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Chatbot in the Online Provision of Government Services

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Abstract

The provision of Government services has been challenging due to their complexity. Citizens use digital channels to obtain generalized information and perform simple services, but many still prefer traditional channels for more complex requests. This paper presents the chatbot prototype SIGMA as a new digital channel for services provided in the form of dialogs. It is instantiated in the context of the Portuguese National Portal for Government services. It uses Natural Language Processing (NLP) to interpret the intentions of citizens, allowing greater expressiveness in the more complex requests. To provide services in the informative phase, the chatbot provides information structured according to the Core Public Services Vocabulary (CPSV) model. This simplifies the data model of services while making it reusable and extensible.

Keywords: Chatbot; Government; Natural Language Processing; Core Public Services Vocabulary; Artificial Intelligence

1. INTRODUCTION

In the past decades, Artificial Intelligence (AI) became more and more relevant. One of the emerging technologies that use AI is chatbots. They can interact with users through conversation interfaces (text or speech) and provides information, services, assistance or entertainment (Klopfenstein, Delpriori, Malatini, & Bogliolo, 2017; Shawar & Atwell, 2007).

The idea of creating a computational program conversing with humans was first presented by Alan Turing (Turing, 1950) and the Turing Test aims to determine if a program can appear human. One of the earliest chatbots was ELIZA (Weizenbaum, 1966). More chatbots were created by time, with ALICE (Artificial Linguistic Internet Computer Entity) being one of the most popular chatbots that won the Loebner prize (attributed to the best chatbots that appear human) in 2000, 2001 and 2004.

Nowadays chatbots can integrate components such as Natural Language Processing (NLP) to identify patterns, intentions, and concepts during conversations. It can also use knowledge bases[1] that use keywords and synonyms to provide information (Bradeško & Mladenić, 2012).

[1] A store of information or data.

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By monitoring the conversations and by registering user feedback, it's possible to perform continuous supervised training. This improves the chatbot's interpretation and response capacity which improves their service provision.

The complexity of Government services makes its provision in digital channels difficult. An effective and efficient provision can reduce the costs from traditional channels (face-to-face or telephone). It can also reduce the time citizens spend to be physically present at the public service counters (Arendsen & Engers, 2004). Citizens use digital channels to obtain non-personalized information and to perform simple service transactions. But many still prefer traditional channels when the request is more specific (Madsen & Kræmmergaard, 2015).

Chatbots have also been researched in the public sector (Razquin & Iñigo, 2018; Boden, Fischer, Herbig, & Spierling, 2006). As a new digital channel, it can improve the communication between citizens and the government and it allows greater expressiveness (Androutsopoulou, Karacapilidis, Loukis, & Charalabidis, 2018). Through dialogs, chatbots can provide Government services even under specific circumstances (Tambouris, Outsetari, & Tarabanis, 2012; Tambouris, 2018).

Another challenge in the provision of services is the structuring of information. The Core Public Service Vocabularies[2] (CPSV) is a model that simplifies and normalizes the Government services data model, improving reusability and extensibility.

This research studies the impact of chatbots on Government service provision. The research method used in this work is the Design Science Research Methodology (DSRM) (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

This work presents the case study of SIGMA, a chatbot implemented for the Portuguese National Portal for Government services (ePortugal.gov.pt). SIGMA aims to facilitate the provision of services using NLP, to allow greater expressiveness to cover the more complex citizen service scenarios. It provides information obtained from the Catalog of Entities and Services (CES), which is an application developed by the Administrative Modernization Agency (AMA). CES provides information structured according to the CPSV model.

This work evaluates the preliminary results of the chatbot prototype, showing its capacity to evolve in terms of interpretation and service provision.

[2] https://joinup.ec.europa.eu/solution/core-public-service-vocabulary/about

2. RELATED WORK

This section presents the existing work that supports this research, to provide a better perception of the existing knowledge and tools that are relevant for the proposed solution.

2.1. Chatbots

A chatbot is an application that can appear human and assist its users to achieve different goals during interactions. The application receives and processes the text extracted from the messages from the users and reply according to its interpretation.

There are different techniques and approaches that chatbots can use to process the extracted text (Bradeško & Mladenić, 2012):

1. **Parsing:** text analysis and manipulation using NLP functions.
2. **Pattern matching:** pattern detection using matching types, such as natural language inquiries, simple statements, or semantic meaning of inquiries.
3. **Interaction flow:** determination of the chatbot interaction flow using pattern matching such as AIML (Artificial Intelligence Markup Language), or ChatScript.
4. **SQL and relational database:** response improvement by using data from previous interactions.
5. **Markov Chain:** responses construction based on correspondence probability.
6. **Language tricks:** predefined responses that improve the simulation of human responses, such as chitchat[3], typing indicators, or alternate responses.
7. **Ontologies:** use of semantic networks (set of concepts interconnected relationally and hierarchically) to process text using synonyms, hyponyms and other conceptual relations found in natural language.

The efficacy of these techniques is demonstrated in chatbots that won the Loebner prize, as well as other chatbots that used the same techniques and approaches (Abdul-Kader & Woods, 2015).

Besides text, chatbots and its users can interact in the form of speech, images, and video and audio. It's possible to implement a more interactive graphics interface, improve usability and have richer and more expressive interactions (Klopfenstein, Delpriori, Malatini, & Bogliolo, 2017).

Nowadays chatbots can be deployed to different IM (Instant Messaging) channels. The communication can be more stable and asynchronous (users can pause and resume conversations) and it can be available on any platform (operating system or device). Chatbots can even use authentication and integrated payment.

[3] Inconsequential conversation.

2.2. Application of chatbots in Government

Government service provision has been challenging due to its complexity. There are different kinds of provision channels, namely:

- **Traditional channels:** face-to-face or telephone interaction.
- **Digital channels:** portals that provide information or ways to perform services.

Citizens use digital channels to obtain general information and perform simple services. To lower their preference for traditional channels, digital channels must cover the more complex requests.

The following studies (Table 1) supports chatbots as a new digital channel that can provide a more complex service provision:

STUDY	DESCRIPTION
(Androutsopoulou, Karacapilidis, Loukis, & Charalabidis, 2018)	Creation of an architecture model of an ICT platform that uses chatbot technology. Government specialists were involved in this creation. The viability of this artifact is validated through simulated service provision scenarios. This validation shows the possibility to contemplate some level of personalization and complexity.
(Tambouris, Outsetari, & Tarabanis, 2012)	Shows the possibility of providing services in the more complex scenarios through the form of dialogs.
(Razquin & Iñigo, 2018)	Instantiation of a chatbot solution. The prototype was developed for a public entity and tested with a small group of users. It was effective and efficient in assisting its users to perform services. Many users were not aware of the existing online services, which showed a better communication of existing digital channels is needed. User expectations on chatbot intelligence also influenced their interaction with chatbots.

Table 1 – studies on chatbots and dialog interactions for Government service provision

To demonstrate the efficacy and efficiency of chatbots in service provision, it's important to study and validate more prototype instantiations in different scenarios.

2.3. Core Public Service Vocabularies

To provide information about Government services it must be simplified and structured.

