Systematic Selection and Prioritization of Communication Channels in the Healthcare Sector

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Abstract: Many industries are using multi-channel approaches to bring users and organizations closer. The services provided through these channels can be leveraged by using chatbots, allowing users to have simpler and more natural interactions. However, this entails designing architectures that make services available through multiple channels, while making the users' experiences coherent, as they switch between them. Media Richness Theory introduces a way to classify the richness of communication channels, resorting to objective factors, however it does not provide a systematic channel selection and prioritization process. To address these needs, this work proposes a systematic approach to select and prioritize communication channels based on six factors: feedback, multiple cues, personal focus, language variety, accessibility and cost. To validate this approach, the systematic process is applied to three use cases in the healthcare domain.

1 INTRODUCTION

When interacting with organizations, users resort to a variety of communication channels. These include traditional channels such as face-to-face communication and phone calls, as well as digital channels such as e-mail, web portals, mobile applications and video-conferences (Androutsopoulou et al., 2019). These channels are distinguished by their richness (the capability of providing information with high levels of understanding), which depends on a variety of factors: some of them are objective, such as rapidness of feedback, available modalities, accessibility and cost; whereas others are subjective to the experience of the user, such as familiarity with a particular channel or topic.

In recent years, multi-channel and omni-channel approaches have been implemented in many industries (Caroll and Guzmán, 2015), allowing consumers to choose from a variety of channels (according to their preferences) and providing a seamless experience when switching between them. Furthermore, some of the communication tasks performed through the aforementioned digital channels have been automated by using task-oriented dialog agents (or chatbots), which can help users complete tasks using natural language (Jurafsky and Martin, 2000). These systems are simpler to use when compared to GUI applications because they mimic human-human interaction.

Chatbots have thus the ability to leverage organizations' services by being available through multiple digital communication channels (Androutsopoulou et al., 2019). As a result, organizations can target a higher percentage of the population, by offering their services through channels that are more convenient, natural and easy to use.

Healthcare is a domain that can benefit from multi-channel approaches (Laranjo et al., 2018). New channels can be easily integrated with the pre-established workflow, providing services to patients who would not, otherwise be able to access them (Morris et al., 2018). They can also reduce patient travel and allow more frequent follow-ups.

1.1 Context

When offering more channels to users, there is one fundamental issue that arises. Since each channel has its own characteristics, not all of them can be applied in the same scenarios. For instance, for use cases in which communication depends on the vocal modality, a channel through which it is only possible to communicate via text is not suitable. Therefore, it is important to evaluate the suitability of channels regarding the desired communication tasks. Additionally, there is the preoccupation of evaluating which channels should be prioritized.

1.2 Objectives

The objectives of this work are thus the following:

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- To assess the factors of communication channels that influence their suitability.
- To create a systematic process for organizations to select and prioritize communication channels.

1.3 Article Organization

This article starts by discussing work related with multi-channel architecture designs. This includes the introduction of chatbots and understanding what use cases are viable for a bot implementation. Afterwards, it focuses on multi-channel and omni-channel strategies, exploring how channels are used in healthcare and what are the factors that make each channel unique.

Following, the Communication Channel Selection Process, which provides a way to select and prioritize channels, is proposed.

Finally, the channel selection process is applied to the healthcare domain and the conclusions are presented.

2 BACKGROUND AND RELATED WORK

2.1 Chatbots

Dialog Systems: communicate with users through different modalities (such as text or speech) and can be classified in two categories (Jurafsky and Martin, 2000): (1) Task-oriented dialog agents help users complete tasks using natural language, such as giving directions, finding restaurants or making calls; and (2) Chatbots, which have the purpose of having extended conversations, being able to mimic human-human interaction, thus providing a more natural communication. For simplicity, throughout this article, the term *chatbot* is used when referring to a dialog system.

