The Challenges of Using Arabic Chatbot in Saudi Universities

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***Abstract*—Nowadays, machine-based conversational systems known as chatbots have emerged for many applications in our lives. Chatbots are intelligent tools that use the concept of Artificial Intelligence (AI) in order to communicate with humans using their natural languages. The inherent role of chatbots is to understand users' questions and provide the most appropriate responses intelligently and naturally. Chatbots have been very successful in some of the most spoken languages; however, Arabic chatbots have not reached the expected level. Recently, many researchers have attempted to fill the gap in implementing Arabic chatbots trying to overcome the complex linguistic features of Arabic language. Although Arabic chatbots can be utilized as a supportive tool for Saudi university students, their implementation, especially in Arabic language, is surprisingly neglected. Moreover, during changing the mode of education into distance learning due to (COVID-19) pandemic, it did not help the emergence of Arabic chatbots in Saudi universities. This research focuses on language-related challenges and obstacles that hinder the implementation of Arabic chatbots. Additionally, this paper presents fundamental recommendations for implementing effective Arabic chatbots for academic uses. In summary, it is noticed that Arabic chatbots literature suffers from paucity, which means further studies are needed in this area.**

***Index Terms*—Chatbot, COVID-19 Pandemic, Artificial Intelligence , Natural Language Processing , Machine Learning, Deep Learning, ELIZA, Alice, AIML.**

I. Introduction

THE revolution of information technology during our era predetermines that all governmental and private sectors need rapid progress of digital transformation and mounting development. Our lives are not devoid of using technologies, especially those involve artificial intelligence techniques. Technology has gathered the world societies in a common cyber environment, where every technology that emerges in any place spreads to all applicable societies. A *chatbot* is apopular and prevailing technology that allows people talk to machine using natural language. Consequently, chatbots have become universally ubiquitous.

Recently, chatbots have been useful assistant tools for various applications. In education, chatbots are considered suitable software for teaching, learning, and supporting academia [1], [2], [3]. They also can be used in health sector to advise and assist patients [4][5]. Chatbots have enhanced e-commerce experience by providing 24/7 customer service machine agents [6], [7], [8]. Chatbots have proved their usefulness in consulting and advising as well as answering frequently asked question [9], [10], [11], [12]. Moreover, chatbots have contributed to facilitating web information access directly and quickly using natural language [13]. Furthermore, chatbots have even gone beyond ordinary uses towards Internet of Things (IoT) for home building automation as an example [14], [15]. Chatbots are expected to be a prominent part of our lives and civil behaviors in future [16].

Since (COVID-19) pandemic had unexpectedly outbroken, help desks became unreachable for handling too many calls [17]. Likewise, the government of Saudi Arabia suspended attendance at workplaces in all governmental agencies including universities [18]. This sudden act made universities' students support centers and admission and registration offices unable to handle the massive number of inquiries due to the lack of enough resources. Many institutions and organizations have used well-known platforms to deploy their own chatbots to provide beneficiaries with information and reply to their most common questions [17]. Since the COVID-19 pandemic caused suspension of attendance at workplaces in Saudi universities, the question that arises is whether Saudi universities have launched Arabic chatbots to mitigate the burden on their resources by curious students or not.

A chatbot is highly dependent on *human natural language* in interaction. This particular feature challenges the effectiveness of chatbots so that its severity varies from one language to another. Several studies have investigated and thoroughly covered chatbots feasibility in many international languages. However, Arabic chatbots seem to have unexpectedly less attention by researchers. This research investigates the challenges of Arabic chatbots emergence, specifically in Saudi universities.

This research aims to answer the following questions:

1) *Are Arabic chatbots utilized in Saudi universities?*
2) *Does the nature of Arabic language impede the implementation of chatbots?*

This paper is structured as follows; (1) a brief background of chatbots and their features, (2) the results of Arabic chatbots emergence on Saudi universities' websites, (3) illustrating the results of an experimental test performed on a governmental Arabic chatbot, (4) description and discussion of challenges against utilization of Arabic chatbots in Saudi universities (5) recommendations for implementing Arabic chatbots that support university students.

II. Background

A chatbot is a well-known term for an interactive conversational technique between a human and a computer using the natural language of the human. Therefore, users communicate with distance agents without knowing they are talking to machines as long as they can find accurate answers to their questions [19]. Undoubtedly, the emergence of chatbots has

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TABLE I: List of Chatbot Characteristics.

No	Characteristic	Description
1	Knowledge Base Techniques	They source of how a chatbot can obtain related information for providing correct responses.
2	Functions	The role of which information and services that a chatbot can deliver.
3	Approaches	The way that a chatbot uses to return the most convenient response to an end-user.
4	Conversation Length	The ability of handling series of questions on a certain topic without being lost.
5	Interaction Media	The different types of media which a chatbot is designed to use during interacting with a user.
6	Domains	A chatbot implemented to make dialogues in a specific or wide-open context or topic.
7	Languages	The number of spoken languages that a chabot can understand.
8	Licenses	Refers to the type of chatbot software which can be free or paid.
9	Answer reaches	A chatbot stretches out a conversation in a specified direction in order to lead the user to the right answer.
10	Hombot	Means adding an human in the loop when a robot cannot handle users' questions.

encouraged both business owners to deploy their machine-agents and researchers to expand and contribute to this field [20], [16], [21].

The term chatbot refers to a chatter robot which communicates with human users using spoken language [22]. This robot appears as an interface that supports the concept of artificial intelligence through understanding user questions and providing intelligent responses accordingly. Chatbot uses different methods of artificial intelligence to understand end-users' questions by relying on correspondent information sources known as knowledge bases [23]. Furthermore, chatbots are trained to learn the most convenient responses through machine learning techniques [24].