The provision of services can be presented in two phases (Tambouris, Outsetari, & Tarabanis, 2012):

- **Informative phase:** provision of the information required to perform a service.
- **Performative phase:** execution of a service transaction after obtaining the necessary information and conditions.

The provision of services in the informative phase is critical for the optimization of the performative phase. During the informative phase, citizens search for information about the services they need to perform, such as the required conditions or how can it be performed. This information can be structured in the following ways:

- **Unstructured:** information is presented without content structuring, in plain text.
- **Structured:** information is structured according to a normalized model applied to all services.
- **Structured in dialogs:** information is structured in dialog flows and provided to users during question and answer based interactions.

The dialog-based structuring allows the contemplation of the more complex scenarios where users need personalized information. Presenting specific information avoids excessive information that is irrelevant to specific scenarios.

The provision of structured information of Government services in a chatbot is presented by a study that presents the CPSV model as a potential solution (Tambouris, 2018). The CPSV is a simplified, reusable and extensible data model that captures the fundamental characteristics of a public service. This model was presented by the European Union (EU) and it aims to solve interoperability issues.

The referenced study presents an architecture with a web interface layer, a backend layer with AI functionalities, an RDF (Resource Description Framework) layer which contains the structured data according to the CPSV model, and an API (Application Programming Interface) layer which integrates the RDF layer with other layers.

The presented solution aims to improve Government service provision in the informative phase. The CPSV model simplifies and normalizes data structures, and the architecture allows content management by the Government. The same content can be provided to other applications using the API layer.

2.4. Discussion

Design and techniques of chatbot implementation have been evolving in the past decades. NLP technologies became more and more sophisticated and precise, and different implementation strategies improve chatbot user interaction. It's possible to integrate chatbots with new digital channels and IM applications to reach more users.

Recently, chatbots became more relevant in the context of Government service provision, improving the communication between the government and citizens. Because of the service provision complexity, in both informative and performative phases, citizens still prefer traditional channels for more complex scenarios. Chatbots can be used as a new digital channel to cover these scenarios, lowering the adherence of traditional channels and therefore lowering the costs for both citizens and the Government.

The CPSV model can simplify and normalize the complex information about Government services.

Taking into account the more recent trends and functionalities, and the challenges of the Government service provision in digital channels, it's possible to implement chatbots that better addresses both the needs of citizens (obtaining information about services and performing them) and the objectives of Government (improving service provision and reducing its costs).

3. PROPOSED SOLUTION

This section presents different aspects of the chatbot prototype implementation.

The prototype presents the following functionalities:

- Government service provision in both informative and performative phase;
- Provision of information about stores and spaces;
- Registration of contact requests;
- Chitchat conversations.

There are two types of Government services provided by the chatbot:

- **Citizen:** services related to the needs of citizens.
- **Business:** services related to entrepreneurship.

In the informative phase, citizen services are provided in two ways depending on their complexity. The information about some services is provided directly with the associated intent[4] (see section 3.5). For the more complex services, the chatbot asks some questions to provide information specific to the user's scenario. These services are:

- Renew the Citizen Card
- Change the address on the citizen card
- Revalidate the driver license

In the performative phase, the citizen service implemented so far is the following:

- Change the address on the citizen card

In the following subsections, ArchiMate and UML (Unified Modeling Language) annotations are used to describe the architecture, behavior, and communication of different components.

3.1. Use cases

The use case in Figure 1 describes the scenarios of a user that interacts with the chatbot. The user can initiate a conversation and view information about citizen or business services, about stores and spaces, perform a service, request contact or have chitchat conversations.

[4] An intended action from the user.

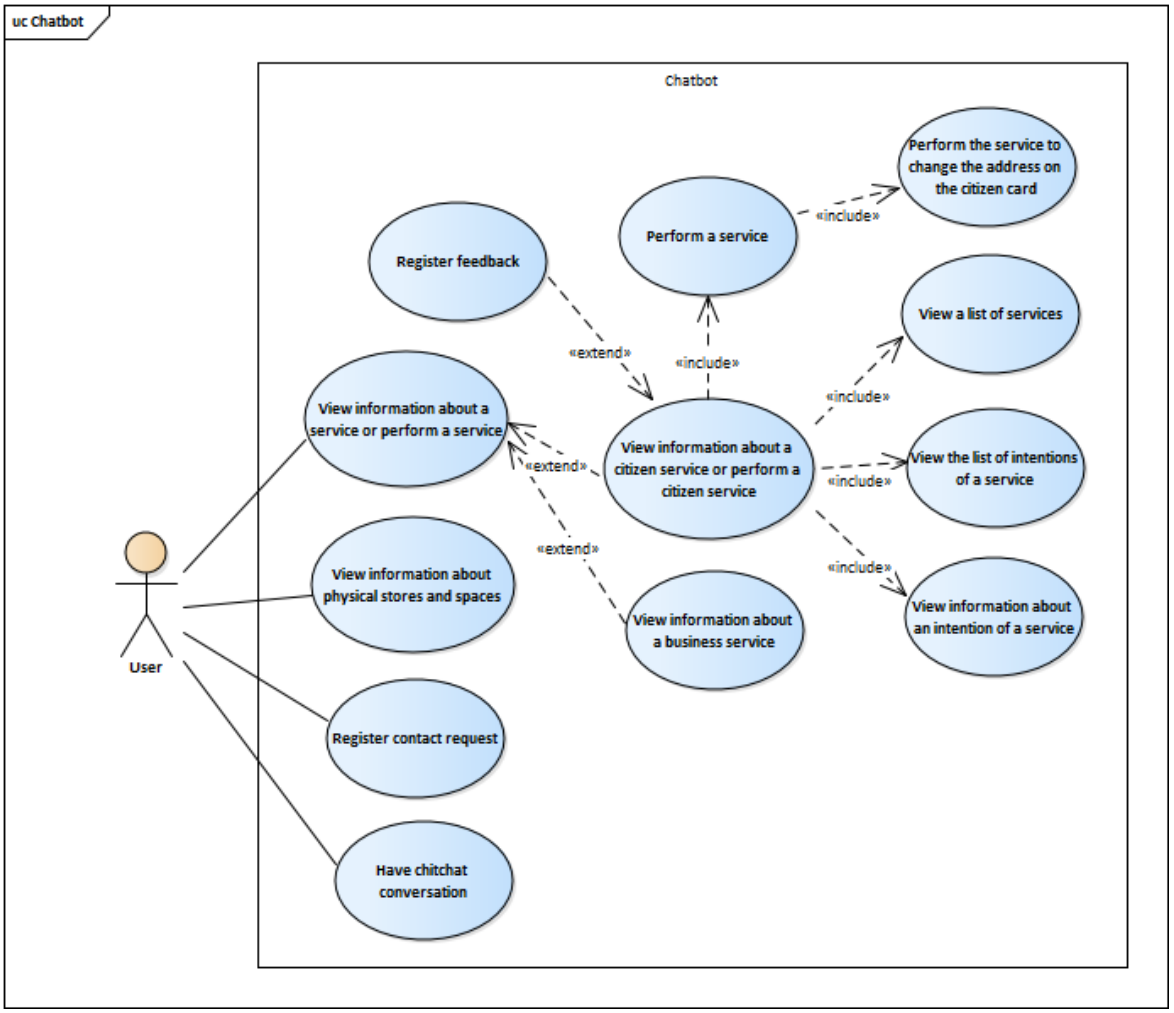

Figure 1 – Use case – Chatbot

Figure 2 describes the scenarios where the chatbot communicates with the Portal to obtain the list of available services (if QnA doesn't return any result), obtain the list of available intents of a service, view information about an intent of a service, register service request, register contact request or register feedback.

