d E. Goldsmith and Charles F. Hofacker in 1991 has been one of the most used studies on the adoption of innovations, with more than 1,900 citations since its publication being used in more studies than 50 publications in Portuguese until March 2021.

Except for better information, the scale had not yet been adapted and validated for use with undergraduate students, which has so often been used as a target audience for research and studies on the adoption of innovations, both by academics and by professionals whom they need to ensure their findings with valid and reliable research instruments.

The adaptation of the scale for application to university students followed the steps suggested by Pasquali (2007) and Hair et al. (2019a), namely: theoretical analysis - which includes the study of the content of the scale by judges and the semantic analysis made by subjects of the population, and the empirical analysis, in this case, we opted for EFA and CFA, following the recommendation by Netemeyer et al. (2003) for existing scales.

As a result of the adaptation and validation of the scale for undergraduate students, the final version presents all six items in a positive form, raised during the semantic validation stage. Half of the items had a positive shape in the original version, and the other half consisted of items presented negatively.

In developing the original version, Goldsmith and Hofacker (1991) circumscribed the object of analysis on the adoption of innovations. In the first study, the chosen object was disc releases of a particular band d and rock. Posterior studies changed the object to fashion clothes, for example.

Like the semantic validation that occurred with undergraduate students, the first study by Goldsmith & Hofacker (1991) presented the scale items with seven response options, which the respondents (American university students) requested to be changed to five points.

For the adapted version of the instrument, a neutral approach was chosen, without choosing any specific product, aiming at a broader validation that would allow the use in particular cases of products or services in their adoption process, and the statements presented as the object of questioning is the concept of technological novelties, as suggested by the judges in the analysis of the test content, as well as the semantic validation carried out with the subjects of the population.

The result, shown in table 6, brings the original version and the adapted and validated version of the *Consumer Innovativeness for Undergraduate Students*.

Table 6
Final adapted and validated scale of Consumer Innovativeness for Undergraduate Students.

Original version	Adapted and Validated Version
Compared to my friends I own few (a lot of) rock albums.	I am the one with the most technological novelties among my friends.
In general, I am the last (first) in my circle of friends to know the titles of the latest rock albums.	I am the first in my circle of friends to know about technological innovations.
In general, I am among the first (last) in my circle of friends to buy a new rock album when it appears.	I am always the first in my circle of friends to buy technological novelties when they appear.
If I heard that a new rock album was available in the store, I would (not) be interested enough to buy it.	I am always interested in buying a technological novelty that I discover.
I will not buy a new rock album if I haven't heard it yet / I will buy a new rock album, even if I haven't heard it yet.	I always buy technological novelties even though I have never heard of them.
I do (not) know the names of new rock acts before other people do.	I always know about new technologies before other people.

An important point to be mentioned during the process of theoretical analysis carried out by the judges is the fact that all the statements bring in their description the extreme attitude, characterized using "always" or "the one who has more", an essential characteristic in the development of scales for measuring attitudes (Hair et al., 2019).

Such insistence on the extreme points of the attitude, which in the specific case of semantic validation, was requested to remove "never ..." and maintain "always ..." finds an echo in Likert's (1932) propositions, which is often cited, and little read:

> "In general, it would seem desirable to have each statement so worded that the modal reaction to it is approximately in the middle of the possible responses."

Two limitations of this adaptation and validation can be the subject of further studies, namely:

(1) the population with which the adaptation and validation were carried out composed of university students.

The biggest criticisms of university students' use in research have been that the public has a greater cognitive capacity than the average population. Therefore, their reading and interpretation of texts could lead to the false assumption that the conceptualizations/assertions presented are valid and are generally not yet inserted in the job market, which would compromise their answers about decision making and purchasing power, as some assertions validated in this study.

In developing the original scale, Goldsmith & Hofacker (1991) carried out three studies with students and one study with non-students to validate the scale.

(2) the use of a generic concept as "technological novelties" in the statements is not specific.

This choice was because it seeks a measurement that is immune to the object or current consumption and behavior trends, seeking a broader measure of the innovative style.

To validate the original version, Goldsmith & Hofacker (1991) used as objects for measurement: of new rock records (releases), clothing (fashion), and electronic articles.

Such recommendations can help researchers adapt and validate the Consumer Innovativeness scale in other contexts, thus contributing to putting together a corpus of internationally used scales adapted and validated to the undergraduate students' usage.

Implications for future studies

Many criticisms are found in the literature regarding the "convenience sample" of undergraduate students for data collection and analysis (Winship and Mare, 1992; Hulland et al., 2018) due to the misuses and abuses that implied biased results since the chosen sample has higher cognitive skills when compared to the average population. They sometimes are not so involved in the marketplace to effectively judge the situations presented.

On the other hand, as pointed out by several authors (Aimeen et al., 2021; Dorie and Lorange, 2020; Chakabrorty and Balakrishna, 2017, Chang, 2017), a new consumer is already in place, and an understanding of the behavior of new cohorts is always beneficial for both scholars and practitioners (Clithero et al., 2021; Sharma et al., 2022), especially when considering the impact of technology in times of global transformation like during COVID-19 (Yap et al., 2021)

In this sense, the adapted, validated, and proposed scale can be helpful as an auxiliary measurement of consumer innovativeness towards any technology, and as a moderator variable to understand different practices in the IT environment

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