2.2 Chatbot Use Case Evaluator

The Chatbot Use Case Evaluator (Ferreira and Vasconcelos, 2019) allows the evaluation of a set of use cases, enabling the identification of the more suitable ones for a bot implementation. It takes into consideration three factors that must apply for a use case to be viable: (1) General factors, that divide into well-defined Business rules and integration with existing systems; (2) Factors over GUI applications, which encompass multiple steps or input parameters, notifications and authentication; and, (3) Factors over Humans, which consider the repetitiveness, consistency and scalability of the use cases. If these three factors verify for a certain use case, then its implementation in a chatbot is viable.

Additionally, use cases that meet a great number of factors, or that meet factors that are of greater importance to the organization should be prioritized. Organizations can thus define weights for each factor and give a higher priority to the ones that have a greater sum of weighted factors. The described methodology was applied to three use cases: (1) Scheduling an appointment, (2) Paying for an appointment, and (3) Medical diagnosis. After applying the Evaluation process, (1) and (2) were the only use cases evaluated as suitable to be implemented. In fact, (3) was considered to not have well-defined business rules, therefore, it did not comply with the General factors assessment.

2.3 Multi-channel and Omni-channel Strategies

Communication Channels are traditional offline or digital online intermediaries used by consumers to interact with services, facilitating the transmission of information and content (Androutsopoulou et al., 2019).

Multi-channel strategy is a trend in many industries toward the use of multiple channels when engaging with customers. These approaches offer a diverse experience across channels consumers can choose from, according to their preferences. Accenture (Caroll and Guzmán, 2015) explains the success of multi-channel strategies with customers having more access to the Internet and social networks, prioritizing convenience and being constantly on the move, valuing the availability of services anywhere and at any time. However, multi-channel strategies have limited or no integration between channels, providing a non-seamless experience as consumers switch between them. Thus, users may be forced to repeat certain procedures or receive ambiguous messages (Deloitte, 2015).

Omni-channel strategy consists on a synchronized operating model in which all of the organization's channels are aligned (Deloitte, 2015). Consequently, it delivers a seamless, consistent and personalized customer experience. This is achieved by integrating different channels that can be used whenever, wherever and however. Using this approach, organizations are able to respond consistently to the consumers' evolving needs, while enabling them with the opportunity of using the channel of their choice to access the services they desire.

Nowadays there are several areas of activity that

use multiple communication channels including retail and commerce (Accenture, 2014), banking and finance (Komulainen and Makkonen, 2018), education (binti Mistar, 2016) and government organizations (Androutsopoulou et al., 2019).

2.4 Communication Channels in Healthcare

In this section we will focus on channels patients use when getting healthcare.

When patients have health-related issues, they seek healthcare in order to obtain a diagnosis (Ferreira and Vasconcelos, 2019). Diagnosis is typically performed in-person, however, alternative channels have been adopted in recent years, in order to provide services to patients who would not, otherwise, be able to access them. Video-conference has been regarded as a suitable alternative, since it has clear similarities when compared with the face-to-face interaction. These two channels have been compared in post-traumatic stress disorder treatment (Germain et al., 2010). The results show that therapeutic alliances developed similarly in both channels.

When a patient has already been diagnosed, it is important to conduct follow-up consultations (post-operative follow-ups, disease management or behavior change (Morris et al., 2018)). Moreover, medical follow-ups are typically used to guarantee that there are no interruptions in medications, identify the need for adjustments, and provide a better compliance with the surveillance of various health parameters and healthy lifestyle habits (Ferreira, 2020). Follow-ups are typically performed in-person, however, research has shown that using telemedicine has the advantage of allowing a more frequent surveillance (Ferreira, 2020). Instant messaging (IM) is also being adopted by clinicians, in particular, dermatologists (Morris et al., 2018).

Before attending an in-person or video-conference consultation (either for diagnosis or follow-up), patients should book their appointments. The scheduling itself is typically performed with clerks (in-person or through phone calls) or by using clinics' portals and applications.