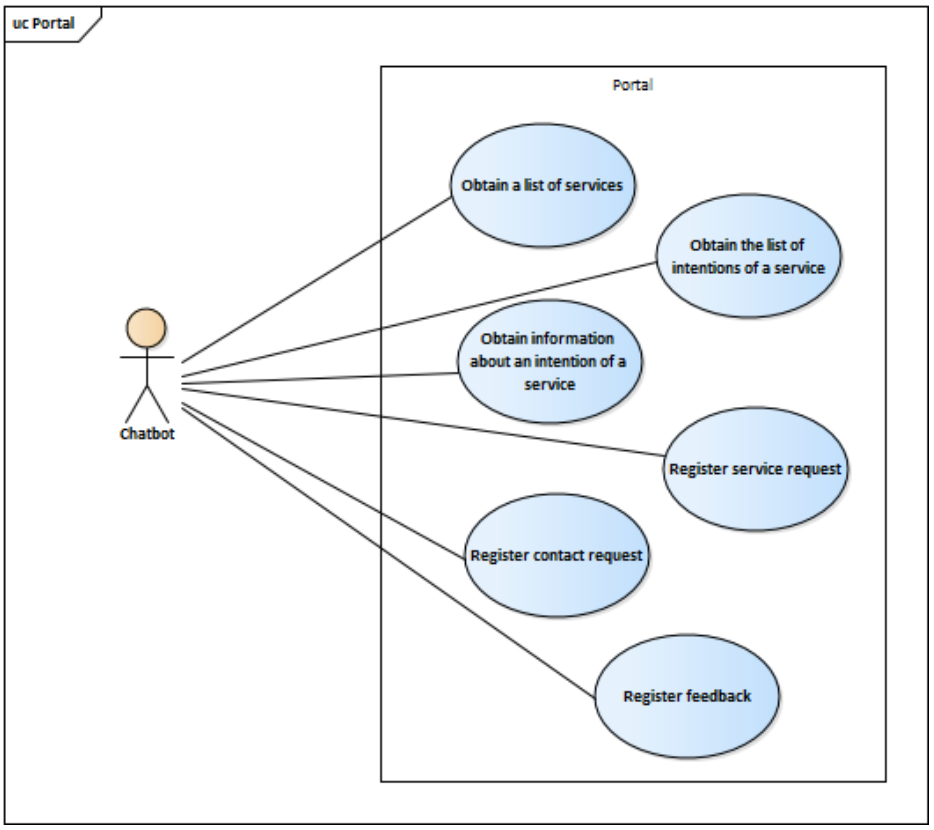

Figure 2 – Use case – Portal

3.2. Systems overview

The prototype presents the following components (Figure 3):

- **Chatbot:** this is the main component of the prototype, which processes the interactions between the chatbot and its user, and executes the dialog flows after the interpretation of the user's intention. This component communicates with others, such as the Portal (ePortugal.gov.pt), the Spellchecker, LUIS (Language Understanding Intelligent Service) and QnA (Question and Answer).
- **Portal:** provides a web application for Government service provision. The chatbot's graphic interface is hosted in the Portal's web pages, allowing citizens to interact with the chatbot. The Portal also provides information and services execution for the chatbot, allowing it to provide Government services in both informative and performative phases.
- **Spellchecker:** corrects spelling mistakes detected in the texts extracted from user messages.
- **LUIS:** interprets and extracts relevant information from the text extracted from user messages. It uses NLP to process texts and ML (Machine Learning) to improve its interpretation capacity through supervised training. LUIS provides the detected intent and entities (relevant keywords found in the text), which are used to determine the dialog flows to be executed.

- **QnA:** works as the knowledge base[5] that provides a list of available Government services and chitchat. The content is organized as questions and its associated answers. The list of Government services is stored in QnA in the form of service names as questions and service IDs as answers.
- **Analytics:** enables the sampling and monitoring of telemetry data. This enables a better perception and analysis of the chatbot performance, as well as its results from interactions with users, which aids the training and improvement of the chatbot.

The prototype is implemented using Microsoft's BotFramework. Spellchecker, LUIS, and QnA are cognitive services provided by Microsoft and included in this prototype. Chatbot communicates with other components using REST (Representational State Transfer) APIs and receives messages from the client-side application (chatbot's graphics interface) through Direct Line API.

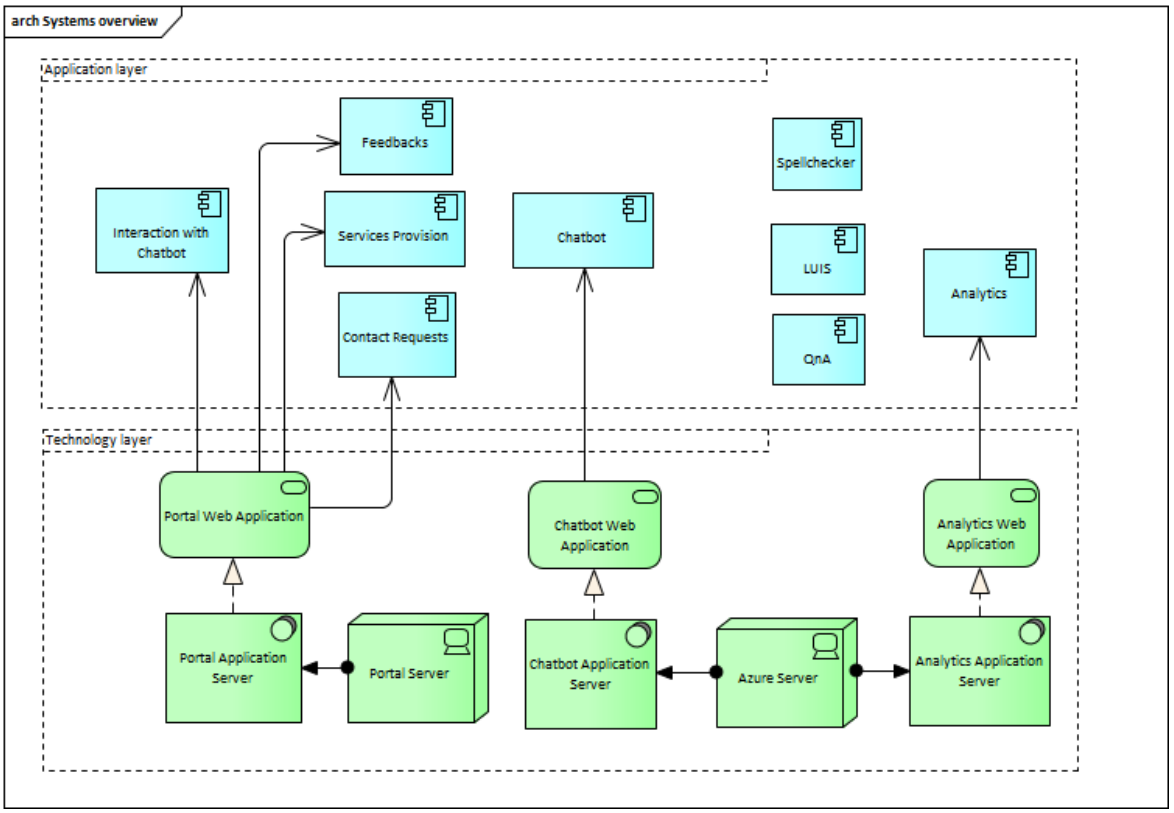

Figure 3 – Systems overview

3.3. System architecture

The architectural layers in Figure 4 describe the cross-layer dependencies of three layers:

- **Technology layer:** technological components of the prototype implementation, such as servers.