Chatbots were originated in 1966 when Prof.Joseph Weizenbaum developed a software known as ELIZA [25]. It utilizes different neutral language processing (NLP) techniques to identify keywords from inputs to be compared with a predefined knowledge base and generate corresponding answers [26], [27], [28]. In 1995, another popular chatbot system named ALICE (Artificial Linguistic Internet Computer Entity) was developed by Dr. Richard Wallace using Artificial Intelligence Markup Language (AIML) [29], [30]. AIML was derived from Extensible Markup Language (XML) that consists of categories which contain patterns of inputs and templates of responses [31]. A powerful feature in AIML is that it can make recursion; redirect to another pattern [32]. It also prioritizes responses based on the context and carries different responses to the user on a random basis [32]. Nevertheless, some chatbots combine artificial intelligence techniques to produce better results [7], [25], [33], [34], [35].

III. Chatbot Characteristics

Chatbots have many characteristics that vary depending on different perspectives and criteria as listed in Table I. The following is a brief explanatory background of the types of chatbots.

A. Knowledge Base Techniques

A knowledge base is a term that describes how a chatbot can obtain related information for providing correct responses, which can be stored as files or documents [36]. Likewise, Relational Databases (RDB) are employed for organizing information and retrieving it using Structured Query Language (SQL) [20], [12]. A chatbot like VPbot depends on SQL and relational database (RDB) for language rule provisioning [23]. In fact, there are two essential techniques regarding chatbots knowledge base: *retrieval* and *generative* [36], [34]. A retrieval chatbot utilizes predefined responses from knowledge bases to return paired answers for user's questions or queries [7]. In contrast, a generative chatbot produces answers by utilizing the user inputs to determine answers accurately [12]. Sometimes, a hybrid chatbot is implemented by joining retrieval and generative techniques to enhance the result [34].

B. Functions

Since chatbots simulate livechat services that are conducted by real agents, it is expected that chatbots provide information and services as well. Consequently, there are two types of chatbots in terms of functionality:

1) *Informational Chatbots*: They aim to help users find information and guidance related to their questions. SuperAgent is a customer service chatbot for online shopping website that helps the user to select convenient products fashionably [13]. UFAQBot was designed and implemented to provide students with academic information and act as a student advisor [11]. In addition, a university chatbot was developed to conduct dialogues for answering frequently asked questions [9]. ChatPy is a conversational agent for Small to Medium Enterprises (SMEs) aimed to improve sales of automotive spare parts business by providing information about automotive spare parts [22].
2) *Transactional Chatbots*: This type of chatbots is intelligently designed to be eligible for organizing tasks and making decisions. For instance, Bozic et al. proposed a chatbot to perform hotel booking for tourism [8]. VAioT is a chatbot that facilitates managing electrical devices using natural language [14]. Likewise, Home Automation Chatbot is a transactional system that allows homeowners to control appliances and devices using natural language [15].

C. Approaches

A machine-based agent uses different approaches to return the optimal responses to end-users. Maroengsit et al. [28], classified chatbot approaches into two general methods: *rule-based* and *artificial intelligence-based*.

An example of *rule-based* is Artificial Intelligence Markup Language (AIML), which prompts ALICE-based chatbots to think [37]. An AIML file must include categories which are essential units of knowledge [30]. Primarily, each category contains additional tags such as:

1) *Pattern*: One or more words intended to match user's potential questions.

2) *Template*: The reply that chatbot will return to the user and natural language.
3) *That*: It keeps responses continue in the same context.

The *artificial intelligence-based* approach, on the other hand, uses Natural Language Processing (NLP) and linguistics. NLP is a branch of artificial intelligence that handles the interaction between machines and humans using the natural language [38]. NLP is classified into (1) Natural Language Understanding and (2) Natural Language Generation [38]. Natural language processing has various techniques such as pattern matching, parsing, keyword matching, semantic network, semantic interpretation, knowledge-based structures, and other generative methods[12], [29]. Additionally, natural language processing has several levels of processing including phonology, morphology, lexis, syntax, semantics, discourse, and pragmatics. Natural language processing is utilized in different applications such as machine translation, text recognition, categorizing and classification, filtering, information extraction and summarizing, etc. ELIZA chatbots applies natural language processing in their dialogues [28].

D. Conversation Length

Chatbots are distinguished from each other by the length of conversation. This means the robot is able handle series of questions on a certain topic without being lost. Hence, there are two types of chatbots: *short conversation* and l*ong conversation*. AlHumuod et al. [39], described the length of conversation depending on the number of responses on a particular topic that a chatbot can handle. Jia [2], specified that the conversation length is the total number of occurrences that includes a complete input from the user and a response from the chatbot. Grudin and Jacques [21], linked the length of conversation to its focus on updating briefly on a narrow and specific topic or delving into previous information. They divided conversation lengths of chatbots based on the number of exchanges into: (1) broad and deep (more than 10 exchanges), (2) broad and shallow (less than 3 exchanges), and (3) narrow and shallow (between 3 to 7 exchanges) [21].

