T.C.
MARMARA ÜNİVERSİTESİ
SOSYAL BİLİMLER ENSTİTÜSÜ
İŞLETME ANABİLİM DALI
ÜRETİM YÖNETİMİ VE PAZARLAMA (İNGİLİZCE) BİLİM DALI

DESIGNING AND BUILDING A CUSTOMER SERVICE CHATBOT FOR STUDENT AFFAIRS OFFICE: MARMARA UNIVERSITY FACULTY OF BUSINESS ADMINISTRATION

Yüksek Lisans Tezi

HIND KHALLABI

İstanbul, 2020

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ABSTRACT

DESIGNING AND BUILDING A CUSTOMER SERVICE CHATBOT FOR STUDENT AFFAIRS OFFICE: MARMARA UNIVERSITY FACULTY OF BUSINESS ADMINISTRATION

Chatbots are practical artificial intelligence tools for both improving communication and strengthening relationships with customers, solving problems, and replying to customers' questions over the internet. In recent years, more users across many industries start to use and give more prominence. Reports reveal that AI-powered chatbots are the future of customer service. Despite several successful applications of chatbots, a large proportion of chatbots have failed, and studies have shown the use of chatbot results with negative user experience. From our point of view, chatbot failure cases are results of three factors: (1) The poor design made by designers, (2) The lack of proper management, (3) The conception that chatbots are used to replace human agents instead of empowering them.

A significant number of existing studies in the literature have approached chatbot design mostly in terms of conversational design. However, there is a lack of a holistic approach to design chatbots, including industry and performance management perspectives. Therefore, as an effort to fill this literature gap, this study suggests a holistic approach integrating two well-known methods: The Axiomatic Design method and the Balanced Scorecard model. Axiomatic Design is used as a formal framework to construct the conversation. On the other hand, a Balanced Scorecard, a strategic management performance metric, is employed by the customer service department to plan for the chatbot before its launch, measure its performance, and identify the areas of improvements after the chatbot launch. The proposed approach is applied to a typical university student affairs office. Students' complaints, needs, and prioritized queries are used to design the chatbot's conversation and determine chatbot's goals and internal features. Results show that the proposed approach help to make better design and management of chatbot service.

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ÖZET

ÖĞRENCİ İŞLERİNİN OFİSİ İÇİN ÖĞRENCİ HİZMETLERİ REHBER ROBUTUNUN TASARIMI VE UYGULAMASI: MARMARA ÜNİVERSİTESİ İŞLETME FAKÜLTESİ ÖRNEĞİ

Rehber/Sohbet robotları, internet üzerinden müşterilerle iletişimi geliştirmek, ilişkileri güçlendirmek, sorun çözmek, ve müşteri sorularına cevap vermek için kullanılan pratik yapay zekâ araçlarıdır. Son yıllarda, birçok endüstride daha fazla kullanılmaya başlamakta ve daha fazla önem verilmektedir. Raporlar yapay zekâ destekli rehber robotları müşteri hizmetlerinin geleceği olduğunu ortaya koymaktadır. Bazı başarılı rehber robot uygulamalarına rağmen, rehber robotların büyük bir kısmı başarısız olmakta ve çalışmalar olumsuz kullanıcı deneyimine sahip rehber robot kullanım sonuçlarını göstermektedir. Bizim bakış açımızdan, rehber robot başarısızlık vakaları üç faktörün sonucudur: (1) Tasarımcılar tarafından yapılan kötü tasarım, (2) Doğru yönetim eksikliği, (3) Tam otomasyon amacıyla rehber robotları güçlendirmek yerine insan çalışanların tamamen yerini alması anlayışıdır.

Literatürdeki önemli sayıda çalışma, rehber robotu tasarımına çoğunlukla karşılıklı konuşma/diyalog tasarımı açısından yaklaşmıştır. Bununla birlikte, endüstriyel ve performans yönetimi perspektifleri dahil olmak üzere rehber robotlarının tasarımında bütünsel bir yaklaşım eksikliği vardır. Bu nedenle, bu literatür boşluğunu doldurma çabası olarak, bu çalışma iyi bilinen iki yöntemi bütünleştiren bütünsel bir yaklaşım önermektedir: Aksiyomatik Tasarım Yöntemi ve Dengeli Puan Kartı modeli. Aksiyomatik Tasarım, diyalog oluşturmak için resmi bir çerçeve olarak kullanılmaktadır. Öte yandan, Dengeli Puan Kartı; uygulamadan önce robotu planlamak, performansını ölçmek ve robotu uygulamadan sonraki iyileştirme alanlarını belirlemek için, bir stratejik yönetim performans metriği olarak kullanılmaktadır. Önerilen yaklaşım, tipik bir üniversite öğrenci işleri ofisine uygulanmaktadır. Öğrencilerin şikayetleri, ihtiyaçları ve önceliklendirilmiş soruları, rehber robotun diyaloğunu tasarlamak, hedeflerini ve dahili özelliklerini belirlemek için kullanılmaktadır. Sonuçlar, önerilen yaklaşımın rehber robot hizmetinin daha iyi tasarım ve yönetimine yardımcı olduğunu göstermektedir.

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Last but not least, I am so grateful to be born in the 21st century, where knowledge is available and accessible. My duty is to learn then share what I have learned to education seekers.

Hind KHALLABI
İstanbul, 2020

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LIST OF ABBREVIATIONS

AD	Axiomatic Design
AI	Artificial Intelligence
AIM	AOL Instant Messenger
AIML	Artificial Intelligence Markup Language
AOL	American Online Messenger
API	Application Program Interface
ASR	Automatic Speech Recognition
BSC	Balanced Scorecard
CHDF	Chatbot Holistic Design Framework
CRs	Customer Requirements
DeepQA	Deep Content Analysis
DESI	Digital Economy and Society Index
DM	Design Matrix
DM	Dialogue Manager
DPs	Design Parameters
FAQ	Frequently Asked Questions
FRs	Functional Requirements
IBM	International Business Machine
LSTM	Long Short-Term Memory
LUIS	Language Understanding Intelligent Services
MSN	Microsoft Network
NLG	Natural Language Generation
NLP	Natural Language Processing
NLU	Natural Language Understanding

1. INTRODUCTION

Conversational agents have primarily evolved in the computer age as software programs that can interact with humans using natural language and via auditory or textual methods. The Oxford dictionary defines the text-based conversation agent (chatbot) as, *"A computer program created to simulate conversation with human users, especially over the internet*." According to Griol et al. (2013) a chatbot is defined as a software program used to communicate based on natural language. Additionally, Desaulniers (2016) defined chatbot as *"an interactive messaging powered by artificial intelligence (AI)"***.** Chatbots are defined variously; however, it can be concluded that all the mentioned definitions agree that a chatbot is linked with artificial intelligence and its extent. As a result, a chatbot can be defined as an artificial intelligence program that mimics human conversation with a user via textual methods.

The idea of imitating a human conversation is back to the sixties when Joseph Weizenbaum created Eliza to work as a psychotherapist (Weizenbaum, 1996). Inspired by Eliza, many chatbots have shown considerable development year by year, along with that, and online users keep being interested in the chatbot industry. According to google trends, the term 'chatbot' popularity is rapidly increasing. Today chatbots are deployed in various domains to achieve many purposes. These domains include FAQ answering, customer service, education, entertainment banking, etc., (Okuda & Shoda, 2016; Kerly et al., 2007; Shawar & Atwell, 2007). Chatbots can be applied in businesses to enhance customer service, help desk, technical support, website navigation, and guided selling (Lester et al., 2004). Additionally, they can be used in healthcare as Bickmore et al. (2011) presented in their research a virtual health counselor. Furthermore, many other domains have been revealed in the academic context such as Shawar and Atwell (2007), who state that chatbots are not only useful for businesses; however, they can be applied in the entertainment sector, language learning, and education. The chatbot can be used in education and remarkably helps teachers. The educational chatbot help teachers detect students' problems and weaknesses through question/answering process; thus, they can assess students' problems and solve them afterward (Knill et al., 2004).

Despite the noticeable chatbot engagement, yet, there is growing evidence showing the failure of chatbots that resulted in dissatisfaction of the customers. According to Chatbots Magazine (2017), chatbots hit a failure rate of 70%, and there are different reasons for this failure. In our opinion, the poor design and the misconception of chatbot position and purpose are the prime risk factor of chatbot failure. Proceeding from that, the purpose of this thesis is to create a holistic design approach of a chatbot in the absence of an integrated, complete design proposition to examine both: the chatbot management and conversational design continuously. Accordingly, the chatbot designed in this study is dedicated to the student affairs office to enhance student satisfaction and facilitate the current student service. The current case study intends to replace Frequently Asked Question (FAQ) pages of business administration faculty; after that, the remainder of the service support is automated. The reason behind chatbot design is due to disadvantages implied by the FAQ pages and guidelines, including the length of the pages and the time consumed. Besides, the complicated language used in the guidelines might be challenging for some students.

On top of that, it takes a long time for students to reach out to student affairs office personnel, and sometimes they are being transferred several times without resolving the problem at the end. Thus, the suggested chatbot aims to empower the current service support in the student affairs office. The chatbot can recognize and reply to multiple questions and be trained to show a better performance to satisfy students' needs. Besides, the chatbot is efficiently used to reduce time and cost (Kumar & Telang, 2012). Undoubtedly, the proposed design can be projected onto every enterprise and entities.

The suggested framework is based on a holistic approach represented in a sum of steps starting from defining the purpose of the chatbot until its launch. The holistic framework emphasis is given to chatbot management as a software service as well as the chatbot conversation through the integration of two existing methods that are extensively discussed in the literature. The first method is the Balanced Scorecard model (BSC) that is used to plan, manage the chatbot, and to measure its performance over the course of the time. Managing the chatbot and measuring its performance leads

to enhancing the overall system (Kaplan & Norton, 1996). Customer service quality is linked to customer satisfaction (Dixon et al., 2010).

The second method is Axiomatic Design (AD) that focuses on designing the chatbot conversation. The AD is employed to link customer queries, the conversation functionalities, design parameters, and process variables (Suh NP, 2001).

Comprehending customer requirements is a crucial step to creating an excellent customer experience with the new service. Thus, the usage of AD (conversational design) and BSC (strategic performance management) that highlight the customer perspective is utterly valuable. The required data in this study is extracted from the existing system (customer service) to gain a precise understanding of both parties: customers and personnel's complaints and needs. The results of the data reveal the customers' major prioritized questions, additionally to their standard requirements, complaints, and expectations concerning different issues in-service support.

The remainder of this thesis is organized as follows: Section 2 overviews the existing approaches related to chatbot design. In section 3, a theoretical background of AD and BSC model are explained. The proposed holistic design methodology and its process flow are introduced in Section 4. The illustrative application of the holistic design is performed over the student affairs office chatbot as a case study in Section 5. After that, discussion, conclusion, and further research are presented separately in the last sections.

2. LITERATURE REVIEW

This section compiles and assesses the existing research on the chatbot design topic. A brief explanation of the role of chatbot in customer service is highlighted. Existing chatbot design approaches in the literature are introduced.

2.1 Chatbot History

The chatbot history begins in the early dates of the sixties of the twentieth century (Figure 1). The chatbot invention witnessed a recession at the beginning of the twenty-first century. However, in recent years, chatbot as a topic has become one of the most sought after services both for-profit and non-profits organizations. In the following chapters, chatbot history for early ages and modern times is explained.

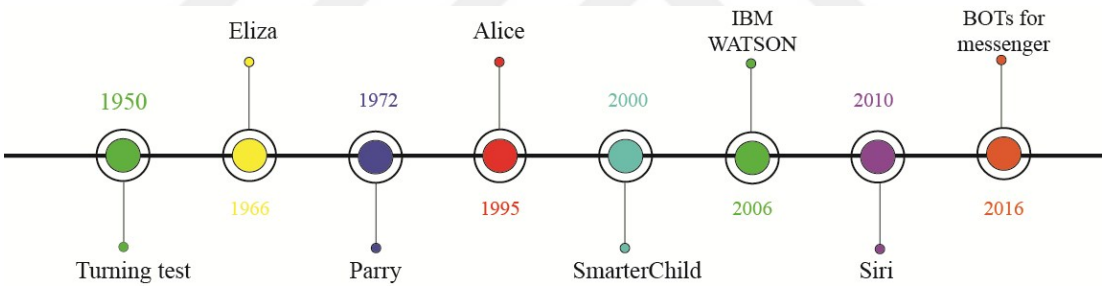

Figure 1: Chatbot History Timeline (illustrated by the researcher)

2.1.1 Early Ages

2.1.1.1 Alan Turing & The Turing Test

In 1950, the British mathematician Alan Turing released his paper "Computing Machinery and Intelligence," where he proposed the question: "Can machines think?", the question later becomes the motive for many scientists and researchers in the artificial intelligence field. The paper was one of the groundbreaking papers in the twentieth century. The paper had initiated a game called: "The Imitation Game," that currently known as the "Turing test." The test aimed to find out whether a

machine can imitate a human or not. The test identified specific criteria to conclude if the machine is intelligent enough or not. Hence, to end up with an outcome, the test introduced a conversation-based approach involving three parties, as Turing described in his paper: a human interrogator and two unknown subjects: a computer and a human. The interrogator's mission was determining their identity by typing questions to both humans and computers (Figure 2). The only way the computer passes the Turing test if the interrogator failed to distinguish between the two unknown subjects (Turing, 1950).

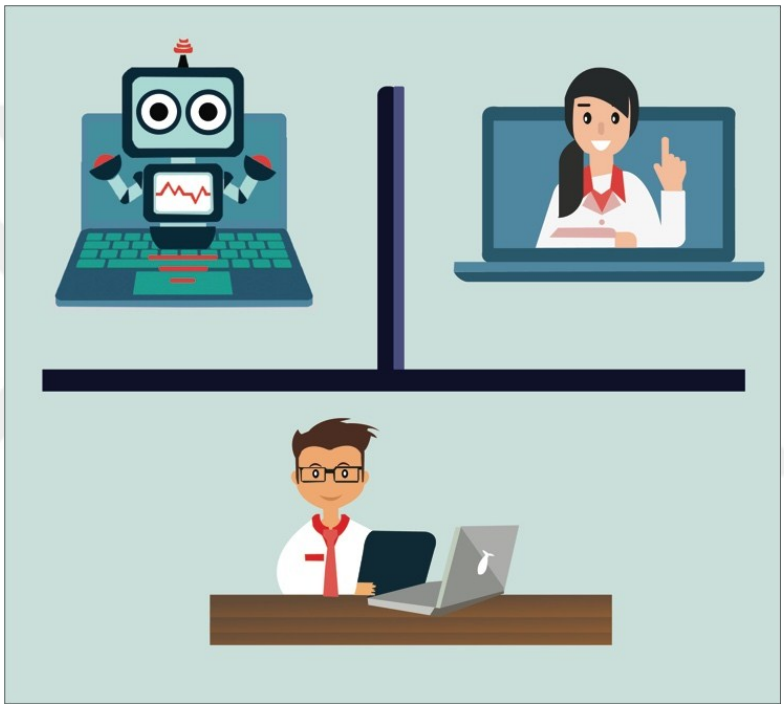

Figure 2: An Illustration of the Turing Test

2.1.1.2 The Annual Loebner Prize Competition

In 1990, Dr. Hugh Loebner, the inventor and businessman, launched the Loebner prize contest that embodies the turning test restrictions. The competition purpose was challenging AI experts and their expertise to show their chatbots look like humans. The highest ranks of the competition win the grand prize of 100,000$ and a gold medal. Dr. Loebner defined the grand prize with $100,000 and a Gold Medal for the first computer whose responses were indistinguishable from humans. However, many claims are accusing the competition unreliability in respecting the turning test

restrictions. These claims are debatable between who agrees and who disagrees (Shieber, 2006; French, 1990).

2.1.1.3 Eliza

Professor Joseph Weizenbaum, in the course of his scientific life, introduced a software program that he called it Eliza at MIT Artificial Intelligence Laboratory in 1964. Eliza was representing a Rogerian psychotherapist based on a script. The Rogerian psychotherapist designed to assist patients by rephrasing their questions related to their mental health (Weizenbaum, 1966). A typical conversation is illustrated below:

Men are all alike.
IN WHAT WAY?
They're always bugging us about something or other.
CAN YOU THINK OF A SPECIFIC EXAMPLE?
Well, my boyfriend made me come here.
YOUR BOYFRIEND MADE YOU COME HERE.
He says I'm depressed much of the time.
I AM SORRY TO HEAR YOU ARE DEPRESSED.
It's true. I am unhappy.
DO YOU THINK COMING HERE WILL HELP YOU NOT TO BE UNHAPPY.
I need some help, that much seems certain.
WHAT WOULD IT MEAN TO YOU IF YOU GOT SOME HELP.
Perhaps I could learn to get along with my mother.
TELL ME MORE ABOUT YOUR FAMILY.
My mother takes care of me.
WHO ELSE IN YOUR FAMILY TAKES CARE OF YOU.
My father.
YOUR FATHER.
You are like my father in some ways.
WHAT RESEMBLANCE DO YOU SEE.
You are not very aggressive but I think you don't want me to notice that.
WHAT MAKES YOU THINK I AM NOT VERY AGGRESSIVE.
You don't argue with me.
WHY DO YOU THINK I DON'T ARGUE WITH YOU.
You are afraid of me.
DOES IT PLEASE YOU TO BELIEVE I AM AFRAID OF YOU.
My father is afraid of everybody.
WHAT ELSE COMES TO YOUR MIND WHEN YOU THINK OF YOUR FATHER. Bullies.
DOES THAT HAVE ANYTHING TO DO WITH THE FACT THAT YOUR BOYFRIEND MADE YOU COME HERE.

Figure 3: A Sample Conversation with Eliza

Source: Weizenbaum, J. (1966). Eliza- a Computer Program for the Study of Natural Language Communication between man and machine. *Massachusetts Institute of Technology Department of Electrical Engineering. Cambridge, Mass., Communication of the ACM.* 9(1), 36-35.

Eliza reacted efficiently if the user input meets the pre-defined keywords that are provided into the chatbot. When Eliza does not understand the use, she attempted to receive more information from the user until the information matched the pre-programmed data. The questions Eliza asked aimed to lengthen the conversation; thus, the user is motivated to continue the dialogue and interact for a longer time. the user to interact even more.

Prof Joseph intended to create a human imitation since he believed sincerely that the relationship between humans and machines is superficial. Unexpectedly people who got to interact with Eliza subjectively attribute emotions to the machine. As an example, the story mentioned in Joseph's book: Computer Power and Human Reason: From Judgment to Calculation where his secretary ended up having a serious conversation with ELIZA and even asked Prof Joseph to leave the room to have some privacy (Weizenbaum, 1966).

2.1.1.4 Parry

There exist another classic chatbot beside Eliza: Parry. The psychiatrist Kenneth Colby created it at Stanford university. PARRY's purpose was to imitate the paranoid schizophrenic speech (Saygin et al., 2000). At the same year, International Conference on Computer Communications in Washington D.C organized an event where Eliza and Parry held a conversation. Despite the fact that the output is predictable due to the way they had been programmed, Eliza and Parry continued their meetings on different occasions.

