

Faculdade de Engenharia da Universidade do Porto



**Determinants of User Acceptance of Frugal Innovation
in Developed Countries**

A Partial Least Squares Structural Equation Modelling Approach

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MASTER THESIS

Dissertation under the programme Master in Innovation and Technological

Entrepreneurship

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June 2018

Acknowledgments

To my family and friends for all the support that they gave to me during my academic life, I am very thankful for that.

To Professor Aurora Teixeira, for being more than a supervisor. Thanks for all the willingness to undertake my dissertation.

Abstract

Frugal innovation is a resource-constraint based innovation. This concept first emerged in developing countries to fulfil the unmet needs of the bottom of pyramid (BOP) individuals. Despite being first introduced in a context of less developed countries, frugal innovations might be of high relevance for users in developed countries, once they can provide market opportunities for cost-conscious or relatively low-income consumers there. Indeed, cutting costs while safeguarding user value, may open opportunities for new business models and also may well-disrupt innovation processes in entire economies.

The present study aims to understand whether there exists demand for frugal innovations in developed countries and understand the reasons why people are interested and have the intention to buy them. For this purpose, it was pursued a quantitative approach based on the theoretical framework of the Unified Theory of Acceptance and Use of Technology, considering as main predictors performance expectancy, effort expectancy, social influence, and facilitating conditions.

Based on purposely built survey, we gathered the responses from 534 university students enrolled in several studies areas (from Science and Technology and Economics to Fine Arts). Then, resorting to Partial Least Squares Structural Equation Modelling (PLS-SEM) we assessed the validity of the hypotheses put forward. Estimation results evidence that, excluding the social influence, all the remaining determinants - effort expectancy, performance expectancy, and facilitating conditions – are critical factors for explaining the intention to buy the Tata Nano car by university students.

Given that there is ‘market’ in developed countries for frugal innovative products, some industries should change the ‘game’ in order to be more competitive in that market and, actually, rethink their strategy towards the needs and wants of that particular market. Specifically, companies should take into account the criteria for an innovation to be considered as frugal: substantial cost reduction, optimal performance level, focus on core functionalities and seek to benefit from it.

Keywords: Frugal innovation; Unified Theory of Acceptance and Use of Technology; Partial Least Squares Structural Equation Modelling; Developed countries; Portugal

Resumo

A inovação frugal é uma inovação desenvolvida num ambiente de escassez de recursos. Inicialmente, este conceito surgiu nos países em desenvolvimento de forma a dar resposta às necessidades dos indivíduos com menos poder de compra. No entanto, apesar deste conceito ter surgido neste contexto, as inovações frugais podem ter grande relevância para pessoas residentes em países desenvolvidos, uma vez que proporcionam oportunidades de mercado para consumidores mais regrados e conscientes ou de rendimento mais baixo. De facto, cortar nos custos de produção e, ao mesmo tempo, adicionar valor ao utilizador, pode potenciar oportunidades para novos modelos de negócios, podendo reestruturar processos de inovação nas economias a nível global.

Este estudo tem como objetivo compreender se existe procura de inovações frugais em países desenvolvidos e perceber as razões pelas quais as pessoas têm a intenção de comprá-las. Como tal, este estudo baseou-se numa análise quantitativa usando o UTAUT (*Unified Theory of Acceptance and Use of Technology*), que considera como principais fatores explicativos da intenção de compra a expectativa de desempenho, expectativa de facilidade de utilização, influência social e condições facilitadoras.

Com base na pesquisa feita, este estudo reuniu 534 respostas de estudantes universitários matriculados em várias áreas de estudos (de Ciência e Tecnologia e Economia a Belas Artes). Posteriormente, recorrendo a um modelo estrutural desenvolvido baseado em mínimos dos quadrados parciais, procedeu-se à validação das hipóteses propostas. Os resultados da estimativa evidenciam que, excluindo a influência social, todos os determinantes restantes - expectativa de esforço, expectativa de desempenho e condições facilitadoras - são fatores críticos para explicar a intenção de comprar o carro Tata Nano por estudantes universitários.

Dado que existe "mercado" nos países desenvolvidos para produtos inovadores frugais, algumas indústrias deviam mudar o "jogo" para serem mais competitivas nesse mercado e, na verdade, repensar e reajustar a sua estratégia face às necessidades deste mercado em particular. Sendo assim, as empresas devem levar em consideração as características da inovação frugal: redução substancial de custos, nível ótimo de desempenho e foco nas funcionalidades principais, tirando o máximo proveito desta oportunidade de mercado.

Palavras-chave: Inovação frugal; Teoria Unificada de Aceitação e Uso de Tecnologia; Modelação de Equações Estruturais de Mínimos Quadrados Parciais; Países desenvolvidos; Portugal

Index of contents

Acknowledgments	i
Abstract	ii
Resumo.....	iii
List of Figures	v
List of Tables.....	vi
1. Introduction	1
2. Literature review on frugal innovation and the related determinants of acceptance	4
2.1. Discussing the concept of frugal innovation.....	4
2.2. Frugal trend: from developing markets to developed markets.....	8
2.3. A brief account on the extant empirical and theoretical literature on frugal innovation: uncovering the research gap.....	9
2.4. Theoretical framework: Unified Theory of Acceptance and Use of Technology	10
3. Research question, strategy and design.....	15
3.1. Research question	15
3.2. Research strategy	15
3.3. Research design	16
4. Findings and discussion	18
4.1. Descriptive analysis.....	18
4.2. Determinants of the intention to buy	25
4.2.1. Measurement model	25
4.2.2. The structural model	27
5. Conclusions	31
References.....	34
Appendix.....	41
Questionnaire.....	41

List of Figures

Figure 1: The concept of frugal innovation and related concepts.....	6
Figure 2: Reverse innovation explanation	8
Figure 3: Publications on frugal innovation indexed in Scopus and Web of Science	9
Figure 4: Main topics addressed by frugal innovation literature, 2012-2017	10
Figure 5: Unified Theory of Acceptance and Use of Technology (UTAUT).....	11
Figure 6: Respondents by age group	18
Figure 7: Respondents by gross monthly family income group.....	18
Figure 8: Respondents by course/scientific area.....	19
Figure 9: Respondents by location (regions) of permanent residence.....	21
Figure 10: Intention to buy a frugal innovation (the Tata Nano) by age and gender.....	22
Figure 11: The estimated proposed model.....	29
Figure 12: Impact and contribution of the variable to the Intention to buy the Tata car (frugal innovation).....	30

List of Tables

Table 1: Concept-centric analysis of frugal innovation.....	5
Table 2: Concept matrix augmented with units of analysis	6
Table 3: Correspondence between the conceptual framework and the questionnaire’s answers.....	17
Table 4: Intention to buy a frugal innovation (the Tata Nano) by area of studies (% of respondents who agree and totally agree with the statement).....	20
Table 5: Intention to buy a frugal innovation (the Tata Nano) by family income (% of respondents who agree and totally agree with the statement).....	22
Table 6: Correlation matrix.....	23
Table 7: Correlations between the intention to buy the Tata Nano (frugal innovation) and the determinants of the buying intentions, Performance expectancy (PE), Effort expectancy (EE), Social influence (SI), and Facilitating conditions (FC).....	24
Table 8: Specification of the outer model	26
Table 9: Construct validity criteria for reflective constructs.....	26
Table 10: Discriminant validity.....	27
Table 11: Structural model results.....	29
Table 12: Summary of the empirical results	29

1. Introduction

A world without innovation will not prosper, rather it will stagnate. Schumpeter (1934) strongly believed that innovation has a special role to economically transform societies. He wittily called it “creative destruction”. Innovation is the key to the economic performance of companies, indeed, evidence exists that once firms innovate their probability to make higher profits will increase (Camagni, 2017).

Developing markets are inserted in a unique context for innovating (Bhatti, 2012). Bhatti (2012) lists three main challenges that persist in emerging markets for innovation: resource constraints, institutional voids and address the needs of bottom of pyramid (BOP) people.

Prahalad (2006) strongly believed in the vast potential of the BOP market. But, in order to meet this low-end market needs, innovation must be frugal so that users can afford it. Here emerges the “win-win” perspective in which companies can earn profits and try to reduce poverty at the same time (Prahalad, 2006).

According to Prahalad & Hammond (2002, p.4), “the economies of developing regions grow vigorously, creating jobs and wealth and bringing hundreds of millions of new consumers into the global marketplace every year. China, India, Brazil, and, gradually, South Africa become new engines of global economic growth, promoting prosperity around the world”. Making the bridge between this exponential market share growth of the developing economies and the fact that all countries are resource-constrained – scarcity (Hoff & Stiglitz, 2001), developed economies must also follow this shifting frugal trend.

Albeit first introduced in a context of less developed countries, frugal innovations might be of high relevance for users in developed countries. Indeed, according to Knorringa, Pesa, Leliveld & Beers (2016), cutting costs while safeguarding user value, may open opportunities for new business models and also may well-disrupt innovation processes in entire economies. Frugal products and services provide market opportunities for cost-conscious consumers in industrialized countries (Immelt, Govindarajan & Trimble, 2009).

The studies on frugal innovation are not voluminous, but are rapidly expanding. Since 2012 it was published in “Scopus” and “Web of Science” bibliographic databases 76 articles, reviews and in press articles on this subject matter. The bulk of this literature deals mainly with theoretical concepts and the definition of frugal innovation, with some few focusing the applications of frugal innovation in specific areas. The perspective adopted is mainly that of less developed countries, with some few recent studies (e.g., Agarwal, Grottke, Mishra,

Brem, 2017) arguing that further research regarding user perspective in developed countries is on demand.

In this latter perspective, it was recently suggested that reverse innovation, that is, frugal innovation which comes to developed countries and becomes commercially successful, is been considered by many companies operating in developed countries such as GE, Siemens, Procter and Gamble (Hossain, 2013). Thus, quality products with low-income is likely to be widely “available not only in developing countries but also in developed countries” (Hossain, 2013, p. 2).

If the concomitant required business strategies and business models of such companies are to be successful one needs to apprehend whether final users/customers are prone to adopt frugal products and services supplied by these companies.

To the best of our knowledge, there is no empirical evidence on the propensity of users in developed countries to adopt frugal/reverse innovations. Thus, the goal of the present research is to assess users’ propensity to accept/adopt frugal/reverse innovations in developed countries and its main determinants.

Specifically, our research questions are:

1. Are users in developed countries liked to buy frugal innovations formerly created in BOP markets?
2. What are the main determinants of the adoption of frugal innovation by users located in developed countries?

In order to respond to these questions, we will pursue a quantitative approach based on the theoretical framework of the unified theory of acceptance and use of technology (Venkatesh, Morris, Davis & Davis, 2003). Specifically, we resort to Partial Least Squares Structural Equation Modelling (PLS-SEM) (Sarstedt, Ringle, Smith, Reams & HairJr, 2014; Hair, Hult, Ringle & Sarstedt, 2017; Sarstedt, Ringle & Hair 2017), which has been widely used in studies about consumers' intentions to purchase given goods and services (e.g., Amaro & Duarte, 2015; Thananusak, Rakthin, Tavewatanaphan & Punnakitikashem, 2017; Toufani, Stanton, Chikweche, 2017; Valaei & Nikhashemit, 2017; Hew, Leong, Tan, Lee & Ooi, 2018), but, to the best of our knowledge, it was never applied in the context of intention to buy frugal innovations.

The data required to respond to the research questions and test the main hypotheses was gathered through direct survey targeting a population of university students enrolled in the

several courses of one of the largest Portuguese public universities (University of Porto – U. Porto). This target population is adequate as university/college students are likely to “represent a large and growing population with considerable disposable income... [and work] as trend setters and early adopters [being likely] to influence the purchasing decisions of peers and parents and establish [consumption patterns] that continue long after college.” (Gill, 2012, p. 1). Moreover, this set of population is likely to be more cost-conscious, characterized by relatively low-incomes, making it highly prone to adopt frugal innovations (Immelt et al., 2009). The questionnaire was responded by 534 students of distinct areas of studies.