Providing healthcare services via digital online channels is a cost effective and flexible alternative that can be easily integrated with the pre-established workflow. Furthermore, it has enabled clinical services between rural areas and urban hospitals, reducing patient travel and the associated time and financial costs (Morris et al., 2018).

2.5 Communication Channels Factors

To provide channels with higher level of richness to Greek citizens (Androutsopoulou et al., 2019), while accounting for the equivocality and uncertainty of communication tasks, the authors decided to use the notions of Media Richness Theory (Daft and Lengel, 1983) and Channel Expansion Theory (Carlson and Zmud, 1999) to provide channels with a higher level of richness. These theories helped them analyze communication channels both from an objective and from a subjective standpoint respectively.

In recent years, other subjective factors regarding communication channels have been studied (Ishii et al., 2019) (apart from the ones introduced by Channel Expansion Theory). These include the channels' accessibility, competency of use, time saving and cost saving. This research concludes that evaluating the richness of a channel according to objective features is not enough. In fact, it is important to regard the objective characteristics of a medium, while keeping in mind subjective experience and perceived richness.

3 SELECTION AND PRIORITIZATION OF COMMUNICATION CHANNELS APPROACH

3.1 Communication Channel Selection Process

This section presents a systematic way to select and prioritize channels, depending on the use case. Firstly, factors that influence channels suitability are discussed. And following, the evaluation process is presented.

3.1.1 Channel Suitability Factors

Before evaluating what channels should be used for each use case, there is the need to identify what factors influence suitability (Tables 1 and 2. Based on (Daft and Lengel, 1983) and (Ishii et al., 2019), it is possible to identify the following factors:

Feedback. Enables individuals to check understanding and correct misunderstood interpretations. Depending on the channel, it can be classified as immediate, fast, medium, slow or very slow. In a face-to-face interaction, for instance, feedback is *immediate*, whereas through a formal email it is *very slow* (Daft and Lengel, 1983).

Table 1: Classification of communication channels, according to objective factors.

Channel	Feedback	Cues	Focus	Language
Face-to-face	Immediate	Full visual/audio	Personal	Body, Natural
Video-conference	Immediate	Limited visual/audio	Personal	Body, Natural
Phone call	Fast	Limited audio	Personal	Natural
Instant messaging platform	Slow	Limited visual/audio	Personal	Body, Natural, GUI
Web portal without IM	Medium	Limited visual	Impersonal	GUI
Web portal with IM	Slow	Limited visual/audio	Impersonal	Natural, GUI
Mobile app without IM	Medium	Limited visual	Impersonal	GUI
Mobile app with IM	Slow	Limited visual/ audio	Impersonal	Natural, GUI
E-mail	Very slow	Limited visual	Impersonal	Natural
SMS	Slow	Text	Personal	Natural

Table 2: Classification of communication channels, according to accessibility and cost.

Channel	Accessibility	Cost
Face-to-face	Very low	Commute
Video-conference	Low	Internet
Phone call	Very high	Per call
Instant messaging platform	High	Internet
Web portal without IM	Medium	Internet
Web portal with IM	Medium	Internet
Mobile app without IM	High	Internet
Mobile app with IM	High	Internet
E-mail	High	Internet
SMS	Very high	Per message

Multiple Cues. Information can be conveyed beyond the spoken or written message, using modalities such as facial expression or tone of voice. The considered cues in the MRT (Daft and Lengel, 1983) are *visual*, *audio* and *limited visual* (referring to written messages). However, when considering modern communication channels these cues are not enough. Communicating through video, for instance, represents visual and audio cues, however, it is far less rich than communicating in-person, since it is not possible to perceive modalities such as facial expressions with the same level of precision. Because of this, the following types of cues will be considered: full visual, full audio, limited visual, limited audio, and text.