E. Interaction Media

Typically, it is assumed that chatbots are written-based dialogues. However, they are designed to interact with users through one or more formats of media including: text, image, voice, video, effect, animation, file and embedded code, etc. AlHumuod et al. [39], listed some examples of chatbots which hold text-based inputs and outputs. Shah et al. [26], tested five modern chatbots that can talk using text-based conversations. Some research showed examples of chatbots that were designed to receive and respond to questions using types of mediums such as voice and text [39], [16], [20]. A chatbot for digital counseling which use artificial characters called (emojis) to express their mood [10]. A chatbot for luxurious branding was implemented to display photos within the conversation interface [6]. Another example is a chatbot that uses animated avatars and effects to enhance users experience and simulating human-like conversations [40]. Chatpy is influenced by responding with embedded codes that visualizes the location of a motor spare parts warehouse with the capability of sharing it throughout the conversation [8]. Many emerging chatbots use Application Programming Interfaces (APIs) with known instant massaging platforms such as messenger, telegram and Skype, etc. [41]. This method utilizes chatbots to exchange multiple formats of messages such as texts, sounds, images, videos, animations, objects and files. The use of media depends on the focus of the chatbot. Therefore, the chatbot named Feels You uses emotional response generation, which is personalized corresponds with the user's emotion and situation [12]. Furthermore, chatbots which are disembodied with social media platforms and applications, are empowered to allow multimedia massages [42]. Media conversion techniques such as text to speech (TTS) and speech to text (STT) are implemented in some chatbots to communicate with users verbally and textually [14], [15].

F. Domains

Conversational dialogues are usually conducted within specific context or topic, or alternatively they can be opened to unspecified areas. Similarly, chatbots are not only exclusively implemented for a specific purpose, but also, they are open to all purposes. Therefore, chatbots vary in terms of domains, broadness and specificity into *open domain* and *closed domain* [34], [43].

In closed educational domains, chatbots were certainly focused on teaching, learning, and some services such as university related FAQs [44], undergraduate advisor [11], student supervision [33], and foreign language educator [2], [3]. Health is a popular domain that has been targeted by many chatbots [45]. A nutrition chatbot, for example, was used to determine diet-related recommendations for users [46]. A chatbot for mental health counseling, that implements fully automated conversational agents, were deployed to provide counseling services [47], [10]. Crutzen et al. [5], applied an artificial intelligence-based chat on a group of teenagers to answer their adolescent questions. Furthermore, chatbots have helped e-commerce by acting as a virtual assistant [35]. FRASI is a chatbot project that was implemented as promising assistant for answering customers' questions regarding Italian milk weaving factory [48]. Chung et al. [6], demonstrated that luxury marketers can utilize chatbots to serve customers efficiently and provide information about luxury brands. Moreover, the Hotel Booking chatbot is a virtual agent that was designed to help tourists plan for accommodation at convenient hotels and book rooms accordingly [8]. Chatbots were also utilized as virtual assistants to manage and control devices on automated home through internet of things (IoT) and technologies [14], [15].

Open domain-based chatbots appeared in different approaches and applications. SuperAgent was improved to serve any e-commerce websites by utilizing the uploaded data on the webpage by customers [13]. Despite the fact that SuperAgent is tailored for e-commerce, it is a potential solution for other domains. ChatPy is a suitable virtual agent for small and medium-sized enterprises (SMEs), which helps in supporting and satisfying customers as well as increasing business sales [22]. AliMe chatbot was developed and released to serve as open domain industrial virtual agent [34]. Xu et al. [49], created a new system that utilizes deep learning that outperforms information retrieval model to serve customers on social Media.

TABLE II: The top ten most spoken languages with the Population in 2019.

No	Language name	Population
1	English	1,132 M
2	Mandarin Chinese	1,117 M
3	Hindi	615 M
4	Spanish	534 M
5	French	280 M
6	Standard Arabic	274 M
7	Bengali	265 M
8	Russian	258 M
9	Portuguese	234 M
10	Indonesian	199 M

* Population in millions.
* source: [46]. Accessed on: 15-01-2020.

TABLE III: The top ten countries which have many spoken languages in 2019.

No	Country name	Languages
1	Papua New Guinea	840
2	Indonesia	710
3	Nigeria	524
4	India	453
5	United States	335
6	Australia	319
7	China	305
8	Mexico	292
9	Cameroon	275
10	Brazil	228

* Languages column refers the total number of spoken languages.
* Source: [46]. Accessed on: 15-01-2020.

G. Languages

Since chatbots use natural languages, it is of paramount importance to consider the variety of spoken languages in the world. Just like human communication, if a person does not speak your language, it would be difficult to understand each other. Similarly, if a chatbot receives inputs using unknown human language, it cannot respond properly. In 2019, Ethnologue released its twenty second edition that includes 7111 living languages [46]. Table II shows the top ten spoken languages in the world sorted by their population. Furthermore, Table III also indicates that some countries could have multiple spoken languages. On top of that, people speak different dialects in some countries even if they share the same standard language. For this reason, chatbots should promote national and international languages to fulfill users' needs and achieve inclusiveness. In general, we expect to see single and multilingual chatbots using either translation techniques or enhanced knowledge bases.

H. Answer Reaches

Chatbots differ in term of finding answers so that there can be two ways to lead a user to the right answers:

1) Guided: The way of leading the user to the desirable answer using specified guidance through menus and choices.
2) Direct: Using advanced techniques to prompt answers directly, which resembles human responses.

I. Licenses

There were many contributions by scholars, developers, scientists and enterprises in the boom of chatbots emergence. While some of them were released as Open-source software (OSS), others were developed as closed source applications with free or non-free license. ChatterBot, for example, is a machine learning-based conversational dialog engine that was built in Python and released on GitHub under a family of permissive free software licenses [50]. Program-O is an open source chatbot that was built on PHP, MySQL, and AIML that was released freely on GitHub [50]. This allows contributors to use or develop existing solutions. For example, an android-based chatbot utilized enhanced Program-O by allowing verbal and textual interaction [5]. Botta was released online as an open source for further improvements and contributions that can be made by interested researchers [51]. Chatbot.com, on the other hand, provides paid closed source solution for businesses to deploy their chatbots easily using graphic interfaces and prebuilt templates [52]. AliMe chatbot is also a closed source e-commerce chatbot that was launched by Alibaba Group as a cloud service [34] [53].