In terms of structure, the present dissertation is organized as follows. Next section (Section 2) reviews the relevant literature on frugal and reverse innovation and puts forward the theoretical framework for the analysis. Section 3 details the methodology of analysis. Section 4 presents and discusses the empirical results. In Conclusions, we detail the study’s main contributions as well as policy implications, limitations and paths for future research.

2. Literature review on frugal innovation and the related determinants of acceptance

2.1. Discussing the concept of frugal innovation

“Frugal innovation is expected to disrupt existing capital-intensive and top-down forms of innovation” (Knorringa et al., 2016, p.143).

Nowadays global population is growing exponentially and, as a result, the planet is running out of resources (Prahalad, Gupta, Mathew & Arokiasami, 2016). In other words, with the raising population, natural resources are being consumed at a higher intensity level. Therefore, this pattern turned to be unsustainable for future generations. The pursue of more sustainable ways of growth explains in part the emergence of frugal innovation.

Frugal innovation is based on user-centric-approach (to certain segments), by creating more value at a lesser cost to reach great amount of people (Agarwal et al., 2017). Frugal innovation has several benefits such as simplicity, affordability and environment sustainability (Simula, Hossain & Halme, 2015).

Frugality in innovation’s strategy is needed as by reducing the price, companies are able to reach a higher number of users and, consequently, a higher profit (Prahalad et al., 2016). Prahalad et al. (2016) contend that this has been the main cause for the economic growth of emerging markets.

Since 2012, frugal innovation has been receiving a lot of attention by academic researchers as a result of its high economic potential and the growth of it applicability in businesses (George, McGahan & Prabhu 2012; Nakata & Weidner, 2011; Zeschky, Widenmayer & Gassmann, 2011).

According to Weyrauch & Herstatt (2016), the criteria for classifying an innovation as frugal should be universal. After gathering a wide set of definitions, they build a study based on a pattern coding to come up with such criteria (see Table 1 which contains some of those definitions of frugal innovation).

Three main criteria are proposed for classifying an innovation as frugal (Weyrauch & Herstatt, 2016): substantial cost-reduction, optimal performance level, and focus on core functionalities.

Substantial cost reduction includes a significantly lower price and/or costs of the product/service, seen from a customer perspective. Optimal performance level includes

performance and quality levels of the product/service. Last but not the least, frugal innovation must focus on core functionalities when compared with the existing products/services in the market.

Combining the definitions of frugal innovation included in Table 1, we can establish that frugal innovation reflects new or significantly improved products, services or systems created in a resource-constraint context. Due to this scarcity of resources, frugal innovation is based on cost-reduction, focusing on core functionalities (sustainable manner), nevertheless, the quality is not compromised (optimal performance level).

Table 1: Concept-centric analysis of frugal innovation

Definition	Substantial cost-reduction	Optimal performance level	Focus on core functionalities	Studies
“We have adopted the term frugal innovation, defined as responding to severe resource constraints with products having extreme cost advantages compared to existing solutions” (p. 39)	x			Zechky, Widenmayer & Gassmann (2011)
“Ability to generate considerably more business and social value while significantly reducing the use of scarce resources” (p. 1)	x			Radjou & Prabhu (2013)
“Frugal innovation is a term that has been used to describe the low-cost products and services, as well as the systems and processes adopted by organizations to develop them.” (p.4)	x			Ojha (2014)
“An appealing solution to this dilemma is the use of frugal-innovations with cutting edge technology to create low-cost products. The adoption of frugality entails design principles that advocate minimal use of re- sources for realizing efficient functioning of products“ (p. 66)	x	x		Rao (2013)
“Frugal innovations in products are vital in developing countries to reach price sensitive customers that seek robust products at low prices” (p. 3309)	x	x		Prabhu & Gupta (2014)
“Frugal innovations combine low-cost solutions, low-cost manufacturing and low-cost materials with design that focuses on basic functionality and minimal feature sets. In this context, the key words are resource scarcity, simplification, environmentally sustainable and lean practices.” (p. 1568)	x		x	Simula, Hossain & Halme (2015)
“Frugal innovation is about creating highly scalable products which have reduced functionalities while reducing costs” (p. 527)	x		x	Pawlowski (2013)
“Seek to minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption, and disposal) with the objective of reducing the cost of ownership while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards” (p. 98)	x	x	x	Tiwari & Herstatt (2012)
“Frugal innovation mostly occurs within the three main categories cost reduction, functionality, and performance level.” (p. 6)	x	x	x	Weyrauch & Herstatt (2016)

Source: Adapted from Weyrauch & Herstatt (2016).

Constraint-based innovations generated a lot of related concepts (see Figure 1). Besides frugal innovation, there exists more constraint-based innovations types such as Jugaad innovation, Gandhian innovation, Catalytic innovation, Grassroots innovation, Indigenous innovation, and Reverse innovation.



Figure 1: The concept of frugal innovation and related concepts

Source: Own elaboration

These concepts share some common characteristics with frugal innovation, namely being affordable solutions (see Table 2).

Table 2: Concept matrix augmented with units of analysis

	Frugal innovation – three main criteria			Scalability		
	Substantial cost-reduction	Optimal performance level	Focus on core functionalities	Local context	Small diffusion	Diffusion
Grassroots innovation	x			x		
Jugaad innovation	x		x		x	
Gandhian innovation	x	x		x		
Indigenous innovation	x	x			x	
Catalytic innovation	x		x			x
Frugal innovation	x	x	x			x
Reverse innovation	x	x	x			x

Source: Own elaboration.

Grassroots innovation only shares one of the three criteria presented by Weyrauch & Herstatt (2016), that is affordability or substantial cost-reduction. The remaining, with the exception of reverse innovation, share two criteria. Specifically, Jugaad innovation differs from the frugal innovation as it is not known for the optimal performance level whereas Gandhian, Indigenous and Catalytic innovations do not focus on core functionalities.

Reverse innovation contains the three main criteria to be considered as a frugal innovation. This happens given that reverse innovation corresponds to frugal innovations originally from emerging markets that are later commercialized in advanced economies (Brem, 2017). An example of a reverse innovation is Renault-Logan (a low-cost car model) that was first commercialized in developing markets and later on in developed countries.

When we add another possible feature of innovation, scalability, we find that Grassroots and Gandhian innovations only spread into local context, whereas Jugaad and Indigenous innovations spread over the local context, but only within a small scale. In contrast, Catalytic and Frugal diffuse in a global context.

Summing up, Jugaad innovation differs from frugal innovation as it compromises quality, providing a temporary solution and do not spread among masses (Abrol & Gupta, 2014). Although Gandhian innovation relies on quality, taking this advantage by the use of existing technologies (technology-driven innovation), this type of constraint-based innovation is spread only within a local context (Prahalad & Mashelkar, 2010). Catalytic innovation is focused on social change due to its higher scalability, and albeit the products have a lower quality, they are still considered “good-enough” (Christensen, 2006). This latter contrast with frugal innovation, which is known for “fulfilling or even exceeding prescribed quality standards” (Tiwari, Kalogerakis & Herstatt, 2016, p. 98). Distinguishing frugal from grassroots or indigenous innovation, we can state that grassroots innovations are ecologic-centric, whereas frugal innovation is not; moreover, indigenous innovation adopts know-how from developed countries to develop capabilities in developing countries, whereas frugal innovation is characterized by the opposite flow of knowledge (Serger & Breidne, 2007).

Frugal innovation started initially to serve mainly those who have affordability constraints, that is, bottom of pyramid (BOP) individuals. Some examples of frugal innovations include Vodafone - M-Pesa, a cell phone-based money transfer, that revolutionized the industry of banking in Africa; Tata Motors – Tata Nano, a \$2,000 car developed by the Indian company; Schneider Electric - BiBop program, which aims to offer solutions for affordable energy, like

the low-cost LED lighting solution In-Diya; and Essilor – 2,5 New Vision Generation, which offers access to visual correction for 2,5 billion people who are yet “excluded”.

2.2. Frugal trend: from developing markets to developed markets

Emerging markets are increasingly dynamic in economic terms, and part of this dynamism is due to frugal innovation (Prahalad, 2006). Berger (2013) forecasted that frugal products and services were going to double their global market share until 2018. Berger (2013) also added that industrialized countries have a very competitive position in the high-end market, but a weak and almost non-existent position in the low-end markets. Furthermore, and accordingly, the low-end markets are the ones that are going to grow in the future due to the changes in environment, demographic, economic and social aspects.

In this context, the potential of frugal innovations for developed countries is a reality, being entitled by Tiwari, Kalogerakis & Herstatt (2016) the Frugal 3.0. Indeed, in developed countries frugal products and services can provide market opportunities for cost-conscious or relatively low-income consumers in industrialized countries (Immelt et al., 2009).

Several authors (e.g., Cunha, Rego, Oliveira, Rosado & Habib, 2014) contend that developed markets must also follow this shifting trend in order to give response to the emerging ones, knowing how to do more with less, in this sense, the frugal innovation paradigm is essential for facing future sustainability challenges and, thus, create a chain value. This chain value is created once the context is changed (Rosca, Arnold & Bendul, 2017): changes in environment, demographic, economic and social aspects (see Figure 2).

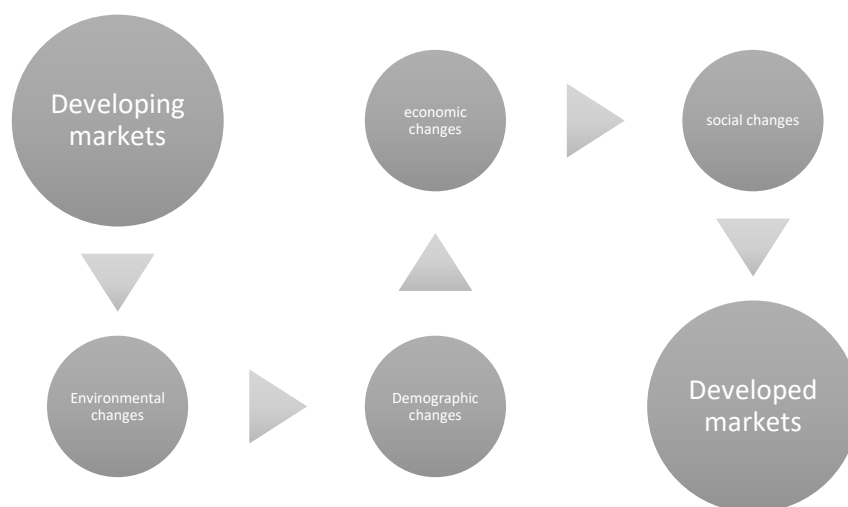


Figure 2: Reverse innovation explanation

Source: Own elaboration

Regarding the environment aspect, as the most important issue is global warming, the reduction of used material in order to reduce emissions and consumption of water and energy is crucial (Rosca et al., 2017). Regarding demographic aspects, as more and more population is ageing they tend to not being interested in buying more expensive products or services with more functionalities (which they are not going to use); rather they are likely to prefer simple (easy to use) and cheaper purchases (Rosca et al., 2017). In what respects to economic related issues, the most recent financial crisis decreased individuals' purchasing power, so the economy should follow the circular economy and sharing economy principles (Rosca et al., 2017). Finally, in terms of social aspects, there is a trend towards seeking improvements of living standards (Rosca et al., 2017).

2.3. A brief account on the extant empirical and theoretical literature on frugal innovation: uncovering the research gap

Using “Scopus” and “Web of Science” bibliographic databases, using “frugal innovation” as search keyword, we found that, between 2012 and 2017, 76 articles (including reviews and in press articles) were published.¹

Excluding 2017 (which is incomplete), we can observe (Figure 3) a clear upward trend in the publication output.