[5] A QnA knowledge base consists of a set of questions and answers pairs to store information.

- **Application layer:** application elements such as components and the available interfaces.
- **Business layer:** business elements such as functionalities, actors and roles.

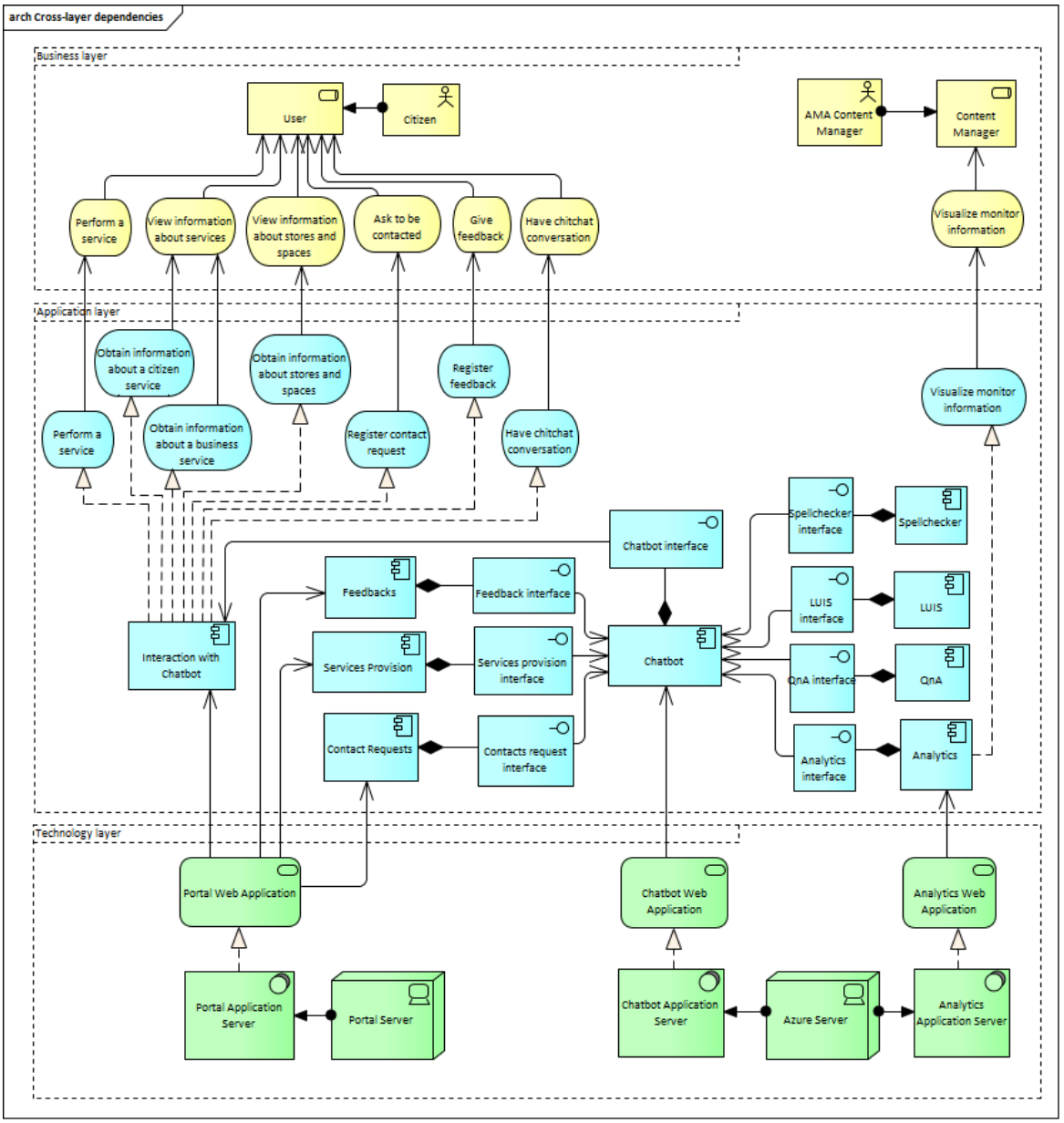

Figure 4 – ArchiMate – cross-layer dependencies

3.4. Components diagram

Figure 5 describes the dependency between the implementation components. The Chatbot component accesses the functionalities of other components through the available interfaces.

