Automation of Service Desk: Knowledge Management Perspective

Michal Dostál[a] and Jan Skrbek
Department of Informatics, Faculty of Economics, Technical University of Liberec, Czech Republic

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Abstract: In the current times, the need for quality and effective service support technologies is high. We can achieve good IT service operations that support good knowledge management practices by employing automation techniques and methods to the Service Desk systems. In our position paper, we look at the literature regarding Service Desk automation in relation to knowledge management. We then propose a theoretical model of Automatized Service Desk Systems that uses several techniques to help and automatize the process of user request resolution. Our proposed system employs text mining techniques, a virtual agent, an expert system, a customer intent detector, and a ticketing system.

1 INTRODUCTION

Nowadays, more than ever, the emphasis on making access to services more accessible and optimized is gaining importance. With Service Desk, it is not different. Employees working from home require a quality Service Desk, and therefore the companies are looking at ways to optimize and level up their IT service operations. One way to achieve this is to automate some processes involved in the Service Desk operations.

This position paper proposes a theoretical model of an automated service desk system, which includes several technologies that enable its effective automation related to practical knowledge management.

For our literature review, we set out several search parameters: research articles and other academic literature published in the last 15 years (however, we also used some sources published before the year 2006). We searched for the topics related to automation of the Service Desk. Based on our literature research, we then prepared and described the theoretical model of the Automated Service Desk System.

Our position paper is structured as follows: Section 2 describes main topic areas of automation in Service Desk and Knowledge Management. We also look at some implementations of expert systems in the Service Desk environment as it is a way to automatize some tasks, and it is also a knowledge-based system. In Section 3 we then describe the proposed automated system.

[a] https://orcid.org/0000-0001-6398-624X

2 LITERATURE REVIEW

In this section, we describe the current literature regarding the topic of Service Desk automation.

2.1 Knowledge Representation

When working with the concept of automated service desk process, one of the essential topics from the knowledge management perspective is the way, which will be the knowledge represented. This brings out the question: What will be the optimal knowledge representation for humans involved in the process, and what would be optimal for the system?

According to (Czarnecki and Sitek, 2013) there are two types of symbolic knowledge representation: (1) procedural representation, through which a set of procedures is identified that describe the operations behind the knowledge; and (2) declarative representation, which uses sets of statements, facts, and rules from the particular problem domain. In the Service Desk environment, there are both types of knowledge and our proposed system should be able to work with both. The procedural representation may describe specific actions in order to resolve specific user requests.

The academic literature is working with knowledge representation for quite some time. The topic is strongly connected to expert systems, where the representation of knowledge is essential. Expert systems are a subtopic of Artificial Intelligence, which as a science was founded in 1956 in Dartmouth and

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where began the development of the first expert system called Logic Theorist (Watson and Mann, 1988). (Jakus et al., 2013) states that the most widespread medium of communication is in natural language; however, it is not appropriate for the needs of automated or intelligent systems. There are several knowledge representation formalisms that are more convenient for use with computer systems. Those are *semantic networks, conceptual graphs, fuzzy logic, frames* or *description logics* (Jakus et al., 2013). Another types of representation of knowledge are *classical logic* (propositional, first and second-order logic), *constraint logic programming*, *ontologies*, *Bayesian networks* (Porter et al., 2008).

When looking at knowledge representation in IT Service Management, in the literature, we can find some examples. (Paramesh et al., 2018) wrote about a classifier for Service Desk tickets that are, by their nature, unstructured. For their classifier, they used methods of machine learning. The unstructured data were pre-processed by cleaning the raw data from unwanted entries. Then they constructed a *feature vector* for each entry, which acts as a representation of the Service Desk ticket data. For building the classification models, they used Bootstrap Aggregation, Boosting, and Voting Ensemble for the predictions from different models to be combined.

In their following work, (Paramesh and Shreedhara, 2019) further described the automated system for Service Desk. The representation of knowledge by feature vectors is achieved by applying the TF-IDF (Term Frequency - Inverse Document Frequency) term weighting scheme. The features are then selected by χ^2 test to reduce dimensionality.

