The risk perception by consumers in the value chain
of cow's milk in Portugal

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Abstract

Milk is one of the main agribusinesses in Portugal and has been increasingly subject to occurrences of risk events, associated with a wide variety of factors.

Understanding how portuguese consumers shape their risk perception in the milk chain is critical for policymakers and regulatory institutions communicate food safety information to consumers and to establish risk management with transparency and consistency.

The objective of this study was to explore and evaluate the risk factors types perceived by consumers in the value chain of cow's milk in Portugal. The literature review helped identify a set of risk factors in the milk chain, then these factors were validated with cow's milk consumers using a questionnaire.

Based on an initial hypothesis of ten risk factors types, the analysis of the data collected allowed to identify the three most relevant types in the cow's milk chain as financial, functional and social context.

Furthermore, it was intended to understand how the socio-demographic information of the consumer, confidence in the stakeholders and the news about risk events in the cow's milk chain, would impact consumers' risk perception.

The results of this study contribute to the investigation of risk perception in Portugal and allow to be a basis for the strategies development by the different milk chain stakeholders in a way to improve consumer confidence in milk.

Keywords: Cow's milk, Risk Management, Risk Perception, Risk Factors

## 1.	Introduction

The risk perception by the consumer and the decision-makers, as a result of an individual cognitive process, is subject to distortions, which can generate serious results for the management process. One of these results is overestimating or even underestimating a risk (Dia Bandaly, Ahmet Satir, 2012; Singhal, Agarwal, & Mittal, 2011).

In order to avoid the influence of these distortions, risk management becomes increasingly important by making possible to identify specific risks to which the organization is subject during its operation, analyze them objectively and generate appropriate and robust response mechanisms.

In Portugal, risk management is increasingly incorporated into organizations, which is proven by the number of organizations certified by ISO

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31000. This ISO provides a generic approach with all the necessary guidelines to guide risk management. In addition, the growing concern with risk management has led the Council for the Corruption Prevention (CPC) to make it mandatory for the financial managers, securities and public assets management entities in order to adopt and disclose plans for the prevention of corruption risks and related offenses, in its recommendation no.1/2009.

A European Parliament report on food fraud, published in 2013, identifies milk among the ten products at greatest risk of counterfeiting in Europe.

The main motivations for this research are the study of the cow's milk chain and its stakeholders; the analysis of risk management techniques and the way risk perception is constructed and, lastly, the investigation of the risk factor types that cow's milk consumers consider most relevant in milk chain in Portugal.

2. Literature Review

In the following subtopics, the concepts associated to risk, risk management, risk perception, consumer behaviour and related to the value chain of cow's milk will be explored.

2.1. Risk Concept

Risk is an important concept in several scientific fields, but even so, there is no consensus on how it should be defined and interpreted (Terje Aven, 2011). However, most of the definitions have a common element: the fact that risk is related to the possibility of human actions or events lead to harmful consequences in value elements to individuals (Robert W. Kates, 2014).

According to the *Project Management Body of Knowledge* book (PMBOK), a risk is an uncertain event or condition that, if it occurs, will have a positive or negative effect on at least one established objective (Project Management Institute, 2013).

In food terms, a risk is a function of the probability of an adverse effect for human health and the magnitude of that effect in food (Lammerding, A.M. (Health Canada, Guelph, Ontario, 1997).

2.2. Risk Management

Risk management is a ponderation process for the guideline's selection and, where necessary, measures for the prevention and problems control, based on the conclusions of a risk assessment, on factors relevant to health, for the promotion of fair-trade practices and for the stakeholders´ consultation (Robert W. Kates, 2014).