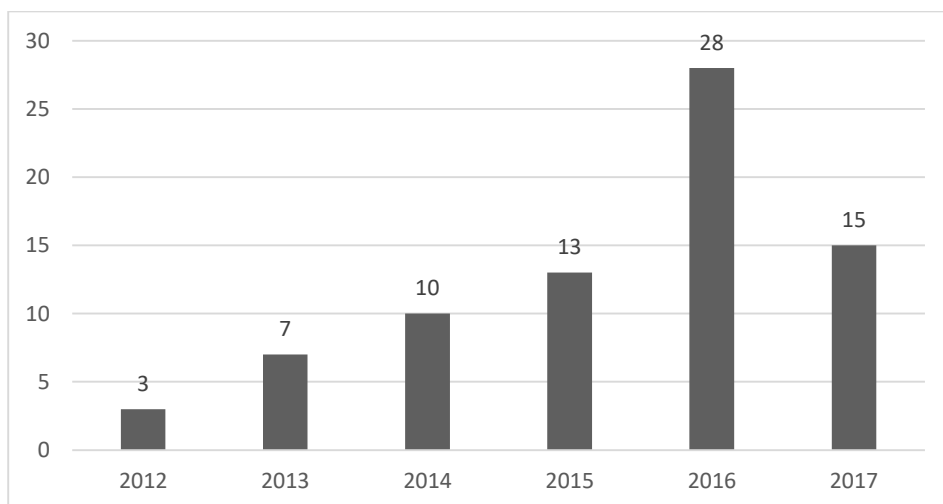


Figure 3: Publications on frugal innovation indexed in Scopus and Web of Science

Source: Own elaboration based on a search made in 20th October 2017.

¹ The search was made on 20th October 2017.

Between 2012 and 2013, the literature on frugal innovation addressed mainly innovations which fulfill needs of BOP in developing countries (see Figure 4). Later, by 2014-2015, the phenomenon of frugal innovation comes also linked to developed countries, with several studies focusing on frugal innovation from developing to developed countries and markets. The last two years (2016-2017) witness a trend toward more conceptual basis studies. In addition, the number of articles regarding frugal innovation from developing to developed markets increased, being reverse innovation a more popular topic. In 2017, a substantial number of papers addressed applications of frugal innovation in several domains, most notably: technology and biotechnology (4), medicine (2), and chemistry (1).

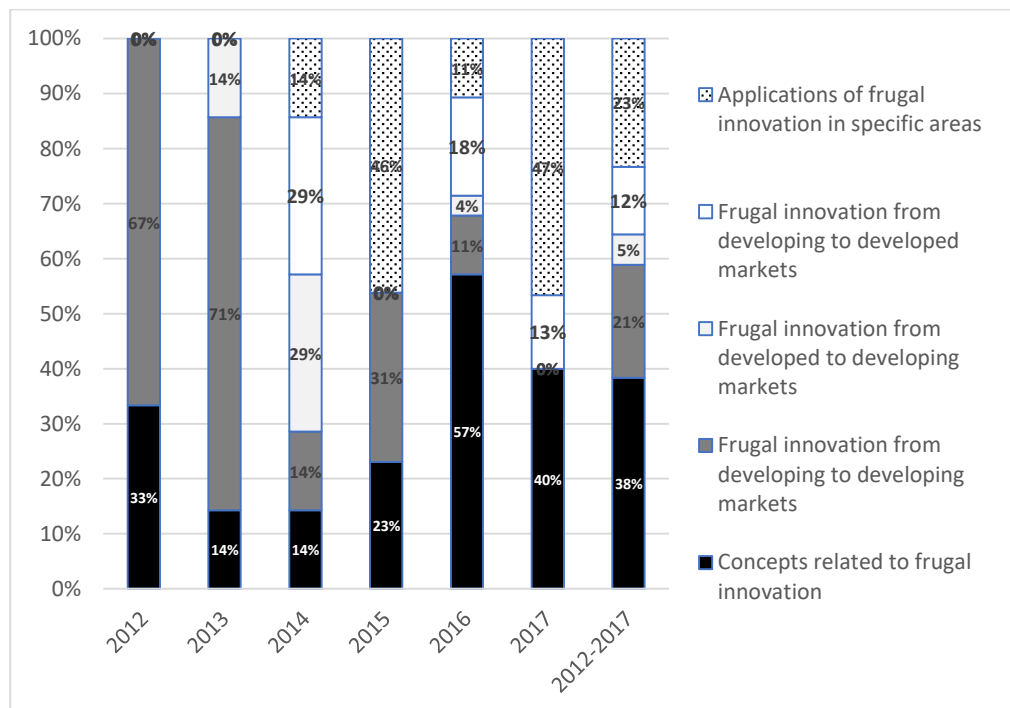


Figure 4: Main topics addressed by frugal innovation literature, 2012-2017

Source: Own elaboration based on a search made in 20th October 2017.

Some authors (e.g., such as Agarwal et al., 2017) suggest that further research regarding user perspective in developed countries is on demand. Thus, the present study seeks to contribute to fill in this literature lacuna.

2.4. Theoretical framework: Unified Theory of Acceptance and Use of Technology

In order to analyze the user acceptance of/intention to buy frugal innovations in developed countries, this study will follow the Technology Acceptance Model (TAM), adapting it to frugal innovation acceptance. How a technology is perceived influence the individual's intention and actual use of it (Holden & Karsh, 2010).

The TAM model has lately become an important theoretical tool (Holden & Karsh, 2010) and was proposed in the 1980's to explain why workers were not using Information Technologies that were available to them (Davis, 1989). This original TAM has evolved and generated an updated model: TAM2 (Venkatesh & Davis, 2000). More recently, a new model emerged, the Unified Theory of Acceptance and Use of Technology (UTAUT) – see Figure 5). As this latter model is unifying the all previous technology acceptance models, the present study is focuses on it.

UTAUT model explains behavioral intention to use (that is, the “individual’s motivation or willingness to exert effort to perform the target behavior” - Holden & Karsh, 2010, p.160), a proxy for the actual use (“the action, specific or general, whose prediction is of interest” - Holden & Karsh, 2010, p.160) of a given technology by the latter’s attributes regarding: performance expectancy, effort expectancy, social influence, and facilitating conditions.

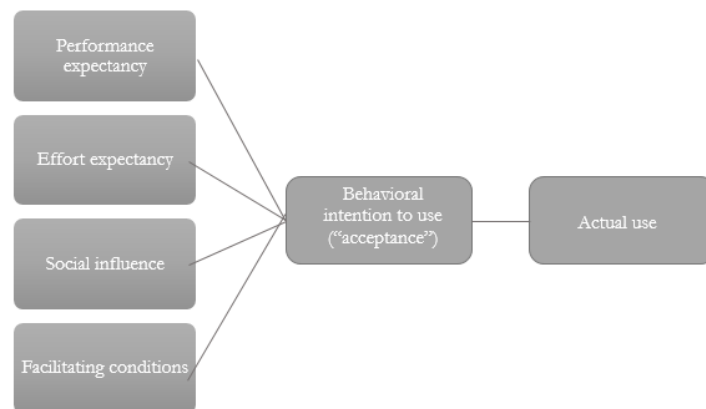


Figure 5: Unified Theory of Acceptance and Use of Technology (UTAUT)

Source: Adapted from Holden & Karsh (2010)

Performance expectancy is the “degree to which an individual believes that using the system will help him or her to attain gains in job performance” (Venkatesh et al., 2003, p. 447). The technology must be perceived as useful (Gupta, Dasgupta & Gupta, 2008), in order to correspond to the individual’s motivation to use and buy it (Tsai, Chih & Hsu, 2007). The technology must support the needs of the task (Brandon-Jones & Kauppi, 2017), enhancing the performance of the job (job-fit) (Thompson, Higgins & Howell, 1991). In addition to this, the technology must have a relative advantage when comparing with the ones that already exist in the market (Moore & Benbasat, 1991).

Some empirical studies prove the positive relationship between performance expectancy and users’ intention to use. Chiou & Fang (2005) concluded that when a website is updated with useful information, users are more willing to use the website. Verma & Sinha (2018) also

concluded that performance expectancy of mobile based agricultural extension service is positively related with users' intention to use.

Therefore, this relationship is hypothesized as follows:

H1: Performance expectancy is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.

Effort expectancy is the “degree of ease associated with the use of the system” (Venkatesh et al., 2003, p. 450). The technology must be easy to use (Pahnila, Siponen, Myyry & Zheng, 2011). The ease of use occurs when a technology is free of effort, clear, understandable and flexible (Holden & Karsh, 2010). Therefore, the complexity should be set aside so that it will not compromise the ease of use.

Empirical studies prove that ease of use is a predominant predictor of intention to adopt. Choi, Lee, Sajjad & Lee (2014) concluded that this is proved in studies regarding mobile recommendation. Chen, Shang, Ho & Hesieh (2008) also concluded the relevance of effort expectancy in electronic public services. However, this variable did not emerge as statistically relevant for explaining the user adoption of knowledge repository systems (Tsai, Zhu, Ho & Wu 2010) or in e-pharmacy application in Turkey (Alasehir, Sezgin & Özkan, 2013).

In spite of these somehow conflicting results, we hypothesized that:

H2: Effort expectancy is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.

Social influence is the “degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al., 2003, p. 451). It is suggested that to a user to adopt a technology, it is important the other's opinion about its use (Pahnila et al., 2011). People tend to be influenced by normative expectations of people from their reference group (Verma & Sinha, 2018). According to the classic comparison theory, people normally compare themselves with their reference group, which is composed by similar and familiars, such as, friends, family, neighbors, co-workers (Verma & Sinha, 2018). In some cases, people are influenced by what other people do and by what they think we should do. Social influence is important during the early stages of adoption of a certain technology (Swinerd & McNaught, 2015).

Lin and Lu (2015) proved that social influence has impact on users' intention to use of mobile social networking sites. On the other hand, there are studies that did not find social influence as a relevant factor to predict users' intention to use, such as, on use of mobile phone for agriculture by farmers in Uganda (Lwasa, Asingwire, Okello & Kiwanuka, 2013).

We nevertheless expect that for frugal innovation:

H3: Social influence is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.

Facilitating conditions, the “degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” (Venkatesh et al. 2003, p. 453). The user must have the knowledge and resources to use the technology. It describes the perceived importance of infrastructures to support systems use (Dwivedi, Rana, Jeyaraj, Clement & Williams, 2017).

Therefore, this relationship is hypothesized as follows:

H4: Facilitating conditions is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.

Summing up, for an individual to adopt a frugal innovation, the acceptance depends on the affordability and if the product or service is able to fulfill the need of the user, maintaining the optimal level of performance (performance expectancy). Thus, as frugal innovations are focused on core functionalities (on the essentials), it must be simple and easy to learn and use (effort expectancy). In emerging countries, it is likely that social influence must would not be fundamental for the individual's intention to use frugal innovations, given that these are made to fulfill unmet needs of low-end market (innovation must be frugal so that users can afford it). However, the context of developed countries, social influence might have a higher impact the individual's intention to use. In addition to this, individuals will only have the intention to use/buy if they feel that they actually have the required knowledge and resources to use it (facilitating conditions).

Several studies underline that despite their importance, the above mentioned four constructs are not enough to explain the user acceptance itself, rather they should be combined with moderators. Venkatesh, Thong & Xu (2012) proposed that three moderators should be added to the equation: gender, age and experience. Age and gender are responsible for

differences in information processing, which can affect their reliance on habit to guide a behavior (Venkatesh et al., 2012). Regarding experience, once it increases, consumers have more opportunities to reinforce their habit. Thus, the routine behavior becomes more automatic (Jasperson, Carter & Zmud, 2005).

3. Research question, strategy and design

3.1. Research question

Given the scarcity of empirical work in this area, some authors (e.g., Agarwal et al., 2017; Brem, 2017; Weyrauch & Herstatt, 2016) suggest that further research regarding user perspective in developed countries is on demand. Thus, the main goal of the present research is to assess users' propensity to accept/adopt/buy frugal innovations in developed countries. The research questions are:

1. Are users in developed countries liked to buy frugal innovations formerly created in BOP markets?
2. What are the main determinants of the adoption of frugal innovation by users located in developed countries?

3.2. Research strategy

According to Pison, Michelini & Martignoni (2018), frugal innovation from the consumer's perspective could be studied in two main streams of research. On one hand, research in developing economies (resource-constrained environments). On other hand, research in advanced economies. This study will focus on the last one. The act of consumption is influenced by several factors and, for example, low-income people, self-conscious' users and simple users could be reasons why some people would like to adopt frugal innovation in advanced economies (Rosca et al., 2017).