J. Humbot

Chatbots automatically manage the conversation between users and machines without any human intervention. Thus, in some cases where the automated chatbot cannot handle hard questions, a human agent intervenes to respond as a part or partner of the bot architecture [21].The chatbot that is designed to have human in the loop is known as: a human-aided bot or *humbot*. For instance, Kucherbaev et al. [54], reviewed academic and industrial examples of human-aided bots showing human computation in chatbots. In addition, Chappie is a semi-automated chatbot that carries out the conversation to a human agent after collecting initial information from the user [25].

IV. Using Chatbots in Saudi Universities

In Saudi Arabia, there are many public and private universities which have been established to meet the growing population of students. Figure 1 demonstrates that the total number of active students has clearly redoubled over the past decade. Therefore, the ability to access universities through the Internet means an increase in the number of inquiries around the clock. This demands a sufficient-number of employees to achieve the desirable level of service quality. Surprisingly after surveying Saudi universities' websites, the findings indicated that chatbots were not used entirely in Saudi universities (see Table V and IV). Additionally, the occurrence of COVID-19 pandemic could not help to enforce the emergence of Arabic Chatbots although 7% of Saudi universities used live-chat software (human-agent) during working hours.

The results showed that all Saudi universities' websites were built in Arabic and English languages. Nevertheless, a few websites support French and Spanish too. In fact, Arabic is the official language of Saudi Arabia and its institutes. However, Saudi Arabia uses English officially as an international language. Table II shows that in 2019, English and Arabic languages ranked as the first and sixth top spoken languages respectively. These universities target multilingual students and seek to create inclusive educational environment. The rapid growth of the Internet users in Saudi Arabia requires innovative solutions. Nevertheless, the enforced shift to online education and remote work after

TABLE IV: Status of using multiple languages, live-chat tools, and Chatbots in Saudi Universities' websites.

Name	Website	Lang	Chatbot	LiveChat
Umm Al Qura University	uqu.edu.sa	Ar,En	no	no
The Islamic University	iu.edu.sa	Ar,En	no	no
Al Imam Mohammed Ibn Saud Islamic University	imamu.edu.sa	Ar,En,Fr	no	no
King Saud University	ksu.edu.sa	Ar,En	no	no
King AbdulAziz University	kau.edu.sa	Ar,En,Fr,Es	no	no
King Fahd University of Petroleum And Minerals	kfupm.edu.sa	Ar,En	no	no
King Faisal University	kfu.edu.sa	Ar,En	no	no
King Khalid University	kku.edu.sa	Ar,En	no	no
Qassim University	qu.edu.sa	Ar,En	no	no
Taibah University	taibahu.edu.sa	Ar,En	no	no
Taif University	tu.edu.sa	Ar,En	no	no
Hail University	uoh.edu.sa	Ar,En	no	no
Jazan University	jazanu.edu.sa	Ar,En	no	no
Al Jouf University	ju.edu.sa	Ar,En	no	no
Tabuk University	ut.edu.sa	Ar,En	no	no
Al Baha University	bu.edu.sa	Ar,En	no	no
Najran University	nu.edu.sa	Ar,En	no	no
Northern Border University	nbu.edu.sa	Ar,En	no	no
Princess Nourah Bint AbdulRahman University	pnu.edu.sa	Ar,En	no	no
King Saud Bin AbdulAziz University for Health Sciences	ksau-hs.edu.sa	Ar,En	no	no
Imam AbdulRahman Bin Faisal University	iau.edu.sa	Ar,En	no	no
Prince Sattam Bin AbdulAziz University	psau.edu.sa	Ar,En	no	no
Shaqra University	su.edu.sa	Ar,En	no	no
Majmaah University	mu.edu.sa	Ar,En	no	no
Saudi Electronic University	seu.edu.sa	Ar,En	no	yes
University of Jeddah	uj.edu.sa	Ar,En	no	no
University of Bisha	ub.edu.sa	Ar,En	no	no
King Abdullah University of Science and Technology	kaust.edu.sa	Ar,En	no	no
Naif Arab University for Security Sciences	nauss.edu.sa	Ar,En	no	no
University of Hafr Al Batin	uhb.edu.sa	Ar,En	no	no
Prince Sultan University	uhb.edu.sa	Ar,En	no	no
Effat University	effatuniversity.edu.sa	Ar,En	no	yes
Arab Open University	arabou.edu.sa	Ar,En	no	no
Al Yamamah University	yu.edu.sa	Ar,En	no	no
University of Business and Technology	ubt.edu.sa	Ar,En	no	yes
Fahad Bin Sultan University	ubt.edu.sa	Ar,En	no	no
Prince Mohammad Bin Fahd University	pmu.edu.sa	Ar,En	no	no
Al Faisal University	alfaisal.edu	Ar,En	no	no
Dar Al Uloom University	dau.edu.sa	Ar,En	no	no
Dar Al Hekma University	dah.edu.sa	Ar,En	no	no
University of Prince Mugrin	upm.edu.sa	Ar,En	no	no
Riyadh Elm University	riyadh.edu.sa	Ar,En	no	no
Al Maarefa University	um.edu.sa	Ar,En	no	no
Sulaiman Alrajhi University	sr.edu.sa	Ar,En	no	no

* Abbreviations on the table: Ar: Arabic, En: English, Fr: France, Es: Espanol.
* The terms (Yes/No) refer to the usage of Chatbot and LiveChat in each visited website.
* The last was on 22-05-2020, after the commencement of curfew to contain Noval Corona-virus (COVID-19) pandemic.