2.1.1.5 Alice

The creation of ALICE, standing for: artificial linguistic internet computer entity in 1995 revolutionized chatbot market. The success of ALICE was a result of the employment of AIML. Alice patterns proved a substantial upgrade on previous chatbots and won several Loebner competitions in addition to an award for the most human-like system. However, the limitation of the AIML ended up in chatbot failure to pass the ultimate turning test, which was due to the lack of its capacity to maintain a chat for an

extended period (Epstein et al., 2008). An example of Alice conversation is presented in Figure 4.

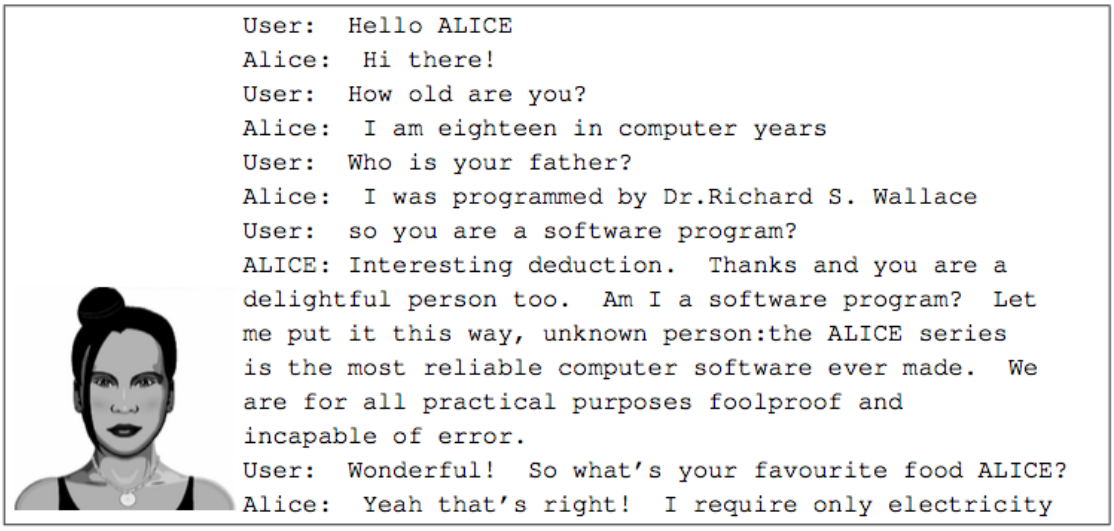

Figure 4: A Sample Conversation with Alice

Source: Shawar, B. & Atwell, E. (2007). Chatbot are they Really Useful?. LDV *Forum*. 22 (1), 29-49. https://www.researchgate.net/publication/220046725_Chatbots_Are_they_Really_Useful (8 March 2019)

2.1.1.6 SmarterChild

By the year 2000, Activebuddy Inc. developed a bot called SmartChild, which was released on AIM & MSN Messenger. Since its start, SmarterChild attracted more than 30 million messenger users aiming to realize the integration between the natural language and the increasingly popular instant messaging and SMS networks. The bot was capable of providing many services such as weather forecasts, delivering stock updates, movie times, or other useful information. The bot was differentiated by having its personality. However, SmartChild failed to meet the customer needs to be aligned with technology growth.

2.1.2 Modern Times

2.1.2.1 IBM Watson

In the modern era, IBM Watson has paved the way for artificial intelligence. IBM Watson was represented as a question-answer computing system, which surpassed the standard of AI back then. This success was a result of the technology used by IBM Watson. In 2011, the most successful candidates of the tv-show 'Jeopardy' lost to Watson, which won the $1 million prize. Watson continued its expansion and growth over the past several years (Ferrucci et al., 2010).

2.1.2.2 Siri

In an intensely competitive era, Apple Inc. introduced Siri in 2010. Siri. the intelligent personal assistant developed by the International Artificial Intelligence Center. Siri used automatic speech recognition (ASR) to convert human speech into text, in addition to its ability to use conversion of commands and short dictations, for example: "set the alarm for the morning." Siri was able to exceed the natural language processing standers when it used the transcribed text (Guzman, 2017).

2.1.2.3 Alexa

Another chatbot well known in the market was Alexa, Amazon’s personal assistant. Alexa has many functions such as to-do lists, providing weather reports and setting alarms, controlling other devices in the home such as asking: “Alexa, turn on the living room fan”. Over the years, Alexa was able to improve its capabilities and built different user experiences, like the games Hunt of Yeti of Alexa.

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Several intelligent chatbots took place in the market each passing year. These chatbots differentiate itself with a useful range of services provided to the user to improve customer experience and meet high expectations. Cortana from Microsoft, Google Assistant, are some of the common examples. They can gather information from different detectors such as location, touch, gestures, etc., store it in the system and employ it when necessary.

2.2 Chatbot in Customer Service

There is a broad agreement on the necessity of automation in customer service, considering the solutions it provides to ease the customer service work pressure (Tezcan & Zhang, 2014). Service agents are crucial to customer problems (Chakrabarty et al., 2014). According to Digital Economy and Society Index, DESI (2018), the majority of internet users engaged in social networks, used online shopping, and online banking. However, there are critical fundamental challenges for social media support agents that may create a negative customer experience. These challenges include the difficulty in providing instant replies and do multitasking jobs. Many studies provide some of the final pieces of evidence that there exists a risk of multitasking. In 2009, a Stanford University study published in the Proceedings of the National Academy of Sciences, "cognitive control in media multitaskers," provided some of the most definitive evidence of the perils of multitasking in a digital age (Ophir et al., 2009). Another study conducted in Michigan state university phycology entitled "Media multitasking is associated with symptoms of depression and social anxiety" (Becker et al., 2013). In the present context, chatbots have the potential to fulfill specific customer service roles due to their artificial intelligence to mimic conversation and their language assistance capacity. Thereby, chatbots are employed to reduce the heavy daily work of the customer service department.

The utilization of chatbots in the customer service industry and other industries grow overtime. Gartner (2019) reported that the more significant part of the white-collar would interact with conversational platforms by 2020. Chatbots are being used by businesses to assist customer service by optimizing the support workflow (Xu et al., 2017). Furthermore, research shows evidence that AI methods can significantly improve

the performance comparing to the tradition analytics techniques (Digital McKinsey, 2019).

The bot empowered by AI can enhance the performance of customer service. Meanwhile, the workers within a company work efficiently and productively when they are focused on challenging tasks. Conversely, bots can provide answers immediately to customers who seek to receive instant replies. Customers' repetitive queries replied by chatbots lead to saving agents' time and improve their productivity. As a result, using chatbots lead to a significant rate of cost-saving (Kumar & Telang, 2012). Briefly, chatbots help optimizing costs by reducing human power and communicating with thousands of people in real-time.

2.3 Chatbot Design

2.3.1 Chatbot Architecture

The importance of design to firms and organizations has never been more recognized than it is today. According to Ulrich and Eppinger, the design is the most crucial element when defining the physical form of a product or service (Ulrich & Eppigner, 2012). Chatbot design is just as crucial as designing another product. The current research noticed that a large number of researchers proposed design models based on technical perspective and computer science (Roca et al., 2019; Isbell ,2006). As a result of that, this section unveils some concepts related to chatbot design.

A typical chatbot architecture consists of three main components: Natural language processing (NLP), Natural Language Understanding (NLU), Dialogue Manager (DM), Natural Language Generation (NLG) as illustrated in Figure 5. The NLP is an AI program that uses a pre-programmed set of algorithms to enables computers to process a large amount of data. NLP is found in services such as chatbots and auto-generated keyword tabs. For chatbots, the NLP is employed to understand natural language speech and convert it into structured data. NLU and NLG are a small part of the NLP. NLU has a narrower purpose than NLP. NLU focuses on

understanding the user message and classify it into intents and entities. NLG generates the human-like response to the user.

Those components are considered compulsory to build a chatbot; besides that, there are few optional elements in the chatbot architecture, such as ASR (Wolff et al., 2019). Since the input provided to the NLU engine can be text or voice, ASR processes the voice and converts the speech into text. NLU engine consists of intent classifier and entity recognition. The intent classifier is a crucial element in NLU systems for chatbots, and a deep understanding of the user's intent as well as providing the right answer is a cumbersome task.

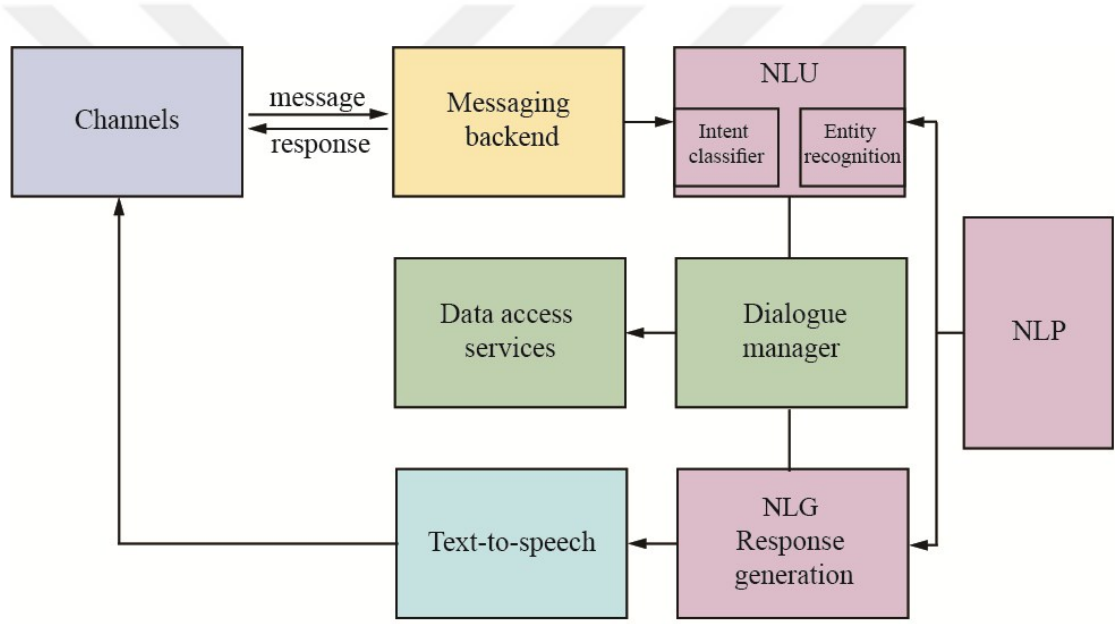

Figure 5: Typical Components of a Chatbot Architecture (illustrated by the researcher)

Afterward, DM processes the actual context of the user input based on data access services such as the data knowledge base, application systems, or API. The DM function is to manage the conversation in an attempt to provide human-like replies. There are different challenges that DM faces, such as conversation context, slot filling, context switching, and initiative. Switch statement involves the user initiatives; this type of DM is built on user effort. The switch statement is an efficient method that can be applied for FAQ since it represents a personalized conversation rather than a regular

search engine. The slot filling method is used when the bot is unable to recognize the user's entity.

The natural language generation (NLG) is a software process that converts statistical data into text that humans can understand based on DM. Its programming determines the most favorable response and translates it back to natural language. The Response Generator provides responses based on different models such as rule-based system, Retrieval-Based system, Pattern-based heuristics, generative system. The rule-based system replies based on the human-defined rules, the bot answers using matched input patterns or keywords. Alice, as a rule-based chatbot that uses AIML tags to deliver responses to users (Schumaker et al., 2006). The retrieval-based system uses a repository of pre-defined answers. The system aims to select the most favorable evidence from a pre-defined conversation and matches it with the user's new query (Ji et al., 2014). Retrieval-based systems consist of different models, such as the LSTM model, which uses the similarity representation of two given messages (Mueller & Thyagarajan, 2016). Unlike the previous system, the generative system is not limited to the information provided by the user.

In contrast, it generates responses according to the context or the current state of the conversation (Shang et al., 2015). An example of the generative based system is the sequence-to-sequence model that emerged in the neural machine translation field. The model has proven successful at related sequence-to-sequence prediction problems such as text summarization and question answering. The majority of the existing bot frameworks are built mainly on natural language interfaces integrated with existing applications enabling them to be conversational. There is an increasing number of chatbot solutions in the market. IBM Watson and Microsoft Bot platforms are the most commonly used bots. In the next paragraphs, a brief explanation of IBM Watson and Microsoft Bot is presented, respectively.

2.3.2 IBM Watson Architecture

IBM developed the Watson system called the DeepQA (Deep Content Analysis) question-answering technology (Ferrucci, 2009). DeepQA is a software information retrieval that assimilates NLP, incorporating techniques such as deep parsing, semantic role labeling, and named-entity recognition. IBM uses sources of information such as encyclopedias, dictionaries, taxonomies, and ontologies to generate a hypothesis. Watson receives user questions and searches in the existing database for an answer. Search techniques include document search, passage search, and text search engines. In the document search, Watson selects the title of the document that contains the text of the search query as a hypothesis, while passage search uses passages with the text of the search query. The next step is the hypothesis and evidence scoring used to determine each hypothesis's level of confidence. The merging and ranking phase is where the confidence scores are processed, and ranked list answers are produced. IBM Watson software evaluates potential answers and gathers scores evidence for those replies in both unstructured sources and structured sources (Figure 6).

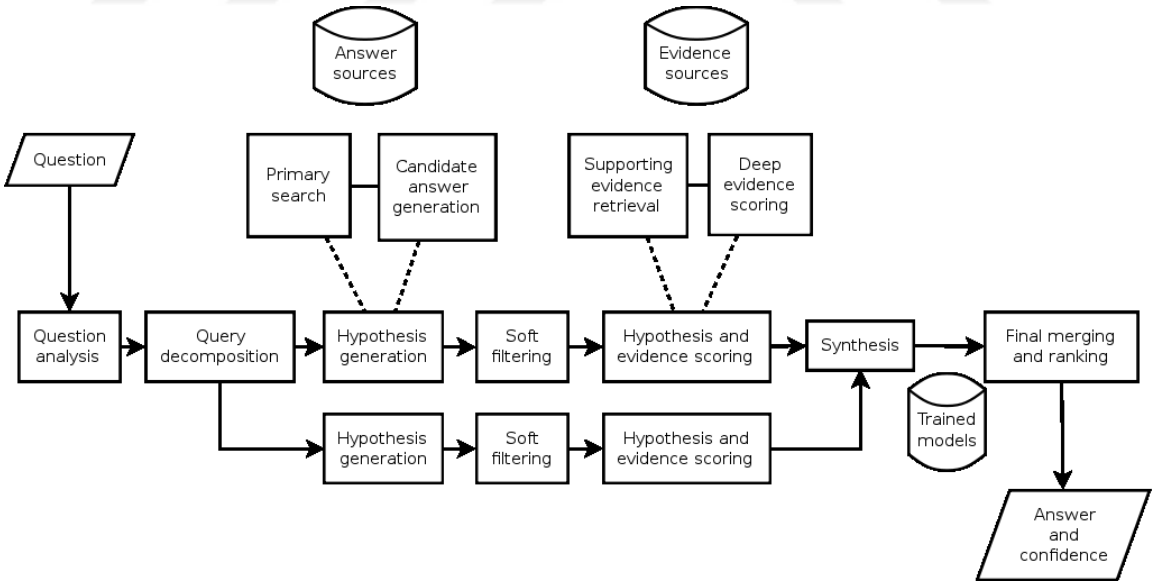

Figure 6: IBM Watson Architecture

Source: Ferrucci, D.A., Brown, E., Chu-Carroll, J., Fan, J., Gondek, D., Kalyanpur, A.A., Lally, A., Murdock, J.W., Nyberg, E., Prager, N.S. & Welty.C. (2010). Building Watson: An Overview of the DeepQA Project. *AI Magazine.* 31(3), 59-79.

2.3.3 Microsoft Bot Cognitive Services

Microsoft bot framework consists of a variety of NLU components and based on the retrieval mechanisms model, Microsoft cognitive services use AI algorithms in computer vision, NLP, speech, Knowledge extraction, and web search. Microsoft bot, with its APIs integration, is continuously learning and improving. Cognitive services provide APIs for language understanding, such as Language Understanding Intelligent Services (LUIS), that uses pre-built or custom-trained language models to process Natural language. Another API used by Microsoft bot is Text Analytics API that discovers topics, key phrases, and sentiment. The second service involves knowledge extraction that uses APIs to detect named entities and search for different types of research like a personalized FAQ service. Another tool to extract knowledge is the QnA Maker, which is RESET API and web-based service developed to respond to user' questions benefiting from the AI technologies. The third service is speech recognition and conversation using algorithms for speech-to-text and text-to-speech conversion. Through some APIs, the bot can access different sources of web searches such as webpages, images, and videos (Figure 7).

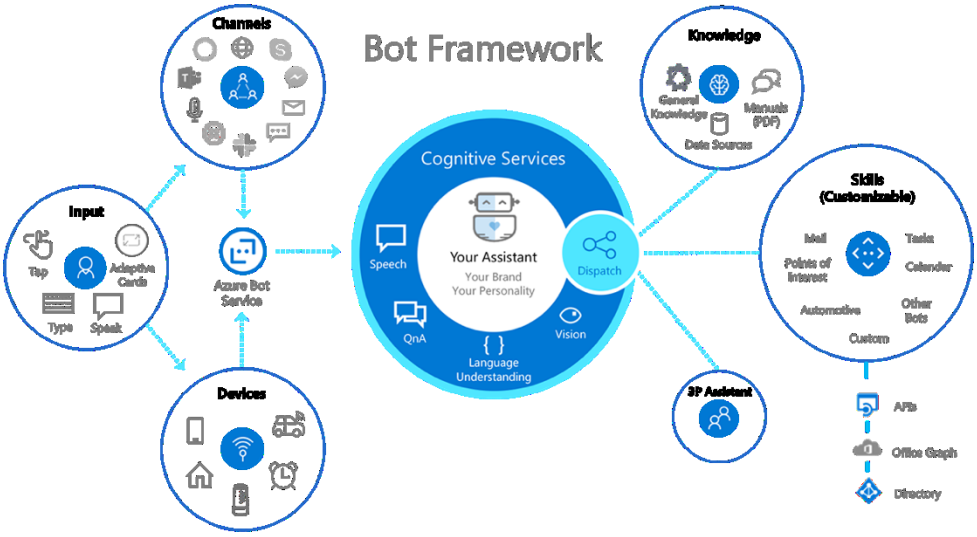

Figure 7: Microsoft Bot Framework

Source: Microsoft Azure. *Azure Cognitive Services.* https://azure.microsoft.com/fr-fr/services/cognitive-services/ (17 February 2020)

2.4 Chatbot Evaluation Metrics

There are various evaluation metrics available in the literature for measuring chatbot success; one of them is content evaluation. It is divided into two types: automatic evaluation and expert evaluation (Maroengsit et al., 2019). The automatic evaluation evolves the machine and is affordable and quicker compared to the expert evaluation conducted by a human. There are two ways the machine evaluates a bot performance: precision and recall of text summarization using mathematical methods (Maroengsit et al., 2019). Precision provides a percentage of the matched current conversation with the context, and the recall represents a percentage number of responses that the system identifies. Human calculates expert evaluation, and it is more accurate comparing to the machine evaluation method. In some cases, the two methods can be integrated to reach an ideal output.

