

Interactive voice response systems for informing citizens about the COVID-19 pandemic: a study on Brazil's *Disque Saúde*

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ABSTRACT

In order to slow down the spread of the coronavirus SARS-CoV-2, it is vital to adopt measures to inform citizens about preventive actions. Such an operation requires a wide-ranged system that comprises a variety of interfaces as channels between citizens and healthcare authority's information services. Amongst such interfaces, the Interactive Voice Response (IVR) systems can present benefits for informing citizens about the pandemic. Although the literature shows that IVR systems have been used for healthcare, the extent of the COVID-19 pandemic demands new examinations on the role of IVR systems on a multiplatform system for delivering information. This paper aimed to identify gaps and opportunities for the use of IVR systems to inform citizens about the COVID-19 pandemic. A case study was conducted by mapping the Brazilian Ministry of Healthcare's channels of information about the coronavirus and analyzing the Disque Saúde IVR system – a phone-based ombudsman channel - based on literature recommendations. The results showed that while IVR systems have great potential for accessibility, it is essential that all types of information are available and continuously updated for citizens. Furthermore, the vast and mutable availability of information in a pandemic scenario may be a challenge for the usability of such systems.

Keywords: COVID-19, Healthcare, Information communication, Interactive Voice Response systems, Usability, Speech interfaces.

INTRODUCTION

The coronavirus SARS-CoV-2 pandemic is causing urgent healthcare needs for populations worldwide. However, recent studies have shown the efficacy of preventive actions such as social distancing (Flaxman et al., 2020) and facemasks adoption (Stutt et al., 2020) in decreasing the coronavirus' reproduction. Thus, to encourage citizens to engage in preventive actions and mitigate the spread of the virus, governors must adopt measures to inform citizens about the COVID-19 pandemic.

Currently, with the advances in hardware and software technologies, information can be communicated through varied means and reach massive audiences. In recent years, e-government platforms – “the use of ICTs to more effectively and efficiently deliver government services to citizens and businesses” (UN, 2020) –, have been growing popular as communication channels. However, such interfaces may not be accessible for all, considering social and economic inequalities. In Brazil, for example, 20.9% of the Brazilians did not have

access to the internet by 2018 (IBGE, 2020), 6.8% of the population is illiterate (IBGE, 2019), and 3.4% of the population had some degree of visual impairment by 2010 (IBGE, 2010).

In the COVID-19 pandemic scenario, it is paramount that information on preventive actions is widely available, and therefore authorities must develop strategies for informing all of the population. Meroni (2008) argues that solutions that meet social demands usually require complex and contextualized product-service-systems, rather than a single product or interface. Therefore, it can be argued that information from governments to populations should be available in a wide-ranged, multichannel system for delivering information. Such a system should comprise various devices, interfaces, and interaction channels as touchpoints between public healthcare authorities and all citizens.

Considering the need for varied and accessible channels of communications, Interactive Voice Response (IVR) systems can bring several benefits for accessibility. These speech-based interfaces can be used offline and use the auditory channel as an alternative to visual or textual information. In the area of healthcare, IVR systems have been used for several functions such as conducting questionnaires with patients, post-discharge follow-up, monitoring of health status, and providing information (Kraft & Androwich, 2012). Nevertheless, such systems need to be carefully designed to avoid user frustration (Pearl, 2016; Pieraccini, 2012).

Despite the known advantages of IVR systems, the extent of the COVID-19 pandemic is unprecedented to contemporaneity, and its impacts demand new investigations on the use of IVR systems for providing information on healthcare. A holistic approach is necessary to examine IVR systems as one of the various touchpoints between citizens and healthcare authority's information services, rather than as an isolated interface. This paper aimed to understand the gaps and opportunities for IVR systems to inform citizens about the COVID-19 pandemic, considering the broad system necessary to provide information for citizens in such a scenario. To achieve this goal, a case study was conducted on Brazil's *Disque Saúde*, an ombudsman channel created by the Brazilian Ministry of Healthcare's (MH) that has been used to present coronavirus-related information for citizens.

1. INTERACTIVE VOICE RESPONSE SYSTEMS AND HEALTHCARE

IVR systems are a type of voice interface that is "capable of understanding human speech over the telephone in order to carry out tasks" (Pearl, 2016, p. 30). IVR systems have menus structured in a branch logic format, through which users can navigate and answer questions by pressing buttons on a touch-tone keypad or by speaking voice commands (Lieberman & Naylor, 2012). IVR systems became popular by the 2000s' (Pearl, 2016), but, even nowadays, IVR systems are a tool that presents several benefits for users and developers.

