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Usability study applied to the Brazilian Infraestrutura Nacional de Dados Espacias (INDE-BR) geoportal considering the role of stakeholders

Estudo de usabilidade aplicado no geoportal da Infraestrutura Nacional de dados Espaciais (NSDI) considerando a função dos stakeholder

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Abstract: The Brazilian National Spatial Data Infrastructure (INDE-BR) was established to coordinate geoinformation users, producers and regulators, referred to as stakeholders or interested parts. This research focuses on the relationship between performance and cognitive workload with the players' role in the INDE-BR, exploring usability problems related to access to data and metadata in the geoportal. The stakeholders were characterised as data users (U), data users and producers (UP), or data users, producers and providers (UPP). The methodology applied was the unmoderated questionnaire, divided into open and closed questions that enabled qualitative and quantitative data collection. The NASA Task Load Index (NASA-TLX) was applied to evaluate the participant's workload. It was noticeable that the individuals in group U presented a higher workload than the other stakeholders. This study made it possible to infer a relationship between performance on tasks involving data use with workload and usability problems related to data access. The study contributes evidence from usability tests with users who interacted with the INDE-BR geoportal, showing a strong relationship with the stakeholder's role. The usability varied widely among the user profiles, indicating that the geoportal interface needs improvements or proper interfaces built from user-centred design concepts to meet each group's specific needs better.
Keywords: SDI. Data. Geospatial. Tests. Users.

Resumo: A Infraestrutura Nacional de Dados Espaciais (INDE), foi estabelecida para a coordenaçãode usuários, produtores e reguladores do uso de geoinformação, denominados partes interessadas ou *stakeholders*. Este trabalho está concentrado na relação entre o desempenho e a carga de trabalho cognitiva com a função que o desempenha na INDE, explorando problemas de usabilidade relacionados com o acesso aos dados e metadados no geoportal. Os *stakeholders* foram caracterizados como usuários de dados (U), usuários e produtores de dados (UP), ou usuários, produtores e provedores de dados (UPP). A metodologia aplicada foi o questionário não moderado, dividido em perguntas do tipo abertas e fechadas que possibilitou a coleta de dados qualitativos e quantitativos. Para avaliação da carga de trabalho foi aplicado o Nasa Task Load Index (NASA-TLX). Foi perceptível que os indivíduos do grupo U apresentaram maior carga de trabalho em relação aos demais *stakeholders*. Este estudo possibilitou inferir que existe relação entre o desempenho nas tarefas que envolveram a utilização dos dados com a carga de trabalho e problemas de usabilidade relacionados ao acesso aos dados. O estudo contribui com evidências advindas de testes de usabilidade com usuários que interagiram com o geoportal da INDE, demonstrando que existe forte relação com a função que o *stakeholder* desempenha na INDE. A usabilidade variou bastante entre os perfis de usuário, sendo um indicativo que a interface do geoportal necessita de aperfeiçoamentos ou interfaces próprias construídas a partir dos conceitos do Design Centrado no Usuário, para melhor atender às necessidades específicas de cada grupo.
Palavras-chave: IDE. Dados. Geoespaciais. Testes. Usuários.

1 INTRODUCTION

The term Spatial Data Infrastructure (SDI) emerged in 1993 when the North American Research Council (US National Research Council) realised that there was a need to have broad and standardised access to geographic information (MAGUIRE, 2005; FILHO et al., 2013). The SDI is generated through the coordination of users, producers and regulators to meet the users' needs and facilitate access to data and metadata (CAMBOIM; SLUTER, 2013; JESUS et al., 2018; FRONZA; CAMBOIM, 2020). Therefore, facilitating access and interaction between stakeholders is a fundamental aspect of the concept of SDI (RAJABIFARD; WILLIAMSON, 2001).

The evolution of IDEs can be classified into three generations: the first is a data-centred model, the change marked the second generation from a data-centred model to a process-oriented model, and the third generation has a user-centred model. (BORBA et al., 2015; DEVAUX; BARBOSA, 2020). Therefore, it is established as an essential issue in the Brazilian National Spatial Data Infrastructure (INDE-BR), an effort to facilitate access to data by the users (CAMBOIM; SLUTER, 2013). Furthermore, according to Devaux and Barbosa (2020), an SDI is expected to be conceived considering users' participation, ensuring that national initiatives align with the world state of the art and with recent technological developments.

In Brazil, the NSDI (INDE-BR) was created through Decree No. 6,666 of November 2008 and defined the CONCAR (National Cartography Commission) as the regulatory entity (CAMBOIM; SLUTER, 2013). Data published on the INDE-BR geoportal aim to meet the transparency and accessibility requirements for open government data, guaranteed by the Access to Information Law (Law nº 12.527), published on November 18, 2011. A National Spatial Data Infrastructure(NSDI) such as INDE-BR is "a dynamic network composed of people, data, policies, standards and technologies for improved use of space data and services within the country's jurisdiction" (GRUS; BREGT; CROMPVOETS, 2006).

To evaluate access to data in the Data Visualizer of the National Spatial Data Infrastructure (VINDE), Araújo, Campos and Costa (2017) found problems in the organisation and arrangement of visualisation elements. Jesus et al. (2018) performed usability tests on the IDE-Bahia portal and found that numerous features need to be adjusted, concluding that the IDE has problems making standardised data available to users in a way that satisfies and meets the users' needs. Human-centred interactive systems design is an approach that aims to make systems usable by focusing on the needs of users (ISO 9241-210, 2010).

Usability evaluations, especially in cartographic interfaces, should consider the technological use context, investigating the effectiveness, efficiency and user satisfaction (ROTH et al., 2017). For example, Bartling et al. (2019) combined qualitative research using a verbal protocol with eye-tracking on mobile map users while performing a set of tasks. Lima et al. (2021) evaluated different access platforms, applying a questionnaire to users of a digital map. Kuparinen (2016) applied usage tasks in mobile maps, employing usability heuristics.

In the context of IDEs, a usability and cognitive workload evaluation was performed by Gkonos, Enescu and Hurni (2018) in comparing two versions of the Swiss geoportal by performing a comparison between both versions. According to Kalantari et al. (2020), there are gaps in knowledge regarding data and metadata access by end-users who use geoservices. In the study by Calderón, Campoverde and Hoehne (2014), the usability of the geoportal used in Spain was evaluated, concluding that developers are often more concerned with the functionality and implementation of the system, giving the user an unimportant role in this process. For Roth (2015), the user is often not included in cartographic studies, at least not representing users in their entirety. Finally, Araújo, Campos and Costa (2017) studied aspects of workload and usability but did not consider stakeholders with different roles in INDE-BR.

