

Multicriteria Usability Evaluation of Websites Offering Road Freight Transport

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Abstract

This work presents a model for assessing the usability of websites available on the internet that offer, in real-time, road freight to independent carriers. The proposed model considers a qualitative plus quantitative multicriteria approach, whose criteria and sub-criteria considered relevant for the evaluation of the usability of freight websites are based on the literature of evaluation of websites in general, however, adapted for users characterized as independent carriers. The evaluation proposes the ranking of websites according to the specific preferences of a standard user submitted to the AHP method (Analytic Hierarchy Process), proposed by Saaty. This method was chosen because it is used in numerous multicriteria decision situations, including for evaluating the usability of web pages. The road freight websites available in Brazil were analyzed for the desktop version, considering the following dimensions: effectiveness, efficiency, and satisfaction. This work concludes with suggestions for improving the architecture of road freight transport pages, as well as suggestions for applying the proposed approach to road freight applications available for portable mobile telephony equipment.

Keywords

Usability, Multicriteria analysis of websites, Online Freight Offer and Analytic Hierarchy Process.

1. Introduction

Usability is a term often used only to qualify “easy to use things” (Stewart 2012). The definition of usability in Human-Computer Interaction (HCI) is, however, broader and its importance was recognized by the International Standard Organization, when in 1998 it created the ISO 9242-11 standard and adopted by the *Associação Brasileira de Normas Técnicas* (ABNT - Brazilian Association of Norms Techniques) in 2002 (Abreu 2004). According to this standard, usability is the “extent to which a product can be used by specific users to achieve specific goals with effectiveness, efficiency and satisfaction in a specific context of use” (ABNT 2002). Effectiveness is defined, in this context, as a characteristic that evaluates the “accuracy and completeness with which users achieve specific objectives”, while the concept of efficiency is related to “resources spent in relation to the accuracy and comprehensiveness with which users achieve objectives” and, finally, the concept of satisfaction is defined as the “absence of discomfort and positive attitudes towards the use of a product” (ABNT 2002). Figure 1 illustrates the concept and measures of usability according to NBR 9241-11. This norm indicates that to measure usability it is necessary:

- 1) to explain the intended objectives with the measurement.
- 2) describe the components of the context of use including users, tasks, equipment, and environments; and
- 3) define actual or desired values of effectiveness, efficiency, and satisfaction for the intended contexts.

The context can be pre-existing or an intended context. Its level of detail will depend on the scope to be addressed, but it must be sufficiently detailed so that those factors that influence usability can be captured with the usability measurement model (ABNT 2002).

Websites offering road freight are the object of study of this work. These websites operate as virtual freight centers that publish on their pages, as a certain cargo to be transported is known, as the main characteristics of the available freight. These characteristics include cities of origin and destination of the freight, type of cargo, product to be transported, weight and/or volume, type of vehicle needed for transportation, and the amount of freight that the owner of the cargo is willing to pay for transportation. On the other end, there is, in general, an independent transporter that has at least one vehicle for transporting loads by road.

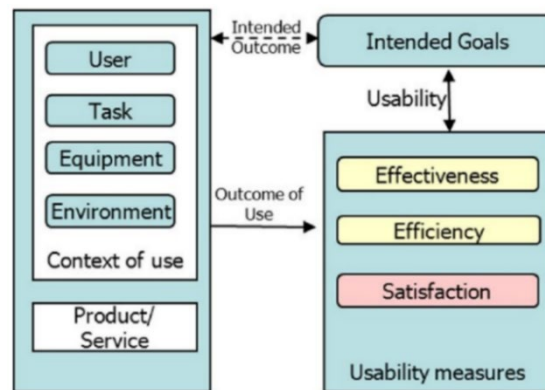


Figure 1. Usability framework, according to ISO 9241-11 (Miki 2014)

The interactivity and almost instantaneous availability of information provided by the Internet make it possible, in the case of interaction between the carrier and the online freight center, to establish a balance between supply and demand in a sector whose transmitted prices are not subject to any governmental control. As in Brazil road freight transport operates on a free market basis - without requiring authorization, permission, or concession of services - the information provided by online freight centers paves the way for free negotiation and competition in providing this service.

1.1 Objectives

The general objective of this work is to evaluate the usability of road freight websites available for free on the Internet. To achieve this objective, the following specific objectives are outlined: 1) to identify, from a bibliographical review and based on the Information Science literature, criteria for evaluating websites; 2) define metrics for applying these evaluation criteria to the websites delimited in the research; and 3) apply a multicriteria model to evaluate these websites regarding their usability, taking into account a set of criteria and sub-criteria that meet the conceptual requirements established by the NBR 9241-11 standard.

2. Literature Review

The concept of usability in the HCI can acquire multiple dimensions, as specified by the NBR 9241-11 standards. Despite its standardization and many studies carried out on its measurement, there is no standardized set of usability criteria that allows its measurement (Hartson et al. 2003). Many researchers have proposed different usability criteria, which may vary in several dimensions, degree of generality or specificity, and level of precision (Park and Lim 1999 apud Villota 2009). Along with the definition and classification specified by the NBR 9241-11 standard, the most common classifications are:

- i. Nielsen's (2012) proposal considers usability as a quality attribute, which specifies how easy computer-human interfaces are to use. It establishes five components: learning, efficiency, memorability, errors, and satisfaction.
- ii. and the classification established by Microsoft, which considers the criteria according to relevant content, ease of use, promotion on the page and in other media, made-for-the-media, and emotional response as the main dimensions (Keeker 2008).

The common point of these proposals is that to estimate the usability value, it is necessary to consider several dimensions and, since the criteria are not equally important, they need to be weighted differently according to their relative importance (Villota 2009). As a result, the context in which usability is evaluated needs to be specified and depends on subjective judgments that can be measured via quantitative statistics (Norros and Savioja 2004, apud Villota 2009).