Firstly, since IVR systems only require the auditory channel, complex and specific information can be presented without requiring users' visual channels (Pearl, 2016; Meeker, 2016), enabling users with visual impairments or low literacy levels to interact with the system. Secondly, voice interaction is ideal for products with small or nonexistent displays, (Meeker, 2016), and thus may be accessed from simple, familiar telephones instead of expensive or potentially unfamiliar devices such as a computer or a smartphone (Lieberman & Naylor, 2012). Voice interaction may also be easier to use than graphic interfaces since speech is intuitive for humans (Pearl, 2016; Meeker, 2016). Furthermore, IVR systems do not require a human operator, and thus are cost-efficient and can automatically collect and store

data in real-time (Lieberman & Naylor, 2012). Also, IVR systems may repeat information as many times as needed (Lieberman & Naylor, 2012; Kraft & Androwich, 2012) and, because there is no human operator, some users may perceive interactions with IVR system as less threatening than a personal discussion (Kraft & Androwich, 2012). Finally, these systems can be accessed by multiple users simultaneously and are continuously available (Pearl, 2016; Lieberman & Naylor, 2012).

IVR systems have several uses for the healthcare area. Brinkel et al. (2017) showed the efficacy of a mobile-phone-based tool to collect individual disease information and offer treatment recommendations for mothers of ill children, educating parents and supporting their decision to seek hospital assistance or not. Likewise, Rigotti et al. (2017) conducted a study with post-discharge smoker patients who wished to quit smoking, and identified a positive relationship between the use of an IVR-facilitated intervention and smoking cessation, indicating the benefits of IVR systems for post-discharge follow-up. Similarly, Besse et al. (2015) conducted a study with an IVR system to monitor pain levels of palliative outpatients with cancer and observed the efficacy of the system for circumventing patients' reluctance to contact healthcare professionals in cases of high pain levels and, consequently, supporting the adjustment of their treatments.

In order to avoid frustration for IVR systems' users, interaction designers must be aware of usability recommendations available in the literature. Firstly, interactions should **minimize the cognitive load on users** (Cohen et al., 2004). Voice-based menus should not present more than five options at a turn (Pieraccini, 2012) and should allow users to select their desired option as soon as it is presented by the system (Wickens & Carswell, 2012). Frequently performed tasks should be presented prior to other options on menus, and recurrent users should be allowed to skip non-essential information (Killam & Autry, 2000). Responses should be written in plain language (Moore & Arar, 2019), and confirmation messages should use consistent wording across the system (Killam & Autry, 2000). IVR systems should not mix input methods, and voice prompts are preferred over touch-tone keypads, as users do not need to associate numbers with options (Pieraccini, 2012).

Similarly, systems must **keep interactions short**. Designers should decrease the necessary steps to complete tasks to increase efficiency (Cohen et al., 2004) and IVR systems should limit their responses to a sentence or less and decompose long answers so that users may navigate at a lower level of granularity (Moore & Arar, 2019). Furthermore, **IVR systems should keep a consistent interaction flow**. Interactions should start with a greeting, and the main menu presenting high-level information should be presented to facilitate users' access to system's features (Killam & Autry, 2000). Throughout the conversation, acknowledgments should be provided to ensure that users' commands were understood (Pearl, 2016). Users should also be able to close an interaction sequence after achieving the desired outcomes, and move on to further options (Moore & Arar, 2019). Finally, **IVR systems should prevent and handle errors**. Voice interfaces may employ confirmations – “reprompting” – as a means to minimize errors (Pieraccini, 2012, p.220), but they should not overload users with confirmations (Pearl, 2016). The system should allow users to cancel menu selections to return to previous options (Killam & Autry, 2000) or ask for a repetition of information (Moore & Arar, 2019).

Although there are studies in the literature pointing out to design recommendations and opportunities for IVR systems in healthcare, the COVID-19 pandemic poses challenges for

implementing these systems that are yet to be addressed. Unlike other scenarios in which information is directed to a target audience, the coronavirus outbreak requires information to be delivered to all the population. Therefore, it is necessary to analyze such interfaces as one of the multiple touchpoints needed to deliver information for all citizens, as aforementioned. Also, since research on the disease is still in progress, healthcare authorities' recommendations are being developed gradually, and a large amount of data is available. Thus, it is unknown which usability issues may arise in the use of such systems in a pandemic scenario.