Several metrics are found in the chatbot platform exactly on the analytics page. Chatbot platforms such as Chatfuel slack, Dahi.ai as shown in figures 8 and 9 provide analytics that measures user engagement (total users, engaged users, new users). The analytics can be based on conversation rates (total conversation, new conversation). Finally, the bot metrics are another method to measure the performance of the bot, such as retention metrics that represent the total number percentage of users that return to use the bot in a specific time frame. Besides the user satisfaction that can be measured using surveys, users can rate their experience with the chatbot.

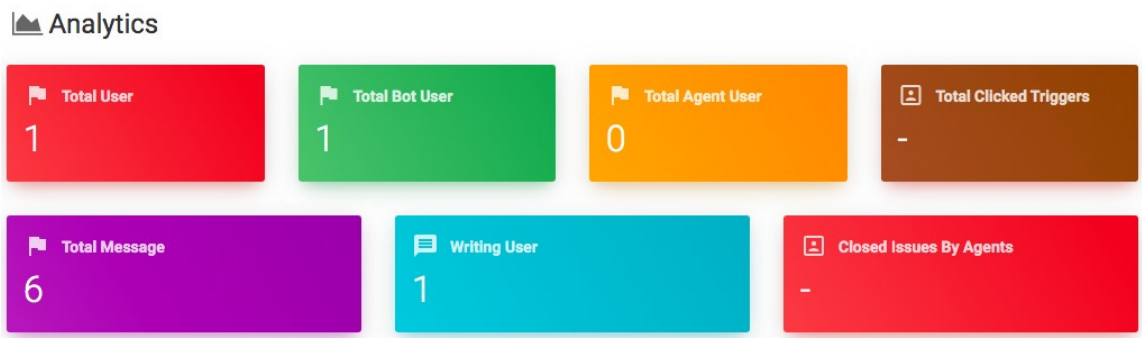

Figure 8: Dahi.ai 's Chatbot Analytics Page

Source: https://dahi.ai/

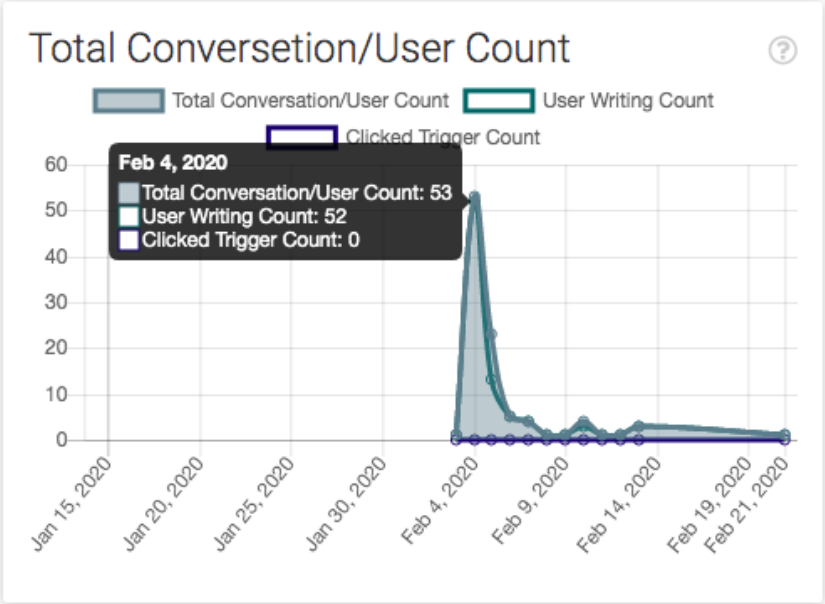

Figure 9: An Example of Dahi.ai Platform Conversation/User Count

Source: https://dahi.ai/

3. THEORETICAL BACKGROUND

This section gives an overview of the relevant theoretical background related to the suggested design. The conceptual basis on Axiomatic Design (AD) and Balanced Scorecard (BSC): the strategic performance management are separately introduced.

3.1 Balanced Scorecard

In 1992, Robert Kaplan and David Norton introduced the BSC model BSC has widely and successfully been used to manage and track an organization's strategy. It has been employed worldwide in a variety of industries, such as health care, manufacturing systems, airlines, educational programs, hospitality, and tourism, etc (Rababa'h, 2014; Niven, 2002). Kaplan and Norton believed that traditional performance measurement systems did not focus on the impact of organizations' intangible assets. For that reason, the model they proposed identifies and enhances different internal business functions and performance measures based on the organization's critical aspects. Both the public sector and private sector opt to use the BSC model to measure the organization's performance when desired and enhance it as required. The term "balance" in BSC refers to the balanced system between financial and non-financial, short-term objectives, long-term objectives, lagging, and leading (Niven, 2002).

3.1.1 Balanced Scorecard Four Perspectives

BSC evolved into efficient management and strategic planning model, while it was only used as a tool to measure performance (Kaplan & Norton, 1996). The BSC four perspectives: financial perspective, customer perspective, internal process perspective, and learning and growth perspective are shown in Figure 10 and are defined as follows;

The first perspective, financial perspective, sits at the top of Figure 10 enables monitoring the implementation of the planned financial objectives for both profit and non-profit organizations. Profit oriented organizations aim to increase shareholder

value. However, in a non-profit organization, the focus is notably different; the financial perspective might include maximization of funding from outside sources instead of profit. The financial perspective is linked with the three other perspectives through cause and effect as mentioned before (Agrawal, 2016)

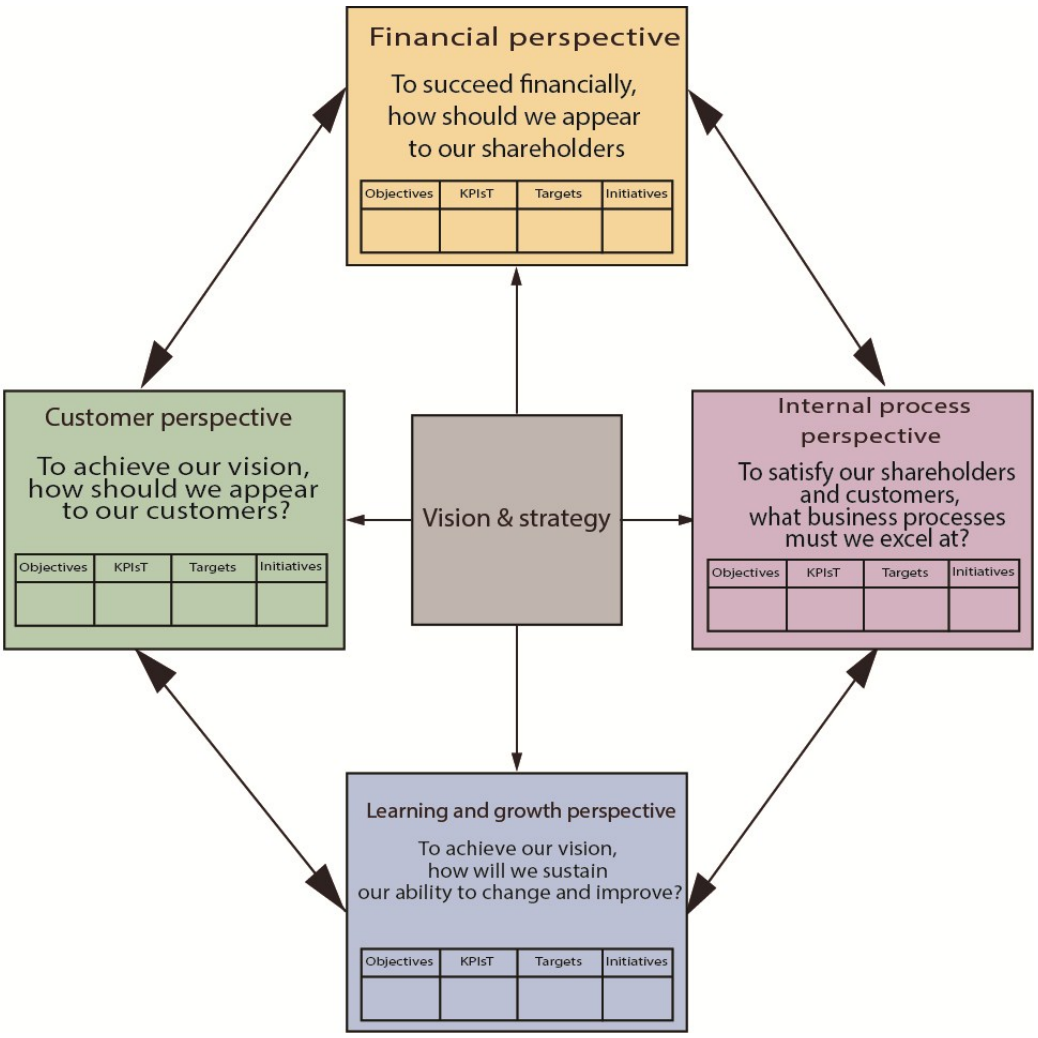

Figure 10: BSC Four Perspectives (illustrated by researcher)

The second perspective, customer perspective is a crucial element in the BSC method since it enables to determine the organization's current position and emphasis customer satisfaction. Additionally, it allows representing the organization strategy from the customer's point of view to enhance customer satisfaction and maximize customer loyalty and retention (Kaplan & Norton, 1996). In short, this perspective measures the entity's performance with target customers.

The third perspective, internal process perspective, specializes in measuring the operating performance such as cost, quality, and cycle times and link the organization's internal goals to customer's value. The focal point of this perspective is related to the customer perspective because maximizing the organization's internal components automatically leads to high customer satisfaction.

The last perspective, learning, and growth perspective, involve elements (people and systems) that enable the organization to grow and sustain. This part examines the ability of an organization to improve, innovate, and learn to create value for customers and excel the operating efficiencies within an organization. the measure involved in this perspective includes employee training, satisfaction, and improvement (Kaplan & Norton, 1996).

3.2 Axiomatic Design

3.2.1 Axiomatic Design Concept & Four domains

The Axiomatic Design (AD) was proposed by Suh in 1990 to answer the questions of what we want and how we want to achieve it (Suh, 2001). AD method has been employed in various fields and solving different design problems noting a remarkable success. These include manufacturing systems, software systems multi-agent reconfigurable mechatronic systems, production systems, etc., (Suh, 2001). AD covers the adequate approach of translating customer' requirements (what) to functional requirements (how). The four domains represent the groundwork of AD: The Customer Domain, the Functional Domain, the Physical Domain, and the Process Domain. The AD suggests that designing requires a clear understanding of goals that are established through customer requirements. Based on the outputs, the design solution is provided. Defining the design solutions before gaining a clear understanding of goals is an inefficient approach that may lead to losing time and cost (Karatas, 2019).

3.2.2 Axiomatic Design Axioms

The designer of AD must follow two fundamental axioms moving among domains: (1) the independence axiom, (2) the information axiom. The independence axiom attempts to maintain the independence of functional requirements (FRs) that translate customers' needs (CRs) into functional traits. The design parameters (DPs) are the critical variables in the design that must be determined to satisfy the identified FRs. The information axiom affirms that the minimum information content that satisfies the first axiom must be selected among all the designs (Karatas, 2019).

3.2.3 Hierarchies and zigzagging

The design process is formulated as a mapping of FRs from the functional domain to the physical domain. Meanwhile, the hierarchical decomposition in the domains starts at a high level of abstraction to levels of more details. Design hierarchy includes FR hierarchy, DP hierarchy. Zigzagging initiate from the "what" domain to the "how" domain to decompose the FRs and DPs into a set of sub-requirements as illustrated in Figure 11. This process continues until the solution is obvious and nothing specific is required.

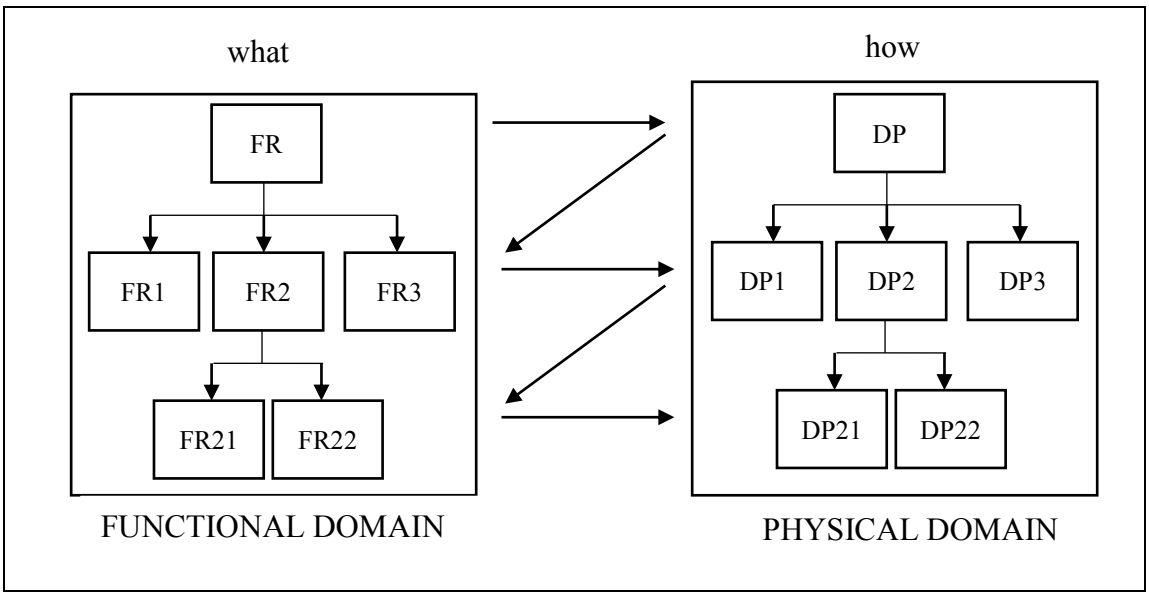

Figure 11: Zigzagging Process Between Domains in AD

In the decomposition process, the design must ensure that the independence of FRs is maintained based on the design matrix (DM). DM is the mathematical translation of the relationship between FRs and DPs that are expressed as follows in Equation 1:

$$\{FR\}=[A]\{DP\}. \tag{1}$$

{FR} is the FR vector, the {DP} is the design parameter vector, and [A] is the DM that characterizes the design.

There are three types of design matrix. (1) uncoupled design (2) decoupled design (3) coupled design. The [A] matrix uncoupled or decoupled design is required to satisfy the independence axiom. Uncoupled design refers to the diagonal design matrix, and its ideals according to AD principles. For that reason, each FR can be satisfied by the corresponding DP. The decoupled design the [A] matrix is triangular, which means at least one DP affects two or more FRs. Consequently, the first n DPs are considered. For coupled design, the [A] matrix seems to be unstructured, and a change in any DP may influence all FRs concurrently. The AD does not accept coupled design since it does not satisfy the independence axiom. The mathematical representations of the three DMs are shown in the following equations:

$$\begin{Bmatrix} FR1 \\ FR2 \\ FR3 \end{Bmatrix} = \begin{bmatrix} X & 0 & 0 \\ 0 & X & 0 \\ 0 & 0 & X \end{bmatrix} * \begin{Bmatrix} DP1 \\ DP2 \\ DP3 \end{Bmatrix}. \quad \text{Uncoupled Design} \tag{2}$$

$$\begin{Bmatrix} FR1 \\ FR2 \\ FR3 \end{Bmatrix} = \begin{bmatrix} X & 0 & 0 \\ X & X & 0 \\ X & X & X \end{bmatrix} * \begin{Bmatrix} DP1 \\ DP2 \\ DP3 \end{Bmatrix}. \text{ Decoupled Design} \tag{3}$$

$$\begin{Bmatrix} FR1 \\ FR2 \\ FR3 \end{Bmatrix} = \begin{bmatrix} X & 0 & 0 \\ 0 & X & X \\ 0 & X & X \end{bmatrix} * \begin{Bmatrix} DP1 \\ DP2 \\ DP3 \end{Bmatrix}. \quad \text{Coupled Design} \tag{4}$$

4. METHODOLOGY

This study proposes a structured methodological framework by integrating the two models Balanced Scorecard (BSC) and Axiomatic Design (AD) following specific steps (Figure 12). The proposed chatbot holistic design framework (CHDF) can be used by organizations to design or plan, and manage a chatbot.

BSC model in CHDF, as mentioned in the introduction part, is employed to plan, manage, and monitor the chatbot as a service. BSC's four perspectives match perfectly the chatbot's needs to work correctly. On the one side, BSC helps to identify the chatbot internal processes perspective that the designer uses to acknowledge the processes that create and deliver the customer value proposition. The learning and growth perspective identifies the way the chatbot and customer service are improving and growing. One the other hand, the strategic planning of the BSC model helps align an organization behind the vision (purpose) of the new system, which is a chatbot, and gets people (staff) working on the right tasks and focusing on results.

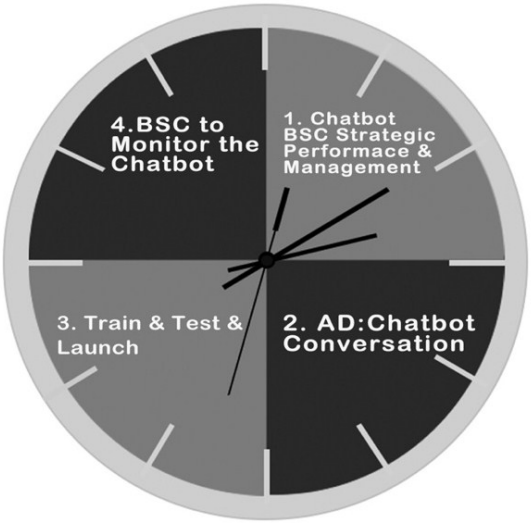

Figure 12: Chatbot Holistic Design Framework (CHDF)

AD in CHDF is used to examine the chatbot conversation. Its role in the current context is to transform the customer's perception of the problem (queries) into

the design object (conversation). The use of AD enables designers to isolate both the functional and physical domain of the chatbot then determine the relationship between the two domains. AD simplifies the process of creating the chatbot conversation as well as providing a proper inter-relationship between the four domains (customer domain, functional domain, physical domain, process domain).

The chatbot conversation is an element in the BSC internal process perspective for the chatbot. For that reason, the design begins with BSC model examination. The AD takes place after the strategic planning of the chatbot.

The suggested CHDF flow diagram consists of two phases: (1) the pre-design phase, (2) the design phase. The flow diagram of the CHDF is articulated and shown in Figure 13. Accordingly, the practical design phases and the related steps are explained respectively below.