According to ISO 31000, this process "shall be an integral part of management and decision-making and integrated into the structure, operations and processes of the organization". It is divided into three stages (Figure 1): definition of the scope, context and criteria; risk assessment and risk treatment. As support activities, this process presents the stages of communication and consultation; of monitoring and review and, finally, of recording and reporting.
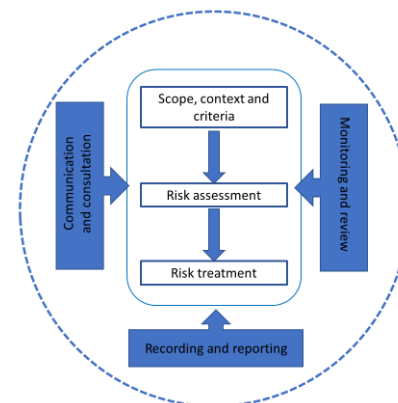

Figure 1 - Risk Management Process
Adapted from rule NP ISO 31000:2018

2.3. Risk Perception

Risk perception is the ability to interpret a situation of potential harm to health or life, ranging from an uncertain opinion to a firm belief, based on experiences previously experienced (Carmona, 2016; Slovic, Fischhoff, & Lichtenstein, 1985). The main impact of risk perception is to lead to underestimation or overestimation of risks (Vasvári, 2015).

The perception results from the psychological side of risk, namely, from the mental model of how a threat is understood, which depends on the

intuitive and contextual understanding of individuals, acquired over time through social interactions and experiences (Carmona, 2016).

There are several models that aim to explain the differences in risk perception among, for example, the public and specialists such as the psychometric model. Using scaling psychometric methods and analysis techniques, the psychometric paradigm aims to produce qualitative measures or cognitive maps that explain human risk perception and attitudes (Slovic et al., 1985; Rea,1982). The psychometric model is the most promising model of risk perception (Burnett, 2015), despite of has some limitations on its assumptions.

2.4. Cow´s milk value chain

2.4.1. Value chain concept

The value chain concept is relatively recent, and was originated from the french concept "Filière". In the 1960s, this concept was first applied to agri-food production chains (Rosales et al., 2012).

A value chain describes the full range of activities that are required to bring a product or service since when it was designed, through the different stages of production (involving a combination of physical transformation and entry of various production services), to delivery to final consumers and the final disposal after use (Drost, Van Wijk, & Vellema, 2010; Faße et al., 2009, Flynn, Huo, & Zhao, 2010).

2.4.2. Cow´s milk

The human milk consumption of animal origin began to grow rapidly after the beginning of agriculture and animal domestication. Currently, the milk most used in dairy production is cow´s milk (*Bos tauros*), being the most adapted to human consumption and the one with more industrial applications (Póvoa, 2016).

Milk is a natural food, without additives and without chemicals. Its nutritional richness and excellent physicochemical characteristics enable it to be deployed in various dairy products (yogurt, cheese, etc.) (APN, 2016).

The value chain of cow's milk in Portugal (Figure 2) presents several actors, according to each segment of action.

The value chain of cow's milk begins with the production of the inputs, which includes cow breeder companies such as *GLOBALNUTRI*. In milk production, there are three unions of dairy cooperatives in Portugal - *Agros*, *Lacticoop* and *Proleite / Mimosa SA*. In the milk collection there are about 70 entities, in Portugal (INE, 2016) included in the supplier's cooperatives. At the processing stage, the main producers of UHT milk in Portugal are *Lactogal*, *Parmalat*, *Fromageries BEL* and *Serra Leite*. The packaging and equipment industries provide inputs to process and pack milk (e.g. *Tetrapak*). In the distribution and retail stages, there are the companies that are in contact with the final customer and that make it possible to consume and trade the final products (supermarkets, grocery stores, restaurants and canteens).

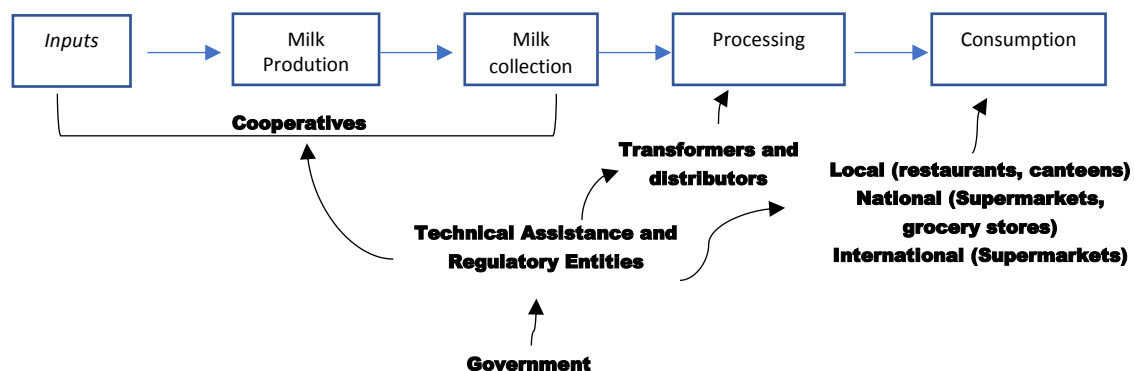Other relevant entities in this chain are the Government and technical assistance and regulatory entities.