2. METHOD

The goal of this study is to understand the gaps and opportunities for IVR systems to inform citizens about the COVID-19 pandemic. Yin (2018) suggests that research seeking to describe or understand contemporary events in which the researcher has little or no control over – such as a new virus' pandemic - can benefit from the case study method. As before-mentioned, there are several accessibility challenges for communicating health-related information in Brazil, making the country an opportune case to be studied in the pandemic scenario. Hence, this paper presents a case study that mapped the Brazilian Ministry of Healthcare's (MH) channels of information about the COVID-19 and analyzed the IVR system *Disque Saúde*. *Disque Saúde* is an ombudsman channel created in 2011 by the MH that can be accessed online (chat) or through phone calls (IVR system). Due to the SARS-CoV-2 outbreak, the MH added new, voice-based features to the platform to evaluate the health condition of the population, monitor the status of symptomatic citizens, and provide information about the pandemic (Casa Civil, 2020)..

The research method comprised three steps: the identification of all communication channels available or suggested on the MH website, a survey of all information related to the COVID-19 pandemic on each platform, and an usability analysis of the *Disque Saúde* based on literature recommendations. All data was collected on May/June 2020.

The gathering of the communication channels available as MH's communication platforms started from the Ministry's main website. Hyperlinks related to the word "coronavirus" were examined, as well as advertisements about other MH's platforms outside of the webpage. The same process was conducted for all platforms examined. The criteria for accepting platforms on the analysis were:

1. The platform must have been developed by the MH. Although there are information channels available from alternative sources, it is vital that public authorities provide reliable information for citizens in a pandemic scenario. The scrutiny of further platforms is beyond the scope of this paper.
2. The platform's content must concern any type of information aimed at informing citizens and preventing the spread of the virus.
3. The information must be directed to layman citizens. Information explicitly directed to healthcare professionals was not accepted.

A total of 12 platforms were accepted for analysis (table 1). A flowchart was developed to visually represent the relationships between the platforms. Such analysis was chosen to represent the system's map and enable the identification of the information organization throughout the interfaces (table 1).

Table 1: Description of the platforms analyzed

Platform	Description
Coronavirus website	A website linked to the MH main website dedicated to coronavirus-related information.
Tele SUS Chat	A chat bot within the coronavirus website that answers questions about the coronavirus with pre-programmed answers. It can also be used for the self-evaluation of symptoms.
Coronavirus panel	A website dedicated to presenting information about the status of COVID-19 cases in Brazil.
Interactive panel	A website dedicated to presenting information about the status of COVID-19 cases in Brazil.
OpenData SUS	A database from the MH containing various types of data, including the coronavirus-related information.
Hospital beds and supplies panel	A website dedicated to presenting information about the availability of hospital beds and supplies across the country.
Coronavirus App	A smartphone application dedicated to coronavirus-related information. It can also be used for the self-evaluation of symptoms and for finding hospitals.
Fake News webpage	A page within the MH's main website exclusive to explaining fake news on varied topics, including the coronavirus.
Prevention campaigns	A page within the MH's main website where citizens can download the advertisements from the MH' coronavirus' prevention campaigns. The page does not specify where or how the advertisements are intended to be displayed.
Fake News Whatsapp line	A WhatsApp line dedicated to coronavirus-related Fake News.
Ministry of Healthcare Answers WhatsApp line	A WhatsApp line dedicated to answering coronavirus-related questions using pre-programmed answers. It can be used for the self-evaluation of symptoms.
<i>Disque Saúde</i>	An IVR system from SUS – not exclusive for coronavirus-related information – in which citizens may evaluate and monitor symptoms and access information.

The second part of the analysis was the scrutiny of each information channel collected on the previous step. All information that satisfied the criteria mentioned above were categorized on a bottom-up approach and recorded on a table. As the COVID-19 pandemic is demanding the communication of varied data, the bottom-up approach was chosen so that the analysis would encompass all types of information identified, rather than being limited to previously established categories. A total of 73 pieces of information (instructions, definitions, etc.) were identified and clustered into 13 categories. An information percentage score was created to identify differences in the amount and type of information available in the analyzed platforms. For each platform, the number of pieces of information identified for each category was accounted, and then divided by the total number of pieces of information encompassed on that category (figure 2). For example, the “Coronavirus app” had eight out of the sixteen pieces of information identified in the “prevention” category. Thus, the information percentage score for the “Coronavirus app” on the “prevention” category was 50%.