Authors (Czarnecki and Sitek, 2013) dealt with the comparison between description *logic based ontologies* and *rule based* approach of knowledge representation with the connection to IT Service Management. This type of representation is classified as a declarative representation of knowledge.

In the older literature, we can also find some automation applications in Service Desk, and what is more important, ways of representing the knowledge. For example, (Greer et al., 1998) described an intelligent help desk system that worked with a type of concept map that was divided into two layers.

Next, (Chan et al., 2000) described intelligent case-based system for help desk operations. The system was built on case-based reasoning technology, so the knowledge used by the system was represented in the form of cases. Specifically, the cases consisted of special objects (folders, cases, questions, and actions).

In our proposed system, there are multiple representations of knowledge with which the system works. During the text mining phase, the input is transformed into a set of keywords in the form of an object. The knowledge base then contains knowledge in the form of rules as the expert system is rule-based.

2.2 Knowledge Discovery

In this subsection of our position paper, we talk about methods of automation that can be applied to knowledge discovery activities. We can describe knowledge discovery as an activity or process that aims to the production of knowledge by discovering or deriving from existing information (Soundararajan et al., 2005). The process of knowledge discovery consists of: selection of target data, data cleaning, preprocessing, reduction, projection of the data, preparation for data mining by choosing the correct function and algorithm; primary data mining process and after that, an interpretation and usage of the discovered knowledge (Soundararajan et al., 2005).

One of the most popular techniques of knowledge discovery today is data and text mining. Text mining, also referred to as Knowledge Discovery in text, is defined as "... *the art of data mining from text data collection*" (Cai and Sun, 2009). Text mining aims to discover information and knowledge in unstructured or semi-structured forms of text data. There are several techniques used for text mining: (1) information extraction, (2) information retrieval, (3) categorization, (4) clustering, and (5) summarization.

Text mining nowadays has a stable role in the Service Desk systems that aim to automate the process of ticket resolution. One example is the system described by (Al-Hawari and Barham, 2021), which uses a machine learning model allowing automatic ticket classification.

The exciting use of text mining is its application on a conversation at a call center, described by (Takeuchi and Yamaguchi, 2014). The telephone conversations are transcribed to their textual form by an automatic speech recognition program—this serves as a prerequisite for a call summarization, which is performed later. According to (Takeuchi and Yamaguchi, 2014) it is essential to identify expressions in the speech transcription that are important for the conversation to be correctly classified and summarized. Their system has two main components. The first one is used to extract words, tag them and assign semantic categories. The extracted words are also compared with an expert knowledge dictionary for the check of their importance.

(Agarwal et al., 2017) described a system for automatic problem extraction and the analysis of text in tickets created in the IT Service Desk. Those tickets contain unstructured data, and a given problem description can be relatively ”noisy.” There is always a high possibility that such data will contain misspelled words or words in the form of abbreviations. They used a very interesting approach of extracting the logical structure of the IT ticket by categorizing the word into two groups: category dependent and category independent. The category dependent contains context-defining words, generic and specific words, or patterns. The category independent words are categorized as domain invariant words or domain invariant patterns. By doing this, they can filter out irrelevant words that may change to correct understanding and classification of the text. They used a support vector machine with RBF Kernel (Radial Basis Function) for the classification engine.

IT Service Desk tickets can also be used for discovering knowledge about the customers, e.g., their satisfaction with the product. The approach of (Eckstein et al., 2016) not only classifies if the customer is satisfied but also tries to discover what their needs are. Their system uses a text mining process called ”bag of words” and techniques such as tokenization, stemming, and the removal of stop words. For the training of the classification models, they used decisions trees, support vector machines, kNN (k-nearest neighbors), and Naive Bayes.

2.3 Methods of Automation

In this subsection, we look at methods of Service Desk automation described in the literature.