TABLE V: Statistics summarize the languages and Chatbot usages in Saudi Universities. Last update on: 23-05-2020

Term	Value
Number of Universities	44
Official Languages	Arabic
Other Languages	English, France, Espanol
Chatbot usage	0% (0)
LiveChat usage	7% (3)

the pandemic have emptied the universities. Hence, they need artificial intelligence techniques to handle vast requests coming from a large number of online users around the clock.

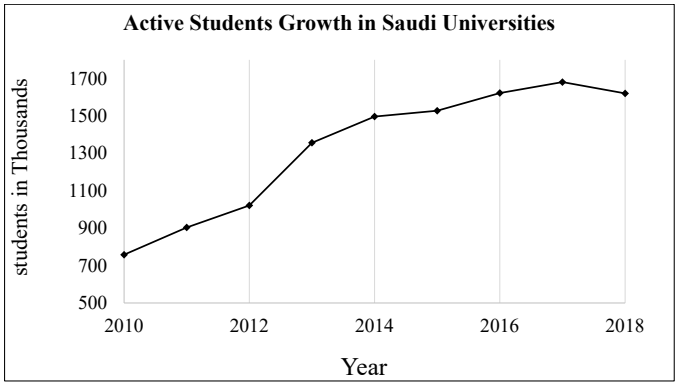

Fig. 1: Growth of active students in Saudi Arabia universities for the period 2010 to 2018. Collected from [55]

V. Arabic language

Arabic is the sixth top spoken language in the world with approximately 274 million speakers as shown in Table II. It has twenty-eight consonant alphabets that sound uniquely as shown in Table VI. Each character is shaped differently depending on its order in a word. On the other hand, Arabic language is distinguished by diacritical marks for vowels as demonstrated in Table VII. In fact, Arabic words are mostly written as they pronounced. Unlike English words, silent letters rarely occur in Arabic words. Table VII demonstrates the big difference in terms of pronunciation as well as meaning when using diacritics.

Arabic is officially used as a first language in over twenty countries including Saudi Arabia. Arabic is multiglossic, which means it has several dialects due to cultural, geographical and demographical multiplicity. In Saudi universities, the written and spoken standard Arabic is officially used for educational purposes. However, Arabic dialects can be

TABLE VI: Arabic alphabets and their shape based on their positions in words.

Alphabet	Sounds	Shape in words		
		Ending	Middle	Beginning
ا	a	ـا	ـا	ا
ب	b	ـب	ـبـ	بـ
ت	t	ـت	ـتـ	تـ
ث	th	ـث	ـثـ	ثـ
ج	j	ـج	ـجـ	جـ
ح	h	ـح	ـحـ	حـ
خ	kh	ـخ	ـخـ	خـ
د	d	ـد	ـد	د
ذ	th	ـذ	ـذ	ذ
ر	r	ـر	ـر	ر
ز	z	ـز	ـز	ز
س	s	ـس	ـسـ	سـ
ش	sh	ـش	ـشـ	شـ
ص	s	ـص	ـصـ	صـ
ض	dh	ـض	ـضـ	ضـ
ط	t	ـط	ـطـ	طـ
ظ	dh	ـظ	ـظـ	ظـ
ع	a	ـع	ـعـ	عـ
غ	gh	ـغ	ـغـ	غـ
ف	f	ـف	ـفـ	فـ
ق	q	ـق	ـقـ	قـ
ك	k	ـك	ـكـ	كـ
ل	l	ـل	ـلـ	لـ
م	m	ـم	ـمـ	مـ
ن	n	ـن	ـنـ	نـ
ه	h	ـه	ـهـ	هـ
و	w	ـو	ـو	و
ي	y	ـي	ـيـ	يـ

TABLE VII: Arabic diacritics that are used in Arabic language to resemble vowel sounds.

Mark	Example	Position	Sounds	Grammar	Meaning
ـَ	سَجل	Top	Sajal	Verb	Register
ـُ	سُجل	Top	Sujel	passive	Registered
ـِ	سِجل	Bottom	Sijel	Noun	record
ـً	سجلاً	Top	Sijillan	Noun	record
ـٌ	سجلٌ	Top	Sijillon	Noun	record
ـٍ	سجلٍ	Bottom	Sijillen	Noun	record
ـَ	سجّل	Top	Sajjal	Verb	registered
ـْ	سجْل	Top	Sajl	Noun	Pouring

unofficially used for verbal and textual communications either face to face or virtually.

VI. Arabic Natural Language Processing Challenges

The diversity of Arabic language dialects poses challenges for artificial intelligence technologies. It is associated with morphological features, orthographic ambiguity and inconsistency, and variety of dialects [44]. The word "سَجَّـلَ"–means registered– is commonly used among university students. However, it could convey many different meanings. Table VIII shows that the word "سجـل" could have at least 16 different nouns and verbs. Although the word "طـالـب" means a student, it has various forms controlled by the Arabic system of affixes so that it may imply other concepts such as requesting service, scholar, and applicant. In orthography, Arabic diacritics may not be used in official and unofficial Arabic text. Therefore, pronouncing and distinguishing unmarked words depend on the context of the sentences, which makes Arabic natural language processing quite challenging.

TABLE VIII: Different forms of the stem for the word register "Sajjil".