As for the usability analysis of the *Disque Saúde*, multiple calls were made to identify the systems' call flow (Appendix 1-3), that is, “diagrams that illustrate all the paths that can be taken through your [voice user interface] system” (Pearl, 2016, p. 75; figure 3). *Disque Saúde's* analysis was based on the literature recommendations presented in the previous section. Such an assessment was conducted to identify which usability issues may be linked to the presentation of coronavirus-related information on IVR systems.

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3. RESULTS

The flowchart illustrated in figure 1 shows a map of the analyzed MH's platforms. It can be noticed that several interfaces are used to communicate information and can be accessed from various devices (telephone, smartphone, tablet, computer). Moreover, varied types of platforms are available such as websites, the dedicated App, WhatsApp lines, and the IVR system. However, all communication channels except for the *Disque Saúde* require an internet connection to function or be installed. Additionally, the *Disque Saúde* is the only platform that primarily presents information through the auditory channel, without requiring any visual support.

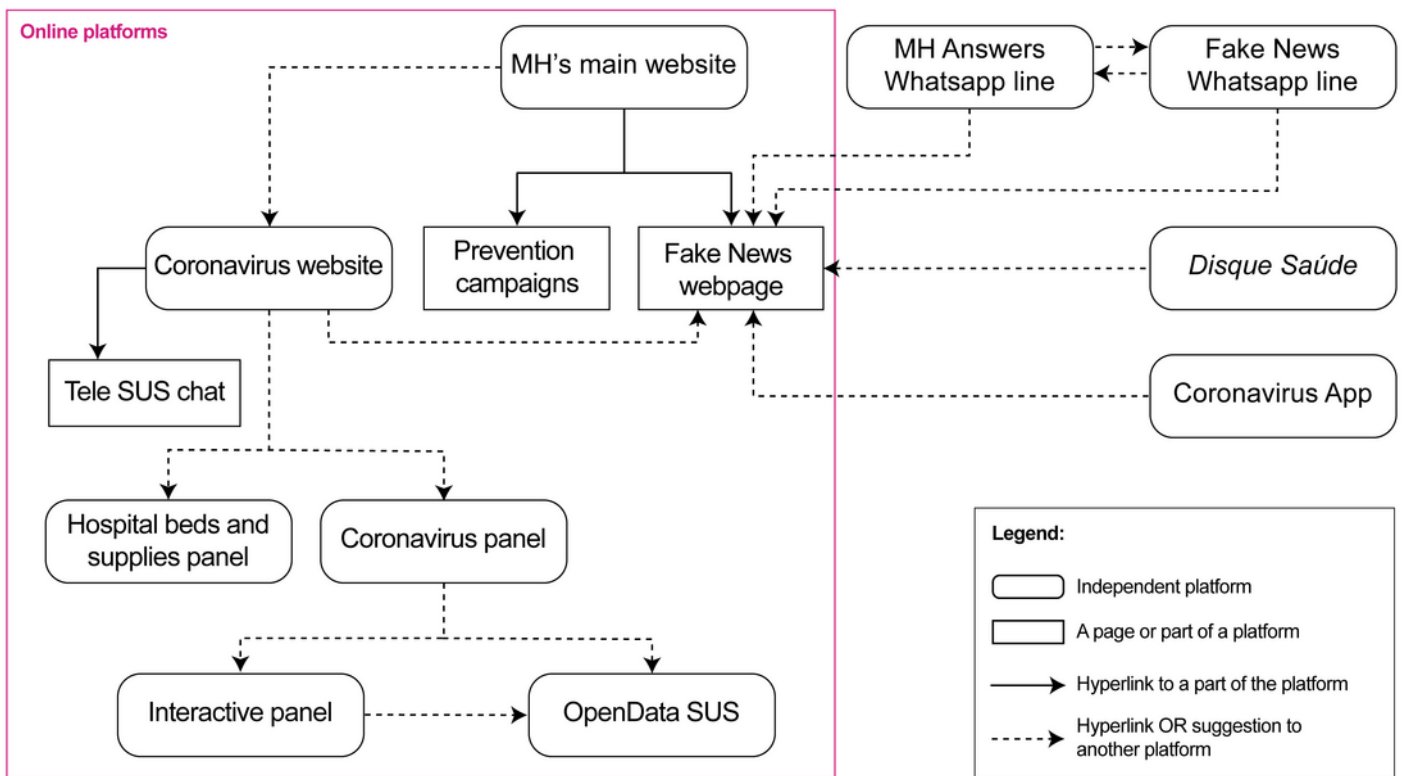


Figure 1. Flowchart containing all surveyed platforms.