(Mani et al., 2017) described a system for question answering that is used in the IT support environment. It has interesting capabilities, such as the ability to process unstructured documents such as web pages, PDF files, and audio and video files. They also describe an ability of ”effective addition of human-in-the-loop,” a way to delegate a specific task that the system cannot complete to a specific person. This relates to Expert Locator Systems, which store employee information and knowledge about company problem domains. The described system can also transcribe audio files, which could also be helpful in the call center environment.

The next topic mentioned in the literature regarding automation of processes in the IT Service Desk is virtual agents. (Lacity et al., 2017) describes a virtual agent employed in the systems of the Bank of Sweden. This system can change the password on behalf of the user’s request, and it can unlock their locked accounts or provide access to certain documents.

The use of an intelligent agent in Service Desk processes is also described by (Koehler et al., 2018). They used machine learning techniques to filter out the non-relevant parts of the request. This way, they isolate vital information about the user’s problem.

(Ali, 2018) describes the use of cognitive technologies as a way of optimizing the IT services, such as Service Desk. Their cognitive system uses methods such as semantic analysis of the tickets, NLP (Natural Language Processing), or extraction of structured and unstructured data for in-depth analysis and visualization.

To the topic Service Desk automation also contribute topics such as user profiling, personalization or stereotypization (Zaslavsky et al., 2007), expert profiling. (Baysal et al., 2009).

2.4 Expert Systems in Service Desk

An expert system is a system able to emulate the knowledge of an expert in a particular problem domain. There are two main categories of expert systems: diagnostic and planning expert systems. The first ones are used for data interpretation with the aim of the best correspondence with actual data. The latter is used for problem-solving, as they try to generate possible solutions to a given problem. Both of these types of systems can be used in a Service Desk environment.

Fundamental parts of an expert systems are *knowledge base* and *inference mechanism*. There is also some form of explanation module and communication module (or user interface) in many cases.

An example of the usage of expert systems in the IT Service Desk is described by (Al-Emran and Al Chalabi, 2015). They developed a troubleshooter expert system focused on three problem domains: printers, HW+SW problems, and problems with internet connection. For building their system, they used CLIPS, a rule-based building tool that uses a syntax of LISP programming language. They created more than 70 rules to cover the possible topics of three problem domains.

(Songsangyos et al., 2012) proposed a prototype of help desk service that uses an expert system. The knowledge base is built with production rules, and therefore it is a rule-based expert system. The proposed system can solve a range of problems with computer hardware, software, or problems with the network. It can also identify the root causes of the problems and provide a step-by-step solving guide. The system searches the knowledge base for the rules that contain the ”goal.” If it finds any, the system re-

turns a list of possible causes.

(Kaushik et al., 2011) proposed an expert system called Network Expert System (NES), which is aimed at troubleshooting problems with computer networks. The proposed system, NES, is classified as a rule-based diagnostic system. This type of system is not implemented in the Service Desk system; however, it has a great potential to be implemented in one.

(Bello et al., 2018) presented an expert system called ExperTI, which automatically assists the users (customers) and the Service Desk operators. The use of web chat enables this. The knowledge base is built on ontologies and rules.

3 AUTOMATED SERVICE DESK SYSTEM

This section of our paper discusses the possible implications and constraints of implementing our theoretical automated service desk system. In the following subsections, we describe each component of the system and its connection to knowledge management.

Let us begin with an overall description of the system. At the core of the automated Service Desk system, there is a virtual agent, which handles the whole operation of the system with the supervision of the system manager, who is a member of the Service Desk staff. Other actors in this use case are:

- **User** - the one, who is contacting the Service Desk Department with their request or question
- **Operator** - a member of Service Desk staff, tasked with resolution of the tickets and requests, that could not be resolved by the system; the operator is also instance of an expert, who is contacted when needed
- **Problem Domain Owner** - a member of Service Desk staff who administers a certain portion of the Knowledge Base, according to their domain of expertise
- **Manager** - a Service Desk manager, who oversees the correct running of all processes in and out of the system

Three types of interfaces are used for the communication and administration of the system. The first interface is through a telephony system, in which case the user calls to Service Desk by phone. At first, the user is greeted by the virtual agent, who handles incoming information from the user. The same goes for the other two interfaces, which are computer-based - one is a chat interface, which could be facilitated by some specific Instant Messaging software or web application. A third interface is a Web Form. This last type of communication is not in real-time as the user sends the request to Service Desk via Web Form and is later either contacted by the system or specific expert or operator about successful resolution of their request or is asked some follow up questions that may streamline the resolution of the user‘s request.