2.1 Usability and criteria for its evaluation

Website usability evaluation methods are found in many relevant sources of the literature (Hartson et al. 2003). Likewise, criteria used to evaluate usability are diverse and depend on the context. In this work, we chose to follow the set of criteria established by Leporini and Paternò (2003). The criteria suggested by these authors are in line with the structure specified by the NBR 9241-11 standard, that is, effectiveness, efficiency, and satisfaction, as shown in Figure 1.

The “effectiveness” criterion will capture the importance of the user reaching his goal by visiting a certain website, which means that if “effectiveness” is not adopted, then users will not be able to fulfill their tasks because they will find it difficult to identify important information. The “efficiency” criterion indicates the user's ability to find the desired information more quickly. Even less efficient pages allow the user to find the desired information, but it takes more time to do so. Finally, the “satisfaction” criterion helps the development of websites that are more user-friendly to navigate during the visit or exploration of the page (Leporini and Paternò 2003).

The three criteria suggested by Leporini and Paternò (2003) are still characterized by sub-criteria that facilitate the measurement of the criteria considering different scales and metrics. For the answer to “efficacy”, the authors suggest the following sub-criteria: information logic, links with appropriate text, loading spreadsheets in an appropriate style, dynamic management of messages and data, consistent terminology, and layout. To meet the "efficiency" nine sub-criteria are suggested by the authors: the number of links and frames, appropriate name for the frames, location of the navigation bar, level of importance of elements, receipt of shortcut keys, properly formatted figures, " last update", content indexing, and navigation links. The fulfillment “satisfaction” can be represented by only three sub-criteria according to the authors: the addition of short children for different elements, colors of the text and background of the page (contrast), and highlighting images and text when hovering over the mouse. The criteria and sub-criteria suggested by Leporini and Paternò (2003) serve as a basic structure for the usability evaluation model of websites that offer online freight. Considering the specific characteristics of the sites evaluated in this work, the sub-criteria will be adapted to its objectives.

2.2 Multicriteria analysis

Decisions permeate all human activities, and many of these decisions are taken informally or intuitively (Meirelles and Gomes 2009). Improving rationality in choosing the alternative that leads to a satisfactory result for the decision maker is the main objective of a decision support tool. The formulation of decision-making problems in the presence of multiple criteria has been addressed by the area of knowledge called multicriteria decision aid (MCDA). MCDA provides a wide set of appropriate methodologies for each situation, where criteria, goals, objectives, and points of view conflict that need to be considered (Montibeller Neto et al. 2008). According to Doumpos and Zopounidis (2011), MCDA is involved in structuring problems, drug modeling, the construction and characterization of different forms of criteria aggregation models, as well as in the design of interactive and decision-aid solutions.

In the present work, the AHP method developed by Saaty in the 70's will be used to develop the multicriteria decision model (Saaty 2008). The AHP method has the distinct advantage that it decomposes a decision problem into its constituent, criteria-instituted parts. In doing so, the decision problem is broken down into its smaller elements. Saaty states that the AHP is successful in practice, because, according to the author, a decision-making approach must have the following characteristics, satisfied by the AHP: being simple in construction; be adaptable to both groups and individuals; be natural to intuition and general thinking; encourage compromise and consensus building; and not requiring expertise to master and communicate. The AHP method also has as a facilitator for application the existence of a software package, with a friendly and easy-to-use interface, called EXPERT CHOICE developed by Saaty.

2.3 Cargo intermediaries via websites

The cargo intermediary business is a long-time model in Brazil, but at least since 2013, different online solutions have offered means of contact with truck drivers/transporters and shippers, reducing the importance of negotiators and agents. Figure 2 schematically shows the elements that make up the Shipper-Cargo Intermediary-Transporter system. The shipper, the one who has the cargo, sends his cargo offer (1) to the cargo broker's online system. This sends or makes available, (2) the offer to all carriers that are registered in the system or by publishing the offer in the cargo classified. The carrier that accepts the offer, returns its freight proposal (3) to the cargo intermediary. The carrier's proposal is sent to the shipper (4) who, if he accepts the freight quote, can then return a collection order (5) directly to the carrier, who performs (6) the contracted service (Parceiro do Frete 2017).

For truck drivers, online solutions favor the use of empty space or the return without load after a trip. The business model is pretty much the same for all companies offering online shipping. These companies generally present themselves as “intermediaries”, being responsible only for the technological platform that brings together companies that have a demand for the transfer of goods and truck drivers or shippers. This is a model like that adopted by Uber and ride-sharing apps. Thus, responsibility for delivery rests with the carrier, while items such as insurance remain the responsibility of contracting cargo companies (Terra 2015). Currently, around 266,000 cargo transportation companies,

847,000 self-employed freight transporters and 519 road freight transport cooperatives operate in the Brazilian market. Together, they comprise a fleet of 2.5 million cargo transport vehicles. This fleet is around 70% higher than that registered 15 years ago, which shows the growth in activity (CNT 2022). More than 60% of cargo transportation is done by self-employed truck drivers. On the other hand, cargo carriers find it difficult to find truck drivers and at the same time, these truck drivers cannot easily find the cargo they can transport with their type of truck. Using one or more cargo offer sites, the self-employed truck driver can earn up to 50% more (Terra 2015).