In order give response to the research questions raised, this study will follow a quantitative approach. As the main goal of this study is to understand the user acceptance/intention to buy frugal innovations, it is required to have a relatively large sample of individuals in order to achieve reliable and more precise conclusions.

As earlier referred, the present research is based on the theoretical framework of the Unified Theory of Acceptance and Use of Technology (Venkatesh, Morris, Davis & Davis, 2003). Therefore, this study settled hypotheses in what regards to adopt or not a frugal innovation based on performance expectancy, effort expectancy, social influence and facilitating conditions. Given that the information needed is not publicly available, there was the need to devise and implement a direct survey to the target population.

The methodology of data analysis was selected based on the theoretical framework. In concrete, we resort to Partial Least Squares Structural Equation Modelling (PLS-SEM) (Hair

et al., 2017), which has been widely used in studies about consumers' intentions to purchase given goods and service (e.g., Amaro & Duarte, 2015; Thananusak et al., 2017; Hew et al., 2018), and was never applied in the context of intention to buy frugal innovations.

The target sample is university students enrolled in the several courses of U. Porto. This target population is adequate in the sense that students are usually not financially independent (at least at the level of the first cycles, most of them depend on their parents) and tend to be, in general, sensible to environmental and other resource constraints issues (Immelt et al., 2009), being more cautious in their purchases.

3.3. Research design

The questionnaire was built by adapting the statements already validated by previous research related to the UTAUT framework (see Table 3).

For each relevant reflexive construct - Performance expectancy (PE), Effort expectancy (EE), Social influence (SI), and Facilitating conditions (FC) – 4-5 (positive and negative) statements were created. For each statement, the respondents were asked to indicate the level of agreement in a Likert scale basis (from 1: strongly disagree, up to 5: strongly agree). The list of statements by construct corresponds to the questions listed in the survey – see Appendix.

A scenario of two buying possibilities was also created, one corresponding to a well-known example of frugal innovation, the Tata Nano (a \$2,000 urban car developed by an Indian company), and the other the closer 'competitors', the Toyota Aygo and the Fiat 500 (urban cars). In the questionnaire, the respondents could visualize the three cars and a small set of characteristics about each car was described, namely the price, fuel consumption, maximum power and if they have or not air conditioning and LED lights.

Besides the statements for the reflexive constructs, it was added to the questionnaire a set of questions regarding respondents' traits. These included age, gender, local of permanent residence, monthly family income, and number of members of the household.

The questionnaire was created and implemented using Google Forms and, after, sent to all students enrolled in the faculties of U. Porto through dynamic e-mail. As the response rate was quite low, the dynamic e-mail was sent three times so that the study could gather as more responses as possible. The questionnaire was opened during two weeks, from 15th April until 30th April of the current year (2018), reaching 534 responses.

Table 3: Correspondence between the conceptual framework and the questionnaire's answers

Constructs	Statements	Author
Performance expectancy	It is recommended that the performance of ETMall/Momo is good. Using the ETMall/Momo enhances my effectiveness on searching and purchasing smartphones. Using ETMall/Momo enables me to accomplish searching and purchasing smartphones more quickly. Using ETMall/Momo makes it easier to do searching and purchasing smartphones. Considering all tasks, the general extent to which use of ETMall/ Momo could assist on searching and purchasing smartphones.	Chang, Fu & Jain (2016)
	I would find BIM (building information modelling) useful in my job. Working with BIM enables me to accomplish tasks more quickly. Working with BIM increases my productivity. If I work with BIM, I will increase my chance of getting a raise.	Howard, Restrepo & Chang (2017)
	Using this online community helps me to solve doubts when I plan a travel. Using this online community helps me to organize travels in a more efficient way. In general, this online community is useful to plan travels.	Agag & El-Masry (2016)
Effort expectancy	It is easy for me to become skillful at using the ETMall/Momo to search smartphones. My interaction to search smartphones with the ETMall/Momo is clear and understandable. I find it easy to search smartphones in ETMall/Momo. Learning to search smartphones in ETMall/Momo would be easy for me.	Chang, Fu, & Jain (2016)
	This online travel community is simple to use, even when using it for the first time. In this online travel community everything is easy to find. It is east to move within this online travel community.	Agag & El-Masry (2016)
	My interaction with BIM would be clear and understandable. It would be easy for me to become skilled at working with BIM. I would find BIM easy to use. Learning to operate BIM is easy for me.	Howard, Restrepo & Chang (2017)
Social influence	Almost all of my friends and family members use smartphones. My friends and family members think that we should all use smartphones. My friends and family members influenced me to buy smartphone. People around me have encouraged me to use smartphone.	Suki (2013)
	People who are important to me/people who influence me/ people whose opinion I value/... think that I should use the system. My supervisor/my colleagues/my friends/my family/my relatives/... think that I should use the system.	Graf-Vlachy, Buhtz & Konig (2018)
	People who influence my behavior think I should use BIM. People who are important to me think that I should use BIM.	Howard, Restrepo & Chang (2017)
Facilitating conditions	The LBS (location-based services) platform is available for most of my queries. Reliability of LBS connection is reasonable. Response time of LBS application is reasonable. Guidance is available to me for assistance with difficulties.	Hossain, Hasan, Chan & Ahmed (2017)
	When I need help to use the computer, guidance is available to me. When I need help to use the computer, specialized instruction is available to help me. When I need help to use the computer, a specific person is available to provide assistance.	Teo (2009)
	I have the resources necessary to work with BIM. I have the knowledge necessary to work with BIM. BIM is not compatible with the work tools I use. A specific person (or group) is available for assistance with BIM difficulties.	Howard, Restrepo & Chang (2017)

4. Findings and discussion

4.1. Descriptive analysis

The questionnaire was responded by 534 students, about 60% with less than 23 years old (see Figure 6). A similar percentage (59%) are female. The vast majority lives (permanent residence) in the district of Porto (72%). Three districts (Porto, Braga and Aveiro) account for 88% of the respondents, which is expectable since U. Porto attracts mainly geographically closer, mostly North region's students.

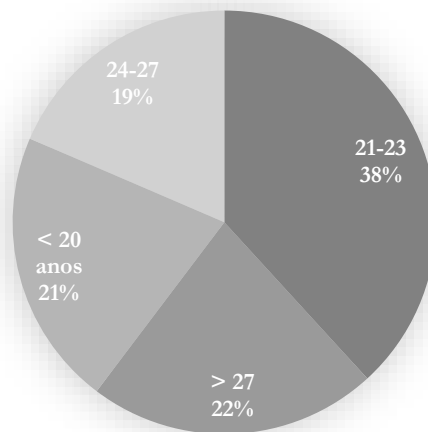


Figure 6: Respondents by age group

Source: Direct inquiry (implemented between 15th and 30th April 2018) to the students enrolled in University of Porto in 2017/18 (Total respondents: 534)

Almost 40% of the respondents (see Figure 7) state that their family's monthly gross income is between 1000 € and 1999 €, with about one quarter pointed to the subsequent income group, 2000 €-2999 €. Indeed, more than 50% (53%) with less than 2000 €.

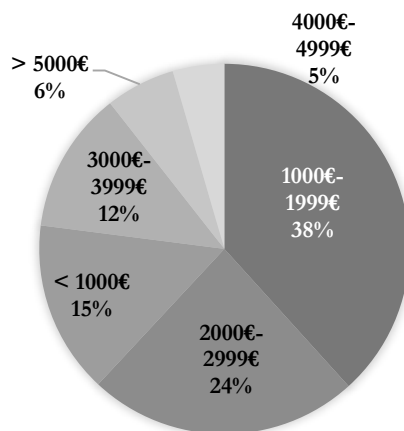


Figure 7: Respondents by gross monthly family income group

Source: Direct inquiry (implemented between 15th and 30th April 2018) to the students enrolled in University of Porto in 2017/18 (Total respondents: 534)

Approximately 70% of the respondents have a family with 3 (27%) or 4 (40%) members. Only 9% of the respondents have large families (with 5 or more members).

The sample is not representative by courses/scientific areas. A large percentage of respondents (43%) is from Engineering related course (FEUP), followed by Sciences (FCUP) and Economics (FEP), with 14% and 9%, respectively (see Figure 8).

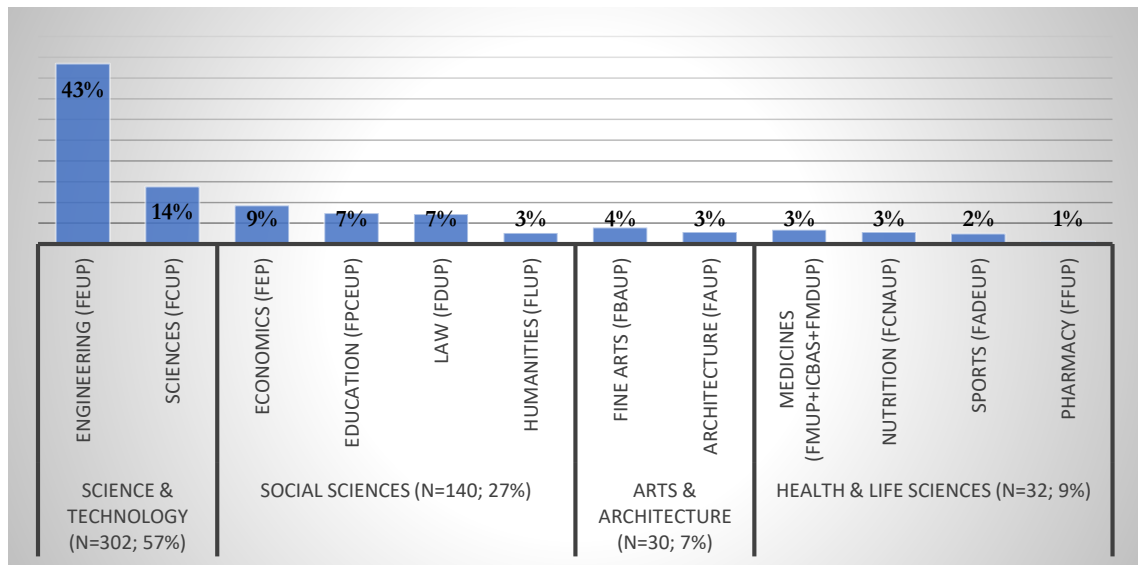


Figure 8: Respondents by course/scientific area

Source: Direct inquiry (implemented between 15th and 30th April 2018) to the students enrolled in University of Porto in 2017/18 (Total respondents: 534)

The main aim of the survey was to assess the extent to which the students of U. Porto were likely to buy a frugal innovation, specifically the Tata Nano car, a city car manufactured by Tata Motors made and first sold in India, at a very reduced price, targeting India's burgeoning middle classes.

We considered 4 statements to assess the likelihood to buy the Tata Nano (see Table 4). Taking the whole sample of respondents, 56% admitted that if they did not have enough money (15000 €, which enable them to buy alternative, non-frugal type of cars, most notably the Toyota Aygo or the Fiat 500), they would buy the Tata Nano. However, only 16% of the respondents would prefer the Tata Nano to the Toyota Aygo or the Fiat 500. This is further corroborated by the statement “Even if I had 15000€, I will prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500”, with only 12% of the respondents agreeing and totally agreeing with it.

It is interesting to observe that the students of Arts & Architecture (that is, students enrolled at FAUP and FBAUP) are the most prone to buy frugal innovations, with 23% of them

stating that they would prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500 (19% affirm that even if they had 15000 € available). This contrasts markedly with Social Science students – only 14% agree/totally agree that they would prefer to buy the Tata Nano (the frugal innovation) rather than the Toyota Aygo/Fiat 500.