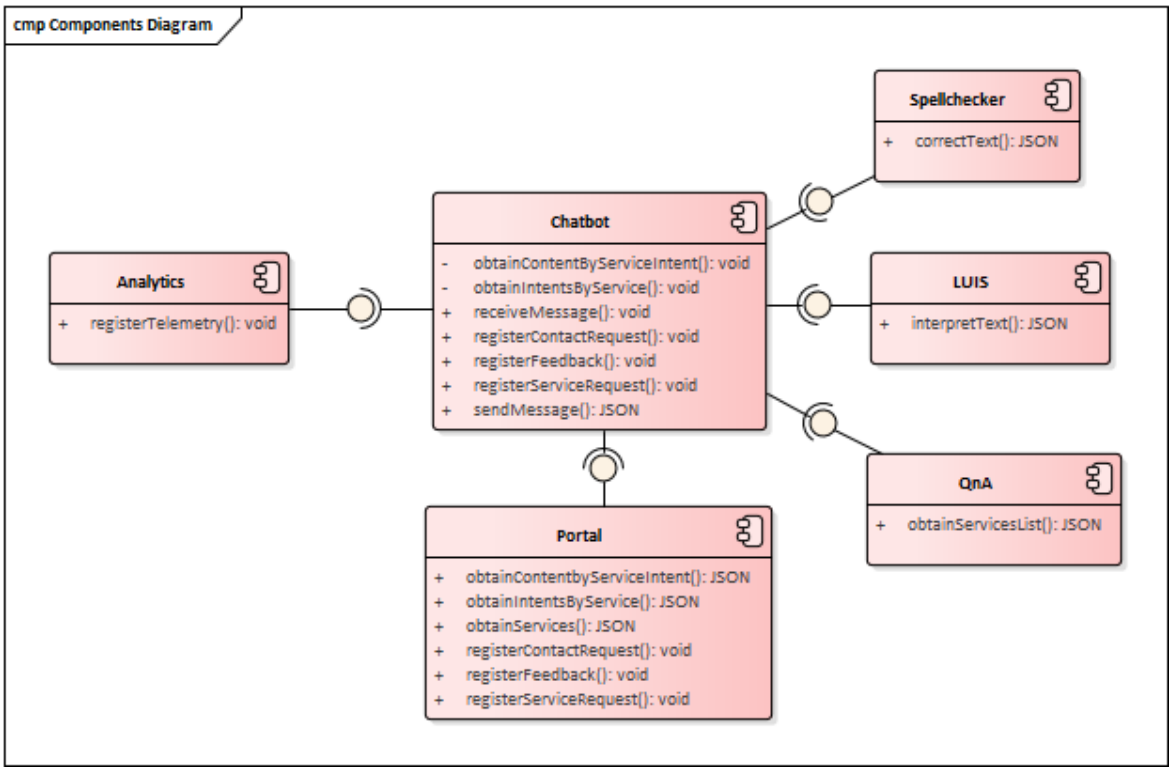

Figure 5 – Components diagram

3.5. Data model

Information about services is provided by the Portal to the chatbot, and it's imported from the Catalog of Entities and Services. CES is the master repository of the data (structured according to the CPSV model) of organizational entities (both public and private) and their available services.

In the Portal, information about services is separated into different types. Each service is characterized by different types of information: Conditions, Contacts, Cost, Where, Why, Deadline, When, Who and Requirements. This structure facilitates the service provision in the informative phase, as the chatbot can show specific parts of a content related to a service.

Figure 6 describes the simplified data structure of the services provided to the chatbot.

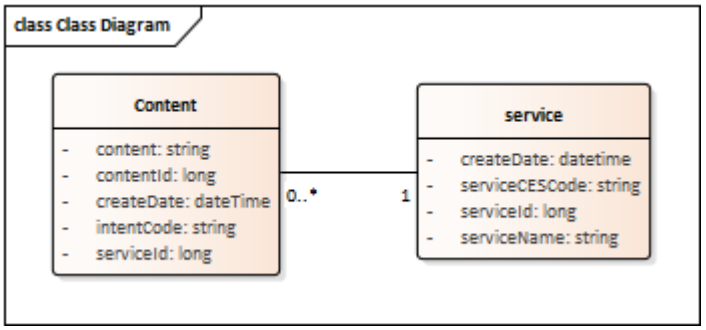

Figure 6 – Class diagram – services data structure

4. DEMONSTRATION

This section describes how the use of the artifact can solve instances of the presented problem and achieve research objectives. In this demonstration, the prototype is instantiated in the context of a National Portal for Government services (ePortugal.gov.pt).

This demonstration presents two scenarios. Both scenarios require contemplation of specific aspects of the citizen that requires the service, and the demonstration shows how the chatbot can provide services in the more complex scenarios.

4.1. Informative phase provision – Revalidate the driving license

This scenario provides information specific to different situations in which users need to revalidate their driving license. The chatbot follows a predefined dialog flow and asks questions to provide the information relevant to the specific scenario (Figure 7, Figure 8 and Figure 9).

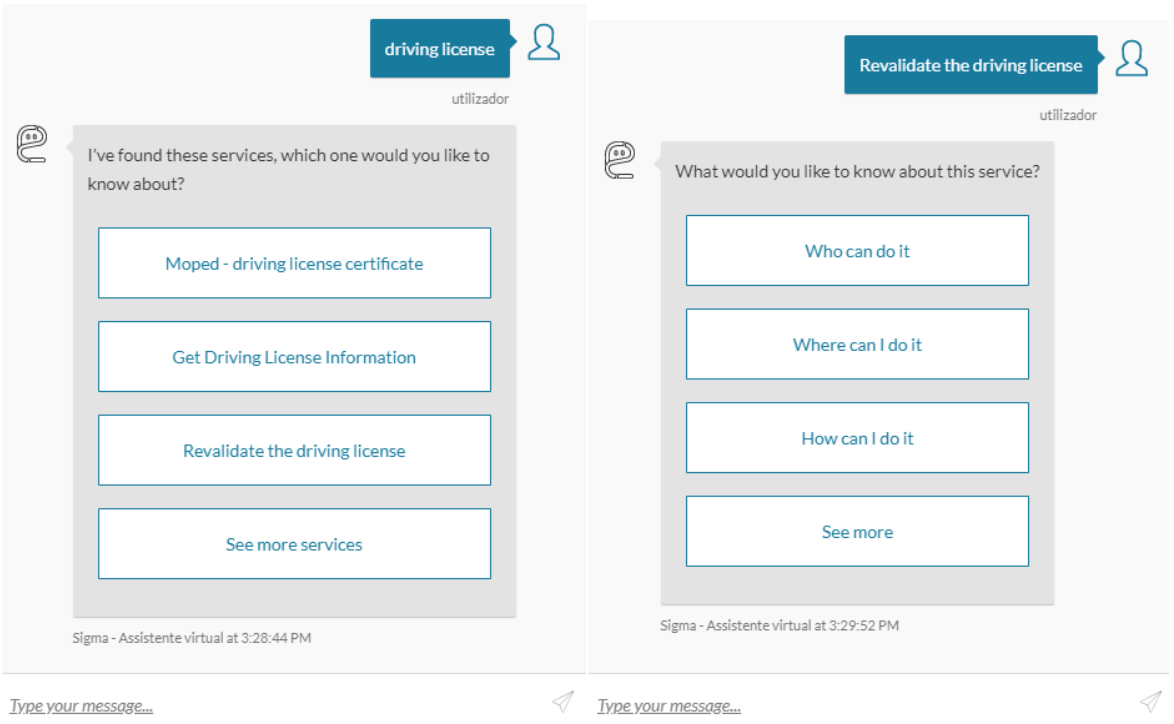

Figure 7 – Demonstration – Revalidate the driving license (1 of 3)