Figure 2 - Value chain of cow's milk and Stakeholders

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2.4.3. Risk Factors in cow´s milk value chain

A risk factor is any type of situation or characteristic likely to increase the likelihood of a risk event occurring, and the task that must be performed to identify it is called a "risk assessment"(Schmidt, 2004).

Based on a wide range of literature and consequent analysis, several types of perceived risk factors were identified in the milk chain (Wang, 2014; Schmidt, 2004; Nasir, Quaddus, & Shamsuddoha, 2015):

o Financial (E.g. Milk price too low when compared to production costs; high expenses with veterinarians and animal treatments; dairy production lost due to contamination…)
o Functional (E.g. Milk with reduced nutritional value due to the incorrect cows feeding; packaging of milk with damage due to improper handling; contaminated milk due to failures in the packaging sealing machine…)
o Technological (E.g. Improved technology shortage (e.g. manual milking) leading to longer processes; damage to collection, homogenization and refrigeration equipment; lack of milk tanks with refrigeration systems…)
o Infrastructure (E.g. Space shortage for expansion of the dairy farm; roads in bad conditions for the movement of the product, which leads to delays and product deterioration; inadequate cold storage facilities…)
o Human resource (E.g. Workers' dissatisfaction with working conditions; scarcity of skilled workers (illiteracy and worker inefficiency); exchange of workers frequently…)
o Social context (E.g. News that "milk is bad for health"; the existence of more and more people consuming alternative "kinds of milks" (e.g. oats, almonds ...) and influencing others to consume these products; unfair competition between producers, processors and distributors…)

o Management (E.g. Lack of dedication and attention to training labour; failure to apply good agricultural practices; failure to verify compliance with quality and hygiene requirements…)
o Political Context (E.g. Dissatisfaction of different entities with public policies; bureaucratic complexity in maintaining the various formalities along the cow's milk chain...)
o Supply (E.g. Failures in milk production, processing and distribution as a result of weathering; failure in milk availability on supermarket shelves due to trucker strikes; accidents of milk transport vehicles…)
o Natural Cause (E.g. Natural uncertainties (e.g. droughts and rains); rapid perishability of milk; pollution; animal diseases; fires; personal accidents…)

Within each of the risk factors types identified there are associated consequences, with the following being highlighted: exit of producers from the market as a result of financial risks; consumer health problems as a result of functional risks; long and time-consuming processes as a result of technological and infrastructure risks; low-productivity workers associated with human resource risks; lower milk consumption as a result of context and social influence; legal processes as a result of mismanagement of the various entities along the chain; emergence of strikes associated with the risks of political context; delay in the replacement of milk in the supermarket as a result of supply risks and the destruction of equipment and facilities in the case of natural cause.

In addition to the risk factors types present in the cow's milk chain, sociodemographic factors must be taken into account, since they affect how the types of factors mentioned are perceived by the consumer.

The factors considered were gender, educational level, income level and household.

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According to several studies, women tend to perceive more risk in a particular danger than men. As for educational level, individuals with a high education level can better understand certain risks, such as the potential risk of chemical residues in food or contamination with bacteria and viruses (Wang,2014).

Another important factor in shaping risk perception is income. As the income level increases, the overall level of the perceived risk of food decreases, since groups with high incomes in society are considered to be highly involved and influential in social management and decision making, which contributes to the feeling of control over all aspects of life, including food security, which leads them to overlook the existence of risks (Wang,2014).