Table 4: Intention to buy a frugal innovation (the Tata Nano) by area of studies (% of respondents who agree and totally agree with the statement)

Statements/Area of studies (no. respondents; % of total)	Science & Technology (n=302; 57%)	Social Sciences (n=140; 27%)	Arts & Architecture (n=30; 7%)	Health & Life Sciences (n=32; 9%)	All
"I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500"	15.0%	<i>14.4%</i>	22.9%	21.9%	15.8%
"If I did not have 15.000€, I will prefer to buy the Tata Nano"	54.8%	59.3%	55.6%	53.1%	56.0%
"If I did not have 15.000€, I will prefer to make a loan and buy the Toyota Aygo/Fiat 500"	10.6%	17.9%	0.0%	12.5%	12.0%
"Even if I had 15.000€, I will prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500"	12.0%	<i>11.4%</i>	19.4%	12.5%	12.4%

Note: Bold represent the maximum and the italics the minimum.

Source: Direct inquiry (implemented between 15th and 30th April 2018) to the students enrolled in University of Porto in 2017/18 (Total respondents: 534)

When analyzing the intention to buy the Tata Nano by regions (location of students' permanent residence), we observe that, for those regions where there is reasonable number of observations (signaled in Figure 9 with the corresponding percentages), respondents that live in the districts belonging to the Metropolitan area of Porto (Aveiro and Porto) evidence lower intention to buy (48%) than the remaining students (higher than 56%). Almost 20% of the students living in Cávado (North region) state that even if they had 15000€, they would prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500. This, however, is a little bit inconsistency with the average obtained for this group in the question "I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500", with only 7% of the respondents living in Cávado agreeing or totally agreeing with the statement.

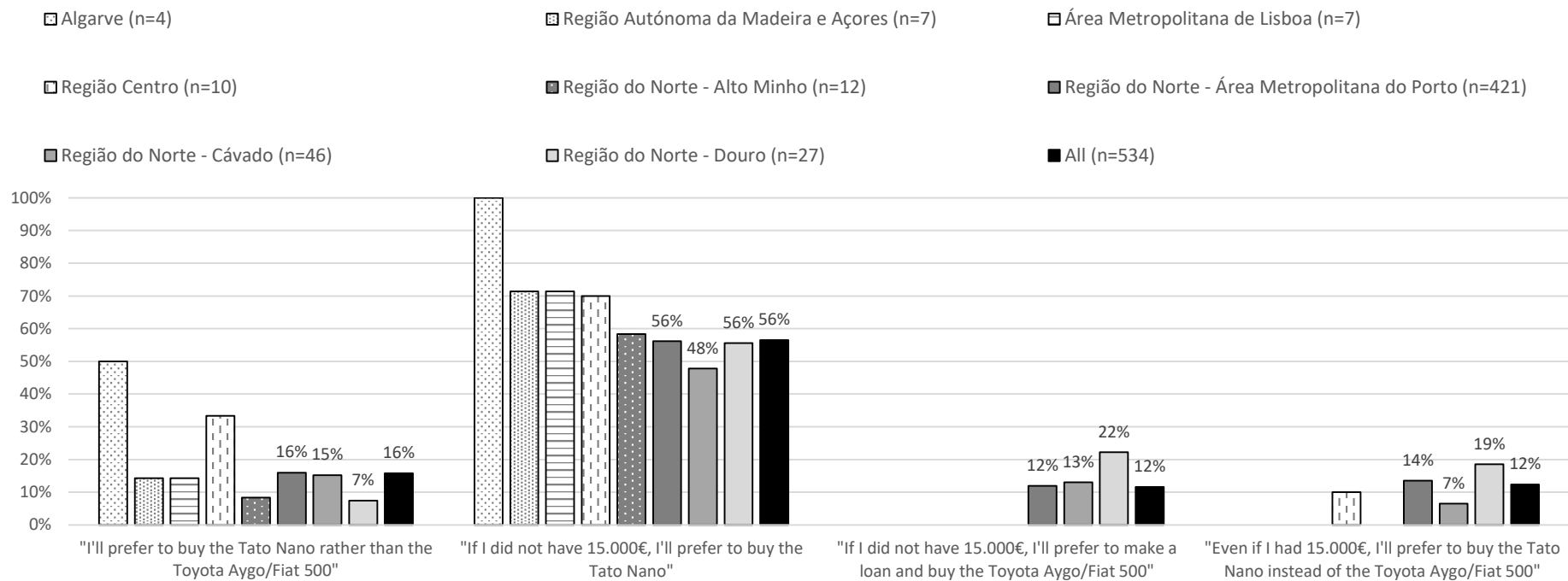


Figure 9: Respondents by location (regions) of permanent residence

Source: Direct inquiry (implemented between 15th and 30th April 2018) to the students enrolled in University of Porto in 2017/18 (Total respondents: 534)

There seems to be a relation between the intention to buy frugal innovations, that is, the Tata Nano, and income constraints. Indeed, students who reported that their family gross income is under 1000 € revealed a higher propensity to buy the Tata Nano, almost 10 points percent higher than their ‘richer’ counterparts – see Table 5. Students who belong to high income families (gross income above 5000 €), reveal consistently lower intentions of buying a Tata Nano, with one third stating that if they did not have 15000 € they would rather make a loan to buy the Toyota Aygo or Fiat 500 instead of buying the Tata Nano.

Table 5: Intention to buy a frugal innovation (the Tata Nano) by family income (% of respondents who agree and totally agree with the statement)

Statements/Gross family income	< 1000€	1000€- 1999€	2000€- 2999€	3000€- 3999€	4000€- 4999€	> 5000€
"I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500"	25%	16%	11%	18%	11%	7%
"If I did not have 15000€, I will prefer to buy the Tata Nano"	64%	56%	55%	56%	55%	48%
"If I did not have 15.000€, I will prefer to make a loan and buy the Toyota Aygo/Fiat 500"	10%	11%	<i>6%</i>	13%	20%	33%
"Even if I had 15000€, I will prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500"	9%	12%	13%	11%	10%	4%

Note: Bold represent the maximum and the italics the minimum.

Source: Direct inquiry (implemented between 15 and 30 April 2018) to the students enrolled in University of Porto in 2017/18 (Total respondents: 534)

The respondents do not differ greatly by age and gender in terms of intentions of buying frugal innovations (see Figure 10). The only exception related with the item "If I did not have 15000€, I will prefer to buy the Tata Nano", where 63% of the students aged 21-23 years olds agree or totally agree, a higher percentage than the remaining younger and older students.

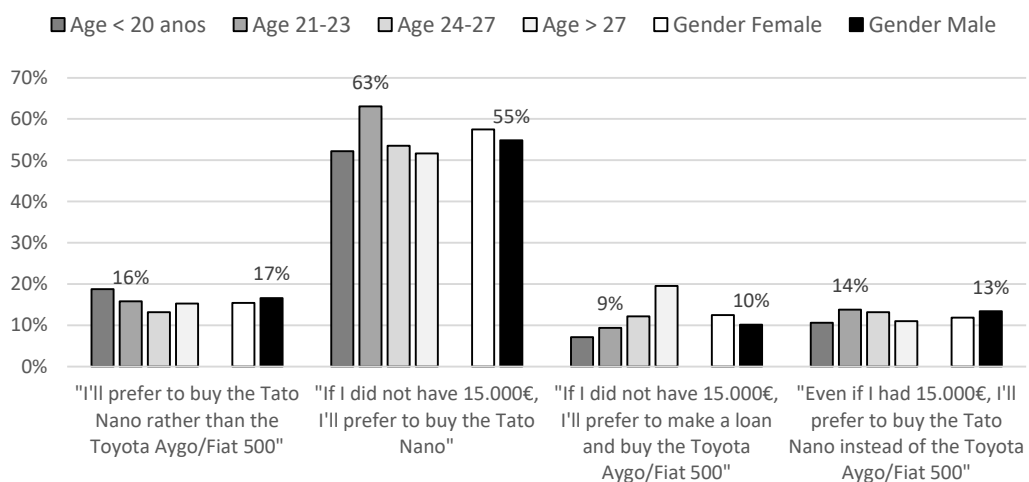


Figure 10: Intention to buy a frugal innovation (the Tata Nano) by age and gender

Source: Direct inquiry (implemented between 15th and 30th April 2018) to the students enrolled in University of Porto in 2017/18 (Total respondents: 534)

Correlating the statements of buying intentions with the characteristics of the respondents, we observe that (see Table 6) the Pearson correlation coefficients are rather low, relatively higher in the case of the gross family income – the negative coefficient of the gross family income with IB1 (“I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500”) reflects the fact the students from high income families tend to reveal lower intentions to buy the Tata Nano (the frugal innovation) as to compared with the Toyota Aygo or the Fiat 500. As expected, among the several constructs of the intention to buy, IB1 (“I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500”) is highly and positively correlated with IB4 (“Even if I had 15000 €, I will prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500”), and evidence the high intention in buying the frugal innovation, the Tata Nano.

Table 6: Correlation matrix

	IB1	IB2	IB3	IB4	Age	Gender	S&T	Social Sciences	Arts and Architecture	Health & Life Sciences	North	Gross family income
IB1	1	0.417	-0.273	0.712	-0.055	0.009	0.027	-0.081	0.021	0.069	-0.070	-0.241
IB2		1	-0.246	0.363	-0.041	-0.008	-0.020	0.019	0.013	-0.009	-0.127	-0.119
IB3			1	-0.224	0.158	0.000	0.015	0.080	-0.143	-0.025	0.048	0.175
IB4				1	0.017	0.072	0.047	-0.126	0.046	0.084	-0.021	-0.148
Age					1	-0.069	-0.083	-0.010	0.043	0.136	-0.098	0.205
Gender						1	0.237	-0.217	-0.061	-0.016	-0.001	0.087
Science & Technology (S&T)							1	-0.729	-0.329	-0.323	0.105	-0.113
Social Sciences								1	-0.172	-0.169	-0.046	0.104
Arts and Architecture									1	-0.076	-0.142	0.017
Health & Life Sciences										1	0.022	0.018
North											1	-0.008
Gross family income												1

Note: IB1: "I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500"; IB2: "If I did not have 15.000€, I will prefer to buy the Tata Nano"; IB3: "If I did not have 15.000€, I will prefer to make a loan and buy the Toyota Aygo/Fiat 500"; IB4: "Even if I had 15.000€, I will prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500".

In a simple bi-variate analysis, the intention to buy the Tata Nano (frugal innovation) is positively and strongly associated with some dimensions of Performance expectancy (PE), namely PE1 (“Tata Nano fulfil my needs”), Effort expectancy (EE), such as EE4 (“I will easily adapt myself to a Tata Nano”), and Facilitating conditions (FC), most notably, FC3 (“Tata Nano is compatible with my lifestyle”) (see Table 7).