Furthermore, it can be observed that several MH's webpages are used to display information about the virus (indicated by the pink square in figure 1), and there are two WhatsApp lines that citizens may contact to search for instructions. However, such an organization may spread different types of information across platforms of the same type (websites; WhatsApp lines) and confuse users about where to look for information. For example, the "Coronavirus website" is a webpage dedicated to the pandemic, but the data concerning confirmed cases are located on other websites ("Coronavirus panel", "Interactive panel"). Contrarily, the *Disque Saúde* and the "Coronavirus App" are the only MH's platforms of its type (IVR system; App) with information about the pandemic.

Figure 2 illustrates the representation of the information percentage scores, which shows how different categories of information are spread across the platforms. Overall, none of the analyzed channels of communication comprised all of the categories of information collected, showing inconsistencies in the availability of information across the interfaces. It can be observed that some platforms were developed exclusively for presenting one category of information, such as the "beds and supplies panel", which only displays information about medical supplies in Brazil. On the other hand, some categories of information are either

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absent or have limited availability across the platforms. Such a tendency can be verified for the “Fake News” information category. While there are two platforms exclusively dedicated to presenting this type of information (“Fake News webpage” and “Fake News WhatsApp line”), 8 out of the 12 communication channels surveyed did not display data on fake news and therefore had to address citizens to other channels, as shown in figure 1.

CATEGORIES PLATFORMS	ABOUT THE VIRUS	INFECTION SITUATION	SYMPTOMS	TRANSMISSION	PREVENTION	FACEMASK USAGE	IN CASE OF SUSPICION	IN CASE OF CONFIRMATION	RISK GROUPS	TREATMENTS/ VACCINES	TIPS FOR TRAVELLERS	NEWS	FAKE NEWS
CORONAVIRUS WEBSITE	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CAMPAIGNS	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CORONAVIRUS PANEL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
INTERACTIVE PANEL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
BEDS AND SUPPLIES PANEL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
OPEN DATA SUS	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
FAKE NEWS WEBPAGE	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
CORONAVIRUS APP	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
TELE SUS CHAT	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
DISQUE SAÚDE	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
FAKE NEWS WHATSAPP	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
MH ANSWERS WHATSAPP	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Figure 2. Visual representation of the percentage scores for each platform. The level of saturation of the purple color ranges from 0-100% and represents the amount of information available from the categories in each platform. White represents zero information (score = 0%) and the most saturated purple means all information (score = 100%).

It is important to point out that the heterogeneity indicated in figure 2 is also due to inconsistencies of the information on subjects across the platforms. For example, the “Coronavirus App” recommended that citizens should only wear facemasks if they are coughing or taking care of infected people. However, this information is outdated compared to other platforms, which not only recommended facemasks to all citizens, but also provided instructions for its usage. Similarly, the *Disque Saúde* and the “MH answers WhatsApp line” were the only platforms in which the chloroquine and hydroxychloroquine protocol was available.

As for the *Disque Saúde*, figure 2 shows that the IVR system does not encompass six categories of information, including basic definitions of the pandemic and symptoms of the COVID-19 disease. Also, the percentage score for all categories except “risk groups” and “treatments and vaccines” is below 100%, indicating that there are missing or inconsistent information on the interface. As represented in figure 1, the result of missing information is the need to address users to other platforms. However, switching platforms to locate information may not only be frustrating and demanding for users, but may also be unfeasible for citizens without an internet connection.

The appendix 1-3 illustrates the flowcharts of the *Disque Saúde’s* call flow. As recommended by the literature (Killam & Autry, 2000), the interaction starts with a high-level menu, in which users may choose to evaluate their health status, monitor their symptoms (if they have contacted the system before), and listen to information on other topics, including general information about the coronavirus. (Appendix 1). Nevertheless, the IVR system is not entirely in line with the literature’s usability recommendations.

Firstly, the *Disque Saúde* does not always allow users to interrupt the system's output to select or go back to a menu option. This is problematic since it forces users to listen to all of the voice response, making interactions slow, cognitively demanding, and complicating the recovery from selection errors. Secondly, the "Coronavirus information" branch has seven options on its menu (Appendix 3), which diverges from the advised maximum of five menu options and may lead users to forget the available choices (Pieraccini, 2012). These issues are aggravated by the use of a touch-tone keypad as the input method for most interactions, making users associate options to numbers and increasing their cognitive load. Contrarily, the entirety of the "monitoring of health status" branch of the system (illustrated in Appendix 2) employs voice commands as the entry method. Although speech is the preferred input method by the literature, it is not recommended to mix voice commands with a touch-tone keypad as entry mechanisms (Pieraccini, 2012).