Personal Focus. This factor is concerned with the information source. Personal sources are related with informal communication such as face-to-face interaction, while impersonal sources encompass formal communication such as emails.

Language Variety. Each communication channel has different possibilities of language use. Face-to-face interaction, for instance, allows to communicate using natural and body language. However, some mediums only allow the use of natural language (SMS, for example). Additionally, the introduction of instant messaging apps also allows interaction to be performed via UI elements (Klopfenstein et al., 2017).

Accessibility. Measures how accessible channels are to users. Instant messaging apps, for instance, are more accessible than face-to-face communication (since the latter requires the interaction actors to meet in-person), but less accessible than SMS (since IM apps require an Internet connection).

Cost Saving. Is an important aspect for users and organizations alike. Each communication channel has different costs associated: the cost of a face-to-face interaction is expressed in terms of commute; the cost of using instant messaging apps is related with internet access; and communicating via SMS or phone calls has costs per message and per phone call, respectively.

When communicating in-person (face-to-face), the actors of the interaction have access to immediate feedback and full visual and audio cues. The focus of the communication is personal and they can use both body and natural language to communicate. However,

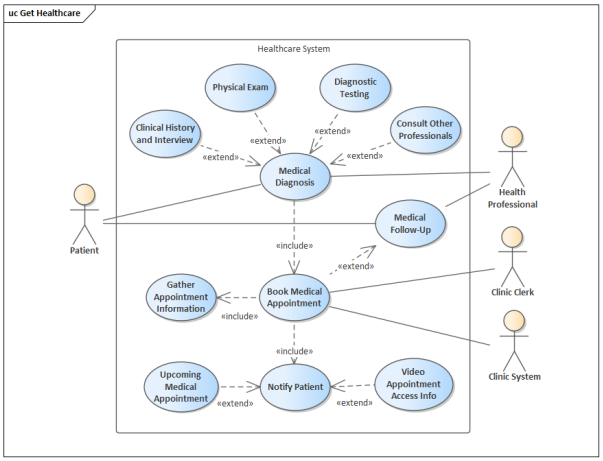

Figure 1: Use cases performed by patients in the healthcare domain.

communicating in-person requires the actors to meet, therefore it has very low accessibility and costs associated with commute.

Video-conference provides a similar experience to face-to-face, however, it only provides limited visual and audio cues, since the interaction occurs through a screen. It has low accessibility since, usually, a specific software is required and has costs associated with internet access.

Phone calls only provide limited audio cues and the feedback is not as immediate as the previous alternatives, thus being classified as *fast*. The focus is still personal, however, it only allows the use of natural language. The accessibility is very high, since the actors only need their mobile phones and no additional software is required and the costs are associated with the cost of each call.

As for instant messaging platforms, feedback is slower than in the previous alternatives, since it requires typing a message or recording an audio or video. It provides limited visual and audio cues, personal focus and a great variety of language types (body - in case of a recorded video -, natural and GUI - it is possible to use interface elements such as quick-replies or carousels). Their accessibility is also high, since most people use instant messaging platforms in their every day life, however, not as high as phone calls, since they require Internet access.

Web portals and mobile apps are similar in factor classification. They both provide medium feedback, since the interaction is faster when compared to instant messaging. Typically they rely on visual elements, providing limited visual cues and allowing users to communicate only via traditional GUI. Furthermore, they have an impersonal focus and require Internet access. Mobile apps are more accessible than web portals, since they can be accessed through a mobile phone.

There are also web portals and mobile apps that support instant messaging. This is the case, for instance, of applications who provide both the traditional GUI and a chat window, through which users can communicate with a human operator or chatbot. In this case, the factors are similar to the traditional web portals and mobile apps, however, feedback becomes slower, since messages take longer to write than GUI interaction. Moreover, they support limited visual and audio cues and the possibility of communicating via natural language.