Table 7: Correlations between the intention to buy the Tata Nano (frugal innovation) and the determinants of the buying intentions, Performance expectancy (PE), Effort expectancy (EE), Social influence (SI), and Facilitating conditions (FC)

			IB1	PE1	PE2	PE3	PE4	PE5	EE1	EE2	EE3	EE4	EE5	SI1	SI2	SI3	SI4	FC1	FC2	FC3	FC4	
Intention to buy (IB)	IB1	"I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500"	1.000	0.643	0.334	-0.090	0.352	0.256	-0.041	-0.215	-0.513	0.553	0.389	0.155	-0.139	0.038	-0.018	0.179	-0.039	0.540	-0.008	
Performance expectancy (PE)	PE1	"Tata Nano fulfill my needs"		1.000	0.459	-0.026	0.334	0.276	-0.013	-0.273	-0.454	0.625	0.304	0.223	-0.071	0.037	0.025	0.211	-0.037	0.635	-0.008	
	PE2	"Tata Nano is useful to drive in city"			1.000	0.092	0.155	0.254	0.136	-0.067	-0.212	0.431	0.199	0.160	0.046	0.027	0.102	0.226	0.116	0.371	0.059	
	PE3	"Performance of the product is a relevant factor in the buying decision"				1.000	-0.005	0.203	0.378	0.172	0.229	-0.059	-0.073	0.031	0.117	0.054	0.123	0.204	0.111	-0.022	0.199	
	PE4	"I always buy the cheapest product"					1.000	0.180	-0.049	-0.174	-0.258	0.340	0.207	0.113	-0.019	-0.010	-0.064	0.101	-0.018	0.283	-0.125	
	PE5	"The fuel consumption is a relevant factor in the buying decision"						1.000	0.299	0.032	-0.214	0.294	0.083	0.057	-0.025	-0.056	0.042	0.459	0.020	0.262	0.104	
Effort expectancy (EE)	EE1	"Features/characteristics of a product is a relevant factor in the buying decision"							1.000	0.360	0.303	0.070	-0.073	0.057	0.165	0.020	0.160	0.262	0.130	0.014	0.230	
	EE2	"Air conditioning is a relevant factor in the buying decision"								1.000	0.469	-0.209	-0.174	-0.030	0.128	0.127	0.152	-0.008	0.108	-0.190	0.106	
	EE3	"I am willing to pay more for a Fiat 500/Toyota Aygo once they have more functionalities"										1.000	-0.398	-0.193	-0.099	0.231	0.117	0.116	-0.120	0.041	-0.373	0.126
	EE4	"I will easily adapt myself to a Tata Nano"											1.000	0.361	0.192	-0.057	0.045	0.092	0.224	0.022	0.629	-0.036
	EE5	"I will adapt myself more easily to a Tata Nano rather than a Fiat 500/Toyota Aygo"												1.000	0.082	-0.087	0.000	-0.014	0.057	-0.138	0.292	-0.058
Social influence (SI)	SI1	"If a lot of people have a Tata Nano, the higher my propensity to buy it"													1.000	0.282	0.362	0.224	0.055	-0.048	0.194	-0.061
	SI2	"My friends would rather prefer Fiat 500/Toyota Aygo than Tata Nano"														1.000	0.198	0.194	0.029	0.026	-0.088	0.049
	SI3	"My friends's opinion is important in the buying decision of a car"															1.000	0.384	-0.003	0.012	0.037	-0.033
	SI4	"My family's opinion is important in the buying decision of a car"																1.000	0.106	-0.021	0.110	0.029
Facilitating conditions (FC)	FC1	"The maintenance cost is a relevant factor in the buying decision"																	1.000	0.029	0.229	0.262
	FC2	"I have the required skills to drive a Tata Nano"																		1.000	0.050	0.074
	FC3	"Tata Nano is compatible with my lifestyle"																			1.000	-0.018
	FC4	"Post-sell service is a relevant factor in the buying decision"																				1.000

4.2. Determinants of the intention to buy

The proposed model considers Performance expectancy (PE), Effort expectancy (EE), Social influence (SI), and Facilitating conditions (FC) as reflective constructs. Accordingly, in reflective constructs the direction of causality is from the constructs to the items. The model under analysis is estimated by means of Partial Least Squares Structural Equation Modelling (PLS-SEM) (Sarstedt et al., 2014; Hair et al., 2017; Sarstedt et al., 2017), which was widely used in previous studies about consumers' intentions to purchase electric vehicles (Thananusak et al., 2017), smartphones (Toufani et al., 2017), clothing (Valaei and Nikhashemit, 2017), travel online (Amaro & Duarte, 2015), mobile social tourism (Hew et al, 2018), or digital goods (Hsieh & Tseng, 2018).

The analysis includes two steps (Hair et al., 2017). First, the estimation and evaluation of the measurement model. Second, the estimation and evaluation of the structural model (structural relationship among the constructs). Hence, two types of relationships are analysed: between the items and the constructs (measurement models) and between the constructs (structural model).

4.2.1. Measurement model

The evaluation of the measurement model results comprises an assessment of indicators' reliability: internal consistency (composite reliability – Cronbach Alpha and rho A), convergent validity (average variance extracted – AVE) and discriminant validity (square roots of AVE's).

The specification of the outer model is presented in Table 8.

As the model only includes reflective constructs, the focus is on the loadings. Bootstrapping methods allow to estimate the t statistic for the measurement model. Those items that presented low value loadings (<0.40) and that are not statistically significant for level of 5% were removed from the analysis. When item loadings are higher or equal to 0.70, there is more shared variance between the construct and its measures than the error variance. The items with loadings between 0.40 and 0.70 whose removal does not increase the composite reliability were included.

Table 8: Specification of the outer model

Construct	Item	Loading	p values
PE	PE1: "Tata Nano fulfill my needs"	0.873	0.00
	PE2: "Tata Nano is useful to drive in city"	0.665	0.00
	PE4: "I always buy the cheapest product"	0.596	0.00
	PE5: "The fuel consumption is a relevant factor in the buying decision"	0.515	0.00
EE	EE3: "I am willing to pay more for a Fiat 500/Toyota Aygo once they have more functionalities"	0.757	0.00
	EE4: "I will easily adapt myself to a Tata Nano"	0.839	0.00
	EE5: "I will adapt myself more easily to a Tata Nano rather than a Fiat 500/Toyota Aygo"	0.596	0.00
SI	SI1: "If a lot of people have a Tata Nano, the higher my propensity to buy it"	0.690	0.00
	SI2: "My friends would rather prefer Fiat 500/Toyota Aygo than Tata Nano"	0.497	0.00
	SI3: "My friends's opinion is important in the buying decision of a car"	0.522	0.00
FC	FC1: "The maintenance cost is a relevant factor in the buying decision"	0.535	0.00
	FC3: "Tata Nano is compatible with my lifestyle"	0.944	0.00
IB	IB1: "I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500"	0.872	0.00
	IB2: "If I did not have 15.000€, I will prefer to buy the Tata Nano"	0.692	0.00
	IB3: "If I did not have 15.000€, I will prefer to make a loan and buy the Toyota Aygo/Fiat 500"	0.487	0.00
	IB4: "Even if I had 15.000€, I will prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500"	0.843	0.00

Note: PE: Performance expectancy; EE: Effort expectancy; SI: Social influence; FC: Facilitating conditions; IB: Intention to buy.

Regarding the internal consistency reliability, the constructs register satisfactory values for the indicators Cronbach's Alpha and rho A (meeting the threshold of 0.7) (see Table 9) and thus exhibit consistent reliability (Hair et al., 2011).

The outer loadings for the reflective constructs are higher than 0.70 and the Average Variance Explained (AVE) higher than 0.50, providing evidence of the convergent validity. An AVE value higher than 0.5 means that the construct explains more than half of its indicators on average.

Table 9: Construct validity criteria for reflective constructs

	Cronbach's Alpha	rho_A	Average Variance Extracted (AVE)
PE	0.740	0.770	0.556
EE	0.753	0.783	0.544
SI	0.700	0.702	0.508
FC	0.733	0.760	0.589
IB	0.793	0.818	0.540

Note: PE: Performance expectancy; EE: Effort expectancy; SI: Social influence; FC: Facilitating conditions; IB: Intention to buy.

In order to test for discriminant validity, the Fornell-Larcker criterion was considered. The results indicate that the square root of the AVE for each construct (in the diagonal) is higher than the highest correlation with any other construct (see Table 10).

Table 10: Discriminant validity

	PE	EE	SI	FC	IB
PE	0.746				
EE	0.444	0.748			
SI	0.048	0.076	0.713		
FC	0.415	0.348	0.045	0.767	
IB	0.445	0.531	0.069	0.360	0.735

Note: Diagonal elements in bold (the square root of AVE)

The analysis of the measurement model revealed that all the constructs exhibit internal consistency, convergent validity, discriminant validity and, thus, item reliability.

4.2.2. The structural model

In a second step, the PLS-PM methods is used to test the hypotheses regarding the relationships between the constructs in the developed model (see Figure 11). The evaluation of the structural model includes the following procedure: to evaluate the significance and relevance of the structural model relationships and to assess the level of R^2 (Hair et al., 2017).

Then, the structural model path coefficients were considered. Whether a coefficient is significant depends on the standard error that is obtained by means of bootstrapping (5.000 runs), which allows a calculation of the empirical t-value and p-value.

The first hypothesis predicts that performance expectancy is a relevant factor (positively correlated) to explain the frugal innovation's adoption in developed countries ($\hat{\beta}=0.251$ – see Table 11). Through the analysis of the correlations between the intention to buy Tata Nano (frugal innovation) and the proposed items for performance expectancy (see Table 7), it is clearly seen that PE1 (“Tata Nano fulfill my needs”) is the one with the highest correlation (0.643). Therefore, the formed hypothesis based on Brandon-Jones & Kauppi (2017) study is supported for frugal innovations. Performance expectancy is also supported by the perceived usefulness (Gupta, Dasgupta & Gupta, 2008) and relative advantage when comparing the Tata Nano with Fiat 500/Toyota Aygo (correlation of 0.334 and 0.352, respectively), otherwise, students from U. Porto are not going to use/buy it.

The second hypothesis proposes that effort expectancy is determinant when understanding buying decision of a frugal innovation. Once the correlation between EE3 (“I am willing to pay more for a Fiat 500/Toyota Aygo once they have more functionalities”) and intention to buy (IB1) is significantly negative (-0.513), it means that students from U. Porto are not sensible to price increment when it means more complexity. They prefer a technology which is easy to use (Holden & Karsh, 2010) and easily adaptable (correlation between EE4, EE5 and IB1 of 0.553 and 0.389, respectively). These results are in line with the expected once one of the three defining criteria of frugal innovation is “focus on core functionalities”. Thus, aligned with others empirical studies (Choi et al., 2014 and Chen et al., 2008), effort expectancy (EE) has the greatest positive and significant effect on the intention to buy (IB1) ($\hat{\beta}=0.453$) in the proposed structural model.

Despite Swinerd & McNaught (2015) said that social influence is important in early stages of user adoption of a certain technology, within the target sample of the present study, the third hypothesis (“Social influence is positively related to frugal innovation’s adoption (intention to use/buy) in developed countries”) is not supported for frugal innovation. Thus, unlike Verma & Sinha (2018) had stated, the majority of students from U. Porto are not socially influenced by their reference group, neither by what other people do nor by what other people think they should do. All the correlations between social influence (SS) and intention to buy (IB) are lower than 0,16 (either for positive or negative direction). In the structural model, the coefficient of social influence when determining the user adoption is below than 0.05 ($\hat{\beta}=0.048$, to be more specifically). So, the impact of social influence is not significant.

Finally, the forth hypothesis state that facilitating conditions is positively related to frugal innovation’s adoption in developed countries. Regarding this predictor, FC3 (“Tata Nano is compatible with my lifestyle”) is by far the item with the highest correlation with IB (0.54), which means that UP’s students are more likely to use/buy this specific frugal innovation (Tata Nano), once it fits and it is compatible with their lifestyles. Aligned with Venkatesh et al. (2003), U. Porto’s students think that Tata Nano has all the infrastructures to support them.

However, despite the fact that the hypothesis is supported, the coefficient is the lowest from all the determinants that are being taken into account in the inner model, corresponding to 0.16. This could be also seen through the coefficient of determination (see Figure 12).