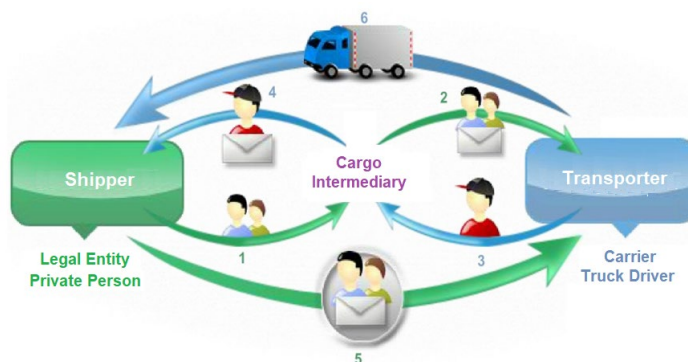


Figure 2. Shipper-Cargo Intermediary-Transporter Scheme (adapted from Parceiro do Frete 2017)

A study carried out in 2021 by the National Transport Confederation (CNT) shows that, on average, one in three return trips is made with empty cargo (CNT 2022), while 80% of self-employed drivers drive empty on the way back. In addition to wasting time, fuel, and revenue for the truck driver, these empty trucks represent a significant percentage of truck congestion and CO2 emissions, the main gas responsible for the greenhouse effect, causing damage to the entire population (Ghisolfi et al. 2022).

3. Methods

In an initial step, websites that offer free freight information were identified. This search resulted in a total of six websites: *FreteBrás* (www.fretebras.com.br), *Sontra* (www.sontracargo.com.br), *FreteNaMão* (www.fretenamao.com.br), *AcheCargas* (www.achecargas.com.br), *TruckPad* (www.truckpad.com.br), *TurboFretes* (www.turbofretes.com).

It should be noted that the search results show other online freight forwarders that: 1) require user registration with information regarding registration with the National Land Transport Agency (ANTT). The authors of this study do not have this working condition and, therefore, these websites were ignored; 2) some websites require the installation of an application on a smartphone. In these cases, it is common for the online freight forwarder to charge a fee (monthly/annual) for using the online cargo search functions. Given that these services are not free, these websites were also excluded from the proposed evaluation. After delimiting the research universe, the following was performed:

- a) the bibliographic survey for the theoretical foundation that makes up the previous section.
- b) the identification and analysis of websites.
- c) the definition and analysis of the criteria during the period from August/2019 to April/2020.
- d) and the application of the multicriteria model to evaluate the usability of online freight websites.

The definition of the criteria is based on the structure suggested by Leporini and Paternò (2003). It comprises effectiveness, efficiency, and satisfaction. The selection of the best online freight intermediary can then be formulated as a hierarchy, which is shown in Figure 3.

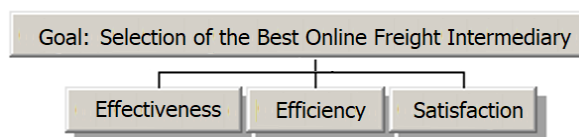


Figure 3. Hierarchy of the objective “Selection of the best online freight intermediary” and its criteria

The direct evaluation of these criteria is, however, hampered by the various dimensions that flow into their measurement. This difficulty can be overcome by defining sub-criteria that are simpler to measure and that can be properly configured for the objectives and the desired context. The definition and way of measuring the sub-criteria are presented in the next chapter, together with the application of the AHP method to the problem addressed in this work. The relative importance of each criterion in the composition of the order of preference of the alternatives (websites) must be initially defined. Given the difficulty of consulting a potential user (truck driver, for example) who was willing to take part in this experiment, the pairwise judgments required by the AHP method were defined by the authors to illustrate the development and potential of the proposed model. Thus, pairwise preference judgments were defined for the criteria in relation to the greater objective of selecting the best freight offer site. The weights are obtained by applying the AHP method, which converts preferences to pairs, along with the degrees of importance of the criteria in the composition of the final ordering of the alternatives. ExpertChoice[®] software was used to determine the weights, or degrees of importance, of each pairwise judgment matrix.

4. Data Collection

The criteria for evaluating the usability of the websites of online freight intermediaries can be hierarchically restructured into sub-criteria, whose measurement tends to be simpler than directly evaluating the alternatives through the criteria. To establish the degree of importance of each criterion in relation to the greater objective, the subjective scale proposed by Saaty (2005) was used to establish preferences pair by pair of criteria. Figure 4 shows the chosen values and weights that guide this work. The magnitude of the weights can be identified in the bars in blue on the identification of each criterion (Effectiveness: 0.625; Efficiency: 0.238; Satisfaction: 0.137).

Goal	Effectiveness	Efficiency	Satisfaction
Effectiveness		3,0	4,0
Efficiency			2,0
Satisfaction	Incon: 0,02		

Figure 4. Pair-to-pair judgments and weights of the criteria in relation to the goal

4.1 “Effectiveness” criterion

The “Effectiveness” criterion captures the importance of a user achieving their objective when visiting the website operated by the freight intermediary. As mentioned, freight websites aim to show potential carriers available freight offers. This must then decide to accept the offer considering the price and other conditions established by the shipper. The user's objective, when visiting the freight broker's website, is therefore to find the best freight offer available. Evaluating the effectiveness in achieving this objective implies defining those dimensions that influence different degrees of importance of this criterion. Eight dimensions (or sub-criteria) were considered to assess effectiveness: freight intermediary logo, the accuracy of the information, adequacy of language, presence of advertising, the volume of freight offers, the attractiveness of offers, availability of offers, and page layout. Figure 5 shows the hierarchy created to evaluate the effectiveness of freight websites.

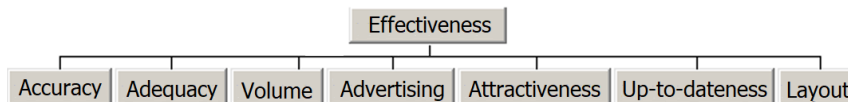


Figure 5. Hierarchy of the “Effectiveness” criterion

The author's subjective judgments considering the relative importance of each sub-criterion in relation to the other, for the “Effectiveness” criterion, are shown in Figure 6. Reciprocal values are shown in red. In the example, the sub-criterion “Accuracy” has an importance level of 5 in relation to the sub-criterion “Adaptation”. According to the scale proposed by Saaty, this value implies that for the user, “Accuracy” is strongly more important than “Adequacy”. “Volume” has a relative importance of 3 (in red) considering the sub-criterion “Adequacy”. This is a convention of the software used to show that “Volume” is slightly less important than “Adequacy” in the composition of the weights for the “Effectiveness” criterion.