Research on SDIs still contains significant gaps, such as the access and use of metadata, considering its efficiency and effectiveness, especially for end-users (MAQUIL et al., 2018). SDIs become accessible through geoportals. However, their interface design does not usually meet the needs of different user profiles, which leads to underutilisation by users (ESTER; ANGEL; LEON, 2017).

SDI geoportals must provide users with robust and easy-to-use interfaces. Although. Henzen (2018) identified several usability problems in geoportals of different SDIs. The authors highlight the lack of methods to evidence and document these problems and present effective solutions. Furthermore, SDIs have an

interdisciplinary nature, influencing the value derived from their use by different groups of people (ZWIROWICZ; MICHALIK, 2016). Therefore, the SDI theme needs to be better studied, considering the different roles of the actors involved in the use, production and dissemination of spatial data and metadata.

This research aims to understand the relationship between usability and stakeholders' cognitive workload when interacting with metadata in the INDE-BR portal. This study bases itself on the assumption that there is a relationship between usability problems, cognitive load and time demand, in the access and interaction with the INDE-BR geoportal, due to the stakeholder's role in the INDE-BR. Therefore, the objective was to conduct a usability assessment of the INDE-BR geoportal, investigating access to data and metadata, to consider the cognitive workload concerning the user group to which the stakeholder belongs.

1.1 Literature review

The International Cartographic Association (ICA) has proposed and implemented a model to describe SDI, regardless of the technology used or the form of implementation, employing the concept defined as the Reference Model for Open Distributed Processing (RM-ODP) (HJELMAGER et al., 2008). The RM-ODP proposes using five points of view: Business, Information, Computing, Engineering and Technology. Using points of view allows the system specification in smaller models, where each point of view answers relevant questions for different system users (OLIVEIRA et al., 2016; COOPER et al., 2019).

The INDE-BR aims to organise the generation, storage, access, sharing, dissemination and use of geospatial data with the most diverse origins. Thus, it facilitates disseminating and accessing data and metadata for various stakeholders (CAMBOIM; SLUTER, 2013; ARAÚJO; CAMPOS; COSTA, 2017). It also allows access to and sharing of data standardised among different stakeholders (COOPER et al., 2019).

Under the now-extinct CONCAR, an Action Plan structured the INDE-BR, which had the participation of several institutional actors. This document defined the five INDE-BR components: data, people, institutions, technology and finally, the norms and standards (CONCAR, 2010). Stakeholders can act by making the data available, producing the data or using the data. According to Cooper et al. (2019), technological changes and different applications or purposes can cause changes in the number of stakeholders interacting with different SDIs.

Stakeholders in the public services, private companies, academic sectors and society play different roles, specialities and functions. Therefore, according to Williamson, Rajabifard and Feeney (2003), an SDI must be conceived with the main focus on the people component, where users determine what data will be required and what functionality the IDE must provide. Table 1 presents stakeholders' roles, functions, and a brief description.

Table 1 – Different roles of the Stakeholders of an SDI.

Role	Function	Description
Data user	Experts and common users.	Users who consume the data and services provided by the IDE for various purposes can explore the functions of visualisation, manipulation and transformation of data.
Data producer	Collaborative, academic, professional and official.	It can be assigned to an individual, group or institution. The function of adding new products (data and services). Official: An organisation with the budget, resources and legal attribution to produce topographical, cadastral, and hydrographic data, among others. Individual or organisation produces data and products as part of their activities.
Provider (data, services)	Collaborative, academic, professional and official.	

Source: Adapted from Silva and Camboim (2021).

Issues related to INDE-BR, such as awareness, capacity building, collaboration, knowledge transfer and data sharing, have to do with political and social factors, as the variety of actors and the intensity of the interactions carried out by them make the SDI a complex system (SILVA and CAMBOIM, 2021). Different stakeholders have different levels of knowledge and skills due to the diversity of agents and institutions that work in INDE-BR. In scenarios where producers can also be consumers or even providers of spatial data, well-structured systems are vital to guarantee that their users succeed in processes involving access and sharing spatial data. Therefore, the geoportal interface must be suitable for the different audiences interacting with their respective functionalities.

1.2 Usability tests

Researchers can apply different methods for the practical application of usability evaluation in interfaces (PUGLIESI et al., 2013). Each method is used individually or in combination with others according to the methodological approach used and which aspects will be studied. The most used ones in usability evaluations are interviews, questionnaires, user observation, think aloud, and heuristic evaluation. In addition, tests can be moderated, corresponding to the more traditional type of test, or unmoderated. The moderator is responsible for guiding the user through the test script.

The term usability can be defined as: "The ability of software to be understood, learned, operated and to become attractive to users when used under specific conditions" (ISO 9241-11, 2018). According to Bevan (1995), usability confers the ease users learn to use a given system, with the efficiency concerning the system's potential to offer practical solutions. Therefore, the ISO 9241-11 (2018) standard establishes that usability should preferably be measured according to three distinct and uncorrelated aspects: effectiveness, efficiency and satisfaction.

a) Effectiveness: corresponds to the accuracy users achieve when interacting with the system, such as the level of success in tasks and challenges;

b) Efficiency: lists resources spent, through indicators, such as time or mental and physical efforts;

c) Satisfaction: is associated with the users' pleasure in interacting with the interface and their positive attitudes related to the system use.

Usability is considered one of the most important quality factors for new technologies. Its assessment techniques can involve expert users, who usually perform more usual and essential tasks in the system, usually numbering the problems and classifying them by degree of severity (KARAMPANAH, 2019; KOMARKOVA et al., 2019; HARLEY et al., 2019; BARTLING et al., 2019; SAARE et al., 2020). Although another way to assess usability is to involve non-expert users, the comparison between efficiency and effectiveness through the application of tests with non-expert users and the evaluation with experts, carried out by Tan, Liu and Bishu (2009), showed that both methods are complementary, making it possible to address different usability problems.

1.3 Methods used in usability assessment

Usability assessments can employ and combine different methods. For example, tests can be moderated, corresponding to the traditional type of test, or unmoderated tests (PUGLIESI et al., 2013; HERTZUM; BORLUND; KRISTOFFERSEN, 2015). Unmoderated usability tests correspond to tests remotely through tools that help the user perform tasks without the presence of the moderator. For instance, the Unmoderated Remote Usability Test (URUT) is a form used to overcome the disadvantages of moderate usability tests, as the physical presence of the moderator can be considered intrusive and even influence user responses (SCHIRRA; ALLISON, 2018).

