Remarks (For office use only):

Smart Knowledge Management for IT Services

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Abstract. Knowledge Management is a critical area for the success of an IT Service Provider, especially for Managed Services providers of infrastructure platforms like iSeries systems on IBM Power Servers. In this niche skilled area, developing the knowledge base (KB), updating, reviewing on regular intervals and ease of access to the support personnel are essential. The support ecosystem contains two different units based on their skill levels- Level 1 (L1) and Level 2 (L2). These teams refer to the Knowledge base (KB) articles that includes info on the Standard Operating Procedures (SOP), troubleshooting guides, etc to perform these duties. One of the main challenges of iSeries Support is the dearth of skilled and talented resources in the open market for hiring. The service providers create a talent pool by providing training to the early professional hires from the campus. The pandemic and the work-from-home followed by that further impacted the technical education progress of talent pools and upskilling of resources. The customer's core business runs on iSeries, so prompt responses are required for any issues reported and incorrect actions can cause a huge impact. A smart KB with ease of access to the team is identified as a solution to address this challenge. This can be achieved by incorporating Azure AI Services into the KB documents and providing a communication channel interface for the end users to interact with KB and receive the proposed resolution. This can help the team to improve the key performance indicator (KPI) of the mean time to resolve (MTTR) the incidents.

Keywords: iSeries Platform Support, knowledgebase, MTTR, Azure AI, Bot services

Introduction

IT Service providers of Infrastructure support's focus is on Core Enterprise Services. Where it manages the mission-critical systems of its customers including but not limited to Compute, Network, Storage, Compliance, and Security. A managed infrastructure helps deliver better availability and uptime and reduces the expense and challenges of a self-managed infrastructure. One of the niche areas of expertise for Core Enterprise Services is iSeries-managed platform support services. iSeries also known as IBMi (which can be interchangeably used later in this paper)[1] is one of three operating systems that run on IBM Power Systems. The IBMi operating system provides a robust architecture and higher availability to help achieve business resilience and cost-efficient operation. Core IBMi applications have been an integral part of many organizations' success for decades in performing their business operations.

The IBMi platform support ecosystem has multiple teams. The operations team-L1 Support, monitor, and review the alerts that the system generates, which are converted into tickets also known as incidents, that are assigned to the team. L1 works on the incidents and fixes the issues reported, if the team is unable to resolve them or if it is beyond their support boundary then escalates to L2. The L2 team engages the Vendor

Support or the Subject Matter Expert (SME) as the situation demands. All these teams refer to the KB articles that include the SOP, FAQs, troubleshooting guide, etc to perform these duties.

There is a shortage in the availability of skilled IBMi resources[2]. The training opportunities, both offline and online are limited and the demand for certifications is lesser compared to the other trending technologies in the market. It is also very important to have the industry, account, and customer-specific knowledge of IBMi. All these factors limit the availability of trained talent from the open market. To effectively address these concerns, the service providers train the new talents from the campus (graduate hires) and infuse them into the support pool. When the Pandemic impacted the whole world, IBMi's fresh talent ecosystem was also got affected. Working from home prevented the offline training and knowledge-sharing sessions at the office. There was an increment in the Mean Time To Resolve (MTTR) incidents[3]. Further root cause analysis proved that some of them have resulted from the newly joined team members not following or delayed accessing the right processes to address an incident/issue. On discussion with the larger team and the SMEs, it was identified that KB documents including the SOPs, were organized in a complex and confusing way, which resulted in the information retrieval as a time-taking exercise for the team.

Literature review

Knowledge is the main differentiator to get a competitive advantage for an organization in the market and that is fully applicable in the Infrastructure Managed Services-platform support space as well. It is one of the most important factors that influence organizational performance and can keep it up in a continuously changing market. To make it more effective within the organization there needs to be a good knowledge management system to be set up. Mostly the idea of the knowledge management system is technology oriented. This perspective that considers knowledge management systems just as technology/software tools, ends up breaking the knowledge management in many organizations. There are four important aspects identified in this study - Technology, Human Resources, Process, and Context, which decide the success of Knowledge management [4].