Arabic Word	Form	Type
سَجَّلَ	Registered	Verb
سَجَّلَ	Scoured	Verb
سَجَّلَ	Added	Verb
سَجَّلَ	Enrolled	Verb
سَجَّلَ	Submitted	Verb
سَجَّلَ	Recorded	verb
سَجَّلَ	Wrote	verb
سَجَّلَ	Joined	verb
سَجَّلَ	Post	verb
سَجَلَ	Throw	verb
سَجَلَ	Read constantly	verb
سَجَلَ	Poured	verb
سِجِلٌّ	File	noun
سِجِلٌّ	Record	noun
سَجْلُ	Pouring	noun
سُجِّلَ	Being registered	Passive verb
سُجِّلَ	Being scored	Passive verb
سُجِّلَ	Being added	Passive verb
سُجِّلَ	Being enrolled	Passive verb
سُجِّلَ	Being submitted	Passive verb
سُجِّلَ	Being recorded	Passive verb
سُجِّلَ	Being posted	Passive verb

Wording in Arabic differs when a question is directed to a male versus female. Although the word "مسجلة" is much like "مسجلة", each has different meaning which means "*registered female*" and "*his registrar*" respectively. Unfortunately, many users might not consider the importance of providing the correct dictation while using Arabic chatbots. Moreover, using different Arabic dialects complicates the faced challenge further and stands behind the slow progress of Arabic natural language processing [51]. Table IX demonstrates how a user could write the word "want" which could be written in more than 60 different forms depending on dictation and dialect forms based on the users' dialects.

Arabic-QA chatbot that uses AIML showed reasonable

TABLE IX: Different stranded and dialect forms of the word "want" pronounced "Oreed".

English Phrase	Forms in Arabic	
	Standard	Dialect
I want	أريد	أبي،آبي،ابي، أبغى، ابغى، أبغي، ابغي، احتاج، أرغب، ارغب، بدي، عاوز، عايز، أمبى
You want	تريد	تبي، تبغى، تبغي، تحتاج، ترغب، بدك، عاوز، عايز، تمبى
He wants	يريد	يبي، يبغى، يبغى، يبغي، يحتاج، يرغب،بده، عاوز، عايز، يمبى
She wants	تريد	تبي، تبغى، تبغي، تحتاج، ترغب، بدها، عاوزه ، عايزه، تمبى
They want	يريدون (Male)	يبون،يبغون، يحتاجون، يرغبون، بدهم، عاوزين، عايزين
They want	يريدن (Female)	يبين،يبغين، يحتاجن، يرغبن، بدهن، عاوزات، عايزات

results; however, changing the form of the questions produces incorrect answers because of Arabic language characteristics [37]. Abu Shawar [37] pointed out the development of natural Arabic language processing is noticeably slower than English. Abu Ali and Habash [51] emphasized that there is a modest interest in natural language processing techniques in Arabic language because of challenges associated with its morphological features, sever ambiguity, orthography and plenty of dialects. BOTTA was implemented as the first chabtbot that focuses on Egyptian dialect using retrieval information approach [51]. Al-Haqbani and Khan [56], mentioned that while Arabic language is supported in some existing chatbots, there are still some limitations where chatbots cannot handle the features of Arabic language. Moreover, they recommended that more attention should be given for Arabic language and finding solutions. Al-Haqbani and Khan [57], indicated that there is still a pressing need to overcome challenges faced by the implementation of Arabic chatbots. BouZiane et al. [58], expressed that many efforts have been made for the application of Arabic language in robot-based conversations, yet, the efforts are below the expectations compared to the development of English and Latin languages. This gap is widened in Arabic language due to the aforementioned challenges.

VII. Arabic Chatbot Experiment

A practical experiment was performed on Sara ChatBot launched by the Saudi Food and Drug Authority (SFDA) [59]. Sara ChatBot facilitates 24/7 services for citizens to reduce effort and cost. Currently, Sara ChatBot is providing citizens with six categories of services which include (1) submitting complaint or inquiry, (2) providing information on drug alternatives and prices, (3) verifying cosmetic products, (4) verifying medical device license, (5) verifying food product, (6) keeping food safety guide, (7) knowing about the corona virus COVID-19, and (8) finding nearby pharmacies. Sara Chatbot utilizes WhatsApp mobile application as a chatting platform. It promotes transactional conversation where the user can submit a complaint directly through the conversation system [60]. As summarized in Table X, thirty participants (16 female and 14 male) experienced the chatbot using their own smartphones over five separate attempts.

TABLE X: The summary of the testing results and characteristics of Sara ChatBot. Performed in: September 2020.

Term	Result
Participants	30
Conversations	150
Masseges	5922
Answers	203
Loses	486
User Greetings	265
Correct Greeting Answers	233
Domain	Focused
Knowledge	Retrieval
Languages	Arabic only
Interactivity	Yes
Functions	Informative and transactional
Approach	Artificial Intelligence-based
Conversation length	Short
Answer Reaches	Guided
Humbot	No

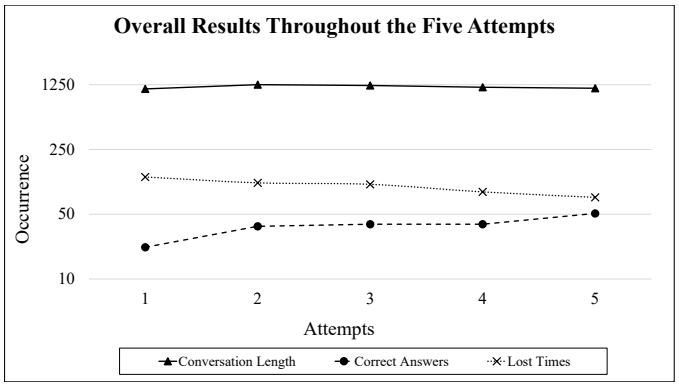

Fig. 2: Overall Results Throughout the Five Attempts performed on Sara ChatBot. Performed in September 2020.

Lastly, the performed chats were backed up and collected for analysis. Based on the results, Sara Chatbot features as follows.