Usability tests with users usually involve usage tasks which allow the researcher to identify possible difficulties in using the product. The methodology for evaluating usability can be qualitative, which involves interpretation and observation during the tests, looking forward to obtaining the impressions, sensations, preferences of use and subtle changes in the mood of the participants during the dialogues established in the

monitoring of use. To measure the magnitude of usability problems, however, one can resort to methods with numerical scales, classified as quantitative methods.

In the literature, there are several methods used to measure usability quantitatively, such as the psychometric response scale, with an emphasis on the Likert scale (COOPER; HARPER, 1969; REID; NYGREN, 1988; COLEMAN, 1993; HARPER; NORMAN, 1993; NIELSEN, 1993; SAURO; ZAROLIA, 2015). Another example is the Nasa Task Load Index (NASA-TLX) method, a subjective multidimensional assessment tool widely used to measure cognitive workload (HART; STAVELAND, 1988). Since task completion rates, task times, and "yes or no" are collected frequently, most data is numerical, allowing for statistical analysis.

2 METHODOLOGY

The method used was the unmoderated questionnaire, divided into open and closed questions, to analyse the stakeholders' differences in usability and workload when accessing and interacting with the geoportal of the NSDI-BR. In addition, the NASA Task Load Index (NASA-TLX) application enabled the workload analysis. It is a subjective multidimensional assessment tool widely used to classify the perceived workload when performing a practical task (HART; STAVELAND, 1988).

Stakeholders were contacted through social networks, especially messaging applications such as WhatsApp and e-mail. The participants' contact information was obtained through internet searching, official websites and WhatsApp groups, targeting people who had some connection with the INDE-BR. Examples of such users would be professionals working at the Brazilian Institute of Geography and Statistics (IBGE), researchers from academic institutions and other professionals working in the labour market who use and produce geospatial data.

The users received an invitation containing a link to a form containing a list of available tasks. Initially, information related to "Characterisation of users" was collected, questioning the participants regarding their interest or role concerning INDE-BR, degree of education, formation field, ethnicity, gender, age and device used to perform the test. Data containing stakeholder characteristics made it possible to investigate the association between the respective characteristics of the different actors involved in an SDI.

After characterising the stakeholders, the participants performed the interaction tasks with the INDE-BR geoportal. In the intervals between the tasks, the participants evaluated the subjective workload perceived during the solution of the task. Three tasks were designed to assess the interaction of stakeholders with the INDE-BR geoportal. The tasks stimulated access to the visualisation and data and the download of the data and metadata. As the tasks:

1) Access the "Metadata catalogue" and search for "hydrography in the Atlantic Forest biome".
2) Access the "Geoservices Catalog" and search for the "CPRM - Geological Service of Brazil".
3) Download the vector file in shapefile format corresponding to the "Geological map of Brazil to the millionth".

The possible results assigned to the tasks were limited to "yes" for success and "no" for failure, aiming to collect data on effectiveness. After completing the tasks, information regarding the start and end times of the test was collected. Finally, the test participants were asked to describe their opinion discursively, reporting their impressions, sensations and preferences when using the INDE-BR geoportal, producing information related to the satisfaction of the interested parties that complemented the results of the test. As it involves research with human beings, the project and its annexes were registered with the National Council of Ethics in Research of the University Federal of Paraná (UFPR), under number 30755920.0.0000.0102. According to resolution 466/2012 of the National Health Council, which indicates in its article V that all research with human beings involves risks in different types of gradation, so to minimise these risks, ethical analysis is essential.

2.1 Data Processing

The data were analysed using software such as Excel and RStudio, which have resources for

programming and formatting statistical calculations and graphical representations. The stakeholder characterisation data was submitted to a Multiple Correspondence Analysis (MCA) in RStudio software. According to Kluger (2018), the MCA can be used in categorical (non-metric) variables, such as qualitative variables, making it possible to investigate whether they are associated. The results are tabulated, forming rows and columns that, in a cross-over, help to identify similarities and differences in the variables' behaviour and categories. The packages "FactoMineR", "factoextra" and "ggrepel" were used. MCA is an extension of principal component analysis (PCA) but for categorical data (ABDI; WILLIAMS; VALENTIN, 2013)

The effectiveness measurement was the success or failure in accomplishing the tasks. Efficiency, associated with the interactions' execution time, was represented by bar graphs generated using Excel. The data obtained using the NASA-TLX questionnaire to assess the workload were formatted and analysed in the RStudio software. It offers several graphing options for data visualisation using several packages, including the Likert scale, using the "'likert" and "jbryer" packages that made it possible to compare the workload among the stakeholders.

As a final part of the usability test, users were asked to answer an open-ended question with no word limit. The question mainly addressed considerations about the tasks performed, asking the personal opinion of stakeholders after interacting with the INDE-BR geoportal. From these answers, it was possible to obtain results that demonstrate user satisfaction, in addition to complementing the usability assessment, with points of view related to problems that were identified and described by more detailed answers, which would allow the use of a larger number of words. which increased the richness in the details.