Finally, regarding the composition of the household, several studies indicate that the risk perception by the consumer is greater when he has children in his / her household (Wang,2014).

3.   Conceptual Model and Hypothesis

The conceptual model of this research suggests that the types of perceived risk factors in the cow's milk value chain are influenced by sociodemographic factors. In this model, it´s intended to analyze all the risk factors identified in the literature, those that are most relevant to the milk consumer, as well as the impact of risk events news and confidence in the chain entities, present in the risk perception in the chain mentioned.

The hypotheses presented in the conceptual model, which will be tested in this study, are:

o   H1: There is a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts of each risk factor type, in the cow's milk chain, with the income level.
o   H2: There is a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts of each risk factor type, in the cow's milk chain, with the education level.
o   H3: There is a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts of each risk factor type in the cow's milk chain with the existence of children in the household.
o   H4: There is a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts of each risk factor type in the cow's milk chain, depending on the gender.

4.   Methodology

This research follows a deductive approach since part of the existing literature was used to construct the conceptual model and the hypotheses that were tested through the results obtained statistically, using a research questionnaire.

The sample size was calculated using the "Survey system calc" tool, through the link *https://www.surveysystem.com/sscalc.htm*. It was considered a universe of 10.31 million people in Portugal (Eurostat, 2017), with an error of 5% and a sample confidence level of 90%. A sample of 384 consumers was obtained, which was surpassed by a total number of valid responses of 413 consumers. This aspect allowed to generalize the data collected for the population studied (Portuguese cow's milk consumer).

Before the questionnaire was launched, a pre-test was carried out with 10 people from March 23 to March 26, 2019, through *Facebook*.

The use of the concept of "risk factors types" and the existence of a question with all the risk factors discriminated, with the purpose of indicating the knowledge of each one of them, were the two most negative factors pointed out by the majority of participants. In order to

address these difficulties, the concept of "risk factors types" has been replaced by "risk types". And due to the lack of sufficient knowledge of the risk factors discriminated by the participants, it was decided to eliminate that question, and to analyze the knowledge of the participants by risk factors types in general, not at the level of detail of the risk factors included in them.

The questionnaire was developed with the help of the software program "*Google Forms*" and was later disseminated through the publication of its access address in the social network "*Facebook*" and by sending it by email, from the secretariat of Industrial Engineering and Management, from IST, for the students of the course. The questionnaire was conducted between March 29, 2019 and April 12, 2019.

4.1. Questionnaire Structure

The questionnaire was developed based on several questionnaires models in the literature, two of which were highlighted: the questionnaire of the master's thesis "Perception of Dairy Product Safety in China" prepared by Fang Wang in 2014 and the questionnaire administered in Portugal in the context of a Master's thesis entitled "Milk and the consumer: Purchasing preferences, consumption trends and evolution trends of a sample of consumers", by Cristiana Silva, in 2016.

The research questionnaire presented twelve questions grouped into three groups according to the type of information to be obtained.

The survey was based only on closed questions and in four of them was used an scale containing five points, ranging from reduced knowledge to high knowledge.

The introductory part consisted of a question about the milk consumption frequency, and a selection question, where the respondent is asked to indicate if he buys cow's milk for his own- or third-party consumption. If the respondent responded negatively to this question, his questionnaire would end, since he is not a consumer of cow's milk.

In the first part of the questionnaire, three questions are presented, concerning the risk factors types identified in the literature:

o In the first one, the risk factors types that the respondent considers relevant in the cow's milk chain are identified. Ten risk factors types are presented, with two to three examples, in parentheses, for each of them.

o In the second one, the respondent is asked to indicate the impact that each of the aforementioned risk factors types has on the cow's milk chain, using a five-point scale in which the first represents reduced knowledge and the fifth indicates high knowledge.

o The third question asks the respondent to indicate the knowledge level he has of the consequences that each risk factor type has on the cow's milk chain.

Although both questions seem to be similar, they are intended to analyze the existence of consumers' perceptions of the impact, consequence and relevance of a particular risk factor.

The second part of the questionnaire comprises two questions related to the information sources and the influence they have on the perception of the respondent. The first one is a five-point scale, where the first point represents a "reduced" confidence degree and the fifth is the "high" confidence degree in the information from each one of the five entities - producers, transformers, distributors, entities of technical assistance and regulation and government.