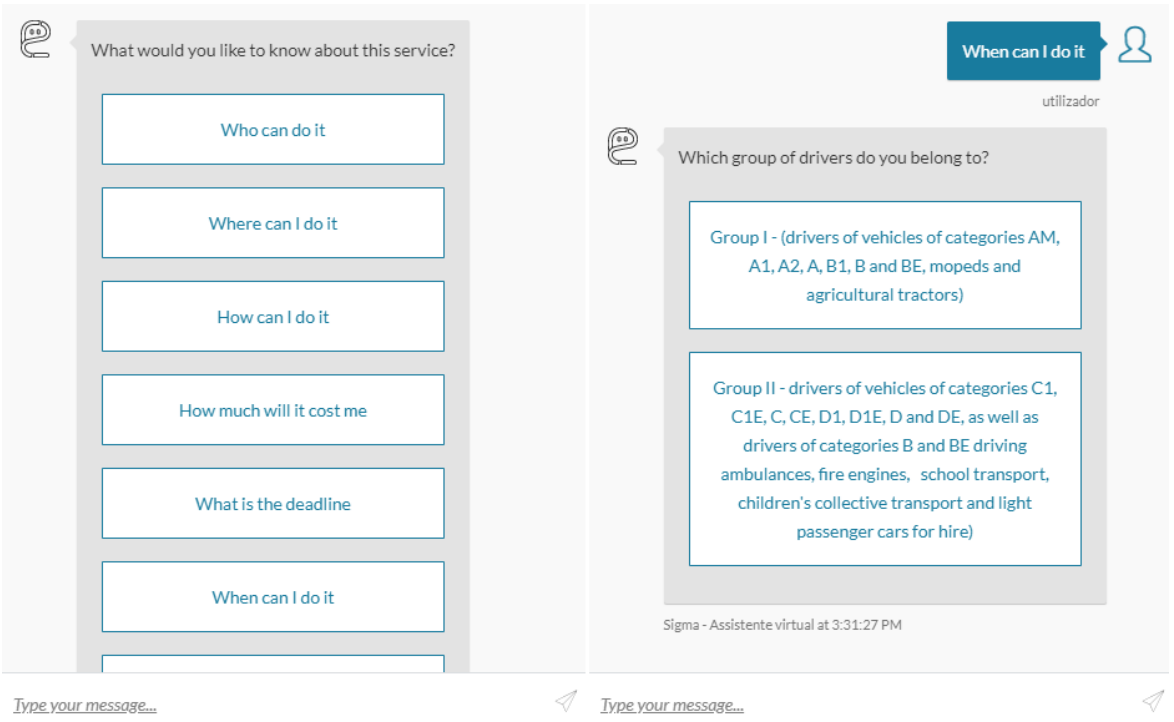

Figure 8 – Demonstration – Revalidate the driving license (2 of 3)

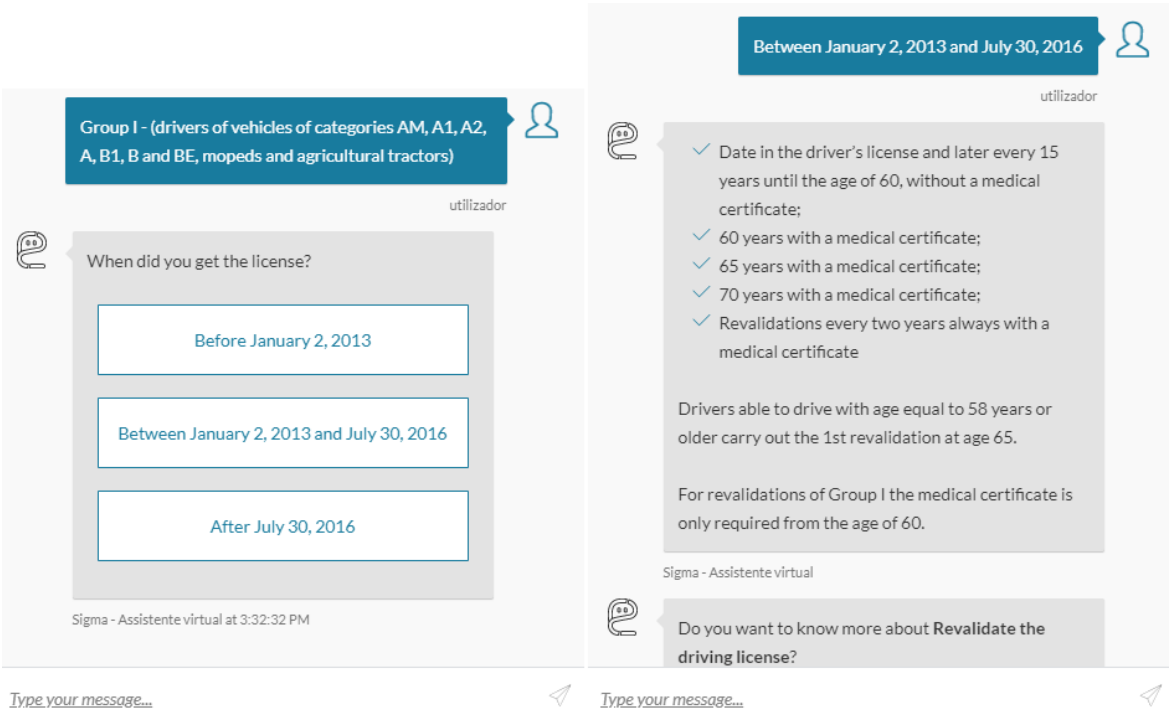

Figure 9 – Demonstration – Revalidate the driving license (3 of 3)

4.2. Performative phase provision – Change the address on the citizen card

This scenario allows users to change the address in their citizen card. The chatbot follows a predefined dialog flow and asks questions to gather the information to perform the service (Figure 10, Figure 11, Figure 12 and Figure 13).

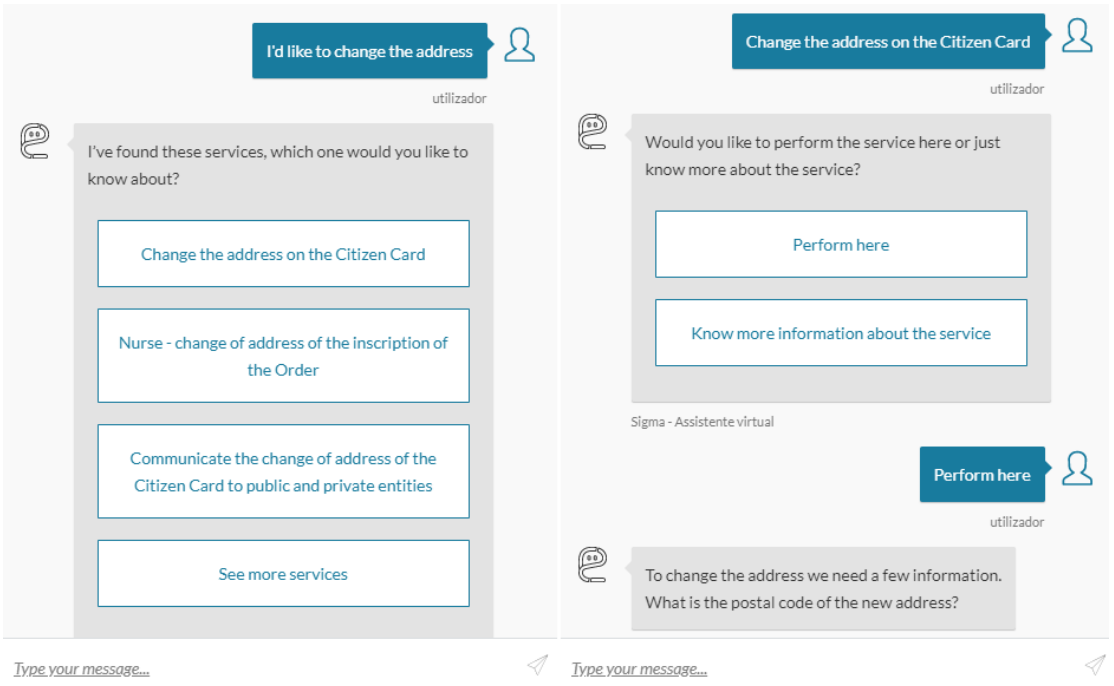

Figure 10 – Demonstration – Change the address on the citizen card (1 of 4)