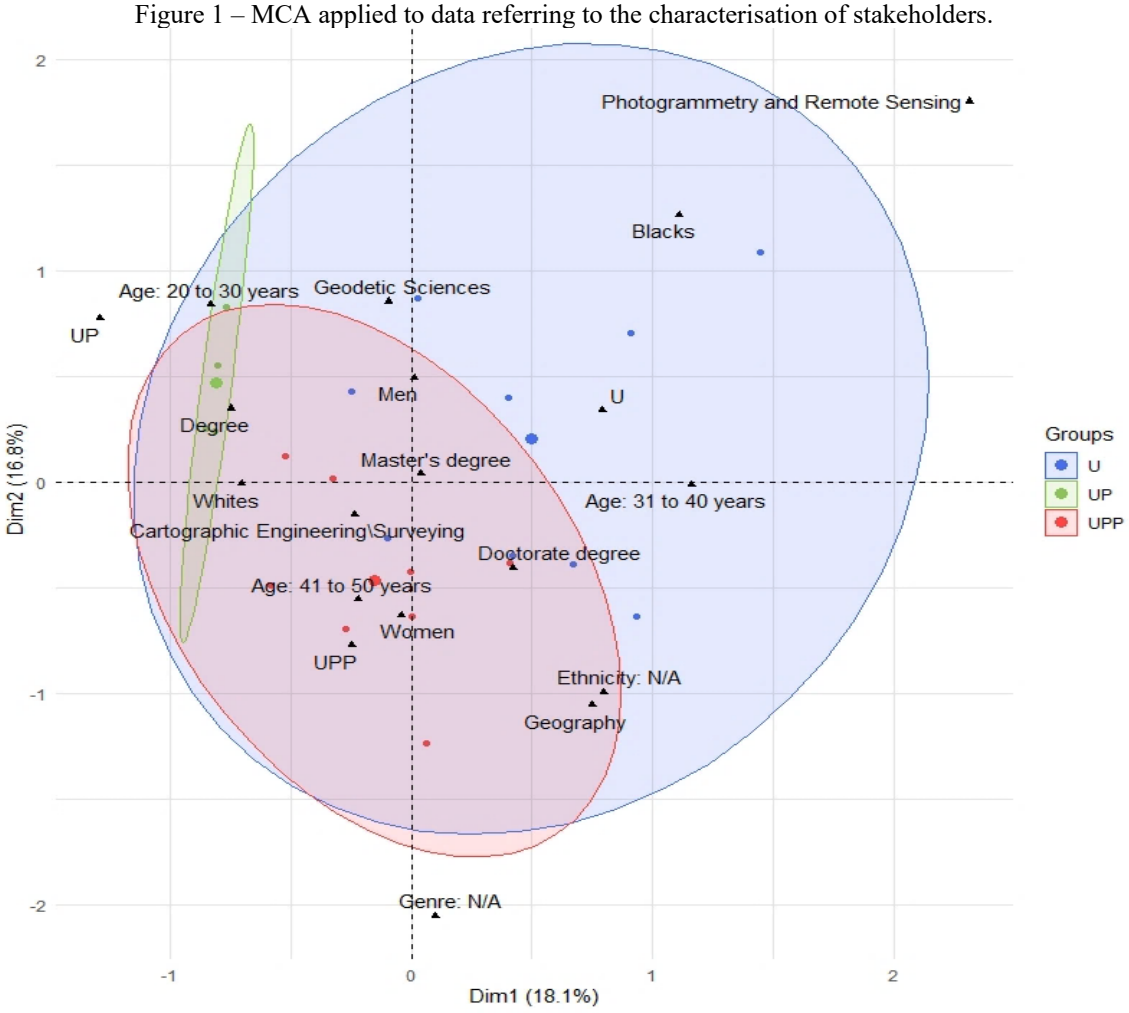
3 RESULTS AND DISCUSSION

The stakeholders who joined the study had more than one role or function concerning the INDE-BR. For this reason, there was a different set of questions according to the user's role. The questionnaire, therefore, seeks to raise the group's needs, not those of the individual user. As a result, stakeholders were classified as Data User (U), Data Users and Producers (UP) and Data Producer Users and Providers (UPP).

All participants responded to the Informed Consent Form (ICF). They agreed to participate in the research voluntarily, and there was a generalised compilation of the data. In this study, 26 volunteers participated. The first five tests were pilots aimed at improving the methodology and were therefore discarded. There were responses from 21 volunteers thus included and analysed. The predominant training of the volunteers was in the area of Cartographic Engineering\Surveying, corresponding to 70% (15 participants), professionals with training in Geodetic Sciences 15% (3 participants), Geography 10% (2 participants) and Photogrammetry and Remote Sensing also participated 10% (1 participant).

The level of training of these professionals corresponded to graduation 14% (3 participants), master's 67% (14 participants) and doctorate 19% (4 participants). The gender identity of the volunteers corresponds to male 62% (13 participants), female 33% (7 participants) and 5% (1 participant) preferred not to self-identify. Regarding the ethnicity of the volunteers, 57% (12 participants) declared themselves white, 19% (4 participants) were black, and 24% (5 participants) preferred not to inform. The device used to access the INDE-BR geoportal and perform the tests was the mobile device 38% (8 participants) and the desktop 62% (13 participants). Stakeholders had the U functions corresponding to 43% (9 participants), UP equivalent to 19% (4 participants) and the UPP corresponding to 38% (8 participants). Figure 1 demonstrates the results of exploring the relationships of categorical variables related to the characterisation of stakeholders.

Figure 1 – MCA applied to data referring to the characterisation of stakeholders.

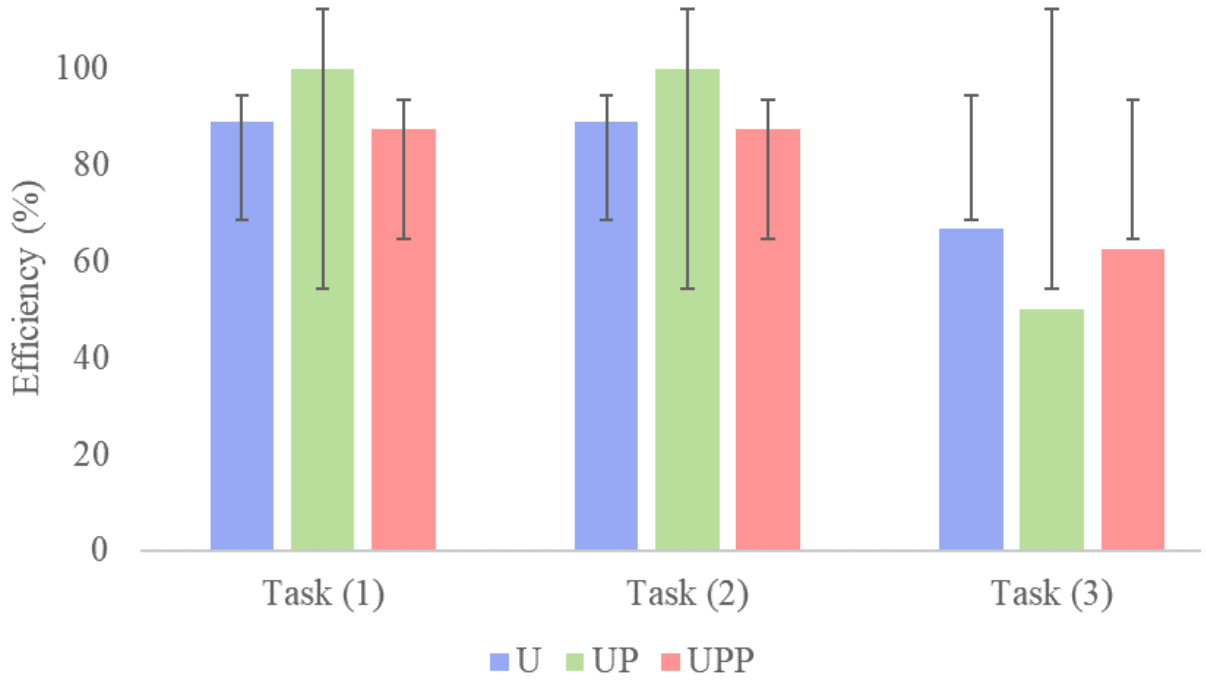


Source: The authors (2022).