1) Its domain is closed and focused on specific informative services.
2) It guides users toward its eight categories using a list of options and keywords.
3) It allows the directive method so that all participants were able to reach at least a correct answers.
4) It prompts interactive features such as locating pharmacies dynamically based on the current location of the user.
5) It is singled language based on Arabic only. Hence, answers replied to English inputs lead to conversation lost or incorrect response.
6) Some limitations simply occur when the form of any input is slightly changed or includes unexpected words.
7) It recognizes most of greeting messages due to its simplicity and the possibility of being confined. Figure 6 indicates that most greeting inputs received correct response.

The over all results are gradually enhanced through out the five attempts. Each attempt have the exact number of conversations and have almost the same cumulative total of messages as illustrated in Figure 2. In addition, the results showed that the lost times of communicating with the chatbot decreased while the correct answers increased progressively. This behavior indicates that the participants were able to

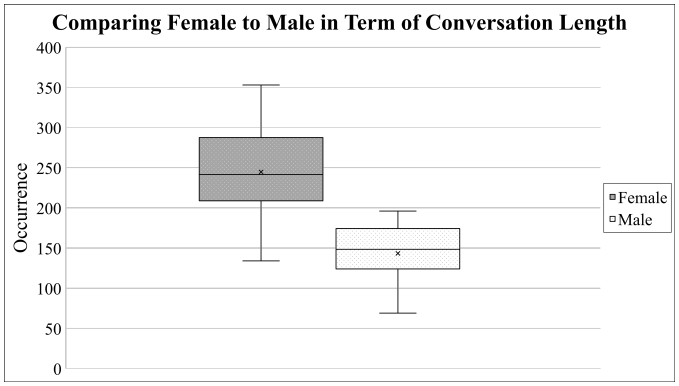

Fig. 3: Comparing female to male in terms of conversation length measured by the total sum of massages. Performed in September 2020.

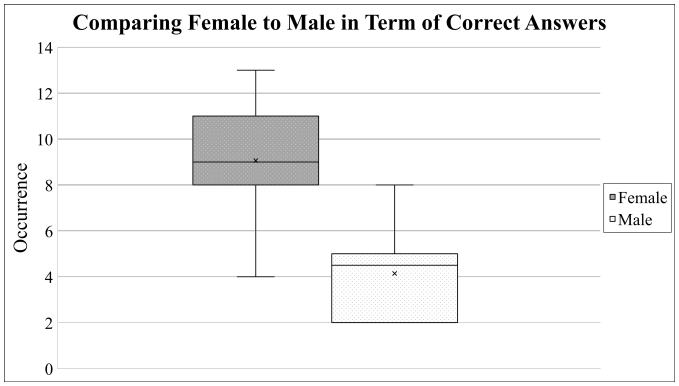

Fig. 4: Comparing female to male in terms of correct answers. Performed in September 2020.

figure out how to communicate with the chatbot effectively.

The whisker box plot in Figure 3 indicates that female participants delivered the longest conversation compared to male participants. On top of that, the female participants have significantly scored higher correct answers than the male participants as indicated in Figure 4. Nevertheless, Figure 5 demonstrates that chatbot lost conversing similarly with both female and male participants due to Arabic languages challenges. Although, the female participants interacted more effectively compared to the male participants if the length of the conversations are considered.

A *t-test* analysis was performed on the collected data to show the statistical difference between female and male participants in terms of receiving correct greeting answers. Distinctly, even though female participants generated higher number of messages, the results with ($p\text{-}value > 0.05$) showed no significant statistical difference between female and male participants. Figure 6 manifests that both groups scored almost similar correct greeting answers ratio.

VIII. Discussion

Due to the rapid growth of technology, e-Business, virtual assistance, etc., organizations need to adopt new technologies and undergo evolution. Chatbot is one technological feature amongst others that is utilized in business, education, health, customer services, virtual assistance and other applications. Nevertheless, it seems that implementing effective Arabic chatbots has not been resolved. In fact, there have been many

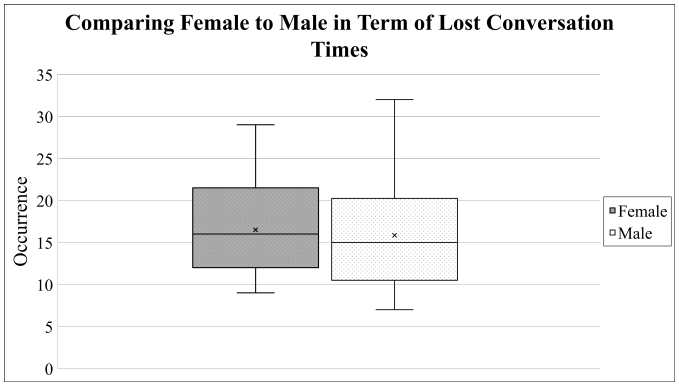

Fig. 5: The number of times the chatbot lost the dialogue for female and male . Performed in September 2020.

scattered efforts for overcoming Arabic NLP challenges, yet each solves an aspect of the problems and challenges to solidify the efficacy of chatbots.

Previously, researchers have made tremendous efforts by introducing many studies, designs, and implementations to overcome challenges for Arabic languages applications. Arabic question-answering chatbots were used in the form of FAQs web pages to build a corpus to retrain chatbot using AIML approach [37], [61]. The results revealed that chatbot could work as long as Arabic inputs are precisely correct. Otherwise, chatbots would deliver wrong answers or become helpless. Botta [51], on the other hand, used AIML popular SaaS platform called Pandorabots with many modifications to the inputs in order to handle Arabic orthography [62]. Further,deep learning techniques that are used for text classification and named entity recognition to implement Arabic dialog systems have shown surpassing results [63]. Conversational Orthography Dialectal Arabic *Star CODA** introduced guidelines for 28 urban Arabic dialects, which are available and connected to online resources [44]. In addition, Freihat et al. [64], proposed an optimal solution for lemmatizing Arabic text using combination of machine leaning and lemmatization dictionary concepts that yield remarkable accurate results. Bouzaine et al [58], revealed a system that supports Arabic users to provide answers from web content using parsing, finite state automaton, and web semantic tool. Although it has some limitations pertinent to Arabic content, it could be useful if the resources are scoped (e.g. a university informative website). Accuracy of Arabic text classification has been enhanced using many methods such as Arabic WordNet and semantic relations [65].