Effectiveness	Accuracy	Adequacy	Volume	Advertising	Attractiveness	Up-to-dateness	Layout
Accuracy		5,0	3,0	7,0	4,0	2,0	6,0
Adequacy			3,0	3,0	2,0	4,0	2,0
Volume				5,0	2,0	2,0	4,0
Advertising					4,0	6,0	2,0
Attractiveness						3,0	3,0
Up-to-dateness							5,0
Layout	Incon: 0,02						

Figure 6. Pair-to-pair judgments of the sub-criteria in relation to the “Effectiveness” criterion

The “Accuracy” sub-criterion of the information was evaluated through sampling. Twenty random freight offers from each website were analyzed. In this analysis, errors in syntax and language and consistency of information regarding freight values, quantity and nature of cargo, and type of vehicle were verified. The evaluation of the websites according to this sub-criterion considered the number of errors/inconsistencies detected in the random sample. Considering that a smaller number of problems of this nature is preferred by the user, the order of preference according to this sub-criterion would be *FreteNaMão* > *FreteBrás* > *Sontra* > *AcheCargas* > *TurboFretes* > *TruckPad*. That is, the *FreteNaMão* website has the highest degree of accuracy considering the sampling test carried out and, therefore, is preferred over the others, considering only this sub-criterion (the symbol “>” is used to represent “strict preference”). The conversion of the preference order of the alternatives in relation to the “Accuracy” sub-criterion in the form of pairwise judgments follows the Saaty scale. The adopted values are shown in Figure 7.

The “Adequacy” sub-criterion seeks to capture characteristics of the language used on the website. Simple, intuitive, easy-to-understand language aimed at the typical user is desired. In this regard, all websites analyzed meet the desired conditions and, therefore, were valued with the same degree of importance, that is, the established order of preference consists of: *FreteNaMão* ~ *FreteBrás* ~ *Sontra* ~ *AcheCargas* ~ *TurboFretes* ~ *TruckPad*, where the symbol “~” indicates that elements to its left and right are “equally preferred”. Analogously to the previous sub-criterion, the peer-to-peer judgments follow the scale proposed by Saaty and are shown in Figure 7.

To evaluate the volume of freight offers, the average number of offers over the course of fifteen days was calculated. In this accounting for the “Volume” criterion, only valid freight was considered, that is, those offers whose loading date had not yet expired on the query date. The loading date is available information representing the latest date that the cargo can be loaded and transported. The pairwise preference judgments for this sub-criterion follow the directly measured values of order volume. That is 16,910 offers for the *FreteBrás* website, 332 for *TurboFretes*, 231 for *TruckPad*, 80 for *Sontra*, 20 for *FreteNaMão*, and 13 for *AcheCargas*. Pair-to-pair comparisons are, in this case, directly determined by the ratio of measurement values. The result is shown in Figure 7.

As it is a free service, most websites have advertising included. The measurement adopted was to count the number of ad frames per page. Only *Sontra* does not include ads, but it is the only website that requires registration from its users. The order of preference for this sub-criterion is inverse to the number of billboards. Thus, *Sontra* > *TurboFretes* ~ *TruckPad* > *FreteBrás* > *FreteNaMão* > *AcheCargas* is the established order of preference, as sites in this order have 0, 1, 1, 3, 4, and 10 advertisement frames, respectively. These values converted by the scale proposed by Saaty lead to the pairwise judgments shown in Figure 7.

“Attractiveness” is defined as the sub-criterion that captures the maximum length of time that a freight offer remains visible on the website. Offers that remain visible for a long period tend to be unattractive for transporters, indirectly indicating that the intermediary's technological platform is not visited frequently by transporters due to the lack of attractiveness of the website. The *FreteBrás* website has a high turnover with offers remaining for a maximum of one day, while *AcheCargas* offers to remain for up to two days. The *TruckPad*, *TurboFretes*, *Sontra*, and *FreteNaMão* sites have older offers of 3, 11, 20, and 180 days, respectively. Pair-to-pair comparisons of the alternatives in relation to this sub-criterion are shown in Figure 7. As they are directly measured values, the inconsistency of subjective judgments is null, as the measures are objective and free of subjectivity.

The “Up-to-dateness” sub-criterion aims to include in the evaluation the degree of updating that the freight offers present on each website. The measurement adopted for this item considers the length of time since the posting of the ten most recent offers observed on the page. Over a period of fifteen days, the average value of these ten durations was

calculated for each of the analyzed websites. *FreteBrás* presented a “timeliness” of 1 minute, while *FreteNaMão*, *Sontra*, *TurboFretes*, and *TruckPad* presented a performance of 2, 2, 3, and 15 hours respectively. The *AcheCargas* website does not provide this information. The assessment is objective and therefore free of subjectivity. However, in this case, one of the measured values does not exist (for the *AcheCargas* website). This uniqueness is circumvented by including pairwise comparisons that penalize the performance of this sub-criterion for the *AcheCargas* website. The values adopted are presented in Figure 7. As a result of this approach, the lack of values for a given alternative leads to a degree of inconsistency slightly above (0.12) that recommended by Saaty, that is, 0.10. This author recommends reviewing judgments paired with alternatives. However, it was not possible to determine judgments that provided a lower degree of inconsistency for the matrix.

The “Layout” sub-criterion indicates the adherence of the website's architecture to a model adopted as a site reference recommended by Memória (2005). The degree of adherence to the reference is measured by the number of items on the page to be evaluated that are arranged in the positions indicated by the reference page. The websites *FreteNaMão* and *Sontra* present 7 items adhering to the reference, while *FreteBrás*, *AcheCargas*, *TruckPad*, and *TurboFretes* present 6, 5, 4, and 4 items, respectively. Considering that objective measurement was used, the pairwise judgments of the alternatives (Figure 7) in relation to the “Layout” sub-criterion are consistent.