As the reader can see in Figure 1, the information from the user is first going through a text mining module, which can filter out the non-relevant parts of the text or transcribed speech. The module tries to detect the core of the user‘s request and prepare it for processing by the virtual agent.

The virtual agent then cooperates with other modules of the system. One of them is the Customer Intent Detector, which task is to detect the emotions and intent of the user. This information can be used to alter the communication style and later be used to retrospectively analyze the interaction and create a space for improvement of the process.

The next module of the system is the Expertise Locator System, which is employed if the Virtual Agent cannot resolve the opened ticket. Expertise Locator System contains knowledge and information about employees and their expertise. These employees also may not be from the IT Service Desk department and can be staff members of any department of the company or corporation. In some cases, there may also be contact information to a former staff member, who was a long-time employee and therefore poses a good portion of the needed knowledge.

The embedded Expert System is then used as a diagnostic tool for investigating problems that belong to a specific problem domain, which knowledge is present in the knowledge base. The expert system works with a combination of types of knowledge representation. The aim is to be compatible with all modules of our Automated Service Desk System, as many of these modules work with the Knowledge Base.

The Knowledge Base is curated and administrated by the Problem Domain Owners. The owners are experts in a given area of expertise, whose knowledge is present in the Knowledge Base. The number of Problem Domain Owners depends on the categories of problems that the Service Desk System can solve and help with.

The Knowledge Base is also connected with a ticketing system that works automatically and is occasionally edited by the operators or experts. The tickets also act as a knowledge item and contain helpful information for later analysis or future user request resolution. Based on this knowledge, the virtual agent can be improved and can learn.