The second question was similarly constructed with other scale for the respondent to indicate the impact of news on their consumption or purchase of cow's milk.

Finally, five socio-demographic questions were asked to help identify the respondent's profile: age group, gender, income level, children in the household, and education level.

5. Results analysis

After all questionnaire responses were collected, a database was created in *Microsoft Office Excel* software - version 2010, which was later transferred to *SPSS* software version 22 for multivariate analysis.

The database allowed for a preliminary analysis of the data, which contains the analysis of the absolute frequencies of the answers, so that it was possible to check the most selected and least selected options.

5.1. Sample Profile

The sample consisted mainly of females, representing about 55% of the 413 responses. Most respondents, about 41%, are between 31 and 40 years of age. Regarding the monthly income of the household, the majority of the answers, about 35.6%, have incomes between 1001 and 2000 €. Regarding the existence of children in the household, about 52.8% of the respondents did not present children in the household. Finally, 14% of the respondents had basic education; 27.3% present secondary education; 38.7% present undergraduate degree; 16.5% have a master's degree and 3% have a PhD.

5.2. Preliminary Data Analysis

Regarding the question (Q3) about the most relevant risk factors types by the consumer, Figure 3 presents the percentage of the choices made for each risk factor type. From the analysis of this figure, it is possible to infer that the type of risk most relevant to the group of respondents studied is financial, followed by functional and social context.
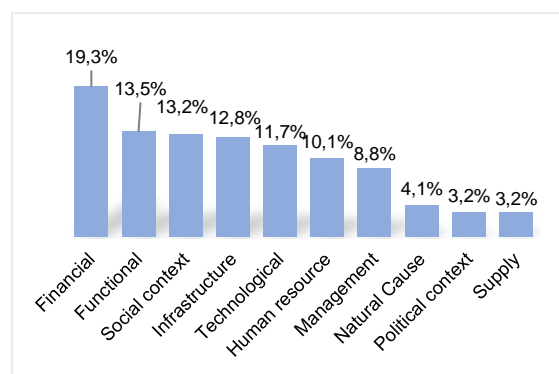

Figure 3 - Selection percentage of each risk factor type among the 3 most relevant

In the fourth question, the respondents were asked what impact they considered to exist on the occurrence of each risk factor type in the cow's milk chain, while in the fifth question asked the knowledge level of the consequences that each risk factor type has in the cow's milk chain. Through the analysis with SPSS, it is possible to observe that the average and the mode of the answers are of value 3 (impact neither low nor high), with the exception of the options related to the knowledge level of the impact of the financial risk, where the mode of the answers is in option 4. It should be emphasized that the selection of option 3, being this an intermediate option may result from lack of knowledge or uncertainty regarding the impacts that each factor type can present in the milk chain.

These two latter questions have as a positive result that the answers obtained in both questions are almost identical, as would be expected. These questions were used in order to verify if the concepts of impact or consequences would have any difference of interpretation by the consumer, which was not verified.

Table 3 - Mean, mode, standard deviation and variance of confidence in each entity in the chain

	Prod	Tran	Dist	Assi Ent	Gov
N	413	413	413	413	413
Mean	3,44	3,05	3,26	3,71	3,33
Mode	4,00	3,00	3,00	3,00	3,00
Standard deviation	0,98	0,97	0,94	0,96	1,07
Variance	0,96	0,94	0,89	0,92	1,14

In the sixth question, it was intended to verify the confidence of the respondents in each of the five entities, considered more relevant, based on the literature review. Relatively to producers, the majority of the answers, around 35%, placed level 4, equivalent to a high level of confidence, which also occurred in the confidence given to the technical assistance and inspection entities, with around 43%. In the case of transformers, distributors and government, most of the responses focused on level 3, with about 44%, 41% and 32% of the options, respectively (Table 3).