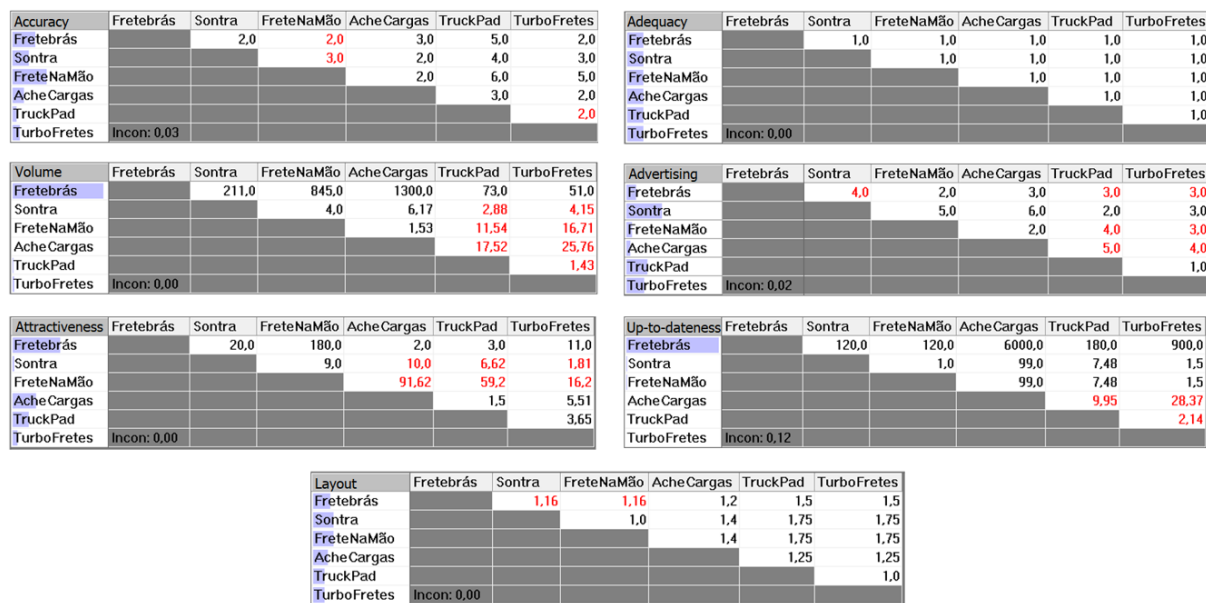


Figure 7. Pair-to-pair preferences of the alternatives for the sub-criteria “Accuracy”, “Adequacy”, “Volume”, “Advertising”, “Attractiveness”, “Up-to-dateness”, and “Layout” related to the Effectiveness criterion

4.2 “Efficiency” criterion

Finding the desired information faster shows that the website is designed to provide the user with facilities to achieve their goal. The “efficiency” criterion captures this intrinsic ability of the website. The lack of efficiency does not prevent the user from finding the desired information, but it will make the search longer and, therefore, less attractive to the user. To measure the “efficiency” criterion, some simplified measurement sub-criteria were defined. In this sense, five dimensions were considered: the degree of user-friendliness of the interface, the ease for the user to find help on the website itself if he needs it, the simplicity in navigating the website, the existence of filters that make it possible to restrict and focus the search for offers of more attractive freight rates and the existence of direct channels of communication with the freight intermediary in the form of email address, telephone, WhatsApp, etc. A detailed description of these sub-criteria is presented below. The proposed hierarchy is shown in Figure 8.

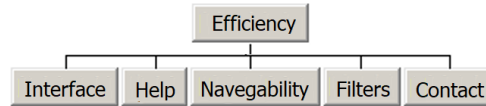


Figure 8. Hierarchy of the “Efficiency” criterion

As already mentioned for the “Effectiveness” criterion, the pairwise subjective judgments that give a relative importance to the sub-criteria in relation to the “efficiency” criterion were established by the author to exemplify the application of the proposed model. In a real application, these judgments should be informed by the user. Figure 9 presents the pairwise judgments used in the evaluation of the “efficiency” criterion based on the five considered sub-criteria. In establishing these preferences regarding the degree of importance of sub-criteria, the scale suggested by Saaty was used.

The “Interface” sub-criterion was considered much more important than the “Help” sub-criterion. Thus, according to Saaty, the value 6 should be assigned to this judgment pair-to-pair. The “Navegability” sub-criterion was considered slightly more important than the “Help” sub-criterion and, therefore, a factor of 3 (in red) was assigned to this judgment of relative importance between these two sub-criteria. The other judgments used are shown in Figure 9. The inconsistency assessed by the AHP method was only 3%, which is considered acceptable, as it is below 10% of the inconsistency observed in random matrices of comparisons of the same order.

A help option included on the website can be useful to speed up situations of failure due to the user's lack of knowledge regarding the use and content of the website. The “Help” sub-criterion makes it possible to assess whether the presence of frequently asked questions content - which can resolve doubts without the need for direct intervention by the freight intermediary, is sufficiently robust for this and/or the active presence of an online chat can be verified. “FreteBrás” stands out for presenting online chat as a quick return. “FreteNaMão” and “AcheCargas” also have this option, however, whenever accessed, they were offline, giving the possibility of submitting an online form. Only the Sontra website has frequently asked questions, but it is not updated and suggests contacting us by phone. Considering these observations, the following order of preference was defined for the “Help” sub-criterion: *FreteBrás > FreteNaMão ~ AcheCargas ~ Sontra > TurboFretes ~ TruckPad*. The pairwise judgments of the alternatives considering this order of preference are shown in Figure 10.