IX. Suggestions

Success stories should be taken into consideration such as university FAQs crossover-chatbot [9], student supervision chatbot for pre-registration process [33], and undergraduate advisor chatbot [11]. However, it is extremely critical and risky when a student, who must not be misled by chatbots, makes his/her academic decisions mistakenly based on wrong information provided by the virtual assistant (chatbot). Not only this would put the university in critical situations, but also chatbots reputation could be influenced negatively and affect their credibility and reliability. Perhaps this issue could be a significant justification for the absence of chatbots on Saudi universities websites.

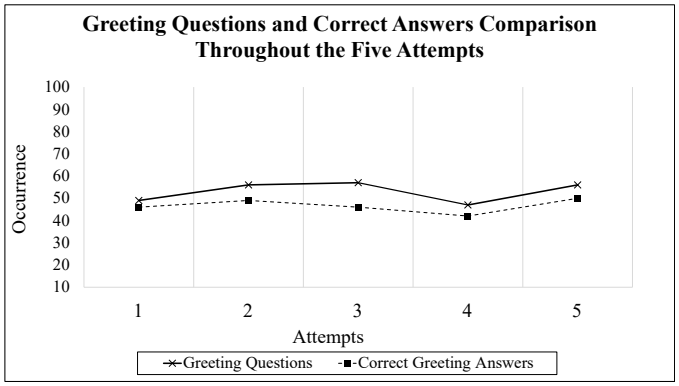

Fig. 6: Greeting questions compared to correct answers over the five attempts.Performed in September 2020.

Based on the findings of this research, there are some substantial recommendations for allowing Arabic Chatbot emergence in Saudi universities as follows:

1) **Focused domain**: A chatbot used in Saudi universities is desirable to be focused on student academic affairs primarily.
2) **Language**: Although all Saudi universities' websites have Arabic and English languages interfaces, the majority are Arab native speakers [55]. Therefore, implementing Arabic chatbots is necessary to fill in the gap of its absence. Additionally, adopting translation techniques to or from Arabic text into other languages such as English helps to implement supportive chatbots for several languages [66].
3) **Eloquence**: Encouraging students (end users) to use standard Arabic –called Fushaa– can remarkably help chatbots process questions more effectively. In fact, a university student in Saudi Arabia must submit his/her assignments, essays, exams, and letters written in standard Arabic. This can reduce the severity of dialects multiplicity when employing Arabic chatbots in education.
4) **Generality**: Most Saudi universities rely on a unified national system and regulations for many of their affairs, thus, the differences occur in their procedures and executive rules. Therefore, an optimal chatbot can be applicable to Saudi universities with minor changes in the knowledge base details.
5) **Guidance**: Instructive methods and options should be used in order to help the user reach the correct answer and avoid confusing the chatbot through open questions. This approach helps both the chatbot and the user to be engaged in an effective dialogue.
6) **Dataset**: All Saudi universities use digitized record of students' affairs in different applications including web services, social media, emails, guides etc. These resources can be utilized to build corpus for enriching and solidifying the university chatbot.
7) **Length**: While students turn to conversations with online agents looking for quick answers to their questions and inquiries, they do not require long conversations. FAQs kind of chatbots fits appropriately with this type of conversation, because it has only one answer that does not require follow-ups.
8) **Collaborative Model**: Based on the reviews of natural language techniques including approaches, architectures, solutions, methods, models, proposals etc, it is recommended to collaborate effective techniques that confront natural Arabic language processing challenges. Arabic language complexity is a fact that does not change; hence, moving forward toward collaborative concepts decreases the shortage of Arabic chatbots.
9) **Human-Aided-chatbot**: Usually university staff become available online during the work hours to chat with students using live-chat or asynchronous messaging solutions. Chatbots can cover the lack of sufficient number of employees to answer students' questions at any time. However, having both a machine and a human agent in the loop where the machine agent handles understandable inquires, while human agent handles the difficult ones during his/her availability. In addition, answers provided by the human agent can be used to train the machine agent.

X. Conclusion

Recently, there has been a tremendous rise in Chatbots technology and its usages in many different applications especially for educational purposes. The emergence of Arabic chatbots, on the other hand, is limited due to the complexity of Arabic language. This research explored the current status of chatbot utilization in Saudi universities. The results revealed that currently chatbots are not implemented in Saudi universities. Although it is known that chatbots can act as a round-the-clock virtual assistant, Saudi universities still rely on human-distance assistant.

The problem behind the absence of chabots in Saudi universities lies in the complexity of Arabic language and its morphological features. Previous research has attempted to resolve the problem though these solutions are not comprehensive. Therefore, an experimental tests were performed on one real Arabic chatbot. The experiment showed that a slight change to a single Arabic word form can confuse the chatbot easly. However, this chatbot implements a guiding method that helps the user to sequentially reach convenient answers, which contributes in its usefulness and effectiveness.

This research carries out some recommendations for implementing effective Arabic chatbots in Saudi universities. Generally, Arabic-language based chatbots are still fertile field for prospective and promising research. The COVID-19 pandemic has drove a huge demand for chatbots, which requires more effort to meet the demand efficaciously.

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