E-mail is the slowest of all mediums, since it usually relies on formal messages written using natural language, which take longer to write. It is a channel that provides limited visual cues and is impersonal. It has high accessibility, since it is available on mobile phones and its costs are associated with Internet access.

SMS is a similar medium to instant messaging platforms, however, its cues only include text, therefore it only supports natural language. Its accessibility is very high and similar to phone calls, since SMS is available on all mobile phones and has a cost per message sent.

It is worth mentioning that the digital channels through which it is possible to communicate using natural language (such as instant messaging applications or SMS) can be integrated with chatbots. For certain use cases, the bot's performance may present advantages when compared with human operators, thus providing more consistent and scalable services (Ferreira and Vasconcelos, 2019).

3.1.2 Channel Selection Process

Using the factors presented in the previous section, it is possible to select and, afterwards, prioritize the channels that are suitable for the given use cases.

Firstly, it is necessary to filter out channels that can not be used in a use case. For instance, if a use case has to be performed in-person, requiring full visual and audio cues, it is possible to filter out all other alternatives. Afterwards, the remaining channels can be prioritized. The Analytic Hierarchic Process (AHP) (Kostelník et al., 2019) is used to tackle this issue, not only because it is widely use in information technology related fields when making decisions, but also because it allows to measure non-quantifiable criteria. Additionally, it has the advantage of being easily understood by general audiences (Kostelník et al., 2019).

The *channel selection process* is thus defined as follows:

1. Assessment of the channels. For each use case:
   (a) Define the minimum requirements (if necessary) for the first 4 factors: feedback, multiple cues, personal focus and language variety.
   (b) Filter out the channels that do not comply with the minimum requirements.
      i. If only one channel remains, the channel selection process stops and that channel is considered as the only suitable option.
      ii. If more than one channel remains, continue to step 2.
2. Prioritization of the channels (using the Analytical Hierarchy Process). For each use case:
   (a) Perform a series of pairwise comparisons, by comparing all factors to one another, using the Saaty method.
   (b) Compute the priority scores.
   (c) Prioritize channels that have greater priority scores.

3.2 Healthcare Use Cases

This section presents use cases in healthcare (see Figure 1) that can benefit from the application of the Communication Channel Selection Process. These use case definitions are based on the Related Work presented in Section 2.4.

3.2.1 UC1: Medical Diagnosis

Use Case Definition. Diagnosis is a patient-centered activity that involves information gathering and clinical reasoning to determine a patient's health problem (Ferreira and Vasconcelos, 2019). This use case is performed by patients who have a health issue and are looking for a diagnosis. In order to understand and diagnose the patient, health professionals may resort to several approaches: (1) perform clinical history and interview, (2) conduct physical exams, (3) perform diagnostic testing, and (4) consulting with other clinicians (Ferreira and Vasconcelos, 2019). Additionally, this use case includes "Book Medical Appointment" (see Figure 1). It is typically performed in-person or through a video-conference.

3.2.2 UC2: Medical Follow-up

Use Case Definition. Follow-up is a patient-centered activity dedicated to patients who have already been diagnosed and are currently being monitored. Patients may schedule an appointment beforehand ("Book Medical Appointment") or they may contact the health professional directly. Furthermore, this use case is typically performed in-person or through a video-conference, however, instant messaging applications, SMS and e-mail have also been used in the past.

3.2.3 UC3: Book Medical Appointment

Use Case Definition. To schedule a medical appointment, patients have to specify multiple parameters (include "Gather Appointment Information", see Figure 1): the desired specialty, the desired and available doctor, the desired and available time slot and whether they desire a video-consultation (see Figures 2 and 3). Some days prior to the consultation, patients are notified of the upcoming appointment (include "Notify Patient") and, if it is a video-conference, how to access the consultation.

This use case is typically achieved with clerks at the clinic (in-person or through phone calls) or using clinic's systems (such as portals). As for the notifications, phone calls, SMS or e-mail are usually used.