Efficiency	Interface	Help	Navegability	Filters	Contact
Interface		6,0	3,0	2,0	9,0
Help			3,0	4,0	2,0
Navegability				1,0	2,0
Filters					4,0
Contact	Incon: 0,03				

Figure 9. Pair-to-pair preferences of the sub-criteria in relation to the “Efficiency” criterion

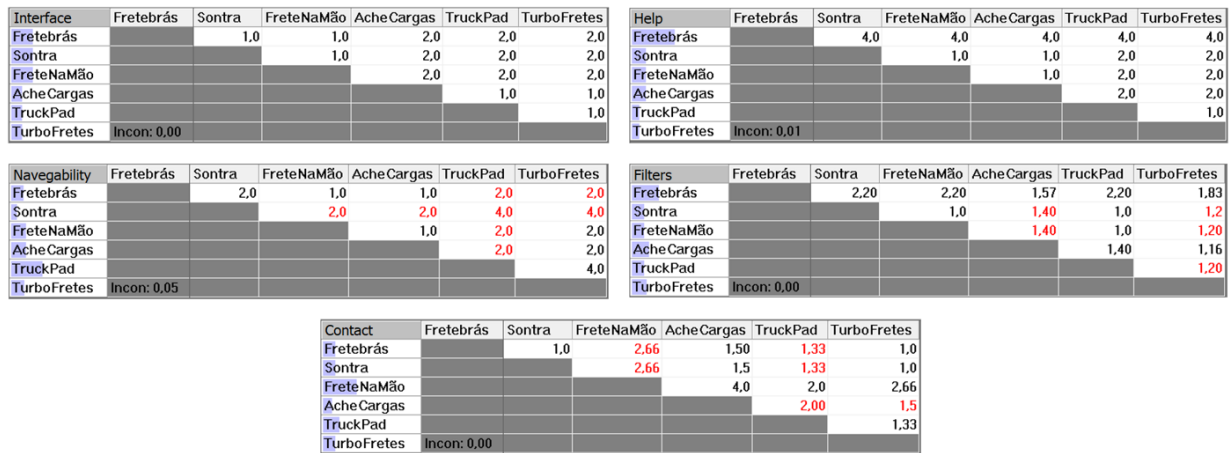


Figure 10. Pair-to-pair preferences of the alternatives for the sub-criteria “Interface”, “Help”, “Navegability”, “Filters”, and “Contact” in relation to the Efficiency criterion

The “Navegability” sub-criterion adds characteristics that indicate the agility with which the user can access the desired information. The evaluation of the websites according to this sub-criterion was carried out using a checklist with the following questions: a) the user can find freight in up to two clicks; b) contact information is clear and accessible; c) the website loads all the information quickly, without showing any errors; d) the website does not display unnecessary information, pop-ups, or other items that may interfere with page loading; e) the website has a mobile version that allows the user to access it through cell phones or tablets. The evaluation showed that only the Sontra website requires more than two clicks to reach the freight offer page, as this website requires the user to log in with their registration data. As for contact information, only two companies have this information in a clear and accessible way (Turbo Freight and TruckPad). All have a version suitable for mobile phones. According to these observations, the following order of preference was defined for the “Navegability” sub-criterion: $TurboFretes \sim TruckPad > FreteBrás \sim FreteNaMão \sim AcheCargas > Sontra$. This order of preference leads to pairwise judgments as shown in Figure 10.

The option to refine options during the search can be streamlined with the use of filters. The “Filters” sub-criterion allows for evaluating whether this option is present to refine the search regarding origins, destinations, distance, vehicle, tracker, agency, price, and complement. As a metric for this sub-criterion, it was decided to count the number of filters available on each website. The websites “FreteBrás”, “AcheCargas”, “TurboFretes”, “FreteNaMão”, “Sontra”, and “TruckPad” have respectively 11, 7, 6, 5, 5, and 5 filters. These direct and objective measures converted to pairwise judgments are shown in Figure 10. Since they are objective values, the inconsistency obtained by these judgments is null.

The “Contact” sub-criterion aims to capture the magnitude of the facilities that the user can count on if he makes use of freight intermediation services. The measurement adopted for this sub-criterion is the number of forms of contact available. The “FreteNaMão” website has 8 ways of contact (chat, Skype, WhatsApp, email, and four cellphone numbers from different operators), while “TruckPad” has 4 ways (email, telephone, WhatsApp, and form), online, phone, and email), “Sontra” also has 3 ways (email, WhatsApp, and phone) as well as “TurboFretes” (email, phone, and form), and “AcheCargas” only has two ways of contact (form and chat). The conversion of this scale leads to the pairwise judgments shown in Figure 10. Since they are objective values, the inconsistency of these judgments is null.”

5.2 Criterion: “Satisfaction”

The “Satisfaction” criterion, according to Leporini and Paternò (2003), should consider the friendly aspects of a website. Elements such as character fonts and colors, background colors, and possible sound elements can generate greater satisfaction when browsing a web page. Satisfaction can also be assessed by the comments that the website generates on social networks if the freight intermediary is present on these pages. Positive (or negative) impressions of users serve as a reference for the degree of satisfaction that shippers and carriers have concerning a given online freight platform. Carriers may consider the need to fill out a registration form to access the information contained on

the pages as an intrusion of privacy and, therefore, not feel fully satisfied with the service provided by the platform and, therefore, migrate to competing platforms.

In this work, the composition of the “Satisfaction” sub-criterion considers three dimensions: the existence of online freight intermediary links on social networks, the nature (type, color, size) of the used fonts, and the privacy conditions that the user is exposed to when using an online freight platform. The hierarchical structure of the “Satisfaction” criterion and its three sub-criteria and the pairwise judgments used in the evaluation of the “Satisfaction” criterion are shown in Figure 11. The sub-criteria “Social Networks” and “Privacy” were considered slightly more important than the sub-criterion “Fonts”, while “Privacy” was considered slightly less important than “Social Networks”.