Studies have shown that a business strategy-oriented knowledge management system can enhance the decision-making process of the management as a long-term benefit, as those decisions would be based on the knowledge and experiences of the organization. Also proposes measures to be taken to preserve the knowledge and industry experience that has been developed over time[5].

When looking at the best way to incorporate these concepts and get the best for the organization depends a lot on a very pragmatic solution that can address these needs, maintain them with minimal effort, and can be used for longer-term is one of the objectives. There were two aspects considered while planning the solution, building an in-house solution from the scratch or identifying a user-friendly and readily available solution that would be easier to implement and manage[6].

Microsoft Azure offers Cognitive Services as a group of services that enables the technical teams to incorporate and inlay AI capabilities within any applications, they created. Azure's AI capabilities empower users to enhance decision-making with the numerous development platform they offer. One of the Cognitive Services is 'Language' which uses the abilities of Natural Language Processing (NLP) to build applications like Custom question answering along with other NLP applications[7]. This adds a real-world conversational layer to the data. The solution can assist in getting the optimal response from a personalized KB of data for any user input.

Social networking applications, chatbots, and speech-enabled desktop programs are a few examples of conversational client applications that use Azure question-answering applications. Solutions are enhanced in relevance using a deep learning ranker, along with exact responses and end-to-end region support. The two key skills of the solutions are listed below. Custom question answering: This enables users to define synonyms and metadata and customize applications like editing question and answer pairs generated from the content source. This also offers a fantastic option for the questions in the form of recommendations depending on the information they receive. Prebuilt question answering: Users are enabled to query a text passage and receive a response. Without any administrative costs for KBs[8].

Chatbots, which are machine agents acting as user interfaces using natural language for data and service providers, have become quite popular. A study that had collected data using an online survey from 146 US citizens who used chatbots and were between the ages of 16 and 55. The study pinpointed key elements that influence chatbot utilization. One of the main factors is that "productivity chatbots help users to obtain timely and efficient assistance or information. Chatbot users also reported motivations on entertainment, social and relational factors, and curiosity about what they view as a novel phenomenon"[9].

Objective

The objective of this paper is to build an effective knowledge management system that provides easy access and relevant information for the Support teams to perform their tasks. The KB is to have all required information as process documents, SOPs, troubleshooting guides, and vendor product support documents. The solution is to use conversational AI with Azure language services and a bot framework. Integrate that to the MS Teams Communication channel as a chatbot called as ProcessBot for the support teams to test and use it. There are three key components involved in this solution, data (KB), technology (Azure AI services), and people (support team). This is to enable the platform support team to access the information required to fix the Customer issues quickly which can improve Customer experience with increased availability of their business systems. If the platform support team was unable to resolve some of the incident tickets on time or ends up making human errors as they were not able to find the right process to fix the issue, which impacted the business systems availability, SLA contracted with the customer which could lead to potential penalties to be paid and hurt the trust and the credibility of the service provider.

Methodology

4.1 Business understanding

Large organizations have a complex IT estate that spans different data centers with varied technologies and types of systems. Managed service provider of their IT Infrastructure manages the IT environment to complement the business. The SLAs are fully aligned with the customer's business requirements by providing 99.9% availability of the critical systems. The technical teams that provide platform support are highly skilled in technology, experienced, and possess industry knowledge of the customers' business. Noncompliance with the SLAs invites penalties, questions the credibility of the service provider as a trusted partner to the customer, also can adversely impact the customer's business, as access to their systems and data is at risk. Successful managed service delivery-platform support is provided by ensuring the technical team that performs the activities have got all the required information, access to the systems, and skills to carry out the operations. The team is advised to follow the SOPs and refer to the KBs for any questions while working on these systems. An updated and well-maintained KB is one of the pillars of success in platform-managed services.

4.2 Problem description

The L1 team receives the tickets and works on them. The time from when the ticket is assigned till that is resolved, the mean is taken for similar severity tickets like Medium (Severity 3) and Low (Severity 4) for the analysis. This MTTR is one of the Key Performance Indicators (KPI) for the Service Level Agreement. The trend is not stable for these Medium and Low tickets over the evaluation time. Further analysis was made on the way a ticket was closed, to understand if the process was mentioned correctly for these tickets. This was manually verified based on the resolution code and identified that some of them were not followed, tracked those tickets and their impact on the overall MTTR as shown in Fig. 2 and Fig. 3, and identified that those incidents have some significant influence on increasing the MTTR.