Table 11: Structural model results

Latent variable	Coefficient (β)	Std. Error	t-value	p-value
PE->IB	0.251	0.040	6.203	0.000
EE->IB	0.454	0.039	11.702	0.000
SI->IB	0.048	0.029	1.692	0.091
FC->IB	0.160	0.037	4.283	0.000

Note: PE: Performance expectancy; IB: Intention to buy; EE: Effort expectancy; SI: Social influence; FC: Facilitating conditions

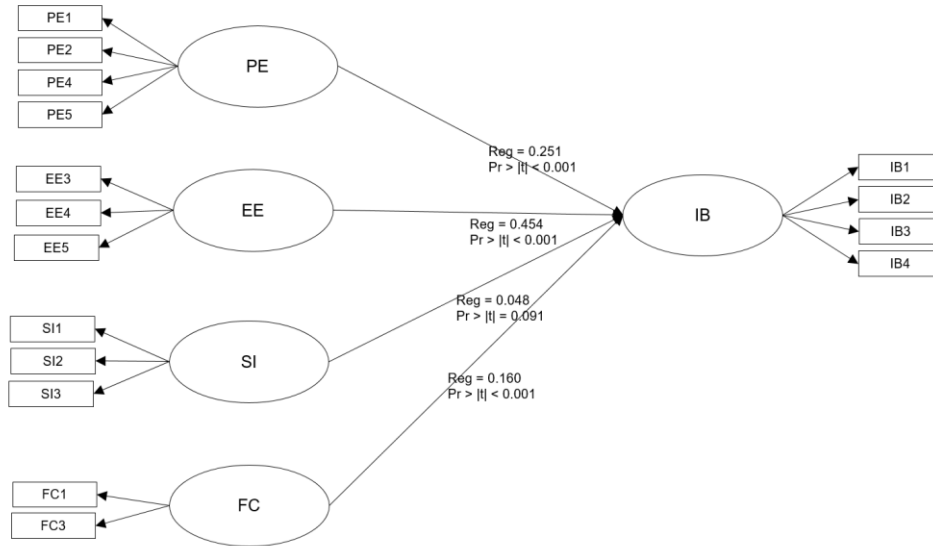


Figure 11: The estimated proposed model

Note: EE: Effort expectancy; PE: Performance expectancy; FC: Facilitating conditions; SI: Social influence; IB: Intention to Buy

Table 12: Summary of the empirical results

Hypotheses	Causality	Validated?
H1: Performance expectancy is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.	PE→IB	Yes
H2: Effort expectancy is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.	EE->IB	Yes
H3: Social influence is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.	SI→ IB	No
H4: Facilitating conditions is positively related to frugal innovation's adoption (intention to use/buy) in developed countries.	FC → IB	Yes

The coefficient of determination (i.e. the R^2 value) is a measure of a model's predictive accuracy. R^2 of 0.672 ($F=201.9$; $p=0.00$) can be considered as a good result. The EE contributes to 54,487% of the R^2 of satisfaction, PE 27,589%, FC 15,840% and SI 2,093% (see Figure 12).

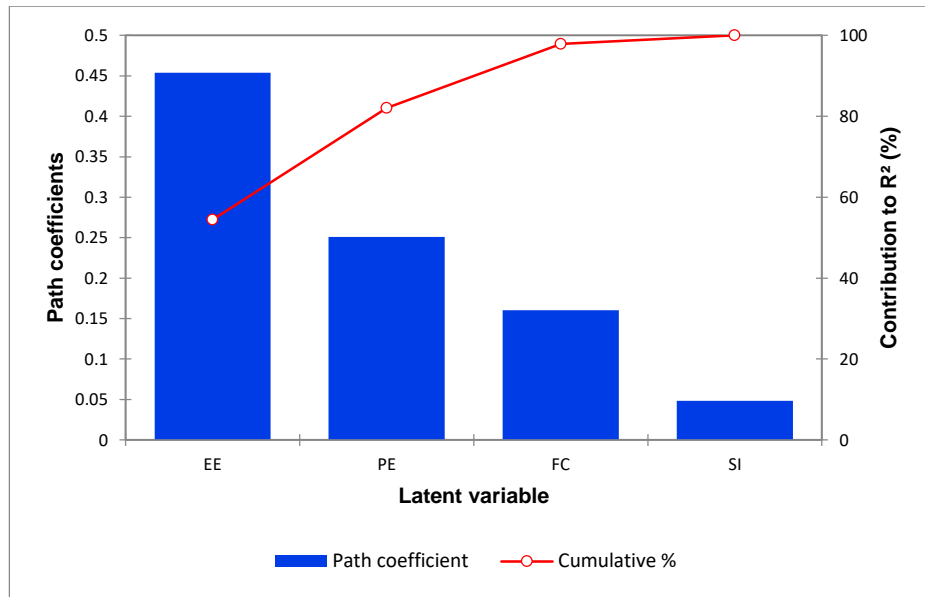


Figure 12: Impact and contribution of the variable to the Intention to buy the Tata car (frugal innovation)

Note: EE: Effort expectancy; PE: Performance expectancy; FC: Facilitating conditions; SI: Social influence

The first two constructs (EE and PE) explain more than 80% of the individual's intention to buy a frugal innovation within the targeted sample.

5. Conclusions

Global population is growing exponentially, so we have to be aware and deal with the scarcity of resources very carefully. As frugal innovation is a resource-constraint innovation, which have been receiving special both in less developed as well as developed countries (Brem, 2017). Frugality is a concept with the potential to grow at a large scale, globally (Brem, 2017). Hence, developed countries must also follow this shifting trend once the whole planet is running out of resources (not only the emerging countries). Frugal innovation, first installed in developing countries, is being moved to developed ones (Knorringa, Pesa, Leliveld & Beers, 2016). This phenomenon is called Frugal 3.0 by Tiwari, Kalogerakis & Herstatt (2016).

Given the above, and the fact that no empirical studies exist on the intention to use frugal innovations in the context of developed countries, the present study aims at filling this literature gap by assessing the determinants of user acceptance of frugal innovation in developed countries targeting a relevant sample of potential users, university students. University students usually bare non negligible financial constraints (at least at the level of the first cycles, a large percentage are financially dependent on their parents/relatives) and tend to be, in general, sensible to environmental and other resource constraints issues (Immelt, Govindarajan & Trimble, 2009).

Based on purposely built survey, we gathered the responses from 534 university students enrolled in several studies areas (from Science and Technology and Economics to Fine Arts). Then, resorting to partial least squares structural equation modelling we assessed the validity of the hypotheses put forward.

The present study contributes to the scientific literature in three main levels.

First, at the theoretical level. Although several studies have already used the Unified Theory of Acceptance and Use of Technology (UTAUT) to assess the main determinants of the adoption of innovations (Holden & Karsh, 2010; Chang, Fu & Jain, 2016; Howard, Restrepo & Chang, 2017; Pahnla, Siponen, Myyry & Zheng, 2011), to the best of our knowledge this is the first attempt to use this holistic framework in the context of frugal innovations.

Second, at the methodological level. We resort to Partial Least Squares Structural Equation Modelling (PLS-SEM) (see Ringle & Hair 2017), which has been widely used in studies about consumers' intentions to purchase given goods and services (e.g., Amaro & Duarte, 2015; Toufani, Stanton, Chikweche, 2017; Hew, Leong, Tan, Lee & Ooi, 2018), but, to the best of our knowledge, it was never applied in the context of intention to buy frugal innovations.

Third, at the empirical level. The present study brings new evidence on the intentions to use/buy a frugal innovation (the Tata Nano car) by resource constrained and environmental conscious set of population (university students) in the context of developed countries. Most of existing studies on frugal innovations are conceptual (e.g., Bhatti, 2012; George, McGahan & Prabhu 2012; 2012; Pison, Michelini & Martignoni, 2018). Those few empirical that exist (e.g., Abrol & Gupta, 2014; Tiwari & Herstatt, 2012) are, in general, descriptive and focus on less developed countries. The present study demonstrates that, excluding the social influence, all the remaining determinants - effort expectancy, performance expectancy, and facilitating conditions – are critical factors for explaining the intention to buy the Tata Nano car by university students.

In political and managerial terms, the current study confirms that there are individuals actually willing to buy frugal innovations in developed countries. These are mostly of lower incomes, enrolled in Arts & Architecture, who reckon that the innovation is useful for their daily lives/jobs, privilege the ease of use, and consider that there are adequate infrastructures to support the use of the innovation. Aligning these findings with the fact that frugal innovation has a high economic potential and applicability on the business world (George, McGahan & Prabhu 2012; Prabhu, 2012; Nakata & Weidner, 2012; Widenmayer & Gassmann, 2011), a potentially interesting business opportunity to spur the economy of developed countries was spotted. Furthermore, the developing countries are increasing their market shares, so, developed countries in order to be more competitive should follow the phenomenon of frugality (Prahalad, 2006), which is likely to contribute to sustainable economic growth (Rosca, Arnold & Bendul, 2017). With frugality, developed countries can increase their macro and micro potential, adding value in a resource-constraint world.

Given that there is ‘market’ in developed countries for frugal innovative products, some industries should change the ‘game’ in order to be more competitive in that market (Radjou & Prabhu, 2013). It is expected that this demand is going to grow, so companies must rethink their strategy towards the needs and wants of that particular market (Brem, 2017). Specifically, companies should take into account the criteria for an innovation to be considered as frugal: substantial cost reduction, optimal performance level, focus on core functionalities (Weyrauch & Herstatt, 2016) and seek to benefit from it.

Despite its novelty and contributions, the present study presents some limitations worth to note. First, even though this study is pioneer regarding the user acceptance of frugal innovation in developed countries, it only explored the four dimensions of UTAUT (performance expectancy, effort expectancy, social influence and facilitating conditions).

Thus, it could be explored the intention to buy through including other variables in the equation modelling, such as, for example, durability (life cycle of the innovation) and design aspects, or/and analyzing moderators of the model most notably age and income. Second, in spite of university students being a pertinent sample, the respondents were only University of Porto's students, who are mainly from North's region. Thus, some cautious need to be taken to avoid improper generalization of the results. An interesting path for further research would be to replicate this research to university students from other locations and/or other groups of the population (lower vs higher income people).

References

- Abrol, D., & Gupta, A. (2014). Understanding the diffusion modes of grassroots innovations in India: A study of honey bee network supported innovators. *African Journal of Science, Technology, Innovation and Development*, 6 (6), 541-552.
- Agag, G. & El-Masry, A. (2016). Understanding consumer intention to participate in online travel community and effects on consumer intention to purchase travel online and WOM: An integration of innovation diffusion theory and TAM with trust. *Computers in Human Behavior*, 60, 97-111.
- Agarwal, N., Grottke, M., Mishra, S., & Brem, A. (2017). A systematic literature review of constraints-based innovations: State of the art and future perspectives. *IEEE Engineering Management Review*, 64 (1), 03-15.
- Alasehir, O., Sezgin, E., & Özkan, S. (2013). The role of gender in pharmacists attitudes towards E-pharmacy. *Procedia – Social and Behavioral Sciences*, 83, 1111–1115.
- Amaro, S. & Duarte, P. (2015), An integrative model of consumers' intentions to purchase travel online. *Tourism Management*, 46, 64-79.
- Berger, R. (2013). Roland Berger Strategy Consultants. Munich, November.
- Bhatti, Y. (2012). What is Frugal, what is Innovation? Towards a theory of frugal innovation. Said Business School, *Working Paper*. Oxford, UK.
- Brandon-Jones, A. & Kauppi, K. (2017). Examining the antecedents of the technology acceptance model within e-procurement. *International journal of operations & production management*, 38 (1), 22-42.
- Brem, A. (2017). Frugal innovation- Past, Present, and Future. *IEEE Engineering Management Review*, 45 (3), 37-41.
- Camagni, R. (2017). Technological change, uncertainty and innovation networks: Towards a dynamic theory of economic space. In: Capello, R. (Ed.), *Seminal Studies in Regional and Urban Economics*. New York: Springer, 65-92.
- Chang, H. H., Fu, C.S., & Jain, H.T. (2016). Modifying UTAUT and innovation diffusion theory to reveal online shopping behavior: Familiarity and perceived risk as mediators. *Information Development*, 32 (5), 1757-1773.

- Chen, Y.C., Shang, R.N., Ho, T.Y., & Hesieh, S.C. (2008). The behavioral intention to use e systems for employees in public utility company: Analysis based on TAM and TTF. *Journal of e-Business*, 10 (1), 305–327.
- Chiou, Y.W. & Fang, G.D. (2005). A study of web portal user behavior. *Web Journal of Chinese Management Review*, 8 (1), 43–60.
- Choi, J., Lee, H.J., Sajjad, F., & Lee, H. (2014). The influence of national culture on the attitude towards mobile recommender systems. *Technological Forecasting and Social Change*, 86, 65–79.
- Christensen, C. (2006). The ongoing process of building a theory of disruption. *The Journal of Product Innovation Management*, 23, 39-55.
- Cunha, M. P., Rego, A., Oliveira, P., Rosado, P., & Habib, N. (2014). Product innovation in resource-poor environments: three research streams. *Journal of Product Innovation Management*, 31 (2), 202-210.
- Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13 (3), 319-39.
- Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2017). Re-examining the Unified Theory of Acceptance and Use of Technology (UTAUT): Towards a Revised Theoretical Model. *Information Systems Frontiers*, 01-16.
- George, G., McGahan, A. M., & Prahabu, J. (2012). Innovation for inclusive growth: Towards a theoretical framework and a research agenda. *Journal of Management Studies*, 49(4), 661-683.
- Gill, K. (2012). College student's attitudes towards ethical consumerism – an Indian perspective. *Journal of Business and Management*, 4 (5), 01-13.
- Graf-Vlachy, L., Buhtz, K., & Konig, A. (2018). Social influence in technology adoption: taking stock and moving forward. *Management Review Quarterly*, 01-40.
- Gupta, B., Dasgupta, S., & Gupta, A. (2008). Adoption of ICT in a government organization in a developing country: an empirical study. *Journal of Strategic Information Systems*, 17 (2), 140-154.
- Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*, 2nd Ed., Sage: Thousand Oaks.