Furthermore, the analysis showed that some voice responses from the system were too long because of the need to provide detailed information. For example, the platform offers instructions for citizens on how to wash their masks, but all information is presented at once, which is not only time-consuming but also gives users little time to memorize or write down instructions. Similarly, some characteristics of the system may affect the interactions' brevity. In the information branch (Appendix 3), users must listen to an advertisement before being redirected to the menu options, and, after hearing a piece of information, they must answer if they were satisfied with the interaction to proceed. Such extra steps decrease the interaction efficiency.

It can be noted that many of the *Disque Saúde's* usability issues are related to the interactions' brevity or high cognitive demands for the users. It is possible to argue that the large and varied amount of information that should be displayed by the system may be the cause of such problems. Presenting information about a pandemic as large as the COVID-19's requires several types of information, as pointed out in figure 2, and may be a challenge for IVR systems.

Considering this study's results, some suggestions may be offered for the *Disque Saúde*. In the first place, for the system to function independently and maximize its potential for accessibility, it is recommended that the system should comprise all information available across the MH's communication channels, and that such data is updated continuously. Based on the before-mentioned literature recommendations on usability, it is suggested that the number of menu options on some branches is reduced, the possibility for users to interrupt system's responses is added, and support for selection errors is provided. Long information pieces should be broken down into chunks of information, advertisements should be removed, and users' evaluation of the system should be optional. Finally, it is suggested that voice commands are standardized as the input method.

4. CONCLUSION

In order to mitigate the outbreak of the SARS-CoV-2 coronavirus, it is paramount that governors provide information about the pandemic for all citizens, and IVR systems may play an important role in such scenario. Yet, an investigation is necessary to assess IVR systems as touchpoints in the complex, broad system for delivering information required to deal with a pandemic as extensive as the COVID-19's. This article presented a case study on the Brazil's IVR system *Disque Saúde*, aiming to understand the gaps and opportunities for IVR systems

for informing citizens about the COVID-19 pandemic. To achieve this goal, a survey and scrutiny of the Brazilian MH's communication channels were conducted, as well as a usability analysis of the *Disque Saúde*.

Despite the limitations inherent to the case study method, some general conclusions can be offered for the use of IVR systems for the COVID-19 pandemic. As expected, including IVR systems as channels of communication can leverage the accessibility of information, especially for populations with high rates of illiteracy, visual impairment citizens, and low levels of internet connection. It is essential that IVR systems provide all of the necessary information for citizens, and that such data is consistent, reliable, and up to date with other platforms. Such homogeneity of information is important for the independent functioning of an IVR system, considering that consulting other platforms might be unachievable for some citizens, and, ultimately, may cause them to give up the search for information. Considering the urgent and unpredictable nature of the coronavirus outbreak, in which new data and recommendations from healthcare authorities are constantly evolving, an alignment of information across platforms might be challenging. This demand highlights the importance of analyzing interfaces as touchpoints of a larger system for delivering information, rather than isolated platforms, to track all the available data and homogeneously distribute such information across communication channels.

Finally, some of the usability issues identified in the *Disque Saúde* were related to the nature and amount of information to be communicated in the COVID-19 pandemic context, which includes lists, instructions, procedures, etc. Such characteristics can be problematic for IVR systems since users need to listen to several menu options, make associations with touch-tone keypad numbers, and listen to long pieces of information. However, voice recognition technologies are now capable of achieving high speech recognition rates (Pearl, 2016). Systems such as voice assistants (Siri, Alexa, etc.) already use automated speech recognition and natural language processing algorithms to fulfill a broad set of tasks for users (Pearl, 2016). Thus, the use of voice prompts as input methods can be used in IVR systems to allow users to directly ask for information about the COVID-19 pandemic, making interactions easier and faster. Interaction designers must follow guidelines on usability so that interactions are effective, efficient, and satisfactory for users, and further testing with users is necessary to identify additional usability issues.