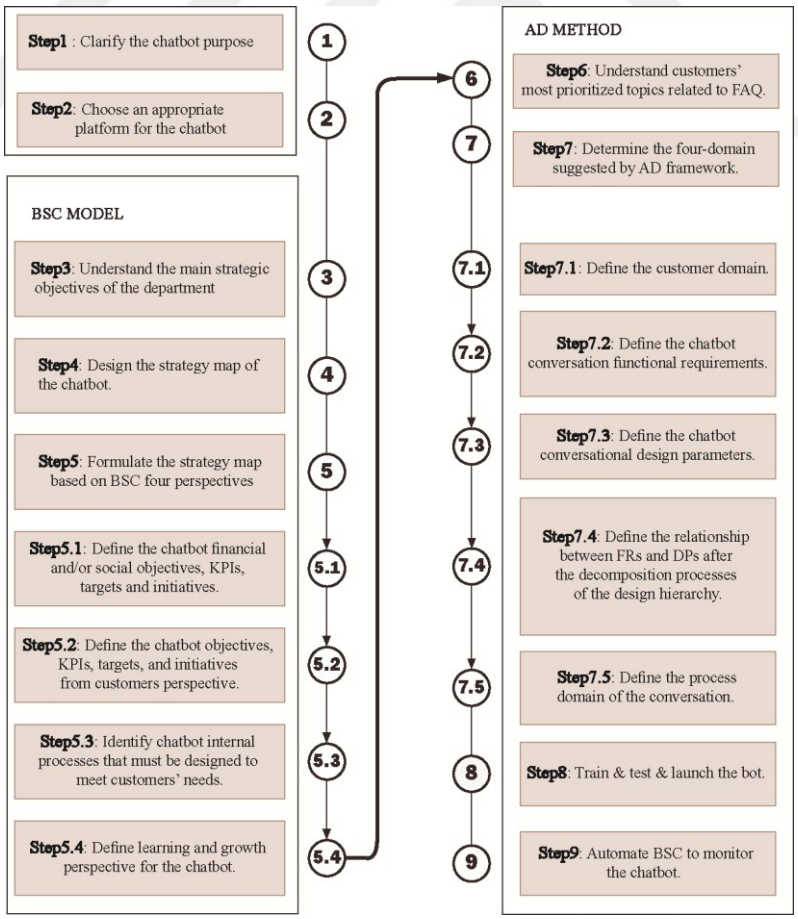

Figure 13: Chatbot Holistic Design Framework (CHDF) Main Steps

There are 12 steps involved in CHDF, as shown in Figure 13, a proper explanation to each step is presented:

Pre-design phase: The pre-design phase consists of two steps: The first step is the first task the designer must define based on the BSC principles. The second step involves choosing the chatbot

Step 1: Clarify the chatbot purpose.

According to the BSC model, the first step is to identify the organization's vision by asking the questions: "what is the direction my organization is heading for?" and "what is my organization trying to achieve?" (Kaplan & Norton, 1996). The chatbot is considered as a virtual conversational service software that interacts with human (*Young, 2010).* It mimics human agents' daily conversations with the customers; for that reason, defining the purpose (vision) behind employing the chatbot in the customer service is the starting point in the suggested methodology.

To define the chatbot purpose, the designer must first identify the problem to be solved by the chatbot. Once the problem is identified and specified, the solution provided by the bot has to be determined, hereafter, the chatbot designer, together with the organization managers, clarify the chatbot purpose statement. This statement clarification ensures that the performance measures developed in the BSC four perspectives (financial, customer, internal, learning, and growth) support the accomplishment of the chatbot strategic objectives.

Step 2: Choose an appropriate platform for the chatbot.

There are plenty of chatbot platforms nowadays that enables organizations to develop and customize the chatbot. These platforms provide features such as AI products that enable the designer to test, train, and monitor the chatbot, live chat, intent, and entities, conversational diagrams, deep learning, etc. These platforms differ in whether there is a necessity for coding knowledge, overall feature, and cost. They also differ based on the bot architecture model and dialog category.

There are two existing methods on which any architecture is based: retrieval-based and generation-based methods (Ji et al., 2014; Shang, 2015). The retrieval-based method selects top-ranked responses from a pre-built index while the generation-based method leverages the NLG techniques to respond to a message. The generation-based method is based on machine learning classification models that promise better and longer conversations.

Recent studies categorized the chatbot dialog into two categories: task-oriented dialog systems and non-task-oriented chatbots. For task-oriented, the former bot purpose is completing specific tasks (*Young, 2010)*, while the non-task chatbots aim to engage humans in social conversations (*Perez-Marin, 2011)*. The architecture model of a chatbot is decided based on the core purpose of development.

Design phase: The design phase is based on the BSC model and AD, respectively. BSC is used as a strategic management system to plan and design. After that, AD is applied to create a formulated conversation and solve any complexity within the dialogue. Finally, BSC is reused to implement by monitoring the progress towards the defined strategic targets.

The proposed methodological approach for planning, designing the BSC for chatbot follows three steps and four sub-steps, as shown in Figure 13.

Step 3: Understand the main strategic objectives of the customer service.

Conduct Face-to-Face interviews or surveys with customer service managers to gain a clear understanding of the main strategic objectives of the department and their perceptions about the linkage between those objectives. The interview questions or surveys are linked to the current system, which is the traditional customer service since managers are not experienced with the target system, which is the chatbot. Manager's knowledge about the current system has a vital impact on defining the chatbot's main objectives.

Step 4: Design the strategy map of the chatbot.

The design of the strategy map requires the identification of the strategic priorities and objectives of the chatbot. Based on Face-to-Face interviews/ surveys conducted in step 3, the chatbot's main strategic objectives are listed, and a graphical representation of cause and effect between the defined objectives is drawn.

Step 5: Formulate the strategy map based on BSC four perspectives.

The identified strategic objectives explained in the previous steps are categorized under the BSC four perspectives. Besides that, performance measures, targets, and initiatives are selected aligned with the strategic objectives. The chatbot is designed, taking into consideration the four perspectives that BSC imposes (Kaplan & Norton, 1996). However, the basic framework suggested by the pioneers can be modified based on organizational needs (*Olson & Slater, 2002)*. In this step, the key performance measures (KPIs) of the chatbot are selected and used to quantify the attainment of the strategic objectives. Additionally, targets and initiatives are determined for each perspective and listed in the BSC suggested figure. The sub-steps below represent a detailed methodological explanation of chatbot's four perspectives.

Step 5.1: Define the chatbot financial and/or social objectives, KPIs, targets and initiatives.

In this step, the key elements (strategic objectives, measures, targets, initiatives) that are brought to a business or an organization from a financial perspective must be defined. The financial or social perspective allows organizations to understand the financial or social benefits, for that reason, the main question that must be asked while deploying the chatbot for and organization is how chatbot employment is helping customer service and the organization from a financial/social perspective? To give an appropriate context, in the design phase, the chatbot's financial/social benefits must be assessed based on the current system, as shown in

Table 1
BSC Financial/Social Perspective's Strategic Objectives, KPIs, Targets and Initiatives for the Target System: Chatbot

Financial/social strategic objectives	Performance measures (KPIs)	Targets (chatbot)	Initiatives
Financial/social goals the customer service wants to achieve after deploying the chatbot	The financial/social KPIs to measure the chatbot success in the customer service department?	The target percentage number of success for each KPI	How do we do it?

Step 5.2: Define the chatbot objectives, KPIs, targets, and initiatives from customers perspective.

Understanding customers' requirements and complaints toward the current system through a data collection to determine chatbot strategic objectives, KPIs, targets, and initiatives. Planning for a chatbot before its launch and designing the bot conversation requires a clear understanding of customer needs and expectations. Accordingly, the data collection aims to understand the customers' and staff's complaints toward the current system; thus, the chatbot can be tailored based on their needs.

The chatbot employment is beneficial for both customers and staff within the customer service. For that reason, hereafter "customer" term is used for both customers and satff. Customer service aims to achieve higher customer satisfaction, increase the success rate of new products, and provide a competitive advantage *(Goffin & New, 2001)*. Studies show that chatbot can be used to build positive relationships with customers (*Bailey & McCollough, 2000).* Besides, using a chatbot to enhance customer satisfaction as well as staff, it can affect the customer service financial performance as Ittner, and Larcker discussed in their research about the relationship between customer satisfaction and financial performance by using various data sorted by company, business, and customer (*Christopher et al., 1998)*

The BSC customer perspective examination starts with setting strategic objectives and KPIs to measure these objectives, targets to attain, and activities to pursue Table 2.

Table 2
BSC Customer Perspective's Strategic Objectives, KPIs, Targets and Initiatives for the Target System: Chatbot

Customer perspective strategic objectives	Performance measures (KPIs)	Targets (chatbot)	Initiatives
Customer perspective goals that the customer service wants to achieve after deploying the chatbot	The customer perspective KPIs to measure the chatbot success in the customer service department	The target percentage number of success for each KPI	How do we do it?

Step 5.3: Identify chatbot internal processes.

In this step, the chatbot internal processes, including internal operational goals and objectives, must be identified to meet customer needs. The internal process perspective aims to define the success factors to achieve the strategic objectives and realize the purpose statement. For the chatbot, the internal processes in general, involves its personality, its ability to handle the unexpected or unknown questions, ability to help with day-to-day tasks, the volume of topics the bot can reply, etc. In this step, the measures that answer the following question: "what internal processes must we excel at to lead to financial/social accomplishment and satisfied customers" must be provided. The internal processes' strategic objectives, measures, targets, and the activities to be performed can be organized in Table 3, as seen below:

Table 3
BSC Internal Processes perspective's Strategic Objectives, KPIs, Targets and Initiatives for the Target System: Chatbot

Internal processes strategic objectives	Performance measures (KPIs)	Targets	Initiatives
What internal processes must we excel at to lead to financial/social accomplishment and satisfied customers?	Measures used to assess the success of the internal processes' objectives periodically.	The qualitative and/or quantitative number that shows the internal processes targets.	How do we do it?

Step 5.4: Define learning and growth perspective of the chatbot.

Learning and growth perspectives guide customer service employees and the management team to learn about the chatbot. Staff training can be a daunting mission

for organizations due to the limited time and resources. Hence, they are employing a bot to help in the segregation of information and consequently provide time for staff. However, leaving the chatbot to deal with customers alone may lead to unexpected and undesired results. Thereby staff and the management team collaboratively must learn about the chatbot to enhance its performance and the end-user experience. To gain tangible outputs related to the learning and growth perspective, the designer must set clear strategic objectives, measures, targets, and activities, as shown in Table 4.

Table 4
BSC Learning and Growth Perspective's Strategic Objectives, KPIs, Targets and Initiatives for the Target System: Chatbot

Learning and growth strategic objectives	Performance measures (KPIs)	Targets (chatbot)	Initiatives
How must the customer service learn and grow together with chatbot to achieve the vision?	How to quantify and measure the learning and growth perspective as an intangible asset?	What are we trying to achieve in terms of the learning and growth perspectives?	How do we do it?

The next three steps and five sub-steps illustrates the AD to create the chatbot conversation.

Step 6: Understand customers' most prioritized topics related to FAQ.

Hereafter, the designer must collect data (Face-to-Face interviews, and or questionnaires, and/ or surveys, and/ or archive…) to categorize FAQ into categories and sub-categories and determine the number of questions for each category.

Step 7: Determine the four-domain suggested by AD framework.

In this step, based on the previous categorization of topics and questions, the customer domain, functional domain (the conversation utterances), the chatbot physical domain (the design parameters: intents, contextual entities), and the process domain (the conversation flow chart), are determined and explained respectively.

Step 7.1: Define the customer domain.

The customers' needs are identified based on data gathering procedures such as face-to-face interviews, questionnaires, interviews, or workshops. It is challenging to satisfy all customer requirements since they are widely varying. Some needs may not be beneficial for the organization at the moment. For that reason, data gathering procedures are organized to understand the prioritized customers' needs that represent their inputs to the chatbot.

Step 7.2: Define the chatbot conversation functional requirements.

The chatbot conversation functional requirements are the varieties of the utterances provided to meet the customer needs (input). The utterance represents the customer input converted into a question. Providing different possible utterances increases the probability of the chatbot's accurate responses.

Step 7.3: Define the chatbot conversation' design parameters.

Chatbot conversation design parameters consist of two main variables: intents and contextual entities. To build a conversation, the first variable that must be identified is the intent. Intents are the customer's intentions that are conveyed to the bot. While designing for the intents, the contextual entities must be determined accordingly. Entities are terms that provide a context for the defined intents. In this domain, it is necessary to determine these design parameters that satisfy the functional conversation requirements (utterances).

Step 7.4: Define the relationship between FRs and DPs after the decomposition processes of the design hierarchy.

After the FRs and DPs identification, the functions must be decomposed into sub-functions and linked to the DPs accordingly. The relationship between FRs and DPs must be clarified, and the solution must be provided when any complexity is shown while examining the AD trees. The AD must be examined based on the two axioms (the independence axiom and the information axiom)

Step 7.5: Define the process domain of the conversation.

In this step, the Process variables (PVs) must be identified. PVs represent the elements that characterize the process that satisfies the specified DPs. Such as conversation type (task-oriented conversation, non-task-oriented conversation), and conversation flow.

Step 8: Train & test & launch the bot.

This step includes three stages:

This step includes three stages:

- Training the chatbot: The old data (call logs, email chains, FAQ pages, social media platforms from customer support can be used to train the chatbot.
- Testing the chatbot: The chatbot must be tested before its launch. The designer must run the test with the help of the customer service team and any volunteer group. The test includes response accuracy and speed, the bot flow, and user experience (UX).
- Launching the chatbot

Step 9: Monitor the chatbot based on the BSC model.

After the launch, the customer service department must analyze the interactions between the chatbot and the users to continue improving it. The interactions between customers and chatbot can be monitored through different methods; the analytics page of the chatbot's platform is an example. However, in the current methodology, the chatbot monitorization does not end with the analytics and evaluation method; it goes beyond the chatbot internal processes and customer perspectives. The BSC, with its four perspectives, is employed to keep monitoring the chatbot continuously.

5. CASE STUDY

The CHDF explained and represented in the methodology section is applied to design a chatbot for the student affairs office of the Business Administration Faculty of Marmara University. The purpose is to provide a comprehensive view of the proposed CHFD steps using a real-life example.

It is important to note that the chatbot is used before and after the suggested design is proposed to assess the design's effectiveness. Before applying the CHDF within the student affairs office, the chatbot Questions/Answers is retrieved from the faculty's website, intents and entities are used randomly without a specific roadmap. On the other hand, based on the suggested CHDF, the conversational design experience, and the outputs are reported and discussed in the discussion session.

Step 1: Clarify the chatbot purpose.

By asking the question “What your organization is trying to achieve by using chatbot” to faculty administration, chatbot purpose is clarified. It is stated that the faculty’s chatbot that is called MiFBot aims to enhance the quality of services provided by the student affairs office by allowing students to interact with the entire department smoothly and through stimulating conversations.

Step 2: Determine the architecture model of the chatbot.

Initially, MiFBot is used to automate the existing FAQ on the faculty website. Subsequently, it aims to assist students in a variety of issues. For that reason, the bot used for this case is a task-oriented bot based on a generative model.

Step 3: Understand the main strategic objectives of the department.

To understand the main strategic objectives of the department; firstly, one-on-one interview with the Dean of the students and the Vice Dean is conducted considering her as the head manager of the faculty. General questions associated with the faculty's

goals, policies, budgets, and working procedures are asked to gain a clear understanding of the general strategic objectives. Questions related to the student affairs office are generated in the interview to allow the Dean of the students articulating her interpretation of the vision, financial, customer, and internal processes of the office, besides the activities the staff attend to improve and grow. Secondly, a one-on-one interview with the faculty secretary is executed. The interview started asking the Faculty Secretary about the office mission and vision, following by the main strategic objectives and their inter-relationships they set to manage the office and enhance the workflow. The interview's findings confirmed the vision quoted: "internationally recognized university leader who provides students with high-quality services," and revealed some strategic objectives that will be used to create the chatbot's main strategic objectives.

Step 4: Design the strategy map of the chatbot.

The interviews conducted in step 3 with the Dean, the Vice Dean of the students, and the Faculty Secretary discussed a general view of the strategic objectives determined by the management team to enhance the student service. However, this study aims to provide a set of specific strategic objectives for MiFBot that mimic the role of the student affairs office in the faculty. For that reason, it is crucial to select objectives defined by managers and decide whether they are suitable for the current chatbot or not.

Based on step 3 MiFBot main strategic objectives are defined as below:

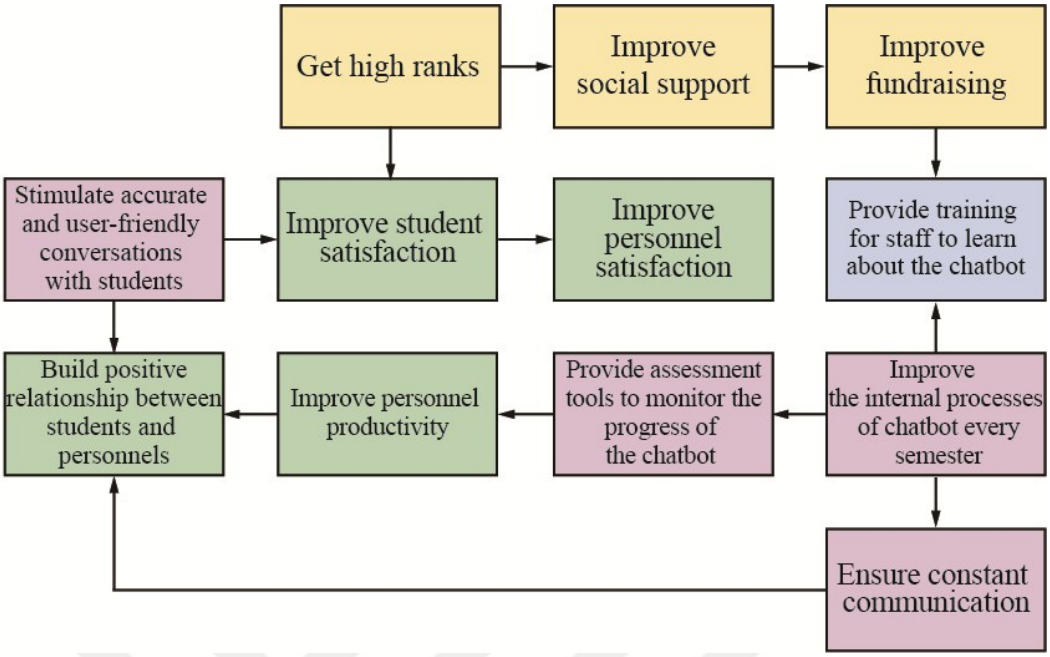

Figure 14: MiFBot Strategic Linkage Model

- Improve students' and student affairs office staff satisfaction
- Improve staff productivity
- Build a positive relationship between students and students affairs office
- Improve fundraising
- Cost efficiency
- Stimulate accurate and user-friendly conversations with students
- Ensure constant communication
- Improve the internal process of MiFBot every semester
- Resolve common support issues in real-time
- Provide assessment and evaluation tools to monitor the progress of MiFBot together with student affair office' workflow
- Provide training for staff to learn about the chatbot and grow together with it.