Figure 1 made it possible to identify groups of individuals with a similar profile in their answers, the first axis (Dim 1) is the most relevant dimension, the second axis (Dim 2) is the second most important, and points closer tend to establish a more significant correlation. Points near the graph's origin have greater relevance for their respective component. Points that align or are close to the axes tend to have similar profiles. For example, most participants with an undergraduate degree were people with a Cartographic and Engineering Surveying background.

The blue ellipse corresponds to group U and gathers most of the characteristics of the sample set. This group showed a strong correlation between the stakeholders' responses, except for professionals with PhDs and people with a degree in Geography. The green ellipse represents the UP group and has a smaller scope, with the strongest correlations associated with white graduated people. In general, they are women aged between 20 and 30 years. The highest correlations of stakeholders corresponding to the U blue ellipse and UPP red ellipse correspond to white people with a doctorate, masters and undergraduate degrees. Most of them are women with a background in Cartographic or Engineering Surveying and Geodetic Sciences, aged between 31 and 40 years old, and people aged 41 and 50. After the characterisation of the stakeholders, the participants received the guidelines and then performed tasks to evaluate the access, visualisation and download of the data in the INDE-BR portal. The task outcomes are given in Figure 2.

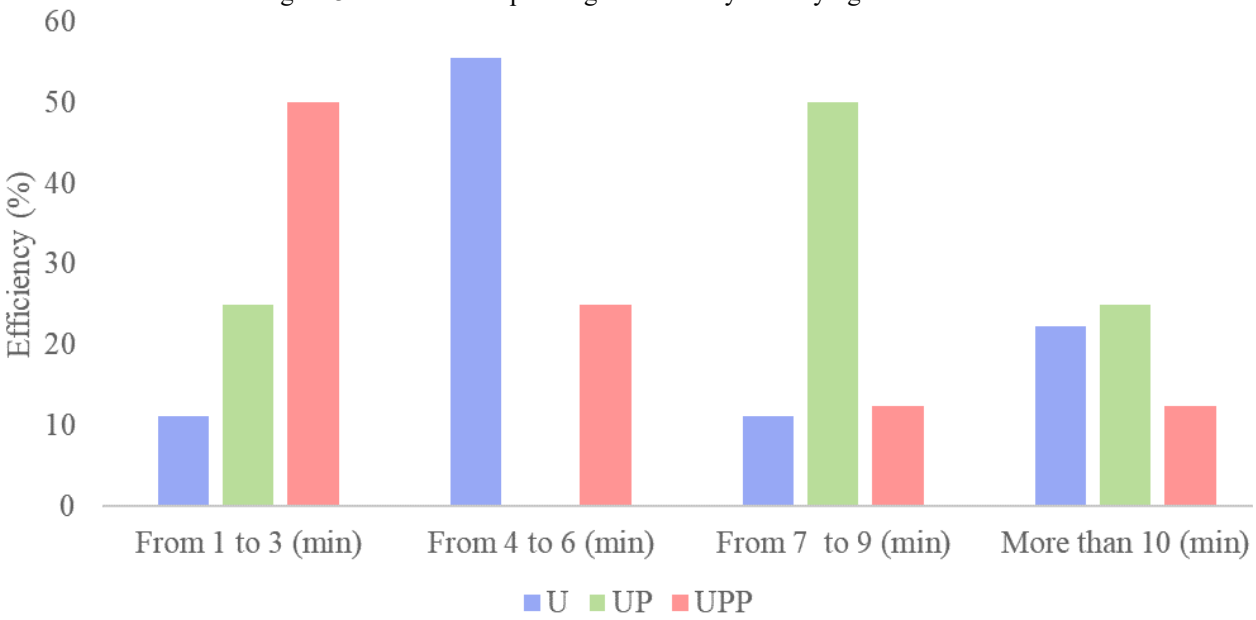
Figure 2 – Result corresponding to the efficiency in carrying out the tasks.



Source: The authors (2022).

According to the results of the tasks presented in Figure 2, it is possible to observe similar effectiveness in tasks 1 and 2, with a higher success rate and higher standard deviation attributed to the UPs. In contrast, in tasks 1 and 2, the U and the UPP groups showed less effectiveness in carrying out the tasks than the UP ones. The participant's performance in task 3 was lower than in the other tasks. In task 3, the lowest rate of effectiveness and the highest standard deviation belonged to the UP group. The U group showed greater efficiency and lower standard deviation than the other stakeholders who performed the test. Figure 3 contains results referring to efficiency, which was related to the time counted in minutes attributed to carrying out the tasks.