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APPENDIX

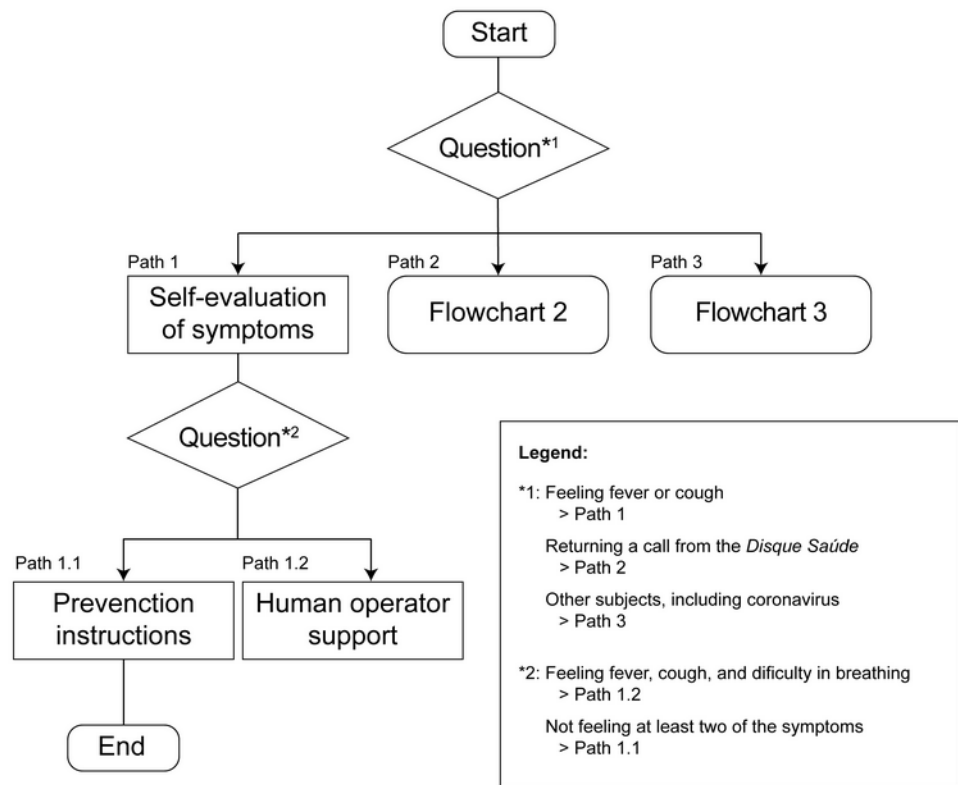


Figure 3. Flowchart of the *Disque Saúde's* call flow (part 1)

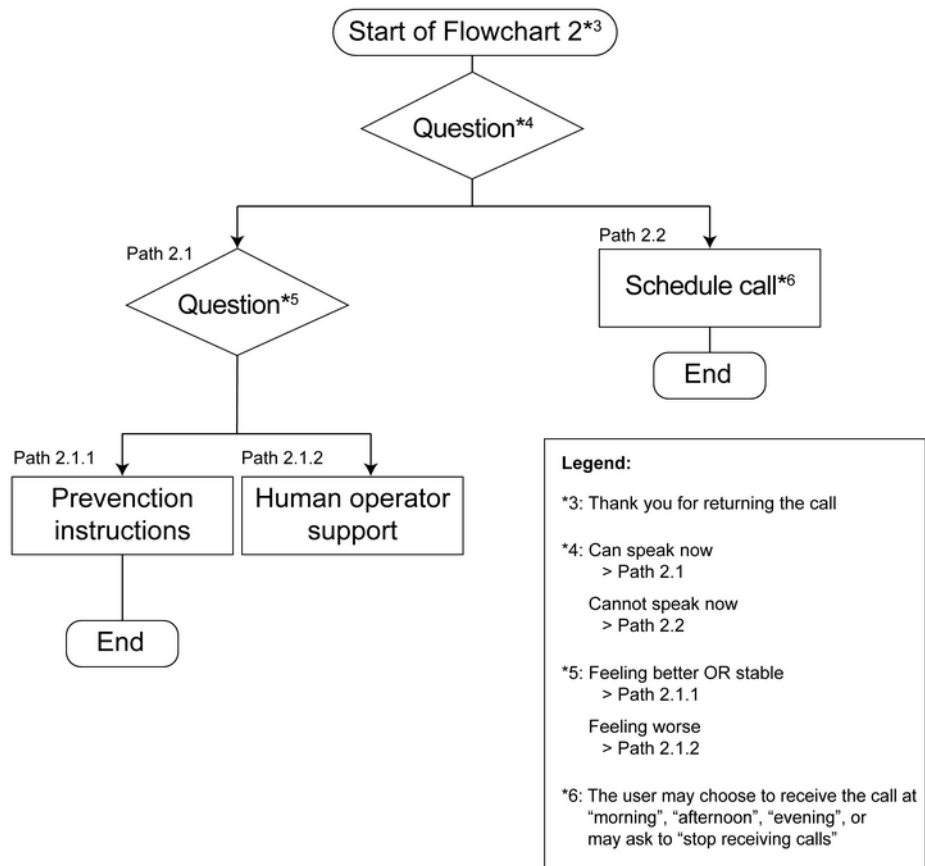


Figure 4. Flowchart of the *Disque Saúde's* call flow (part 2)