4 CHANNEL SELECTION APPROACH IN THE HEALTHCARE CONTEXT

The selection process is applied to the healthcare use cases introduced previously: medical diagnosis (UC1), medical follow-up (UC2) and appointment scheduling (UC3).

The first step is to filter out the channels that do not comply with the minimum requirements for each use case. UC1 and UC2 are more complex

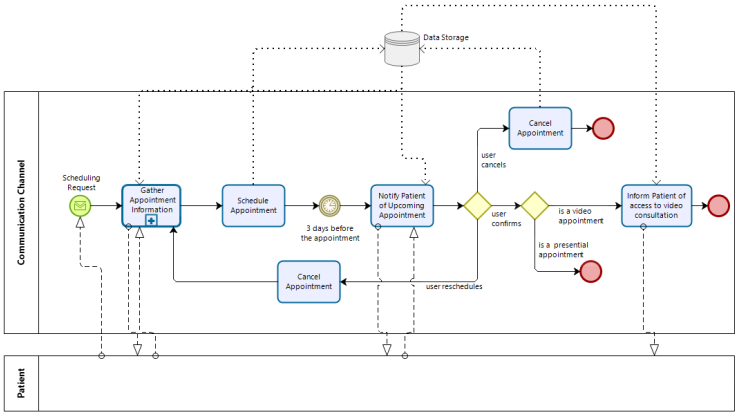

Figure 2: Scheduling an appointment business process (based on (Ferreira and Vasconcelos, 2019)).

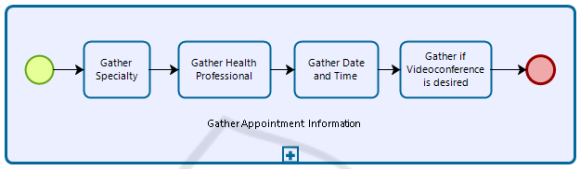

Figure 3: Gather Appointment Information subprocess (based on (Ferreira and Vasconcelos, 2019)).

and patient-centered when compared to the other use cases. In fact, UC1 ideally requires immediate feedback, personal focus, body and natural language and at least, limited visual and audio cues. This is important because during the phase of diagnosis it is important for patients to understand the information being conveyed to them as unequivocally as possible. Therefore, only face-to-face and videoconferencing are suitable for UC1. UC2 is more flexible, however, it still requires personal focus, may require body and natural language, and at least, limited visual and audio cues. As a result, face-to-face, video-conference, phone call and instant messaging apps are suitable for UC2. UC3 can, in theory, be performed using any of the channels, so it requires no restrictions.

The second step is prioritizing the remaining channels. One can start by comparing all factors in a pairwise manner, using the Saaty method. The computed weights, resulting from this method, can be observed in Table 3. Next, the channels need to be scored from 1-5 across the 6 considered factors. Based on Tables 1 and 2, it is possible to grant with them scores shown in Table 4. Finally, the weighted scores for each communication channel are computed, as presented in Table 5.

From the obtained results, we can verify that UC1 and UC2 achieve similar results in terms of prioritization. Therefore, if possible, patients should opt to have diagnosis and follow-up consultations in person before opting for video-conferences. Additionally, for follow-up, patients can also resort to phone calls or instant messaging platforms.

As for UC3, all channels can, in theory, be used. However, instant messaging applications and web/mobile applications with instant messaging rank higher than the other ones. This result can be attributed to their higher scores in language variety, accessibility and cost, which are the most important factors when performing this use case. Therefore, when implementing UC3 in a multi-channel architecture, although all channels are considered suitable, these should be prioritized.

5 CONCLUSIONS

Multi-channel and omni-channel strategies are trends in many industries toward the use of multi-channel approaches to bring users and organizations closer. The services provided through these channels can be leveraged by using chatbots, allowing the user for a simpler and more natural experience. However, this entails designing architectures that make services available through multiple channels, while making the users' experiences coherent as they switch between them. This also means that organizations should be ready to select suitable channels and prioritize them.