Figure 11. Hierarchy of the “Satisfaction” criterion and pair-to-pair preferences of the sub-criteria

The “Social networks” sub-criterion makes it possible to assess the degree of receptivity of online freight services offered by carriers and shippers. Since the popularization of social networks, people have gone from mere passive recipients of information to opinion makers, and with that, influencing day-to-day trends. To assess the intensity of the “Social Networks” sub-criterion in the composition of the “Satisfaction” criterion, the number of social networks that each platform reports to be linked to was quantified. The websites “*Sontra*” and “*TruckPad*” are present in four networks (Facebook, Twitter, Youtube, and Google+), “*FrenteNaMão*” and “*AcheCargas*” are present in two networks (Facebook and Twitter) while “*FreteBrás*” is present in only one social network (Facebook). “*TurboFretes*” does not indicate on its page that it is present in any social network. The number of social networks was considered as a metric to be included in the peer-to-peer judgments, as shown in Figure 12. As “*TurboFretes*” is not present in any social network, a relatively high value was arbitrated for the high preference of others in relation to this website. The order of preference for establishing peer-to-peer judgments in relation to “Social Networks” is given by: *Sontra* > *TruckPad* > *FrenteNaMão* ~ *AcheCargas* > *FrenteNaMão* > *FreteBrás* > *TurboFretes*.

Providing an online service will not make sense if your audience does not understand or is not attracted to its content. According to Vasconcelos (2015), in 51% of the websites, sans-serif fonts (letters with straight corners) lead in the presence of titles (headlines) that tend to capture the user's attention; according to the same author, 61.5% of sites use serif typefaces (extensions at the ends of the letters) in the body text and that the contrast provided by a white background and black text is the most popular. The evaluation of freight websites according to this sub-criterion was subjective. Except for the “*AcheCargas*” website, which has small fonts, all the others were evaluated as very good, with appropriate size and contrast. Thus, the order of preference that supports the establishment of the pairwise judgments necessary for the application of the AHP method is the following: *TurboFretes* ~ *TruckPad* ~ *FreteBrás* ~ *FrenteNaMão* ~ *AcheCargas* > *Sontra*. Figure 12 shows the pairwise judgments derived from this order of preference.

The “Privacy” sub-criterion seeks to assess whether the user needs to include their personal data to use the services of an online freight platform. Only the *Sontra* website requires registration, but this can be linked to the Facebook or Google+ login. Considering that preserved privacy is preferred, the order of preference for establishing peer-to-peer judgments is given by: *TurboFretes* ~ *TruckPad* ~ *FreteBrás* ~ *FrenteNaMão* ~ *AcheCargas* > *Sontra*. The pairwise judgments and the importance of the alternatives in relation to “Privacy” are presented in Figure 12.

Social Networks	FreteBrás	Sontra	FreteNaMão	AcheCargas	TruckPad	TurboFretes
FreteBrás		4.0	2.0	2.0	4.0	9.0
Sontra			2.0	2.0	1.0	20.0
FreteNaMão				1.0	2.0	20.0
AcheCargas					2.0	20.0
TruckPad						9.0
TurboFretes	Incon: 0.04					

Fonts	FreteBrás	Sontra	FreteNaMão	AcheCargas	TruckPad	TurboFretes
FreteBrás		1.0	1.0	2.0	1.0	1.0
Sontra			1.0	2.0	1.0	1.0
FreteNaMão				2.0	1.0	1.0
AcheCargas					2.0	2.0
TruckPad						1.0
TurboFretes	Incon: 0.00					

Privacy	FreteBrás	Sontra	FreteNaMão	AcheCargas	TruckPad	TurboFretes
FreteBrás		2.0	1.0	1.0	1.0	1.0
Sontra			2.0	2.0	2.0	2.0
FreteNaMão				1.0	1.0	1.0
AcheCargas					1.0	1.0
TruckPad						1.0
TurboFretes	Incon: 0.00					

Figure 12. Pair-to-pair preferences of the alternatives for the sub-criteria “Social Networks”, “Fonts”, and “Privacy”

5.4 Results of the relative importance of alternatives, sub-criteria, and criteria

The final hierarchical structure constituted for the purpose of this work, with all its levels and elements, is presented in Figure 13. This structure comprises four levels: the upper level that establishes the objective of the order of preference for the alternatives that are located at the lowest level of the hierarchy. Intermediate levels include the criteria and sub-criteria, from top to bottom, respectively.

Once the pairwise judgments of the alternatives have been defined in relation to the sub-criteria immediately above in the proposed hierarchy, as well as the pairwise judgments of the sub-criteria in relation to the criteria and of these in relation to the greater objective, it is finally possible to determine the weights, or degrees of importance, of each element of a level lower than its level immediately above. Finally, by composing these weights in a multiplicative way, the ranking of alternatives in relation to the main objective is determined.