Figure 3 - Result corresponding to efficiency in carrying out tasks

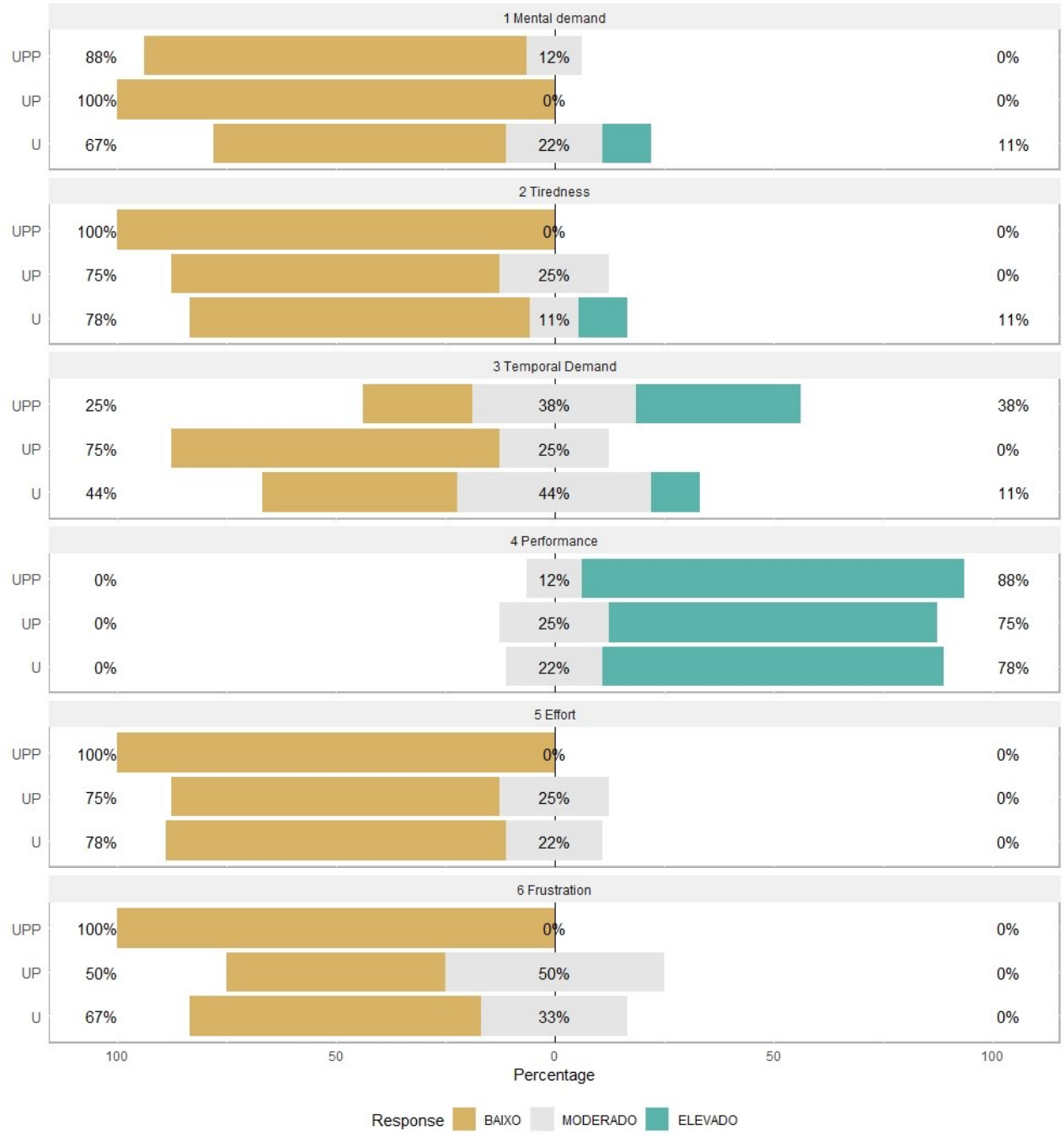


Source: The authors (2022).

According to the results shown in Figure 3, it is possible to see greater efficiency in the group UPP, in which participants mostly took 1 to 3 minutes to solve the proposed tasks. On the other hand, most U took 4

to 6 minutes to solve the tasks and complete the questionnaire. Finally, the lowest efficiency was from the UP group, which mostly took 7 to 9 minutes to solve the tasks. Figure 4 contains the graphics with the results from applying the NASA-TLX questionnaire after the end of task 1.

Figure 4 - Result corresponding to task 1 workload.

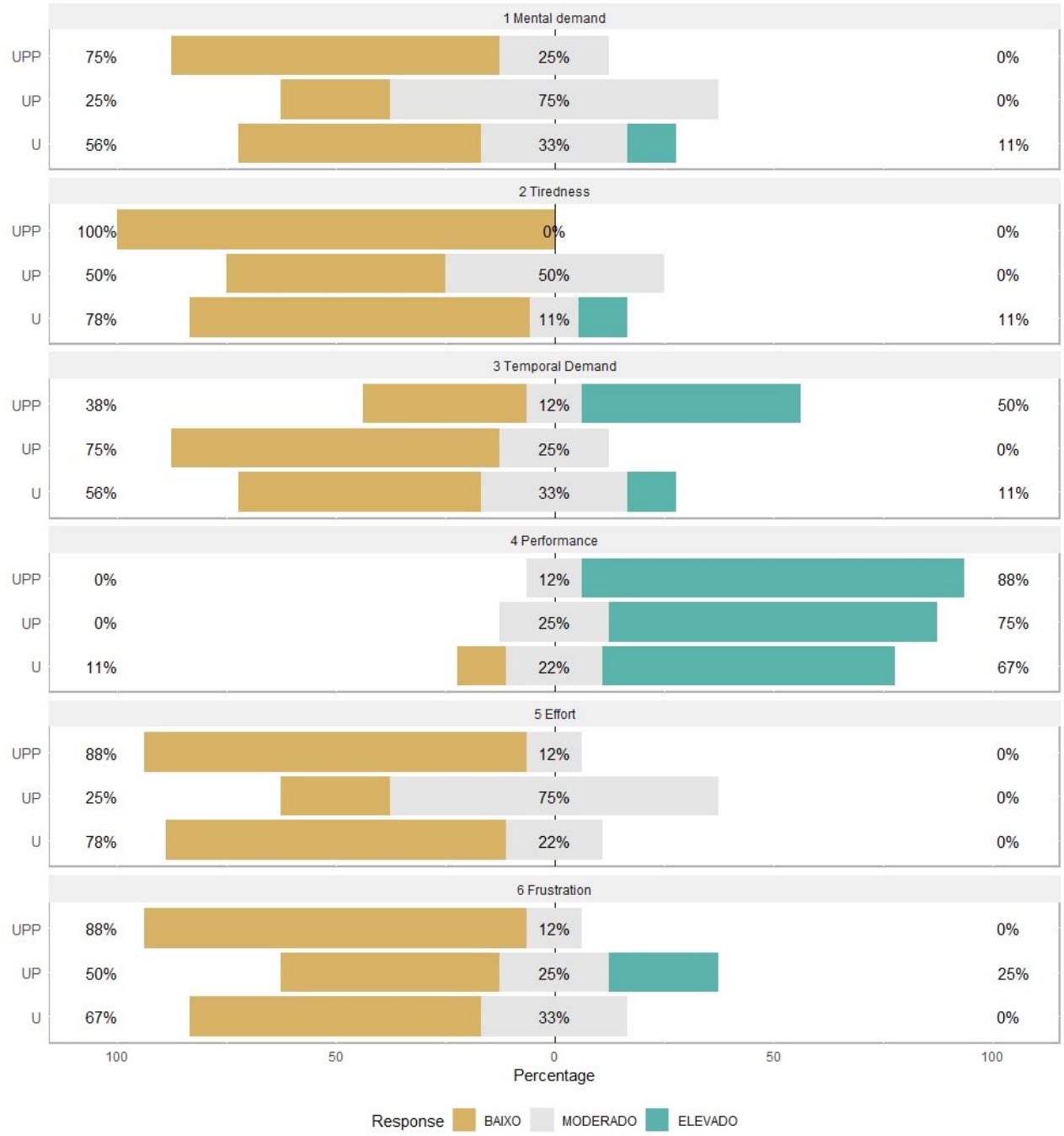


Source: The authors (2022).