As presented in the Related Work of this article, there are a couple of works that aim to address these

Table 3: Weights of each factor per Use Case.

	Feedback	Multiple cues	Personal focus	Language variety	Accessibility	Cost saving
UC1	0.234	0.234	0.234	0.234	0.042	0.021
UC2	0.228	0.228	0.228	0.228	0.062	0.024
UC3	0.061	0.025	0.028	0.289	0.298	0.298

Table 4: Classification of communication channels, according to the factors that influence suitability.

Channel	**Feedback**	**Multiple Cues**	**Personal Focus**	**Language Variety**	**Accessibility**	**Cost Saving**
Face-to-face	5	5	5	5	1	1
Videoconference	4	4	4	4	2	5
Phone call	4	3	3	3	5	2
OIS	2	4	4	4	4	5
Web app (without IM)	3	2	1	1	3	5
Web app (with IM)	2	4	1	4	3	5
Mobile app (without IM)	3	2	1	1	4	5
Mobile app (with IM)	2	4	1	4	4	5
E-mail	1	2	2	3	4	5
SMS	2	1	2	3	5	3

Table 5: Channel prioritization scores.

	Face-to-Face	Video Conference	Phone call	Instant messaging platform	Web portal without IM	Web portal with IM	Mobile app without IM	Mobile app with IM	E-mail	SMS
UC1	4.743	3.933	-	-	-	-	-	-	-	-
UC2	4.646	3.892	3.322	3.356	-	-	-	-	-	-
UC3	2.611	3.698	3.356	4.172	2.934	3.79	3.232	4.088	3.716	3.454

issues. The one that is the closest to reaching this goal (Androutsopoulou et al., 2019) aims to expand the channels through which Greek citizens interact with governmental services. Even though the authors present Media Richness Theory and Channel Expansion Theory as a basis for their work, it is not clear how they are able to select and prioritize channels. However, both these theories present ways to classify the richness of communication channels, resorting to objective and subjective factors.

5.1 Major Contributions

In Section 2.2 we have explored the Chatbot Use Case Evaluator, which allows the evaluation of a set of use cases and enables the identification of the more suitable ones for a bot implementation. This process, allied with the Channel Selection Process, could allow organizations to identify not only whether a use case should be implemented in a bot, but also prioritize channels through which a use case should be available.

To address these needs, this work proposes a systematic approach to select and prioritize communication channels based on six factors: feedback, multiple cues, personal focus, language variety, accessibility and cost.

Finally, the Channel Selection Process was applied to three use cases in the healthcare domain (diagnosis, follow-up and appointment booking). From the obtained results, patients should opt to have diagnosis and follow-up consultations in-person before opting for video-conferences. Additionally, for follow-up, patients can also resort to phone calls or instant messaging platforms. As for the appointment scheduling use case, all channels were concluded to be suitable, however, instant messaging applications and web/mobile applications with instant messaging should be prioritized.

5.2 Limitations of the Current Study

The first limitation of this study is that, although there are many works addressing the classification of communication channels according to their richness, there is a lack of research regarding processes for channel

selection and prioritization. Moreover, there is also a lack of experimental results. Therefore, it is difficult to evaluate the results of this process when compared with other selection methodologies.

5.3 Future Work

Future work can be developed in order to further improve and validate the proposed channel selection process. In terms of evaluation, another use cases should be assessed. Furthermore, another communication channel factors can be explored in the healthcare domain (for instance, regarding the privacy and confidentiality of the mediums).

Additionally, an architecture that is able to integrate multiple channels, while providing a seamless experience to users can be proposed and implemented. This architecture could not only provide coherent information across channels, but also allow users to finish uncompleted actions across them. Besides, this implementation would allow the evaluation of the selection process. User tests could then be conducted, measuring the success and efficiency of task completion across different channels and allowing a performance comparison between them.

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