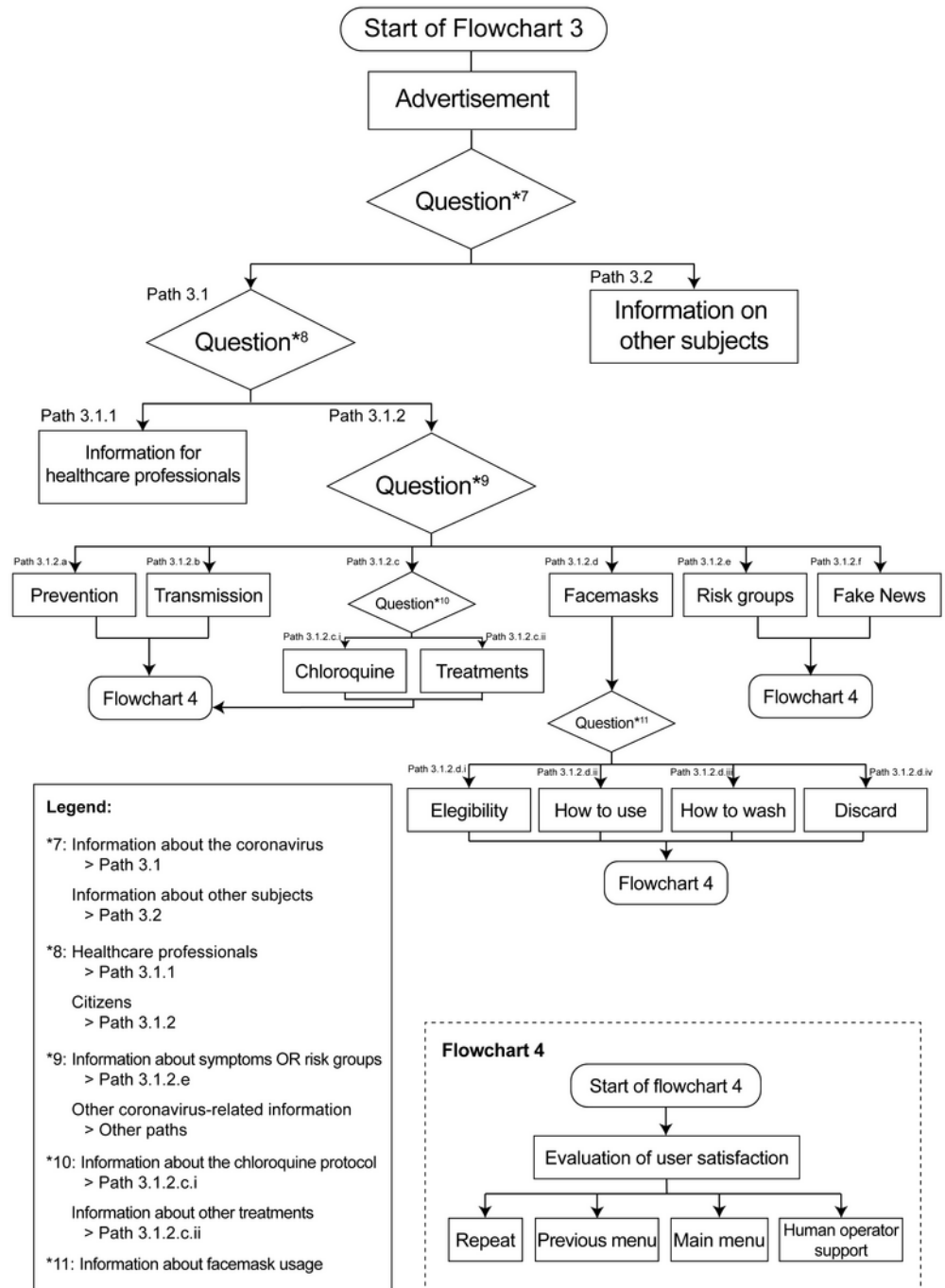


Figure 5. Flowchart of the *Disque Saúde's* call flow (parts 3 and 4)