The next step is to encompass the identification of the linkage between the strategic objectives determined above based on the one-on-one interviews conducted with student affairs office managers. The chatbot cause-effect model is presented in Figure 14.

Step 5: Formulate the strategy map based on BSC four perspectives.

The strategic objectives mentioned above are categorized into four perspectives: financial and social, customer, internal, learning, and growth perspectives, and shown in Figure 15. The corresponding measures, targets, and initiatives are presented separately in the next steps.

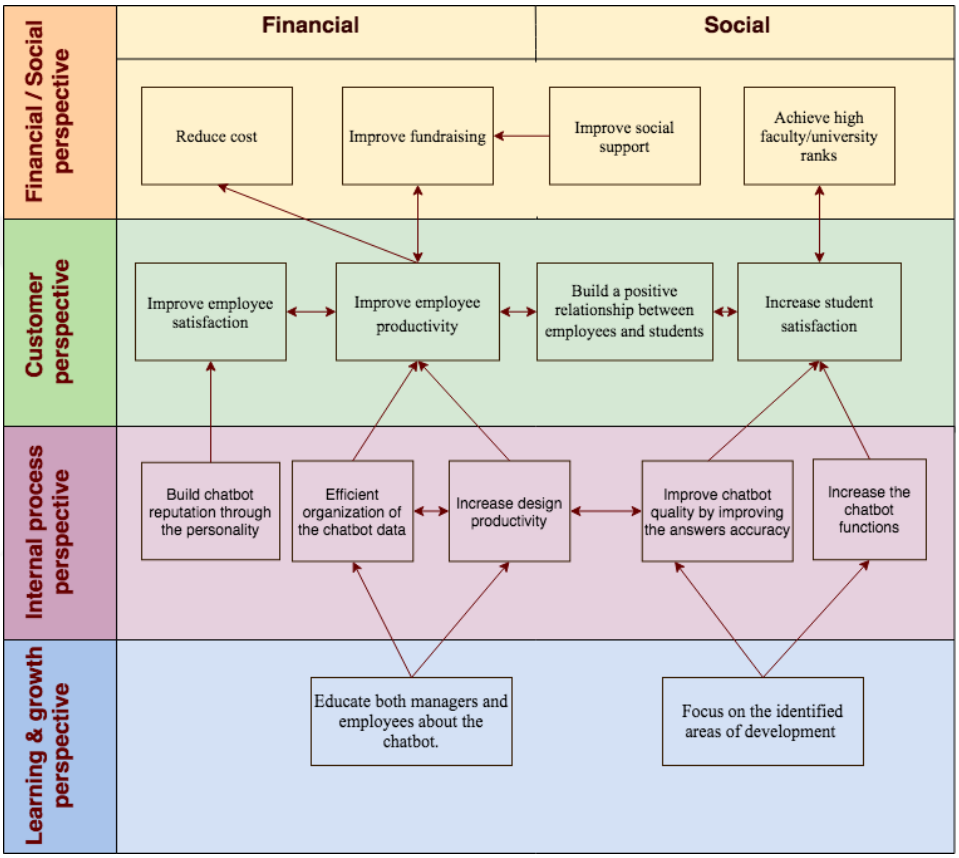

Figure 15: BSC Model for MiFBot

Step 5.1: Define the chatbot financial and/or social objectives, KPIs, targets and initiatives**.**

In this case study, financial and social perspectives exist with equal importance. The main question to ask when defining the financial objectives is: how chatbot employment is serving student affairs and our faculty from a financial perspective. The initial financial objective of the chatbot is reducing the cost of support calls and employment. The chatbot can help student affairs office saving on student

service costs by speeding up response times and replying to the repetitive daily questions. The employment of the chatbot accompanies the reduction of support call numbers. This reduction leads to significant cost savings.

Table 5
BSC Financial Perspective's Strategic Objectives, KPIs, Targets, and Initiatives for MiFBot

Financial strategic objectives	Performance measures (KPIs)	Target: Chatbot	Initiatives
Reduce cost	Total cost of support calls per year	Reducing the cost by 20% for the first year of launch	Increasing MiFBot efficiency. Freeing up current staff to solve complicated issues the bot is unable to solve, and leave one personnel to work together with the bot.

Regarding the social perspective, MiFBot's objectives involve helping the office to enhance its reputation, which leads to improving social support and getting high ranks between other faculties and universities (Table 6). The high ranking makes the government satisfied with the value of the investment in higher education and encouraged reinvestment.

Table 6
BSC Social Perspective's Strategic Objectives, KPIs, Targets, and Initiatives for MiFBot

Social strategic objectives	Performance measures (KPIs)	Target: chatbot	Initiatives
Improve social support	Number of tangible supports the faculty receives per year	Increase social support activities by 20% for the first year of launch	Enhancing the faculty's reputation through MiFBot

Step 5.2: Define the chatbot objectives, KPIs, targets, and initiatives from customers perspective.

Table 7
Results of the Student/Staff Data Collection

Students' complaints	Students' requirements	Personnels' requirements
• Long waiting time • Receiving unclear answers • Switching many personnels • Receiving wrong replies	• Receiving adequate answers • Service availability • Real time solutions to the queries • Receiving answers on the complex queries • Multi-lingual support	• Questions are repetitive • Multitasks are hard to handle and stressing. • Queries are not clear

This step is vital for the chatbot design because understanding students' needs and complaints are crucial when designing the chatbot conversation for the first time. In this case, both the students and student affairs office staff are the customers. Face-to-face interviews are conducted with the faculty secretary to learn about the main staff complaints. The general staff complaints are noted and listed in Table 7. Secondly, one-on-one interviews with student representatives are conducted, and general complaints and requirements are noted. The results are illustrated in Table 7.

On the one hand, the results showed that students need instant, adequate replies, while some look for answers to their complicated questions. However, International Students who do not speak in Turkish are interested in multi-lingual support. On the other hand, the Faculty secretary comment on the staff's daily interactions with students, especially in the course enrollment period. The general perceptions of daily work is listed in Table 7.

In this case, the chatbot plays such an essential role for the student affairs, since it has a direct interaction with students 24/7. For that reason, enhancing customer satisfaction is a primary objective. The second objective is the staff's satisfaction that leads to student satisfaction, which in turn creates a positive relationship between the two parts and ultimately drives financial benefits (Table 8).

Table 8
BSC Customer Perspective's Strategic Objectives, KPIs, Targets, and Initiatives for MiFBot

Customer Perspective Strategic Objectives	Performance Measures (KPIs)	Target Chatbot	Initiatives
Improve staff satisfaction	Staff Satisfaction Surveys/ Attrition Rate	Increase 50% at the end of the Year	Automate FAQ of the faculty
Improve staff productivity	Output/Input Agent Utilization	Increase 50% at the end of the year	Optimize the data center through the chatbot
Increase student satisfaction	Graduate Surveys/Engagement Surveys/CSAT/The Chatbot Total Active Users/Interaction Per Student	Gain a high amount of total active users in chatbot Increase the number of student interaction with the chatbot	Improve the accuracy of Q/A Use chatbot to collect student information in the initial part of the conversation
Build a positive relationship between staff and students	Feedback Rate CSAT Score	Keep the chatbot productivity sustainable	Increase the chatbot correct answer rate compared to the unanswered questions Add new topics to the bot every semester

To evaluate the chatbot's performance, it is vital to assess the current system performance based on the strategic objectives. The current staff's satisfaction based on information received from the managers of student affairs is considered low. The KPIs used in the assessment in the BSC implementation phase are staff satisfaction surveys in the archives and attrition rates. In the current context, the chatbot aims to improve the staff's productivity, and that can be realized starting by the automation of FAQ of the website. Another objective highlighted in Table 8 is student satisfaction, measured by CSAT (customer satisfaction). The chatbot purpose is to increase student satisfaction in each passing year. For that reason, improving the accuracy of Q/A and using the welcoming text to collect students' information is action to take; thus, chatbot achieves a high rate of student satisfaction. The last objective associated with the student perspective is building a positive relationship between personnel and students. The KPI used to measure this objective is the feedback rate. Building a positive relationship requires a continuous effort in improving the bot and keeping its sustainability.

Step 5.3: Identify chatbot internal processes that must be designed to meet customers' needs.

In this step, the Internal process of the chatbot is examined. Internal/operational process objectives are linked to the customer perspective and determined based on it. The chatbot internal process as shown in Table 9 and involves seven objectives and a set of KPIs, targets, and initiatives. These objectives are determined to satisfy students' needs and excel with their expectations.

Besides that, achieving the identified targets gain university a competitive advantage; thus, it can be qualified for high levels in the ranking. Designing the chatbot personality is one of the strategic objectives determined to create the bot reputation. The personality is based on the student persona. The efficient organization of the chatbot data and the increase of design productivity is one of the objectives defined in this perspective. These objectives can be achieved following the AD principles and measured by KPIs that evaluate the performance of conversation, such as retention rate, active users, etc.

Table 9
BSC Internal Processes Perspective's Strategic Objectives, KPIs, Targets, and Initiatives for MiFBot

Internal processes strategic objectives	Performance Measures (KPIs)	Target Chatbot	Initiatives
Build the chatbot reputation through the personality	Student Survey	Create the bot image through its personality	Define the bot scope based on the defined purpose. Determine the greeting message Understand students' needs to design for the bot personality. Translate the personality into dialog Integrate the chatbot in the student BYS system, thus the bot can remember students and based on it can build a dialog. This feature may lead to an emotional connection between students and the bot
Efficient organization of the chatbot data.	Retention Rate/ the conversation length/unanswered questions & answered questions rate	Maintain the usage of AD to organize data and evaluate the relationships between the AD suggested domains	Apply AD to categorize questions and define intents based on the categorization. Examine relationships between the AD four domains.
Increase design productivity	The conversation rate before and after applying the conversational design model/ Conversation length / Active user rate/	Maintain the usage of AD to examine any complexity in the conversation.	Use AD to design for the conversation Modify the design content when it is needed.
Improve chatbot' quality by improving the answers accuracy.	Correct Answers rate/ Goal completion rate (GCR)/ Fallback rate (FBR)/ Human takeover rate	Achieve high rate of response accuracy	Keep the specific content. Feed the bot with a number of utterances with a set of intents and entities. Add slots to categorize, interpret and store the student inputs. Test the chatbot continuously. Use high quality tools to train the bot. Reduce the bot unanswered questions.
Improve the chatbot functions by feeding it with new topics and specializations every semester	The number of new queries per semester	Achieve new 100 queries for the launch year	Understand student requirements in order to feed the bot with new topics Add new topics with new Q/A while prioritizing the quality over the quantity

In addition to the mentioned objectives, enhancing chatbot quality through the improvement of the answer's accuracy is an imperative objective since students need accurate answers rather than false ones. For that reason, to provide accurate replies, specific content accompanied by several utterances and a set of intents and entities are required while designing for the dialog. The last initiative required to achieve a high quality of chatbot is testing and training the bot continuously. The final internal objectives would be improving the bot functions and reducing the unanswered questions. The improvement of the chatbot functions can be realized by feeding the bot with new specialization every semester; however, the quality must be prioritized over the quantity of the bot data. On the other hand, the reduction of the unanswered questions can be accomplished by understanding the reason behind the bot disability to provide the answers and solutions required to resolve this situation. Also, the automatic direction of the ongoing inquiries to live student representatives is essential to help the bot in challenging situations.

Step 5.4: Define learning and growth perspective for the chatbot.

The faculty must provide educational programs and seminars to teach staff about the chatbot functions and purpose. After that, staff can invest in time by training the bot and assisting in its early stage. The target aligned with this objective is unifying the chatbot with the student affairs office to create high-quality service. The second objective as presented in Table 10 in this perspective is to focus on the identified areas of development; it can be measured by the number of unanswered questions and student satisfaction surveys. Workshops are an excellent opportunity to discuss the chatbot's performance and understand the areas that effort must be put. Finally, a section on the faculty website about chatbot can be added to educate the campus community about the bot and to get reviews.

Table 10
BSC Learning and Growth Strategic Objectives, KPIs, Targets and Initiatives for MiFBot

Learning and growth strategic objectives	Performance Measures (KPIs)	Targets	Initiatives
Educate both managers and staff about the chatbot.	Hours of staff training/Professional development offered and completed / Staff satisfaction/Engagement scores	Unify chatbot and student affairs office to create a high-quality service.	Held an educational seminar to educate staff and managers about chatbot vision and functions. Facilitate students and staff training on chatbot topics. Create an action plan to train the bot after the completion of the seminars.
Focus on the identified areas of development	Unanswered Questions Rate/ Student Satisfaction Survey	Optimize the revealed areas of development.	Identify the areas of development through analytics and insights Organize workshops to discuss the performance of the chatbot and how to enhance it. Provide a section in the university website about chatbot to educate the campus community about the bot and to get reviews.

The next four steps examine the chatbot conversation design based on the four domains of AD. The customer domain involves student requirements that represent their frequently asked questions. Each requirement must be addressed by functional requirements that are converted into design parameters and after that into process variables.

Step 6: Understand customers' most prioritized topics related to FAQ.

Table 11
Students Most Prioritized Questions in Category

Categories	Sub-categories	Question variation for each sub-category
C1. Course selection	6	15
C2. Tuition Fees	3	15
C3. Syllabus	2	5
C4. ECTS	4	5
C5. Preparatory Year	2	10

Chatbot's conversation design of the student affairs office requires to consider student needs. For that reason, topics retrieved from the FAQ page on the university website are used as a database, a sample of Students Petition Form records in the student affairs office archive are evaluated to understand the students' most prioritized questions, Face-to-Face interviews with student representatives are conducted to understand their prioritized topics based on the FAQ page. Results showed that students prioritized "the course enrollment" and "tuition fees" related questions, syllabus, ETCS, and preparatory year's queries followed. In the long term, other topics can be added to the chatbot, such as "summer school" or "scholarships" related queries to accomplish the chatbot vision. Nevertheless, the current conversation design is based on the prioritized topics shown in Table 11. Five categories are linked with subcategories with possible questions and one accurate, clear answer received from the Faculty secretary. In addition, the instant and adequate answers the bot delivers are retrieved from student affairs office regulations, student counseling handbooks, and a student-centered curriculum. The answers fed in the chatbot are revised by the faculty secretary to ensure the accuracy of the replies.

Step 7: Determine the four-domain suggested by AD framework.

The chatbot conversation in the present study is examined based on AD principles. First of all, students' requirements, the highest level FRs, and other information have been defined as shown in Table 12. In the next sub-steps, a detailed explanation of each domain, in addition to the required mapping and decomposition processes are presented.

Table 12
Characteristics of AD Four Domain for MiFBot Conversation

Student requirements (CNs)	Functional requirements (FRs)	Design parameter (DPs)	Process
Feel connected	Provide welcome text message that is harmonious with the bot personality	Provide intent related to welcoming	-The conversation is based on text-to-speech. -The chatbot uses generative modelling to generate replies -The conversation is task-oriented conversation -The chatbot initiate the conversation -The chatbot switch to a human agent when it is unable to provide an answer. (Figure 21)
Get adequate answers about problems related to Course Enrollment	Determine utterances related to Course Enrollment category	Determine one main intent /entity for the Course Enrollment category	
Get an adequate answer about problems related to Tuition Fees	Determine utterances related to Tuition Fees category	Determine one main intent /entity for the Tuition Fees category	
Get an adequate answer about problems related to Syllabus	Determine utterances related to Syllabus category	Determine one main intent /entity for the Syllabus category	
Get an adequate answer about problems related ECTS	Determine utterances related to ETCS category	Determine one main intent /entity for the ETCS category	
Get an adequate answer about problems related to Preparatory Year	Determine utterances related to Preparatory Year category	Determine one main intent /entity for the Preparatory Year category	

Step 7.1: Define the customer domain.

Students' needs are their written inputs to the chatbot, as shown in Table 12, each input is directly satisfied by selecting an appropriate FR. Thus, based on the provided data, as shown in Table 11, students prioritized both course enrollment and tuition fees related questions, followed by the syllabus, ECTS, and preparatory year between a variety of categories presented in the FAQ.

Step 7.2: Define the chatbot conversation functional requirements.

The chatbot functional requirements represent the utterances which referred to the questions that students say and that the bot understands as a certain intention (Table 12). Each intent has a range of utterances. In this step, a list of all utterances related to

each category is listed to simplify the design process. The bot cannot assume the way the student provides a question, however, defining different utterances increases the probability the bot gives an adequate answer. Currently, five possible utterances in which a particular intent can be asked are listed. These utterances must be provided for all categories. For example:

- The course selection category: utterances that express the "enrollment week date" can be asked in multiple ways, such as:

  I don't know my course enrollment date; how can I know?
  Can I learn about my enrollment date?
  Can you tell me the official course enrollment date of my department?
  What is the exact date for course enrollment?
  What is the exact date for course enrollment?

- The tuition fees category: utterances that express the "tuition fees price" can be asked in multiple ways, such as:

  "how much is the tuition fee?"
  "what is the amount of money should I pay for tuition fees?"
  "I want to learn about the tuition fees total cost?"
  "the annual tuition fees?"
  "how much should I pay for the tuition fee?"

Step 7.3: Define the chatbot conversational design parameters.

There is one main design parameter in this case, as indicated in Table 12, which is the intent that represents the purpose of student input. Students' needs are transferred to the functional domain that has to be fulfilled by the final output. Another design parameter is the contextual Entity, which is relevant to the defined intents and provides a specific context for an intent that helps to define the conversational flow. An entity is a variable that compliments the intent. Entities are defined when it is needed.

An example of the design parameters that the utterance is built on is shown below.

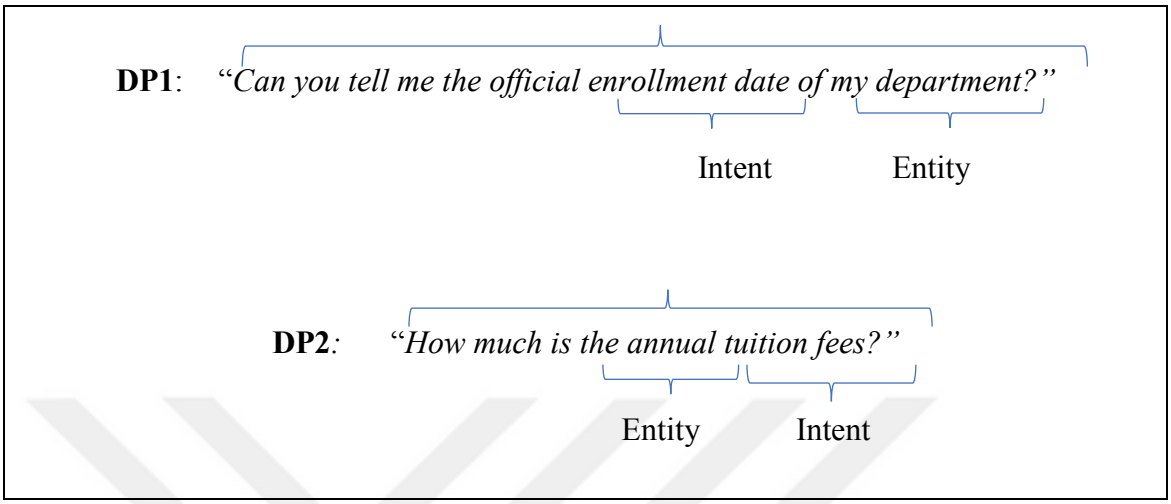

Figure 16: An Utterance Design Parameters: Intent and Entity

Step 7.4: Define the relationship between FRs and DPs after the decomposition processes of the design hierarchy.