- Hew, J.-J., Leong, L.-Y., Tan, G.W.-H., Lee, V.-H., & Ooi, K.-B. (2018). Mobile social tourism shopping: A dual-stage analysis of a multi-mediation model. *Tourism Management*, 66, 121-139.
- Hoff, K. & Stiglitz, J. (2001). Modern Economic Theory and Development. In: Meier, G-M. & Stiglitz, J.E. (Eds.), *Frontiers of Development Economics: The future in perspective*. New York: Oxford University Press, 389-459.
- Holden, R.J. & Karsh, B. (2010). The technology acceptance model: its past and its future in health care. *Journal of Biomedical Informatics*, 43 (1), 159-172.
- Hossain, M. (2013). Adopting Open Innovation to Stimulate Frugal Innovation and Reverse Innovation. Available at SSRN: <https://ssrn.com/abstract=2197782> or <http://dx.doi.org/10.2139/ssrn.2197782>
- Hossain, M. A., Hasan, M. I., Chan, C., & Ahmed, J. I. (2017). Predicting user acceptance and continuance behavior towards location-based services: the moderating effect of facilitating conditions on behavioral intention and actual use. *Australasian Journal of Information Systems*, 21, 01-22.
- Howard, R., Restrepo, L., & Chang, C. (2017). Addressing individual perceptions: An application of the unified theory of acceptance and use of technology to building information modelling. *International Journal of Project Management*, 35, 107–120.
- Hsieh, J.-K. & Tseng, C.-Y. (2018). Exploring social influence on hedonic buying of digital goods - Online games' virtual items. *Journal of Electronic Commerce Research*, 19 (2), 164-185.
- Immelt, J. R., Govindarajan, V., & Trimble, C. (2009). How GE is disrupting itself. *Harvard Business Review*, 87 (10), 56-65.
- Jasperson, J., Carter, P. E., & Zmud, R. W. (2005). A Comprehensive Conceptualization of the Post-Adoptive Behaviors Associated with IT-Enabled Work Systems. *MIS Quarterly*, 29 (3), 525-557.
- Knorringa, P., Pesa, I., Leliveld, A., & Beers, C. (2016). Frugal innovation and development: aids and adversaries? *European Journal of Development Research*, 28 (2), 143-153.
- Lin, K.Y. & Lu, H.P. (2015). Predicting mobile social network acceptance based on mobile value and social influence. *Internet Research*, 25 (1), 107–130.

- Lwasa, S., Asingwire, N., Okello, J.J., & Kiwanuka, J. (2013). Awareness of ICT-based projects and the intensity of use of mobile phones among smallholder farmers in Uganda: the case of Mayuge and Apac districts. *International Journal of ICT Research and Development in Africa*, 2 (2), 26–38.
- Moore, G. & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an innovation technology innovation. *Information Systems Research*, 2(3), 192-222.
- Nakata, C. & Weidner, K. (2011). Enhancing new product adoption at the base of the pyramid: A contextualized model. *Journal of Product Innovation Management*, 29 (1), 21-32.
- Ojha, A. K. (2014). MNCs in India: focus on frugal innovation. *Journal of Indian Business Research*, 6(1), 04-28.
- Pahnila, S., Siponen, M., Myyry, L., & Zheng, X. (2011). The influence of individualistic and collectivistic values to UTAUT: the case of the Chinese eBay. *Proceedings of European Conference on Information Systems*, 45.
- Pawlowski, J. M. (2013). Towards Born-Global Innovation: The role of knowledge management and social software. *European Conference on Knowledge Management*, 2, 527-534.
- Pison, A., Micheline, L., & Martignoni, G. (2018). Frugal approach to innovation: State of art and future perspectives. *Journal of Cleaner Production*, 171, 107-126.
- Prabhu, G. N. & Gupta, S. (2014). Heuristics of frugal service innovations. *Proceedings of PICMET '14th Conference: Portland International Center for Management of Engineering and Technology*, 3309-3312.
- Prahalad, C. & Hammond, A. (2002, September). Serving the world's poor, profitability. *Harvard Business Review*, 48-59.
- Prahalad, C.K. (2006). *The Fortune at the Bottom of the Pyramid*. Upper Saddle River, NJ: Wharton School Publishing.
- Prahalad, C.K. & Mashelkar, R.A. (2010, July-August). Innovation's Holy Grail. *Harvard Business Review*, 88 (7/8), 132-141.

- Prahalad, V., Gupta, S., Mathew, J., & Arokiasami, W. (2016, 30 June). Frugal innovation [video file]. Retrieved from url <https://www.youtube.com/watch?v=DnQi7ndgx3Y>
- Radjou, N. & Prabhu, J. (2013, January). Frugal innovation: A new business paradigm. *Entrepreneurship*. Available in <https://knowledge.insead.edu/innovation/frugal-innovation-a-new-business-paradigm-2375>
- Rao, B.C. (2013). How disruptive is frugal? *Technology in Society*, 35 (1), 65–73.
- Rosca, E., Arnold, M., & Bendul, J.C. (2017). Business models for sustainable innovation – an empirical analysis of frugal products and services. *Journal of Cleaner Production*. 162, 133-145.
- Sarstedt M., Ringle C.M., & Hair J.F. (2017). Partial Least Squares Structural Equation Modeling. In: Homburg C., Klarmann M., Vomberg A. (Eds.), *Handbook of Market Research*. New York: Springer.
- Sarstedt, M., Ringle, C.M., Smith, D., Reams, R., & Hair Jr., J.F. (2014). Partial least squares structural equation modeling (PLS-SEM): A useful tool for family business researchers. *Journal of Family Business Strategy*, 5 (1), 105-115.
- Schumpeter, J. (1934). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Cambridge, Massachusetts: Harvard University Press.
- Serger, S. S. & Bredine, M. (2007). China's fifteen-year plan for science and technology: an assessment. *Asia Policy*, 4, 135-164.
- Simula, H., Hossain, M., & Halme, M. (2015). Frugal and reverse innovations – Quo Vadis?. *Current science*, 109 (9), 1567-1572.
- Suki, N. M. (2013). Students' demand for smartphones: Structural relationships of product features, brand name, product price and social influence. *Campus-Wide Information Systems*, 30 (4), 236-248.
- Swinerd, C. & McNaught, K.R. (2015). Comparing a simulation model with various analytic models of the international diffusion of consumer technology. *Technological forecasting and Social Change*, 100, 330–343.
- Teo, T. (2009). The impact of subjective norm and facilitating conditions on pre-service teachers' attitude toward computer use: a structural equation modeling of an

- extended technology acceptance model. *Journal Educational Computing Research*, 40 (1), 89-109.
- Thananusak, T., Rakthin, S., Tavewatanaphan, T., & Punnakitikashem, P. (2017). Factors affecting the intention to buy electric vehicles: Empirical evidence from Thailand. *International Journal of Electric and Hybrid Vehicles*, 9 (4), 361-381.
- Thompson, R., Higgins, C., & Howell, J. (1991). Personal Computing: Toward Conceptual Model of Utilization. *MIS Quarterly*, 15 (1), 125-143.
- Tiwari, R. & Herstatt, C. (2012). Assessing India's lead market potential for cost-effective innovations. *Journal of Indian Business Research*, 4 (2), 97-115.
- Tiwari, R., Kalogerakis, K, & Herstatt, C. (2016). Frugal Innovations in the mirror of scholarly discourse: Tracing theoretical basis and antecedents. *R&D Management Conference 2016 'From Science to Society: Innovation and Value Creation'* 3-6 July, Cambridge, UK.
- Toufani, S., Stanton, J.P., & Chikweche, T. (2017). The importance of aesthetics on customers' intentions to purchase smartphones. *Marketing Intelligence and Planning*, 35 (3), 316-338.
- Tsai, C.H., Chih, W.H., & Hsu, W.L. (2007). Using tam to study the personal motivations and social context factors influence the acceptance of knowledge management systems-based on high technology firms' samples. *Electronic Commerce Studies*, 5 (1), 81-108.
- Tsai, C.-H., Zhu, D.-S., Ho, B.C.-T., & Wu, D.D. (2010). The effect of reducing risk and improving personal motivation on the adoption of knowledge repository system. *Technological forecasting and social change*, 77, 840-856.
- Valaei, N. & Nikhashemi, S.R. (2017). Generation Y consumers' buying behaviour in fashion apparel industry: a moderation analysis. *Journal of Fashion Marketing and Management*, 21 (4), 523-543.
- Venkatesh, V. & Davis F.D. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, 46 (2), 186-204.
- Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36 (1), 157-178.



- Venkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27 (3), 425–478.
- Verma, P. & Sinha, N. (2018). Integrating perceived economic wellbeing to technology acceptance model: The case of mobile based agricultural extension service. *Technological forecasting and social change*, 126, 207-216.
- Weyrauch, T. & Herstatt, C. (2016). Frugal innovation – What it is? Criteria for frugal innovation. *Journal of Frugal Innovation*, 2 (1), 01-17.
- Zeschky, M., Widenmayer B., & Gassmann, O. (2011). Frugal innovation in emerging markets. *Research-Technology Management*, 54(4), 38-45.

Appendix

Questionnaire

Consider a scenario in which you are going to buy a car (either by making a loan or with your own money).

Two different scenarios are available to you (Tata Nano and Fiat 500/Toyota Aygo) with the following characteristics:

	Tata Nano	Fiat 500/Toyota Aygo
LED lights	No	Yes
Air conditioning	No	Yes
Maximum power	Low	Medium
Fuel consumption	2,5 liters/100 km	4,5 – 5,0 liters/100 km
Price	2.000€	13.000€ - 15.000€
		

What is your level of agreement with the following statements (1: strongly disagree 5: strongly agree):

Performance expectancy (PE)	"Tata Nano fulfill my needs"
	"Tata Nano is useful to drive in city"
	"Performance of the product is a relevant factor in the buying decision"
	"I always buy the cheapest product"
	"The fuel consumption is a relevant factor in the buying decision"
Effort expectancy (EE)	"Features/characteristics of a product is a relevant factor in the buying decision"
	"Air conditioning is a relevant factor in the buying decision"
	"I am willing to pay more for a Fiat 500/Toyota Aygo once they have more functionalities"
	"I will easily adapt myself to a Tata Nano"
	"I will adapt myself more easily to a Tata Nano rather than a Fiat 500/Toyota Aygo"
Social influence (SI)	"If a lot of people have a Tata Nano, the higher my propensity to buy it"
	"My friends would rather prefer Fiat 500/Toyota Aygo than Tata Nano"
	"My friends's opinion is important in the buying decision of a car"
	"My family's opinion is important in the buying decision of a car"
Facilitating conditions (FC)	"The maintenance cost is a relevant factor in the buying decision"
	"I have the required skills to drive a Tata Nano"
	"Tata Nano is compatible with my lifestyle"
	"Post-sell service is a relevant factor in the buying decision"
Intention to buy (IB)	"I will prefer to buy the Tata Nano rather than the Toyota Aygo/Fiat 500"
	"If I did not have 15.000€, I will prefer to buy the Tata Nano"
	"If I did not have 15.000€, I will prefer to make a loan and buy the Toyota Aygo/Fiat 500"
	"Even if I had 15.000€, I will prefer to buy the Tata Nano instead of the Toyota Aygo/Fiat 500"

Other data

- age
- gender
- Permanent residence
- Family's monthly gross income
- number of family members
- Faculty of U. Porto