The next step was the workload measurement using the NASA - TLX method. Figure 4 shows the results of this procedure, related to the completion of task 1, which encouraged participants to access the "metadata catalogue" and search for "hydrography in the Atlantic Forest biome". It is possible to obtain the individual perception of the groups of participants in the face of real situations using the INDE-BR geoportal, such as the higher mental demand and fatigue attributed to the group characterised as U. The perception of temporal demand was higher for the UPP group. The very high performance was linked to the UPP, followed by the UP and lower performance from the U group. The U group perceived more significant effort and frustration. The results from the evaluation of the workload perceived by the stakeholders after task 2 are

represented in Figure 5.

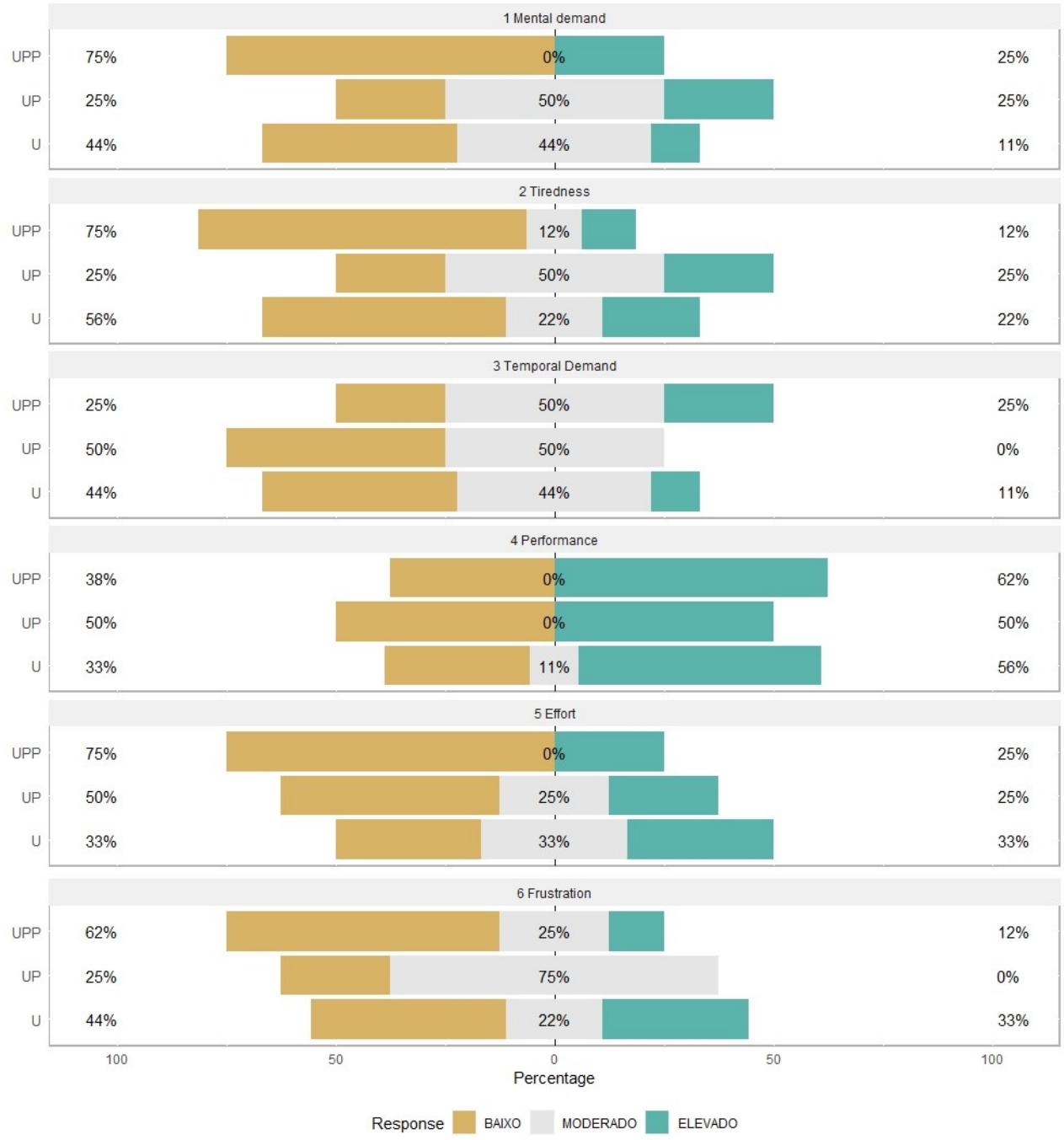
Figure 5 - Result corresponding to task 2 workload.



Source: The authors (2022).

The results with the evaluation of the workload after the accomplishment of task 2 evaluated the access to the "geoservices catalogue" and search "CPRM – Geological Survey of Brazil" the data referring to the workload were compiled and presented in Figure 5, which made it possible to verify an increase in the mental demand of the group characterised as U comparing to the other interested parties. The increase in fatigue in the UP and U groups was also noticeable. The perception of time demand was more significant on the part of the UPP than the other stakeholders. The performance criterion presented better results for the UPP group than the other stakeholders. The subjective perception of more significant effort and frustration was attributed to the UP group compared to the other groups evaluated.

Figure 6 - Result corresponding to task 3 workload.



Source: The authors (2022).

Figure 6 corresponds to the results with the evaluation of the workload assigned by the stakeholders after the solution of task 3, involving the download of the vector file in shapefile format corresponding to the "Geological map of Brazil to the millionth scale", as the results presented in Figure 2, it was found less efficiency in fulfilling the respective task for both groups of users who underwent the usability test. However, the results presented in Figure 6 corroborate the low efficiency demonstrated by the interested parties, suggesting a significant increase in the stakeholder's cognitive workload.

The UP and U group noted an increase in mental demand and fatigue compared to the UPP. The perception of high temporal demand was reported by the UP and U groups contrasted with the UPP group. The highest performance was attributed to the UPP group, although the UP and U groups also perceived high performance. The subjective perception of effort and frustration was higher for the U group than for the other volunteers. Corroborating the results obtained with the workload assessment, most individuals in the U group solved the tasks in 4 to 6 minutes, followed by those from UP, who mainly took 7 to 9 minutes to solve the

tasks. While the data UPPs, mostly took 1 to 3 minutes to solve the proposed tasks, demonstrating a superior time efficiency to the U and UP.

Kalantari et al. (2020) found similar results when proposing improvements to the user interface through usability tests on stakeholders. According to Zwirowicz and Michalik (2016), users demonstrate usability problems when accessing spatial data. Therefore, they suggested improving the coordination responsible for operations between the departments responsible for providing the data and metadata. This recommendation could help build cooperation between different producers to facilitate information exchange and improve service quality (ZWIROWICZ; MICHALIK, 2016).