The relationship between FRs and DPs after the mapping and decomposition processes of the design hierarchy is identified in this step. The first step is to map from FRs to DPs: the strategic design process progresses from a system-level to levels of more detail. High-level categories utterances and the corresponding intents and entities are decomposed into more detailed sub-categories in terms of a design hierarchy. The decisions the bot made at higher levels may affect the statement of the sub-functions at lower levels. Before a certain function is decomposed, the corresponding design parameter must be determined. Finally, the two strategic design axioms are used to evaluate the proposed designs according to the independence of the functions and information content of the design.

Decomposition Level 1: During the decomposition of the chatbot conversation, hierarchical positions for each step are shown in figures. Figure 17 exemplifies the decomposition phase *(Level 1).* Chatbot initiative message forms the root of the tree. The conversation starts with a welcoming message text. The welcoming statement is the first response that the chatbot sends to the students who initiate a live

chat. It is crucial in the design of the conversation since it reflects the student affairs office image. D0 represents the intent keyword the designer defines; thus, the bot can understand the student input. F0 consists of five FRs, as indicated in Figure 17 each FR is linked to one DP.

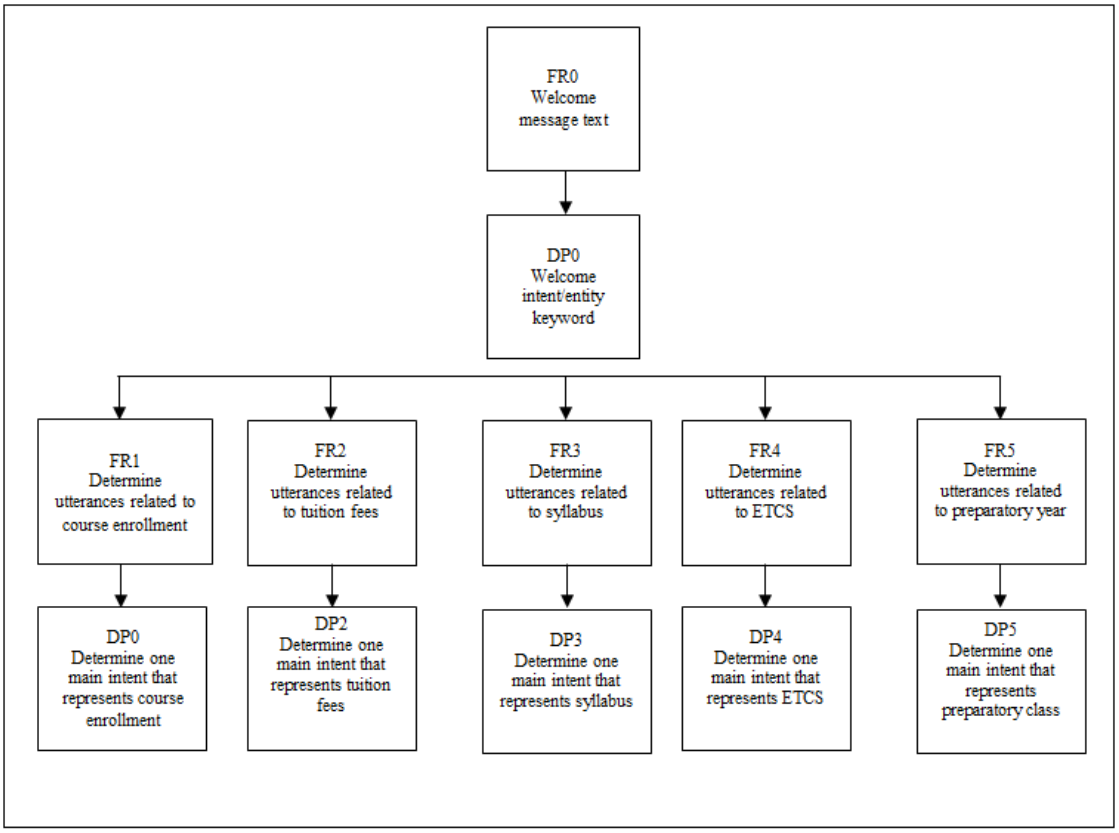

Figure 17: Decomposition of FR0-DP0 (Level 1)

Axiom 1: FR1 represents the utterances categorized and untitled as course enrollment. The DP1 is one primary intent linked to the course enrolment category that affects only FR1 as a modification on each DP only influences the corresponding FR. Similarly, with the remained FRs in the first level of the hierarchy. Therefore, the independence axiom is satisfied, and the design matrix takes the form of a diagonal matrix, as shown in Equation 5 which is desirable.

The DM of the set of FRs and DPs of the first level

$$\begin{Bmatrix} FR1 \\ FR2 \\ FR3 \\ FR4 \\ FR5 \end{Bmatrix} = \begin{Bmatrix} X & 0 & 0 & 0 & 0 \\ 0 & X & 0 & 0 & 0 \\ 0 & 0 & X & 0 & 0 \\ 0 & 0 & 0 & X & 0 \\ 0 & 0 & 0 & 0 & X \end{Bmatrix} * \begin{Bmatrix} DP1 \\ DP2 \\ DP3 \\ DP4 \\ DP5 \end{Bmatrix} \tag{5}$$

Axiom 2: In the first level of FR's decomposition, the design is uncoupled; thus, the smallest sum of the information content is equal with the higher probability of meeting all the functional requirements within the limits of the tolerances.

Decomposition Level 2: The second level of the hierarchy represents the subcategories in the chatbot conversation design. FRs in the second level illustrates the subcategories utterances and the corresponding DPs intents and entities as needed (Figure 18).

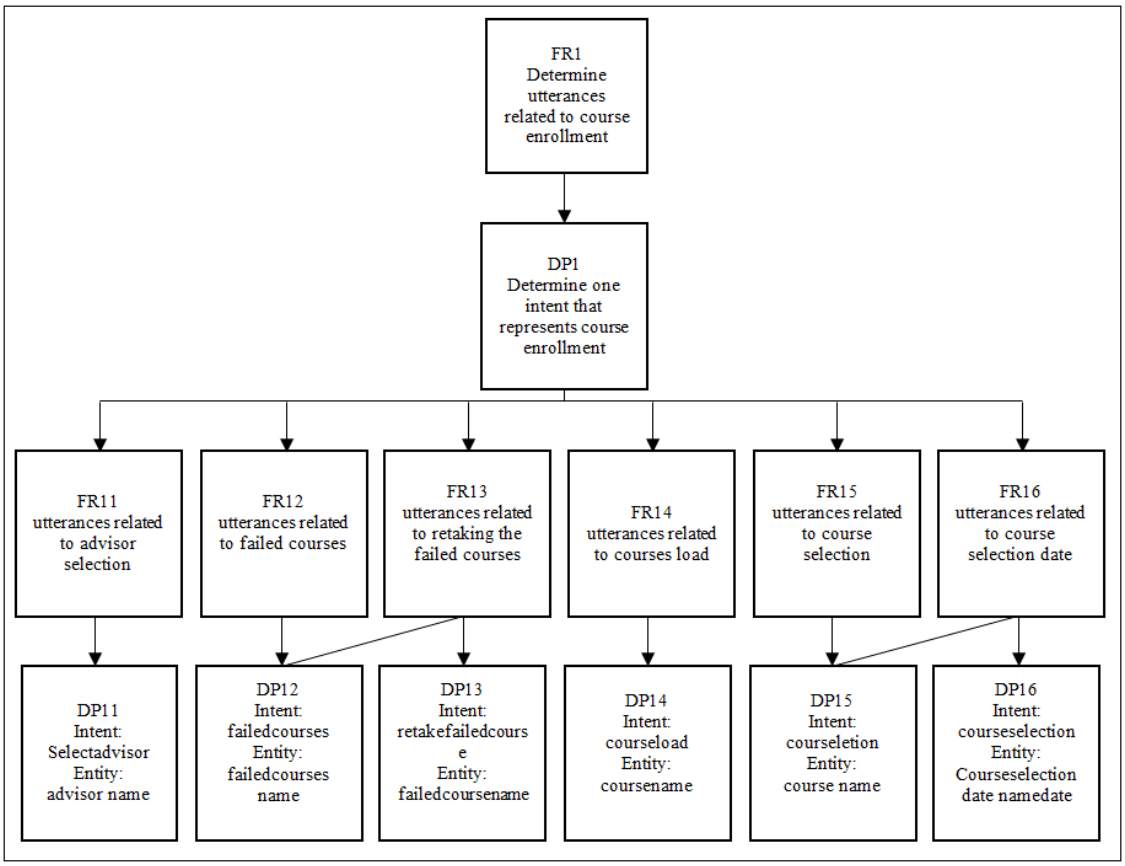

Figure 18: Decomposition of FR1-DP1 (Level 2)

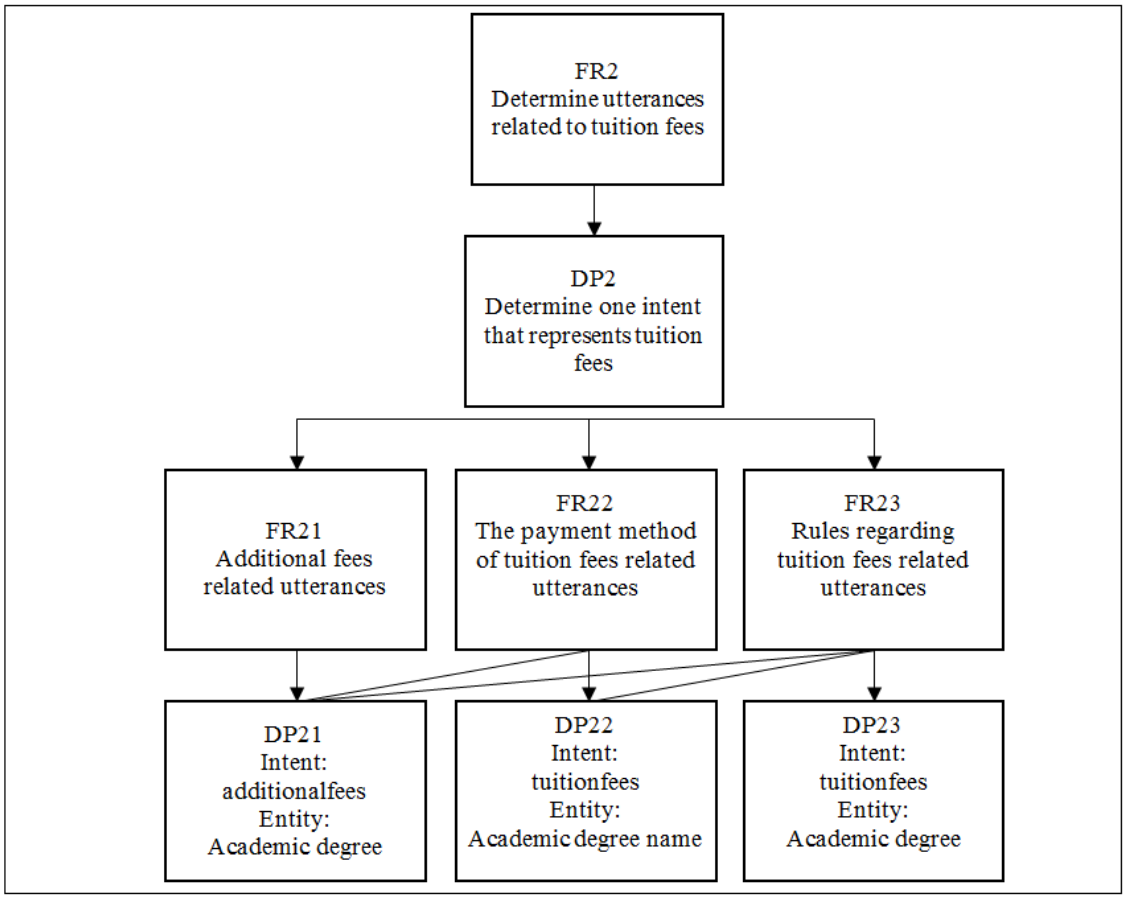

Figure 19: Decomposition of FR2-DP2 (Level 2)

Axiom 1: Based on the utterances categorized in subcategories, the DP11 affects FR11, DP12 affects FR12 and FR13. The remaining interrelationship is shown in Figure 18 and 19. Therefore, the independence axiom is unsatisfied, and the design matrix takes the form of a decoupled matrix, which is undesirable. The mathematical representations of decomposition of FR1 and DP1, FR2, and DP2 are presented in Equation 2 and 3. Providing one single intent that affects two or more subcategories utterances is violating the independence of the FRs according to axiomatic design principles.

The DM of the set of FRs and DPs of the Course Enrollment category:

$$\begin{Bmatrix} FR11 \\ FR12 \\ FR13 \\ FR14 \\ FR15 \\ FR16 \\ FR17 \end{Bmatrix} = \begin{Bmatrix} X & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & X & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & X & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & X & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & X & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & X & 0 \\ 0 & 0 & 0 & 0 & 0 & X & X \end{Bmatrix} * \begin{Bmatrix} DP11 \\ DP12 \\ DP13 \\ DP14 \\ DP15 \\ DP16 \\ DP17 \end{Bmatrix} \quad (2)$$

The DM of the set of FRs and DPs of the Tuition Fees:

$$\begin{Bmatrix} FR21 \\ FR22 \\ FR23 \end{Bmatrix} = \begin{Bmatrix} X & 0 & 0 \\ X & X & 0 \\ X & X & X \end{Bmatrix} * \begin{Bmatrix} DP21 \\ DP22 \\ DP23 \end{Bmatrix} \quad (3)$$

Axiom 2: the information axiom must be minimized to provide a higher probability of success.

A complete decomposition level is provided to gain a comprehensive insight into the overall processes, as illustrated in Figure 20. This case study focused on a limited range of topics. However, based on the AD tree shown in Figure 20, the designer can create a more extended tree based on a variety of topics and different relationships.

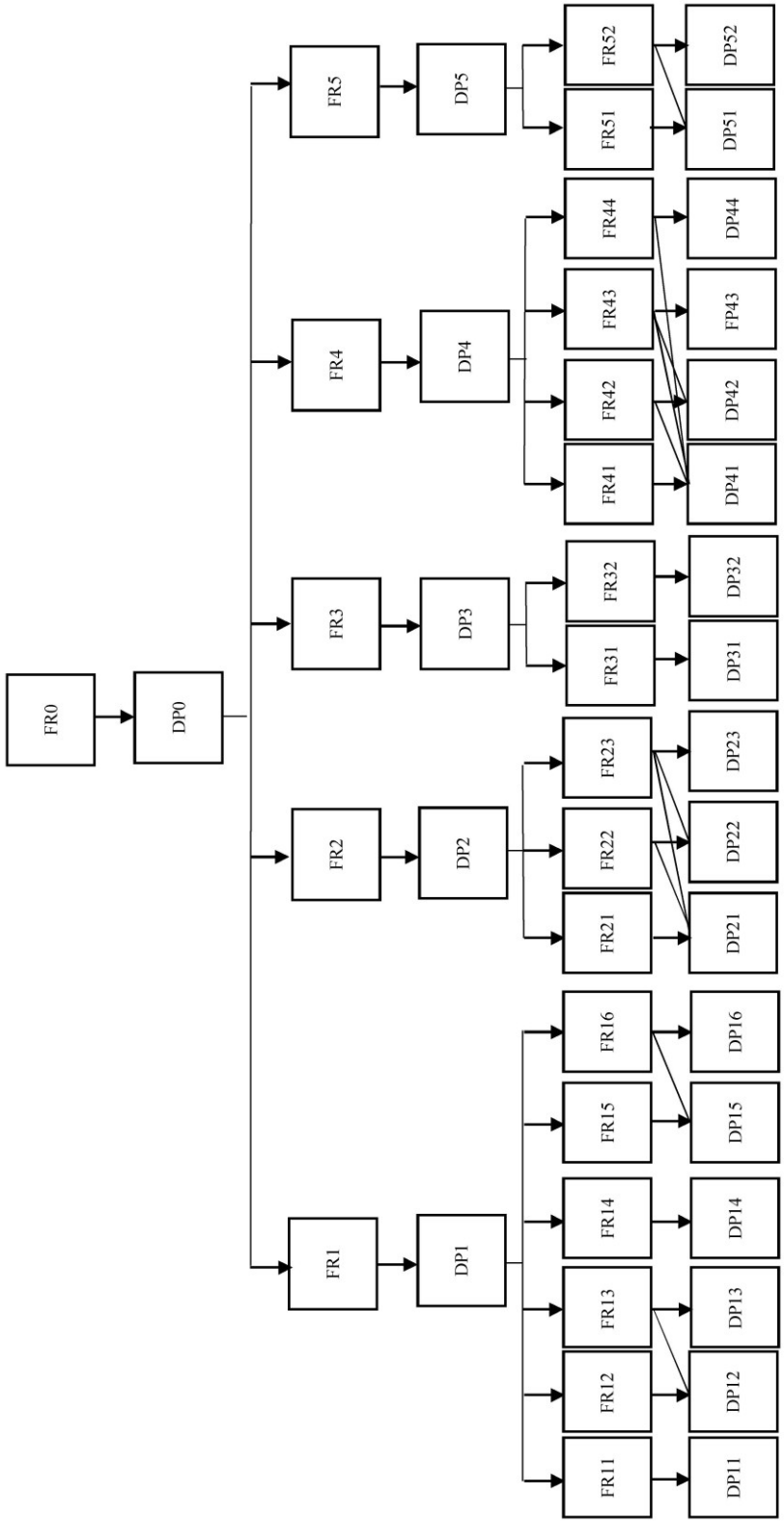

Figure 20: Decomposition of the Complete Hierarchy.

The proposed solution

Figure 20 denotes the repeated decomposition process that illustrates the different design levels of the mapping and "Zig-Zagging." The entire FR-DP levels in this paper consist of two hierarchy levels. However, the variety of conversation paths can determine the length and complexity of the AD tree. In this case, the complexity of AD-axioms can be reduced at a minimum through the revision of AD-axioms on every design level. The aim is to provide one single intent to five utterances for each sub-category. Providing similar intents for different categories is not desirable according to AD principles. For that reason, to reduce the chatbot confusion, the designer must define intents that are connected to one sub-category and avoid the similarities that may lead the bot to misunderstand the user input.

Results showed that the developed AD to design for chatbot conversation helped effectively avoiding and minimizing design iterations when defining the conversation intents and entities. The elimination of the repeated intents and the dialog specific content saved time while redesigning for the chatbot conversation based on AD principles. Besides that, the suggested AD roadmap allowed the selection of the best intents among a variety of intent keywords.