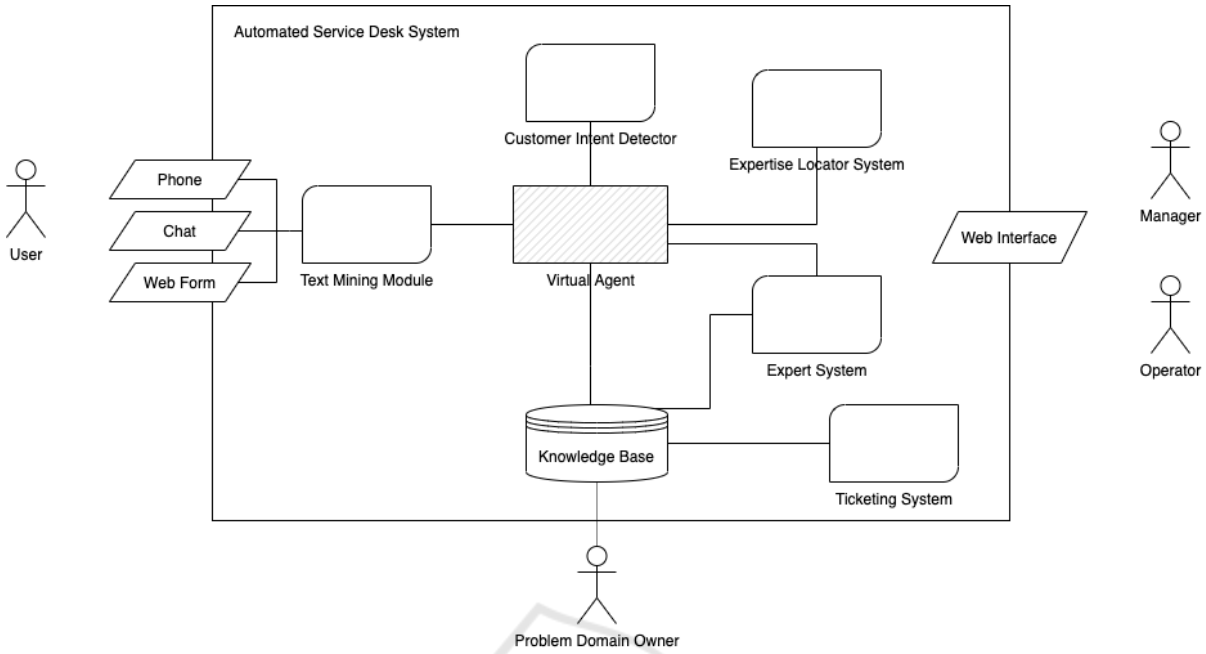

Figure 1: Model of theoretical Automated Service Desk System.

Following is a specific example of the user's interaction with the Automated Service Desk System. Suppose that the user needs to contact the Service Desk in the matter of not being able to log in to a specific module of the company's information system. In the first step, they chose the tool for communication, for example, a phone. So they call a specific telephone number mapped by the telephony system to redirect the call to an Automated Service Desk System and its Virtual Agent module. The interaction is initiated by the system asking the user to state their problem or request. In our case, it might look like: "Hello, this is the Automated Service Desk System. Please state your request." The user then responds with the description of their request: "Hi, I am trying to login to the XYZ module of our information system. My username is xjohn001. The system returns an alert that I do not have sufficient rights; however, yesterday it worked." Through its text mining capabilities, the system can detect specific keywords and phrases. It extracts the following keywords: login, XYZ module, our information system, the username is xjohn001, not have sufficient rights. Based on this keyword, the system now knows that the problem concerns access rights to a specific module for the user xjohn001. Every interaction between the system and the user is run through Customer Intent Detector to detect any unwanted emotions or patterns from the user. The Virtual Agent module then employs the Expert System, which works the knowledge base and detects if the system already resolved a similar problem in the past. Suppose it was, and the expert system finds an entry in the knowledge base. The information about the resolution of such request states that the access rights need to be assigned by an authorized employee. So in the next step, the system activates Expertise Locator System to choose an appropriate employee/operator. If there are two or more authorized operators, the system also considers their current occupancy by other requests and selects the most available one. When the suitable operator is chosen, the system creates a transcription of the interaction with the user and prepares a summary consisting of the main keywords. This data is then transferred to the authorized operator tasked with the request resolution, and a ticket is created. The call is now delegated to the operator, who will verify if the user is eligible to access the requested information system module. After successful resolution, the ticket is marked as resolved, and a corresponding entry in the knowledge base is created.

3.1 Knowledge Management Perspective of the System

The proposed theoretical Automated Service Desk System is, by its nature, an instance of a knowledge-based system. The core asset of this system is the knowledge that it creates, stores, and applies. What needs to be taken into account when such a system is developed?

One of the first essential questions one must answer is what type of knowledge representation will be used? In our literature review part of this paper, we mentioned what representation types are used in similar systems. A classic approach would be to use rules; however, it would be more beneficial to use some ontology or concept maps due to the nature of Service Desk data. It is essential to consider that the proposed system has multiple modules that work with the knowledge stored in the Knowledge Base; therefore, they must be able to effectively and correctly work with the knowledge.

To ensure the quality of the knowledge stored in the knowledge base, we propose for the individual types of the knowledge domains to be "owned" by a specific expert in that field, who is also a member of the staff of the company or corporation. This way, the expert can supervise and control the knowledge store and ensure that it is appropriately stored and the information provided by the Knowledge Base entry is sufficient for both the system and its users (incl. operators). These tasks should also be covered and encouraged by the company's Knowledge Management Department or its Service Desk subdivision.

4 CONCLUSIONS

The role of automation in the Service Desk is indispensable and will keep being important in the future. Thanks to employing automation methods, the processes of the Service Desk and related knowledge management can be optimized and improved. In our position paper, we proposed a theoretical model of an Automated Service Desk System that consists of a number of modules. We would like to build a prototype of such a system and perform feasibility tests in our future research.

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