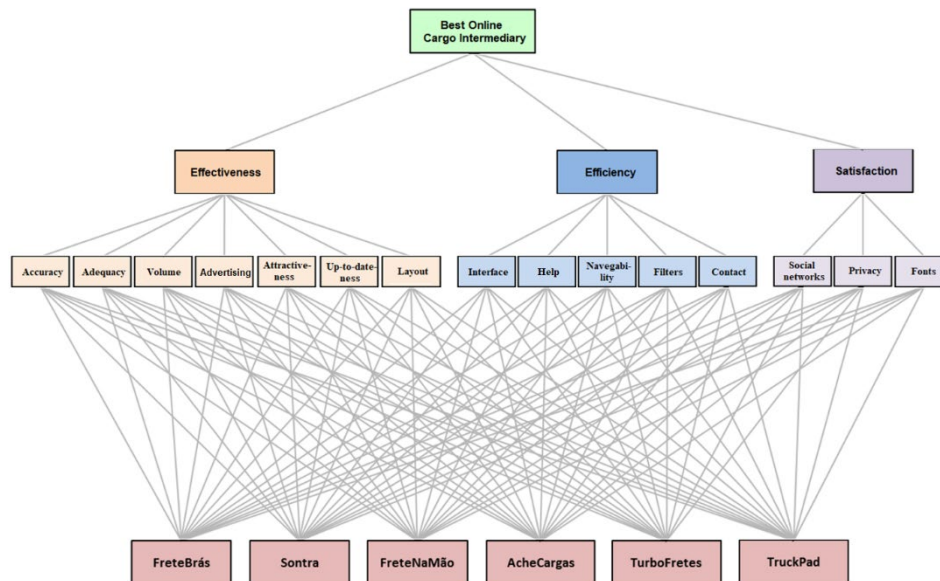


Figure 13. Hierarchical structure with criteria, sub-criteria, and alternatives

The results of the relative importance of the alternatives, sub-criteria in relation to the criteria, and these in relation to the major criterion are shown in Figure 14. These results were obtained considering the user with preferences established by objective and subjective judgments pair by pair, according to what was presented in this research.

The website “FreteBrás” is the most preferred with 41.4% of the degree of relative importance followed by the site “FreteNaMão” with 16.4%. These results show the dominance of “FreteBrás” over the others, for the set of established preferences. The hierarchical structure of Figure 14 shows the local importance (denoted by L) of each sub-criterion in the composition of its respective criteria and of this in relation to the major criterion. The overall importance (denoted

by G) of each criterion and sub-criteria indicates their importance in relation to the major criterion. It is observed that the most relevant criterion is “Effectiveness” with 62.5% of influence in establishing the order of preference of alternatives. Among the sub-criteria, “Accuracy” contributes 22.1% in the composition of this order of preference, therefore being the most important sub-criterion for the user.

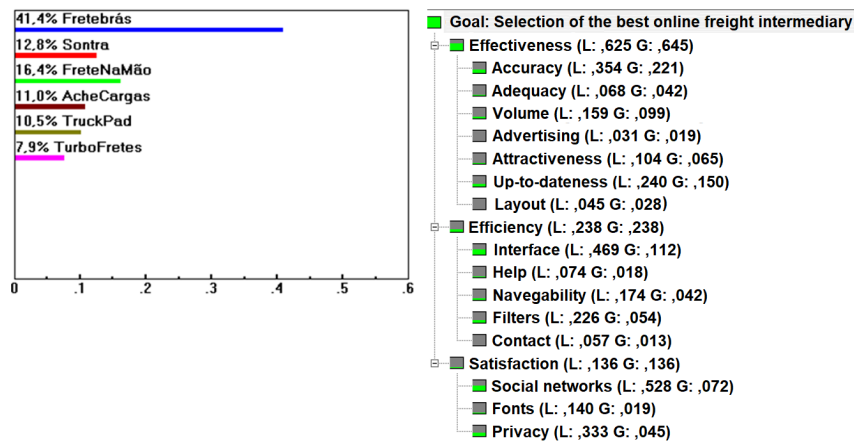


Figure 14. Relative importance of alternatives, sub-criteria, and criteria

The ExpertChoice[®] software used to carry out this study presents a series of options for graphical reports, which allow the qualitative assessment of the assertiveness of the pairwise judgments, promoting sensitivity analysis with the variation in these judgments and, thus, reassessing them in case of doubt or lack of consistency. Figure 15 shows the contribution of each criterion in the final ranking of alternatives. It is observed that for the “Satisfaction” criterion, the best-positioned site (FreteBrás) is in the penultimate place. This is mainly due to the lack of links between this site and social networks, as shown by the peer-to-peer judgments in Figure 15. The dominance of the “FreteBrás” website is mainly dictated by its better use in the “Effectiveness” criterion and, more specifically, in the “Volume” sub-criteria “Up-to-dateness” and “Attractiveness”.

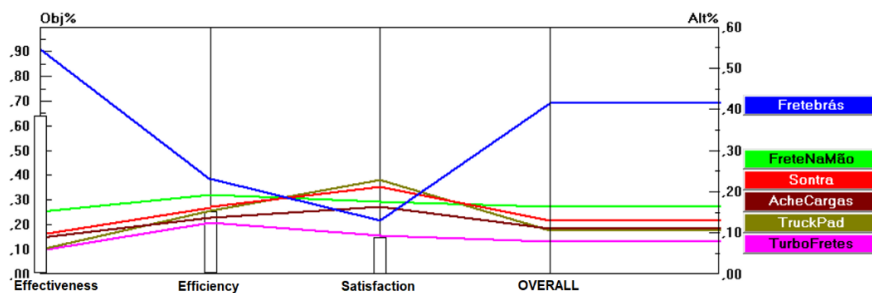


Figure 15. Preference variation of websites considering the adopted criteria

6. Conclusion

The objective of this work was to propose a multi-criteria model for assessing the usability of road freight websites freely available on the Internet using the AHP method. The model establishes a set of criteria and relevant sub-criteria for the context of the studied problem. These criteria allow the evaluation of these sites using both objective and subjective metrics, which are possible to be incorporated into the model because the AHP method can support subjective judgments, according to a scale suggested by the developer of the method, which has been widely used in recent decades.

Results show the viability of the model in the sense of allowing, in a relatively simple way, to select the best online freight intermediary. The flexibility of the *Expert Choice* software allows you to any user to establish their individual preferences for peer-to-peer judgments, thereby inducing custom ranking solutions.

Considering that information technology is continuously subjected to technological advances with new features, especially in the evolution of smartphones and applications, the set of criteria and sub-criteria should also be continually reassessed so that the proposed multicriteria model incorporates technology evolution.

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