Step 7.5: Define the process domain of the conversation.

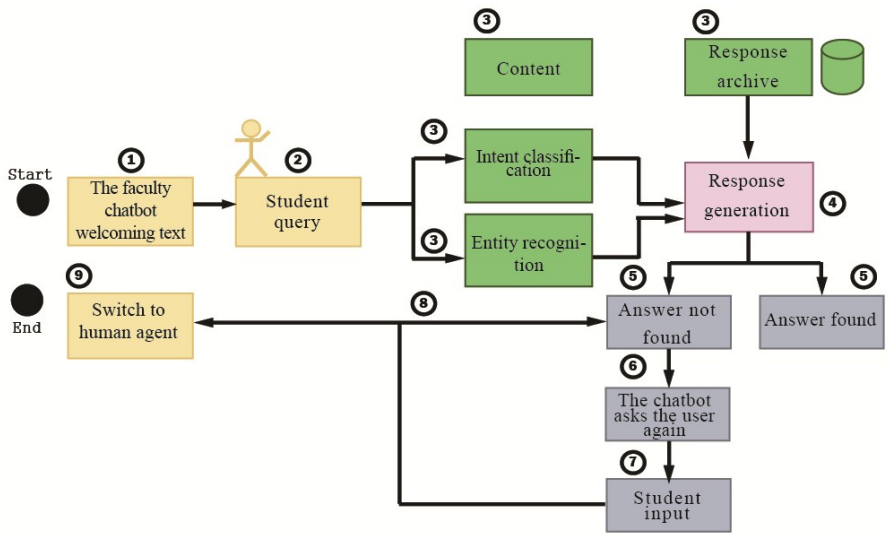

Figure 21: MiFBot Conversation Process

MiFbot is task-oriented bot that attempt to assist students. MiFbot greets a student. Student ask a question as shown in Figure 22. The bot replies by providing a clear answer. At the end of the answer, the chatbot asks student if everything is clear to make the ensure that student is satisfied. For example:

Chatbot	Welcome # (name of the student). I can help you with one of the topics listed below: o Course Enrollment o Tuition Fees o Syllabus o ECTS o Preparatory Year
Student	I don't know my enrollment date; how can I learn?
Chatbot	You should enroll into your courses in the announced date for your "Projected Academic Level" which can be found on MÜ Home Page.
Student	Thank you,

Figure 22: An Example of a Conversation Between a Student and MiFBot

Step 8: Train & test & launch the bot.

- The current chatbot is trained based on the dataset retrieved from the FAQ page of the faculty and the student affairs office archive. The dataset is limited to the categories defined in step 6. Besides, the chatbot can train itself afterward since it is based on NLP.
- The chatbot is tested with the student affairs office staff and Faculty secretary. It is also tested with some students to ensure the accuracy of the

responses and to evaluate the students' experience. The questions that the chatbot failed to respond are noted.

- After the chatbot training and testing, the chatbot was released on the faculty website page. It is ready to work in public.

Step 9: Automate BSC to monitor the chatbot.

Chatbot monitoring is a necessary action that must be taken to ensure the chatbot productivity continuously. The chatbot monitoring strategy is based on the BSC model that focuses on the four perspectives KPIs. There are many ways to use BSC automation for monitoring, whether by using templates, applications, frameworks, or software. In this case, BSC templates are used due to the limited amount of information related to the faculty chatbot. However, BSC software can be used when the information is expanded.

For this case study, the BSC four perspectives model as shown in Figure 15 is used to monitor the chatbot and the progress. KPIs, targets, initiatives for each perspective are determined in Table 5, 6, 8, 9, and 10.

Chatbot performance Findings Based on Dahi.ai Platform

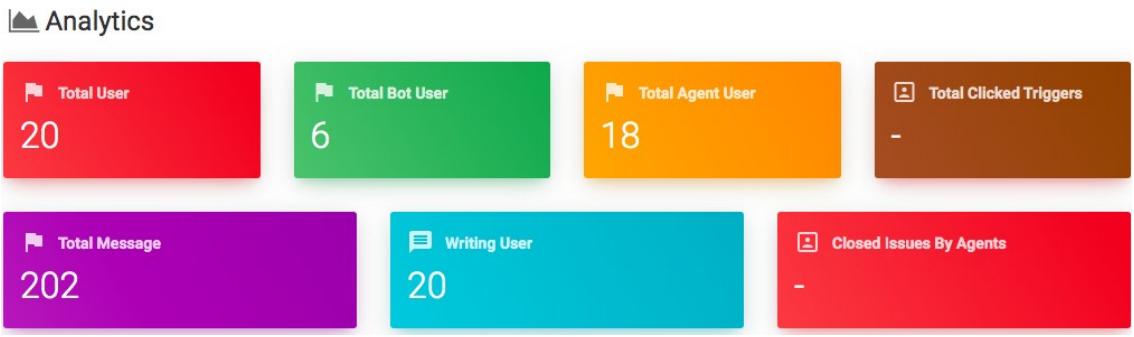

Figure 23: Dahi.ai's Analytics Page in 2019 Form 31 January Until 12 February on MiFBot Interaction With Marmara University Business Administration Faculty' Bachelor Students.

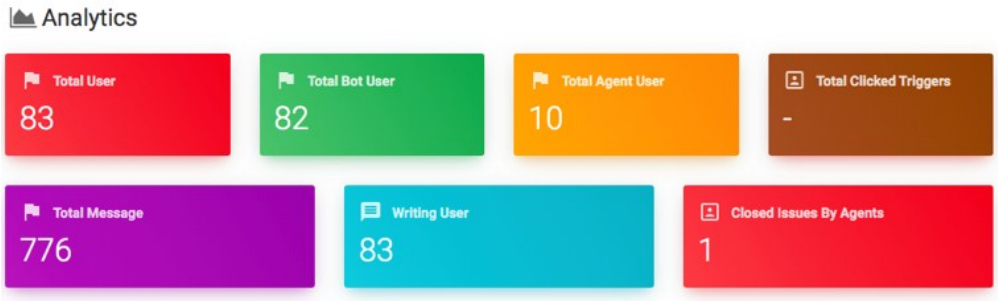

Figure 24: Dahi.ai's Analytics Page in 2020 Form 31 January Until 13 February on MiFBot Interaction With Marmara University Business Administration Faculty' Bachelor Students.

As indicated in Figure 23 and Figure 24, MiFBot was used with students at the beginning of 2019 and 2020 for the same period. In 2019 within one month, the number of messages between students and MiFBot reached 202, while it reached 776 during the same period at the beginning of the year 2020. Within one year of running the design, the number was tripled. The number of users in 2019 reached 6 users, and this number increased to 80 users in 2020.

There exist different KPIs In Dahi.ai's Analytics platform to evaluate the chatbot performance. Figure 25, 26, 27, and 28 highlights the change of the Total Message Count (Total Message Count, User Message Count, Bot Message Count), and Total Conversation (Total Conversation/User Count, User Writing Count, Clicked Trigger Count) for about 30 days in 2019 and 2020. A noticeable increase in Total message count. For example, the Total message count in 2019 reached a pick of 65 messages, while in 2020, it reached 455 messages. In brief, it is noticed an obvious increase in student engagement with MiFBot in 2020 compared to the previous year.

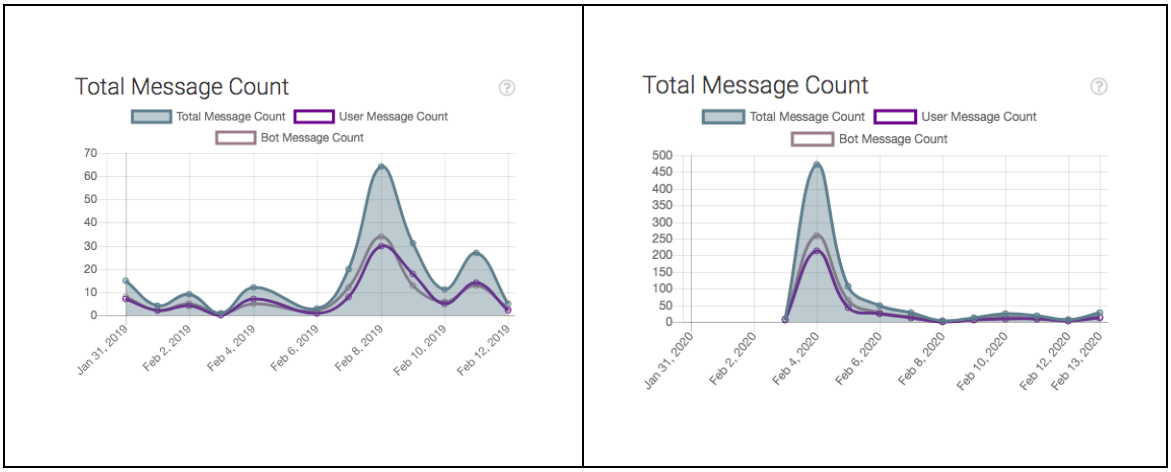

Figure 25: MiFBot's Total Message Count From 31 January Until 12 and 13 February in 2019 and 2020

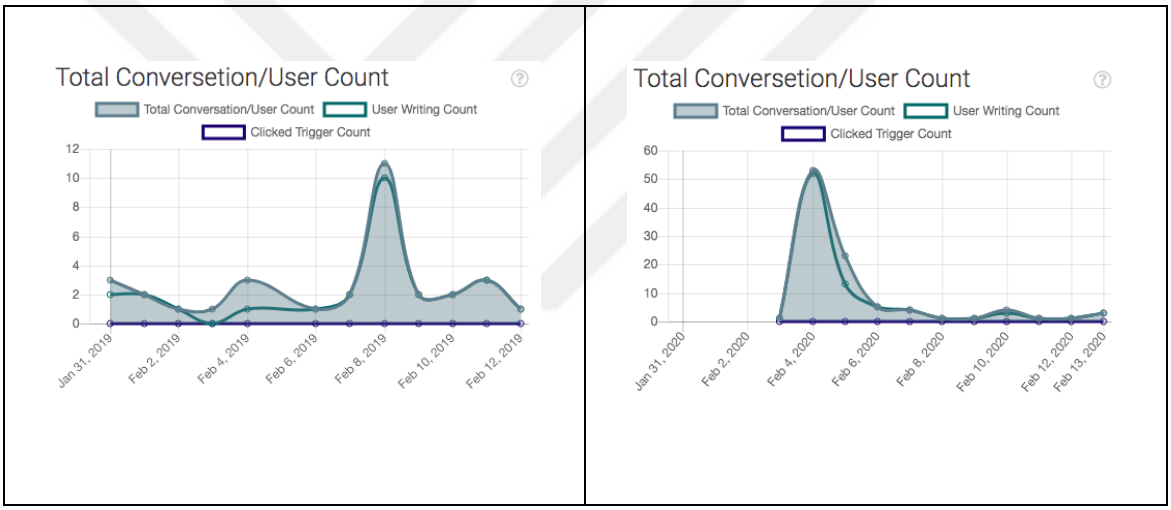

Figure 26: MiFBot's Total Conversation/User Count Form 31 January Until 12 and February in 2019 and 2020

6. DISCUSSION

This thesis was the first to study the chatbot design from different perspectives easing the process of the design. The study provided a real-life case study that has been conducted to a faculty. However, this thesis has potential limitations, such us time restriction. Besides, the chatbot testing was limited on the enrollment weeks. Another limitation refers of the usage of one case study which is a chatbot for a student affair office.

In this study, a novel methodology for chatbot design is presented from a managerial and industry perspectives. The CHDF is a roadmap developed to assist designers, team managers, business owners to create a chatbot step by step. The design is based on the holistic approach of design that suggests focusing on all factors that may affect the product or service. Generally speaking, the holistic design integrates all aspects that are part of the ecosystem in which the product or service is used. In this sense, the CHDF is formulated and presented as seen in the methodology part. Therefore, the present study aimed to fill the gap in the literature by answering the question of: "what are the exact steps that must be taken to create a chatbot design and keep its sustainability?". The chatbot design proposed in this study is divided into two main parts: (1) the pre-design phase (2), and the design phase.

The pre-design phase involves two simple steps: the purpose of the chatbot and its architecture. The purpose of a chatbot reflects the vision of an organization that answers the question of "where we are going", and without a clear understanding of the organization's vision, the planning for further goals and their implementation remains impossible (Kaplan & Norton, 1992). Chatbot represents the customer service that interacts directly with the customers, expresses the brand image, and influence the customer satisfaction rate (Dixon et al., 2010). For that reason, dealing with the chatbot as a human in the design stage is a vital decision. Chatbot architecture is the second step the designer must take into consideration. The architecture is based on retrieval-based and generation-based methods, besides, the chatbot dialog can be task-oriented or non-task-oriented (Ji et al., 2014; Shang et al., 2015; young et al., 2010; Perez-Marin, 2011)

The design-phase is integration between the BSC model and AD. In fact, BSC is used for organizations. On the contrary, the BSC in this study was applied for a chatbot as a software. As it is mentioned, the chatbot plays the role of a digital agent that assists customers 24/7. However, the chatbot still a part of an organization, for that reason, in our analysis the collaboration with the faculty secretary and managers was always present. The application of BSC for a chatbot cannot be done without the support of the organization that attempts to employ the chatbot.

BSC for a chatbot is based on four perspectives, however, the designer can add or eliminate a perspective when it is required. Generally, the chatbot design must be examined from four perspectives: financial, customer, internal process, learning, and growth perspectives. The customer is a critical perspective in the design, especially while designing for a customer service chatbot. Customers includes staff, in view of the fact that one of the most known chatbot purposes is increasing the staff's satisfaction by reducing their workload. Financial perspective may differ depends on the organization, whether it is public or private. The internal process is linked to the key elements the designer follows to ensure the delivery of the primary services through the chatbot. Learning and growth perspective necessitates the presence of staff and managers to improve the chatbot performance. There are a variety of activities that can be done to educate staff and managers about the chatbot. Besides, understanding the chatbot identified area of development leads to time and cost reduction. Understanding the linkage between each perspective is important for BSC implementation and sustainability. Another step in the design to preserve the chatbot sustainability and monitor its improvement is the automation of the BSC. Thereafter, the AD was employed to design for the chatbot conversation. AD's role in CHDF is to create a conversation for the chatbot. The AD is a holistic design that examines a product or a service from four domains: customer domain, functional domain, physical domain, and process domain (Suh, 2001). In the current context, the customer represents people who asked questions to the bot. Thus, understanding their needs is crucial before designing for a conversation. The customers' needs are aligned with the conversation functionalities. Besides, the conversation design parameters must be determined based on the functional requirements. Finally, the process variables are the element that

characterizes the chatbot conversation process and that satisfies the DPs. In this case, the study was done for a faculty, and evaluation of the pre-design and after-design was conducted. The results showed that the categorization of topics linked with their functions and design parameters in the AD helped us significantly reducing time and effort in the design stage. In addition, the chatbot could reply to student questions more accurately than it did before the design. Student engagement has shown a significant raise after the conduction of the design.

7. CONCLUSION

The chatbot is one of the inventions that provided many solutions for the services sector and many industries from different fields. However, despite the release of Eliza in the 1966 as the first chatbot, it remained unknown (Weizenbaum, 1966). The reason is the lack of clarity in the chatbot purpose, as their goal was to test the intelligence of chatbots compared to humans (Turing, 1950). Another reason Eliza had limited use is the absence of social media use. In the twenty-first century, the world has seen an explosive growth of social media and smart applications on the Internet, and the revolution that the world witnessed in the field of the Internet has entrenched new values among users and made them more believers in all that is digital.

In light of the chatbot widespread, customer service employs the chatbot for many purposes. The essential purposes are increasing customer engagement, reducing agent workload, and saving cost. However, there are few other benefits, and these include using chatbots as data storage, offer 24/7 service availability, increase sales, enhance the user experience, and task automation. Despite the benefits of using a chatbot for customer service, there are still disadvantages regarding this issue; these include the rising of unanswered questions that can be a frightening experience for the customer, the poor memory for some chatbots disables the bot to remember customer names or the experience. Another significant disadvantage that leads to chatbot failure is poor design. In this thesis, the focus was on this point. The studies of chatbot design are well documented; it is also well acknowledged with different methods to design conversation to increase the chatbot answers accuracy and conversation length. Despite this interest, no one to the best of our knowledge has studied the chatbot design from different perspectives except conversation design. Based on this gap, this thesis outlines the importance of the chatbot holistic approach and examines it from two perspectives: Design and Management. The design includes the conversation design and the chatbot design seen as a product. The management includes strategic planning and performance measurement.

The proposed methodology integrates two existing methods: Balanced Scorecard and Axiomatic design. These methods are serving different goals for chatbot design, and they are examined from different approaches. The BSC is deployed to plan, manage the chatbot and measure its performance from four perspectives. These include financial/social, customer, internal processes, and learning & growth perspectives. While the AD is used to design for the conversation from four main domains, these domains are customer domain, functional domain, physical domain, and the process domain. The distinctiveness between the used methods refers to the objective behind the employment. The similarity is considering the two methods characterized by being holistic.

BSC model is used in the literature for organizations such as customer service. While in our proposed methodology, it is designed to match the chatbot since it mimics a customer service. BSC cannot work on chatbot without the interference of humans. The management team of the organization that employs the chatbot with the help of the chatbot designer must implement BSC considering the new automated service. Leaving chatbots to improve by themselves remain insufficient because AI is only a small part of the holistic view that must be seen. The chatbot represents customer service. Hence, understanding the relationship between the chatbot and customers can be equal to their relationship to real human agents. Besides, clarifying the chatbot internal process objectives, KPIs, and initiatives, as mentioned in the previous chapters, is particularly important. Finally, customer service must know about the new product as well as managers; thus, they can implement BSC in real life.

The chatbot conversational design in this thesis examined to save time while feeding data to the bot. Through a clear conversation process' roadmap, the designer avoids repetition and similar intent keywords. AD is used to group the questions and classify them into different categories, each category's intent is identified. Sub categories are also determined and linked together in a hierarchical way. The AD helped us to overview the similar intents that may create confusion to the bot, after that increase the unaswered questions or wrong questions in the bot. Another reason stands behind using AD for the chatbot conversation is the inter-relationship that link between

the functional domain of the conversation and other domains, such as customer domain. Customer domain facilitate the topic selection between a huge amount of topics. The physical domain in AD specifies the exact design parameters that must be chosen to satisfy the "utterance" which represents the functional domain. Finally, the process domain is what creates the conversation flow which is also based on the design parameter and other criterions as defined previously.

This study has gone some way towards enhancing our understanding of chatbot as a service. The CHDF suggest several courses of action to enhance the chatbot productivity. The findings of the implication of the chatbot in the current case study proved a significant increase in user engagement after the design is implemented. However, these findings cannot be generalized for other applications. Further studies are needed to measure the success of the design on large data with different case studies. Furthermore, Future research can examine the BSC performance measures on chatbot in-depth and the application of AD on the different types of dialogues can be investigated by researchers.