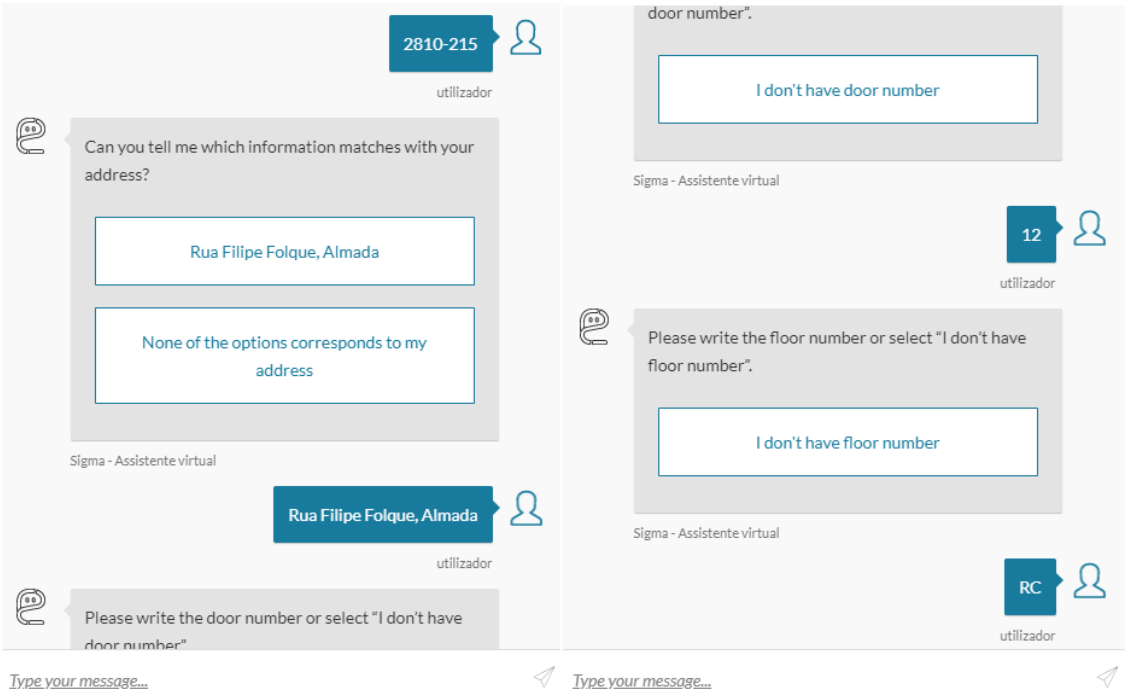

Figure 11 – Demonstration – Change the address on the citizen card (2 of 4)

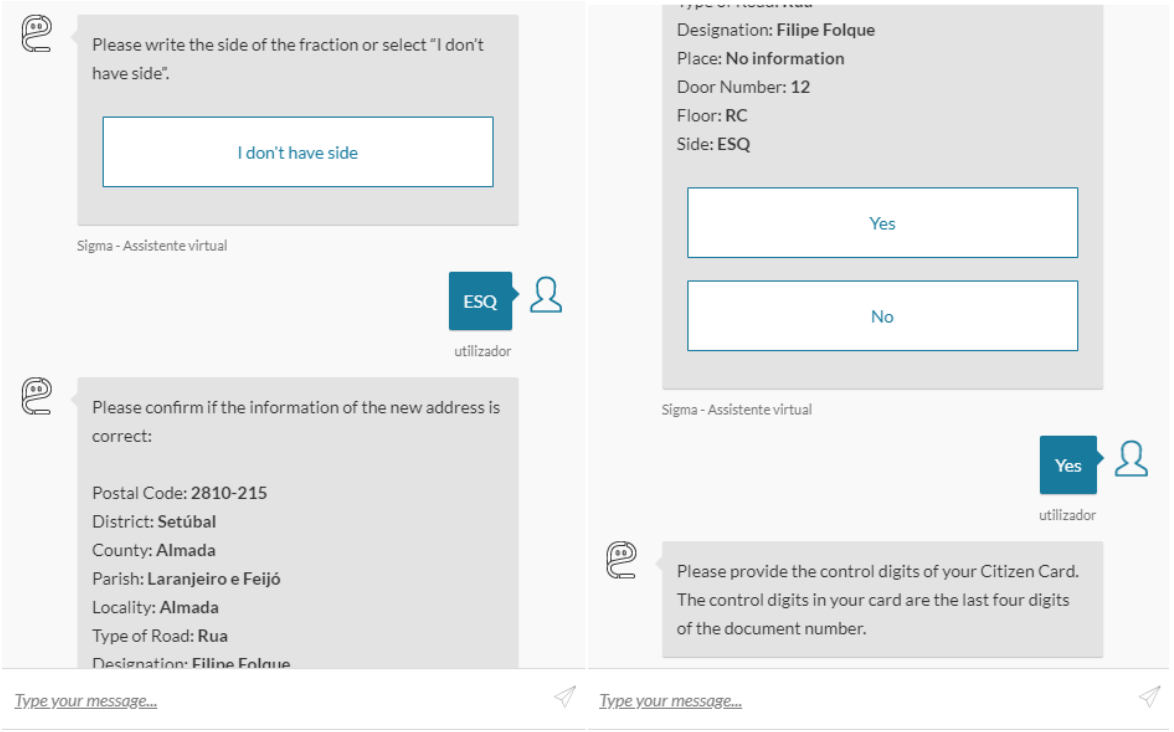

Figure 12 – Demonstration – Change the address on the citizen card (3 of 4)

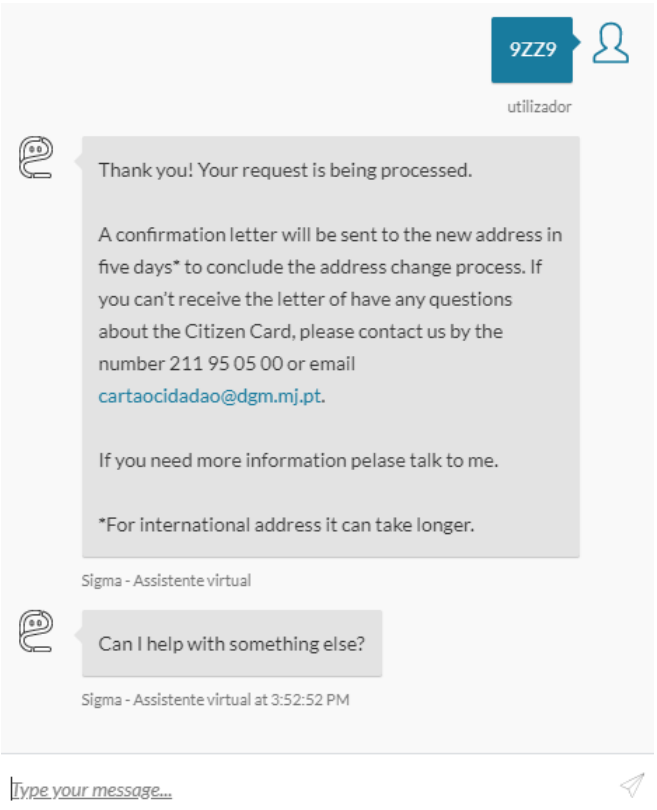

Figure 13 – Demonstration – Change the address on the citizen card (4 of 4)

5. PRELIMINARY EVALUATION

The preliminary evaluation in this work is based on the telemetry data collected from the interactions between the chatbot and its users.