In the seventh question, the respondents were asked to indicate the degree of impact that news about risk events in the milk chain shows in their consumption of this product. Observing Figure 5 it is possible to observe that the majority of respondents described the level of impact as being level 4 (high) and level 3 (neither low nor high).
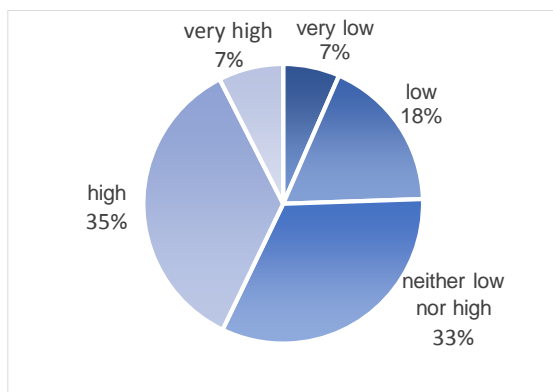

Figure 4 - Impact that news of risk events in the milk chain, present in the consumption of this product

5.3. Analysis of research hypotheses

To carry out the analysis of the research hypotheses, non-parametric tests were performed for independent samples.

In non-parametric tests, for independent samples, to be considered to exist a significant difference between the variables, their values in column sig. must be equal to or less than 0.05.

Regarding hypothesis 1, through the non-parametric test, it was verified that this hypothesis is wasn´t supported, by the questionnaire carried out. It was not possible to infer that there is a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts of each risk factor type, in the cow's milk chain, depending on the income level.

In hypothesis 2, it's supposed to verify if there was a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts of each risk factor type, in the cow's milk chain, with the education level. The hypothesis was not supported, since there were only differences, in the types of risk factors "Functional", "Technological", "Supply" and "Management", according to the education level, but it is not possible to infer for the others that there is a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts for each risk factor type.

In hypothesis 3 there were no statistically significant differences in the risk factors types, according to the existence of children, in the household of the respondents. In this way, it is not possible to infer that there is a strong association between the level that the consumer perceives to have about the consequences and impacts for each risk factor type, according to the existence of children in their household.

Lastly, taking into account the non-parametric test performed to test hypothesis 4, it is possible to say that it is not supported by the questionnaire carried out. There were only differences, both in the knowledge of the impacts and the consequences of each risk type, for "Management", and also for "Social Context" in the knowledge of the consequences, and it is not possible to infer that there is a strong association between the knowledge level that the consumer perceives to have about the consequences and impacts of each risk factor type in the cow's milk chain, depending on the gender.

6.   Conclusions

The present work used the risk perception theory to identify the risk factors types most relevant to the cow's milk consumer, as well as to investigate the impact of some sociodemographic factors on this perception.

As a result of the investigation about the three most relevant risk factor types by the consumer, it was identified the financial, the functional and the one of social context, as the most relevant. This may be due to the fact that these are the risk factors types most mentioned in the news. It is possible to observe on a daily basis the constant emergence of news about producers' dissatisfaction with financial support for their activity; on the existence of damaged packaging and late-night milk on grocery store shelves, and on the emergence of "alternative" kinds of milk and indications that "milk is bad."

Regarding the research hypothesis that were intended to study the impact of sociodemographic factors on risk perception, none of them were supported by the questionnaire carried out.

After conducting this research there is the awareness that this study is not exempt from limitations that lead to the interpretation of the results obtained with some reservations.

One of the main limitations of this study is the small sample size studied. Due to this, and by the statistical analysis of the profile of the respondents, it can be concluded that there may have been some bias in the responses. Moreover, due to the exclusive collection of online responses, the oldest consumer's access to the questionnaire was limited. In order to obtain more representative results from the Portuguese population, it would be necessary to extend the questionnaire application form through paper distribution.

Another limitation that must be pointed out concerns the subjective nature of the subject, which does not allow the consumer risk perception to be accurately and without redundancy. Moreover, this type of respondents, through online surveys, likes to remain anonymous and does not respond so readily to calls for collaboration.

Despite the limitations mentioned, it is considered that has been developed a valid and rigorous work, at least on the basis of the literature review realized, and that, therefore, it can contribute to the investigation of the risk perception area in Portugal.

In possible future research, it would be relevant to carry out a larger quantitative study, with a more representative sample of the Portuguese population, including a higher incidence in the older population.

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