APPENDIX

Appendix 1: Student Petition Form

ÖĞRENCİ DİLEKÇE FORMU
STUDENT PETITION FORM

MARMARA ÜNİVERSİTESİ 1883 — 130. yıl

Öğrencinin İsteği / *Student's Request*

Lütfen aşağıdaki ilgili kutucuğu işaretleyiniz / *Please tick the appropriate box below*
Her bir istek için lütfen ayrı bir dilekçe doldurunuz / *Please fill out a separate application form for each request*

- BB ☐ Nota İtiraz ❶ *Objection to Grade*
- D/M ☐ Mazeretli Ders Kaydı ❶ *Late Course Registration*
- BB ☐ Ders Ekleme-Çıkarma ❶ *Course Add-Drop*
- ÖİDB ☐ Öğrenci Katkı Payı *Tuition Fee*
- D/M ☐ Mazeret Sınavı ❷ *Excuse Exam*
- ÖİDB/BÖİ ☐ Diğer *Other* : _____
- BB ☐ Erasmus İşlemleri *Erasmus*
- BB ☐ Farabi İşlemleri *Farabi*
- BÖİ ☐ Transkript Belgesi *Transcript*
- BÖİ ☐ Öğrenci Belgesi *Student Certificate*
- ÖİDB/BÖİ ☐ Muafiyet İşlemleri *Course Exemption*
- ÖİDB/BÖİ ☐ İlişik Kesme ❹ *Early Leave*
- ÖİDB/BÖİ ☐ Kurumlararası Yatay Geçiş ❹ *Transfer to/from Another University*
- ÖİDB/BÖİ ☐ Kurumiçi Yatay Geçiş *Transfer within University*
- ÖİDB ☐ Çift Anadal/Yandal İşlemleri *Double Major/Minor Programme*
- D/M ☐ Kayıt Dondurma *Leave of Absence*
- ÖİDB ☐ Yeniden Diploma Çıkarma (Duplikata) ❹ *Duplicate Diploma*

BB İlgili Bölüm Başkanlığı *Relevant Department*	D/M İlgili Dekanlık ya da Müdürlük *Relevant Deanery or Directorate*	ÖİDB Öğrenci İşleri Daire Başkanlığı *Department of Student Affairs*	ÖİDB/BÖİ Öğrenci İşleri Daire Başkanlığı ya da İlgili Birimin Öğrenci İşleri *Department of Student Affairs or Student Affairs Office of Relevant Unit*

❶ İlgili kişinin görüşü Öğretim Üyesi/Danışman Görüşü bölümünde belirtilmelidir / *Instructor's or Advisor's comment should be stated in the relevant section* ❷ Yarıyıl Sonu ve Bütünleme sınavları için mazeret sınavı yapılmamaktadır / *No excuse exams for Final and Final make-up exams* • Lütfen mazeretinizi gösterir belgeyi ekleyiniz / *Please attach the document that indicates your excuse* ❸ Lütfen İlişik Kesme Belgesini doldurunuz / *Please fill the relevant form* ❹ Kayıt için değildir / *Not for the registration* ❺ Lütfen Öğrenci Bilgi Formunu doldurunuz / *Please fill the relevant form*

Öğrenci Bilgileri / *Student's Information*

Lütfen eksiksiz doldurunuz / *Please fill out completely*

Tarih / *Date* ____ / ____ / ____

Öğrenci No / *Student Number*		Fakülte/Yüksekokul/ Meslek Y.O./Enstitü / *Unit*	
T.C. Kimlik No / *TR Identity Number*		Bölüm/Program / *Department/Programme*	
Ad Soyad / *First & Last Name*		GANO / *GPA*	
Cep Telefon No / *GSM Number*		Tamamlanan Kredi / *Credits Completed*	
E-Posta Adresi / *E-mail Address*			

Öğrencinin Açıklaması / *Student's Explanation*

İsteğinizi lütfen kısa, net ve eksiksiz olarak ifade ediniz / *Please make a brief and clear explanation*

Ekler / *Attachments*

Dilekçenize ekleyeceğiniz ilgili evrakı lütfen aşağıya yazınız / *Please write down the documents you would like to attach*

Ek Yok / *No Attachments* ☐

Evrak Adı / *Document Name*	Sayfa Sayısı / *No. of Pages*
1	
2	

Bu dilekçe ve eklerindeki bilgilerin doğru olduğunu beyan ederim.
I certify that the information given on this application form and its attachments is accurate.

Öğrencinin İmzası / *Student's Signature* _____

Bu bölüm öğrenci tarafından doldurulmayacaktır / *This section will not be filled by the student*

Öğretim Üyesi/Danışman Görüşü ☐ Destekliyorum ☐ Uygun Görmüyorum ☐ Çekimserim

_____
_____
_____
_____

Adı Soyadı ve İmzası _____

İlgili Yönetim Kurulu Kararı

☐ Kabul
☐ Şartlı Kabul
☐ Red

v. 270313

Appendix 2:

A. Face-to-Face Interviews with student representatives about their requirements and complaints
   1. What is the most thing that bothers you about student affairs office services?
   2. What is the average waiting time you have experienced most frequently when you called the student affairs office?
   3. How often do you receive answers to your complicated questions?
   4. Is it vital for you to get answers to the complicated questions?
   5. If I give you a choice between getting answers on complicated questions or getting accurate answers, which one choose?
   6. How many times you have experienced switching between call center agents of the student affairs office until now? What do you feel about it?

B. Face-to-Face Interviews with Secretary Faculty to understand the main staff complaints
   1. What kinds of complaints do Staff typically bring to the management related to students' questions?
   2. Do you think staff suffers from Multi-tasking anxiety?

C. Face-to-Face Interviews with student representatives about their most prioritized topics.
   1. Can you tell me about the most prioritized topics you would like to ask the support of the student affairs office?
   2. What do you prioritize between course enrollment and scholarship related questions?
   3. What do you prioritize between Tuition fees and summer school-related questions?
   4. What do you prioritize between ECTS and graduation-related questions?
   5. Looking at FAQ, what are the most frequent question you have asked before the student affairs office?

Appendix 3:

Face-to-Face Interviews with Dean of students, Vice dean of Students,

1. What is the vision of the Faculty?

2. What are the strategic objectives of the faculty?

3. If we have to divide these objectives into four perspectives: Financial/Social, Customer, Internal, and Learning & Growth perspectives, how to classify them?

4. Is there any linkage between these strategic objectives?

5. What are the KPIs used by the management team to evaluate these perspectives?

REFERENCES

Agrawal, S., Singh, R.K. & Murtaza, Q. (2016). Outsourcing decisions in reverse logistics: Sustainable balanced scorecard and graph theoretic approach. *Resources, Conservation and Recycling.* 108, 41-53.

Bailey, J. J. & McCollough, M. A. (2000). Emotional labor and the difficult customer: Coping strategies of service agents and organizational consequences. *Journal of Professional Services Marketing.* 20(2), 51-72.

Becker, M.W., Alzahabi, R. & Hopwood, C.J. (2013). Media multitasking is associated with symptoms of depression and social anxiety. *Cyberpsychology, Behavior and Social Networking.* 16(2), 132-5. https://doi.org/10.1089/cyber.2012.0291 (3 Mai 2019)

Chakrabarty, S., Widing, R. E. & Brown, G. (2014). Selling behaviours and sales performance: the moderating and mediating effects of interpersonal mentalizing. *Journal of Personal Selling and Sales Management.* 34(2), 112-122. https://www.researchgate.net/publication/271930592_Selling_behaviours and_sales_performance_the_moderating_and_mediating_effects_of_interpersonal_mentalizing (4 April 2020)

Dale, R. (2016). The Return of the Chatbots. *Natural Language Engineering.* 22 (5), 811–817.

Desaulniers, S. (2016). Chatbots rise, and the future may be 're-written'. https://www.cnbc.com/2016/04/08/chatbots-rise-and-the-future-may-be-rewritten.html (17 April 2020)

Digital McKinsey (2019). Driving Impact at Scale from Automation and AI. February 2019. https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Driving%20impact%20at%20scale%20from%20automation%20and%20AI/Driving-impact-at-scale-from-automation-and-AI.ashx (17 April 2020)

Dixon, M., Freeman, K. & Toman, N. (2010). Stop Trying to Delight Your Customers. *Harvard Bus. Rev.* 88(7/8), 116-122

European Commission 2018. *Digital Economy and Society Index Report.* https://ec.europa.eu/information_society/newsroom/image/document/2018-20/3_desi_report_use_of_internet_services_18E82700-A071-AF2B-16420BCE813AF9F0_52241.pdf (17 April 2020).

Epstein, R., Roberts, G. & Beber, G. (2008). *Parsing the Turing Test: Philosophical and Methodological Issues in the Quest for the Thinking Computer.* 181. file:///Users/Mac/Downloads/epdf.pub_parsing-the-turing-test-philosophical-and-methodol.pdf

Ferrucci, D.A., Nyberg, E., Allan, J., Barker, K., Brown, E., Chu-Carroll, J., Ciccolo, A., Duboue, P., Fan, J., Gondek, D., Hovy, E., Katz, B., Lally, A., McCord, M., Morarescu, P., Murdock, W., Porter, B., Prager, J., Strzalkowski, T., Welty, W. & Zadrozny, W. (2009). *Towards the Open Advancement of Question Answer Systems.* Yorktown Heights, NY: IBM Research Report RC24789 RC24789 (W0904-093) April 22, 2009. https://pdfs.semanticscholar.org/825c/7a9b17a3fef7bd81d1bdf57b10b78b83a274.pdf

Ferrucci, D.A., Brown, E., Chu-Carroll, J., Fan, J., Gondek, D., Kalyanpur, A.A., Lally, A., Murdock, J.W., Nyberg, E., Prager, N.S. & Welty.C. (2010). Building Watson: An Overview of the DeepQA Project. *AI Magazine.* 31(3), 59-79.

French, R. (1990). Sub cognition and the limits of the Turing test. *Mind.* 99, 53-65. https://academic.oup.com/mind/article-abstract/XCIX/393/53/970196?redirectedFrom=PDF (15 Mai 2019)

Gartner 2019. *Chatbots will appeal to modern workers,* https://www.gartner.com/smarterwithgartner/chatbots-will-appeal-to-modern-workers/ (17 April 2020)

Goffin, K. & New, C. (2001). Customer support and new product development - An exploratory study. *The International Journal of Operations & Production Management.* 21(3), 275-301. https://www.researchgate.net/publication/235293497_Customer_Support_and_New_Product_Development_-_An_Exploratory_Study

Griol, D., Carbó, Z. & Molina, J.M. (2013). An automatic dialog simulation technique to develop and evaluate interactive conversational agents. *Applied Artificial Intelligence.* 27 (9), 759-780

Guzman, A.L. (2017). Making AI safe for humans: A conversation with Siri. Chapter 4. In book: *Socialbots and Their Friends: Digital Media and the Automation of Sociality.* Chapter 4. 69-85 https://www.researchgate.net/publication/301880679_Making_AI_Safe_for_Humans_A_Conversation_With_Siri

Hoque, Z. (2014). 20 years of studies on the balanced scorecard: Trends, accomplishments, gaps and opportunities for future research. *The British Accounting Review.* 46(1), 33-59. https://www.sciencedirect.com/science/article/abs/pii/S089083891300084X

Isbell, C.L., Kearns, M., Kormann, D., Singh, S., Stone, P. & Shelton, S.R. (2006). Cobot in LambdaMOO: An adaptive social statistics agent. *Autonomous Agents and Multi-Agents Systems.* 13(3), 327-354.

Ittner, C.D. & Larcker, D.F. (1998). Studies on enhancing the financial reporting model. *Journal of Accounting Research.* 36, 1-35.

Ji, Z., Lu, Z. & Li, H. (2014). *An Information Retrieval Approach to Short Text Conversation*. https://arxiv.org/abs/1408.6988(17 April 2020)

Kaplan, R.S. & Norton, D.P. (1992). The balanced scorecard– Measures that drive performance. *Harvard Business Review.* 59, 71-80

Kaplan, R.S. & Norton, D.P. (1996). Translating Strategy into Action. Boston, MA: HBS Press.

Karatas, M. (2019). Hydrogen energy storage method selection using fuzzy axiomatic design and analytic hierarchy process. *International Journal of Hydrogen Energy.* doi:10.1016/j.ijhydene.2019.11.130

Kerly, A., Hall, P. & Bull, S. (2007). Bringing chatbots into education: Towards natural language negotiation of open learner models. *Knowledge-Based Systems.* 20(2), 177-185.

Knill, O., Carlsson, J., Chi, A. & Lezama, M. (2004). *An Artificial Intelligence Experiment in College Math Education.*

Kumar, A. & Telang, R. (2012). Does the web reduce customer service cost? Empirical evidence from a call center. *Information Systems Research.* 23(3), 721-737.

Lee, S. & Choi, J. (2017). Enhancing user experience with conversational agent for movie recommendation: Effects of self-disclosure and reciprocity. *Journal of Human-Computer Studies.* 1. https://www.researchgate.net/publication/314254348_Enhancing_user_experience_with_conversational_agent_for_movie_recommendation_Effects_of_self-disclosure_and_reciprocity (13 December 2019)

Lester, J., Branting, K. & Mott, B. (2004). Conversational agents. In M. P. Singh, *The Practical Handbook of Internet Computing*, Chapman & Hall /CRC.

Lexico. *Definition of Chatbot in English.* https://www.lexico.com/en/definition/chatbot(accessed 17 April 2020)

Lin, Q.-L., Liu, L., Liu, H.-C. & Wang, D.-J. (2013). Integrating hierarchical balanced scorecard with fuzzy linguistic for evaluating operating room performance in hospitals. *Expert Systems with Applications.* 40(6), 1917-1924. https://www.sciencedirect.com/science/article/abs/pii/S0957417412011219. (14 January 2020)

Maroengsit, W., Piyakulpinyo, T., Phonyiam, K., Pongnumkul, S., Chaovalit, P. & Theeramunkung, T. (2019). A Survey on Evaluation Methods for Chatbots. *Proceeding of the 2019 7th International Conference on Information and Education Technology.* March 2019, 111-119. https://dl.acm.org/doi/10.1145/3323771.3323824

Medium 2017. *Chatbots Magazine.* https://chatbotsmagazine.com/why-most-chatbots-fail-1c085b74d6ad (17 April 2019)

Microsoft Azure. *Azure Cognitive Services.* https://azure.microsoft.com/fr-fr/services/cognitive-services/ (17 February 2020)

Mueller, J., Thyagarajan, A. (2016). Siamese recurrent architectures for learning sentence similarity. *Proceedings of the Thirtieth AAAI Conference on Artificial Intelligence.* AAAI Press. 2786-2792.

Niven, P. (2002). *Balanced scorecard step-by-step: Maximizing performance and maintaining results.* (1st edition). New York: Wiley. Chapter 4.

Okuda, T. & Shoda, S. (2016). AI-based chatbot service for financial industry. *Fujitsu Scientific and Technical Journal.* 54(2), 4-8.

Olson, E. M. & Slater, S. F. (2002). The balanced scorecard, competitive strategy, and performance. *Business Horizons.* 45(3), 11-16.

Ophir, E., Nass, C. & Wagner, A.D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences of the United States of America.* 106(37). https://doi.org/10.1073/pnas.0903620106

Rababa'h, A. (2014). The implementation of management accounting innovations "The case of balanced scorecard implementation within jordanian manufacturing companies." *International Review of Management and Business Research.* 3(1), 174-182. https://www.researchgate.net/publication/292982093_The_Implementation_of_Management_Accounting_Innovations_The_Case_of_Balanced_Scorecard_Implementation_within_Jordanian_Manufacturing_Companies (21 April 2020)

Roca, S., Sancho, J., Garcia, J. & Alesanco, A. (2019). Microservice chatbot architecture for chronic patient support. *Journal of Biomedical Informatics.* https://www.sciencedirect.com/science/article/abs/pii/S1532046419302242 (7 March 2020)

Saygin, A.P., Cicekli, I. & Akman, V. (2000). Turing test: 50 years later. *Mind and Machines.* 10(4), 463-518. https://link.springer.com/article/10.1023%2FA%3A1011288000451

Schulman, D., Sidner, C. & Bickmore, T.W. (2011). An intelligent conversational agent for promoting long-term health behavior change using motivational interviewing. *AAAI spring symposium: AI and Health Communication.* 61-64

Schumaker, R. P., Liu, Y., Ginsburg, M. & Chen, H. (2006). Evaluating mass knowledge cquisition Using the ALICE Chatterbot: the AZ-ALICE dialog system. *International Journal of Human-Computer Studies.* 64(11), 1132-1140. https://dl.acm.org/doi/abs/10.1016/j.ijhcs.2006.06.008 (10 June 2019)

Shang, L., Lu, Z. & Li, H. (2015). *Neural Responding Machine for Short-Text Conversation.* China, Beijing: ACL. 1, 26-31.

Shawar, B. & Atwell, E. (2007). Chatbot are they Really Useful?. LDV *Forum*. 22 (1), 29-49. https://www.researchgate.net/publication/220046725_Chatbots_Are_they_Really_Useful (8 March 2019)

Shieber, S.M. (2006). Does the turing test demonstrate intelligence or not? *Proceedings of the Twenty-First National Conference on Artificial Intelligence* (AAAI-06), Boston, MA, 16-20. https://dash.harvard.edu/bitstream/handle/1/2252596/Shieber_TuringTest.pdf?sequence=2&isAllowed=y

Suh, N.P. (2001). *Axiomatic Design: Advances And Applications*. New York: Oxford University Press.

Tezcan, T. & Zhang, J. (2014). Routing and staffing in customer service chat systems with impatient customers. *Operations Research.* 62(4): 943-956 https://doi.org/10.1287/opre.2014.1284

Turing, A.M. (1950). Computing Machinery and Intelligence. *Mind, Oxford University Press.* 59(236), 433-460 https://phil415.pbworks.com/f/TuringComputing.pdf

Ulrich, K.T. & Eppigner, S.D. (2012). *Product Design and Development.* (5th edition). New York: McGraw-Hill.

Weizenbaum, J. (1996). ELIZA computer program for the study of natural language communication between man and machine. *Communications of the ACM.* 9(1), 36-45. https://web.stanford.edu/class/linguist238/p36-weizenabaum.pdf (20 February 2019)

Wolff, R.M.V., Hobert, S. & Schumann, M. (2019). How may ı help you? -State of the art and open research questions for chatbots at the digital workplace. *Proceeding of the 52nd Hawaii International Conference on System Sciences.* 95-104. https://scholarspace.manoa.hawaii.edu/handle/10125/59450 (25 February 2020)

Xu, A., Liu, Z., Guo, Y., Sinha, V. & Akkiraju, R.A. (2017). *New Chatbot for Customer Service on Social Media*. Proceedings of CHI, New York, ACM. 3506–3510. https://doi.org/10.1145/3025453.3025496 (25 July 2019)

Young, S., Gaˇsi´c, M., Keizer, S., Mairesse, F., Schatzmann, J., Thomson, B. & Yu, K. (2010). The hidden information state model: A practical framework for pomp-based spoken dialogue management. *Computer Speech & Language.* 24 (2), 150-174.