According to Ester, Angel and Leon (2017), the interface design of SDI usually does not meet the needs of different user profiles, which can lead to users abandoning geoportals. The results of Ester, Angel and Leon (2017) show that users had difficulties accessing both the information provided by the geoportal and interacting with the map viewer. According to Zwirowicz (2016), SDIs often have an interdisciplinary character, influencing their use and assimilation by different groups.

Some issues related to stakeholder satisfaction were not thoroughly addressed. Additionally, the results of the tasks and NASA-TLX, due to the limited number of responses, did not provide complementary information, such as the problematic aspects that the group of volunteers believes to be relevant to improve. For this purpose, the stakeholders were asked to describe their opinions discursive about their impressions during the tasks. Table 2 highlights the comments of the stakeholders.

Table 2 – Stakeholder Response (translated from Portuguese).

Stakeholder	Answer
U	Error in the first task when accessing metadata catalogue, could not access via mobile device.
U	I'm familiar with using the viewer and similar tools. I don't know if I would have the same result if I searched for data without the specifications contained in the questions in this questionnaire.
U	Menus for accessing and consulting maps could be more self-explanatory.
U	It was not possible to download, which generated frustration in the process.
U	It was not possible to download through the Google Chrome browser, it was necessary to switch to the Firefox browser.
U	It was difficult to download, perhaps using a mobile device. The same exercise was different using a desktop.
U	Unable to download it. Even though I found the icon, it didn't work. When I imagine a spatial data platform, I expect to find the map geovisualization environment, i.e. I wouldn't like to have to think about which topic to access: "map viewer", "metadata catalog", "geoservices catalog" and "download area", as it consumes unnecessary time and these options could be more integrated and "intuitive" in the geoviewer itself. The INDE-BR home page could be the geovisualizer itself, and its layout could have a list of institutions that share the data. Then, we could click on the institution of interest and view the layers it makes available. In each layer, we could perform the download of interest. Users generally have an affinity for GIS software, Google Maps, Google Earth, etc. and expect to handle similar interfaces to get what they need. However, if institutionally it is mandatory to present the INDE-BR before any service, at least there could be a very large button in the centre of the screen: "ACCESS THE GEOVIZUALIZER".
U	I couldn't complete the tasks.
U	The site takes a long time to load and this creates frustration and stress.
UP	There was no problem in accessing the requested information, as they are very basic activities.
UP	It is not an intuitive system to perform layer preview requests once you have interacted once the tasks become easier.
UP	It is very difficult to view and download specific data. Often data is not found by its type or function. The clutter of the portal confuses the user.
UP	There is still a need to improve the assertiveness of the search, taking into account accents and other spelling changes.
UPP	The INDE-BR is very intuitive.
UPP	I am quite familiar with the data access channels available on the INDE-BR.

(to be continued)

(Conclusion)

Stakeholder	Answer
UPP	Accessing the metadata catalogue is not intuitive. It is hidden in a position on the main site that is unclear as to its content. Accessing metadata from the "Maps" tab is also not very intuitive. The INDE-BR Viewer could separate the services by institutions. The download process is also inefficient.
UPP	I found the search a little confusing.
UPP	Difficulty finding metadata.
UPP	There was no problem.
UPP	It crashed the load once. After that, it was quick to perform the tasks.
UPP	There is a lack of a search area for the site as a whole. The last task could not be completed with the parameters defined in the download area.

Source: The authors (2022).

The results with answers to the descriptive question showed that access to the metadata catalogue and map viewer presented problems because it was not very intuitive. After accessing the data, the download process was also described as inefficient. Some Stakeholders suggested that the menus for accessing and querying data and metadata should be more self-explanatory and that access should be more intuitive. The more significant difficulty was found by individuals in the U group, according to the comments in Table 2, followed by UP and UPP.

Some stakeholders reported limitations in downloading data due to difficulties in finding the data and buttons, problems associated with the Google Chrome browser were also pointed out, requiring a browser switch to Firefox to download. However, the data and metadata download presented the most extensive problems according to the metrics used in the usability evaluation, caused mainly, according to the volunteers' own words, "due to the geoportal disorganisation". Another aspect was related to the INDE-BR homepage, as stakeholders should be better designed, facilitating user interaction with the geoportal by improving the location of buttons and menus, another negative highlight of the geoportal is the excess of texts and visual information on home screens that overwhelm the user with information overload.

Another relevant aspect was the statement that the geoportal took too long to load the researched content, increasing the time demand and, consequently, the workload of the stakeholders. According to Kim, Xiong and Liang (2017), users' perceptions of waiting time are strongly associated with users' overall satisfaction with the service offered on the web. According to Jahromi, Delaney and Hines (2020), users tend to start to lose attention and interest in the site's content after two seconds of waiting time without any apparent progress.

4 CONCLUSIONS

This research identified a relationship between performance, cognitive workload, and the stakeholder's role in the INDE-BR. Through the finding usability problems when accessing, viewing and downloading data and metadata. It was noticeable that most UPP took less time to solve tasks than U and UP, proving the established hypothesis that there is a relationship between performance and the role that stakeholders play in the INDE-BR due to usability problems in the geoportal, such as difficulties accessing data and metadata, as well as problems interacting with the geoviewer.

Another aspect that the study made it possible to verify from the sample group's participation was that, generally, individuals in group U have a more significant workload than other stakeholders. The results showed evidence that the processes carried out in the INDE-BR geoportal present differences according to the stakeholders' role in the INDE-BR. The usability assessment on the INDE-BR geoportal, investigating access to data and metadata compared to the stakeholder's role in the INDE-BR, was successfully carried out.

The usability evaluation was successfully carried out, investigating access to metadata and analysing the cognitive workload compared to the stakeholder's role in the INDE-BR geoportal. However, further studies related to SDI, in general, are needed. Another point that deserves more attention in future works is to increase the number of UP voluntaries in the tests. This study presents evidence that there is a strong relationship

between stakeholders' performance and their respective roles. However, each individual perceives reality from aspects vital to him/her from cognitive content, cultural values and social norms. Therefore, a more heterogeneous group of actors makes it possible to obtain a larger quantity of information related to SDI, making the statements more comprehensive and conclusive.

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Authors' Contribution

The author Vinícius Emmel Martins participated in the conceptualization, data curation, formal analysis, research, methodology and writing of the article. The author Jaqueline Lima Amorim participated in the visualization, writing, investigation, review and editing of the article. The authors Marcio Augusto Reolon Schmidt and Silvana Philippi Camboim participated in the conceptualization, investigation, methodology, supervision, review and editing of the article.

Interest conflicts

The authors declare that there are no conflicts of interest.

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