The time range selected for data sampling is between the following dates:

- 15th February 2019 – 01:00:00 GMT
- 16th April 2019 – 01:00:00 GMT

This section presents the evaluation of the chatbot's evolution in its interpretation and response capacity. The data sample shows the statistics of the types of results returned to the user (Figure 14) after the chatbot receives a message and interprets the text within. The types of results are the following:

- **QnA Services:** list of Government services obtained from QnA.
- **QnA Chitchat:** chitchat response.
- **Portal Search:** list of Government services obtained from the Portal, in case QnA doesn't return any relevant result.
- **Citizen Map:** information about a store or space.
- **Contact Portal:** registration of contact request.
- **No Result:** chatbot informs the user that it couldn't understand the user question and asks to reformulate the question.

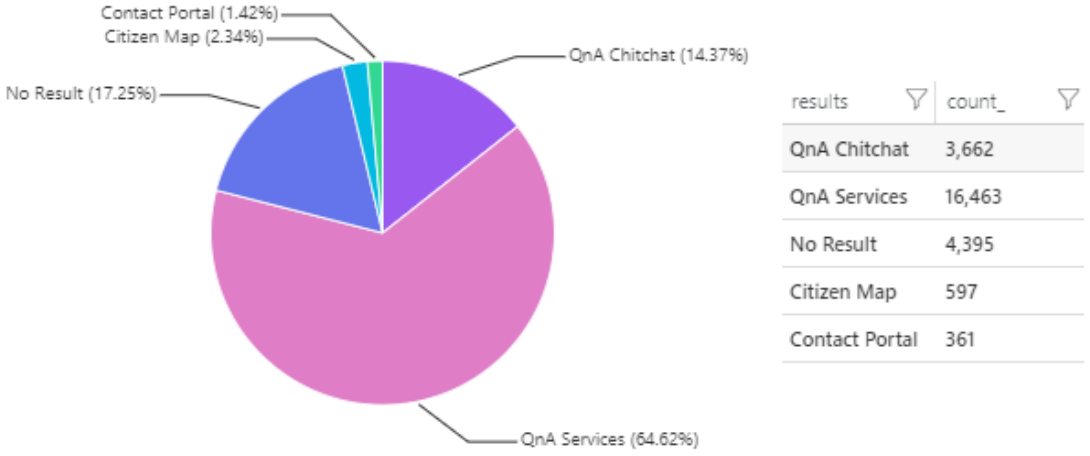

Figure 14 – Results returned to the user

For the selected time range, the percentage of the times chatbot interpreted user message and returned a result is 82.75%. To evaluate the evolution of its interpretation and response capacity, this percentage is also calculated for each day of the selected time range (Figure 15).

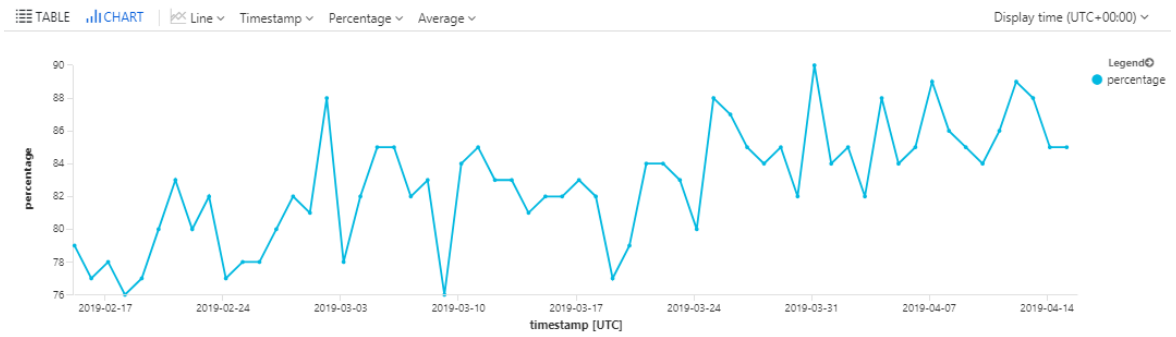

Figure 15 – Evolution of chatbot interpretation and response capacity

Preliminary results show a growth of the percentage of times where the chatbot succeeded in interpreting and responding to users.

6. DISCUSSION

While chatbots have many advantages, adopting a chatbot solution can present some challenges. These can be overcome using different approaches.

6.1. Organizational challenges

One of the barriers is related to the organization's culture. A more progressive culture is generally more open to new adoptions, whereas a more traditional culture can be more reserved towards changes.

One of the ways to foster receptivity is to involve employees early on in the design and development of the chatbot. By doing so, it can increase their acceptance of the delivered solution, and their expertise also contributes to the betterment of the design.

6.2. Supervised training

Training is critical for the chatbot's capacity to interpret users' questions and respond accordingly. Depending on the training platform, supervised training might require a basic understanding of NLP concepts.

To perform effective and efficient training, it's important to define what should be monitored during the conversations. By collecting specific telemetry data and projecting relevant queries, it's possible to understand how different users interact and what kind of questions can be incorporated into the training data. It's also useful to know where the users found most difficulties and therefore improve specific content and conversation flows.

6.3. User awareness and expectations

Users will not adhere to new service provision channels if they are not aware of them. Therefore communication about such channels is very important.

However, their expectations and interaction experience might affect their satisfaction and continuous use. Aside from continuous training, it's important to pay attention to the chatbot's personality, and how they present the contents. An adequate tone makes the interaction more engaging, and the right wording can help users understand that chatbots are programs in progress. At the beginning of the conversation, a brief introduction of what a chatbot can do helps users know what to expect. This can lower their expectations and therefore increase their tolerance for less accurate interpretations.

An adequate fallback or escalation to human contacts can also improve user experience.

6.4. Existing processes and systems

Chatbots should enhance existing processes and systems as an alternate channel that extends existing services. However, integrating existing services with a chatbot can present some challenges. One of them is integrating an existing information provider. The contents need to be normalized and structured in a way that the chatbot can use and provide to its users. In this work, the data model for services is simplified and normalized, making it possible for the chatbot to reuse.

7. CONCLUSIONS

Compared to other digital channels, one of the main advantages of the chatbot is that the users can find the right service without extensive search and navigation. They only need to formulate a question, and the chatbot interprets the natural language and identifies the services to provide.

While it's not yet mature to cover all the complex scenarios covered by traditional channels, it can evolve through supervised training. With the preliminary results, we can conclude that the chatbot's interpretation and response capacity evolved positively. With this evolution, along with the instant availability, chatbots can lower the adherence to the traditional channels and therefore lower the service provision costs of the Government.

These advantages can be applied to solve different organization problems. Chatbots can ease the staff required to provide certain information or services. Its users can also benefit from having an alternate digital channel that is easy to use and instantly available, any time of the day and online.

ACKNOWLEDGMENT

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