Fig. 2. Weekly MTTR Trend for Medium-Severity-3 Ticket

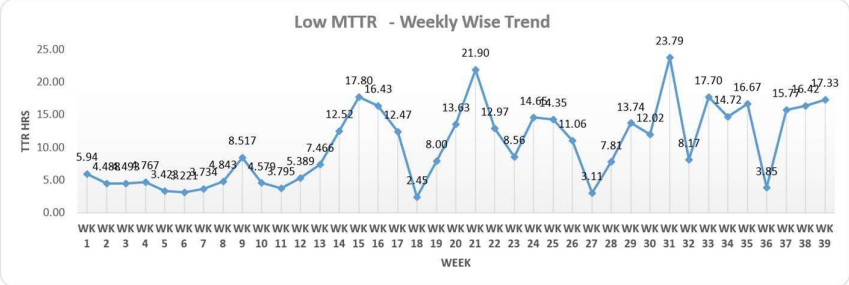

Fig. 3. Weekly MTTR Trend for Low-Severity-4 Tickets

4.3 Proposed solution

As in the root cause analysis for higher MTTR, it was found that some of the newly joined team members are taking more time to resolve issues, when feedback was taken from the team members on their usage of KBs some challenges were identified. The challenges are 'Information spread across multiple documents' the team ended up checking more documents to get the required information which took more time than usual, 'Searching the documents was not an easy task when they worked on critical issues.' These challenges directed the thought process towards a smart knowledge management system that can complement the technical teams working on the systems. Where they can easily access the information, that is required to perform the duties and prevent any mistakes which can happen by not following the SOP.

Several solutions were reviewed for this and from a data mining perspective, the data need to be made available to the users as per the search request, in an easy-to-use way was the primary objective of the solution. 'Microsoft Azure AI services'[10] that use 'Language Services' and 'Bot services' turned out to be the most effective solution to help to achieve these objectives with their inbuilt AI capability. They also provide easy integration with multiple user interface channels that can be used for the team to communicate.

One of the other solutions that were evaluated, was to create an independent Webchat service. However, that was not as effective as getting the Chat assistant on frequently used communication and collaboration mediums like MS Teams. One of the advantages of the Azure solution was the ProcessBot can be used in different ways on multiple MS Teams Channels. This made the integration of the solution easier, more effective, and more meaningful in addressing the requirement.

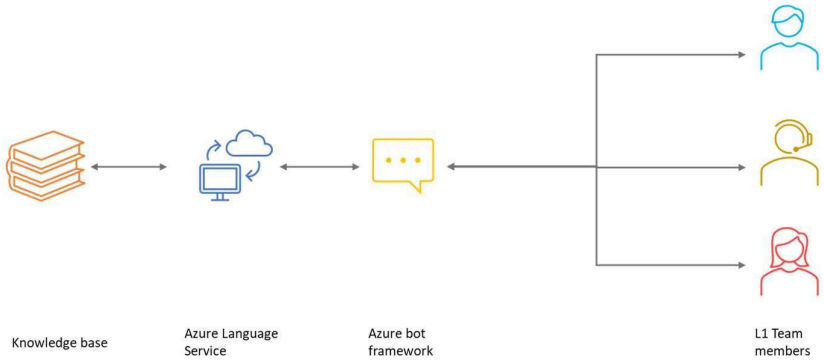

Fig. 1. Proposed solution diagram

KB to feed the data to cloud storage as shown in Fig. 1 and then use a chatbot as an interface to communicate with the team. The team members can then type the errors or questions on the issues they are working, on onto the chatbot. Chabot to fetch the information from the KB stored on the cloud. The Support Team uses MS Teams for communication & collaboration, and they keep the process documents on the SharePoint sites. Easy integration with these channels made Microsoft Azure AI Services the first choice. Additional improvements can be made with the help of Azure bot SDK with Python programming, as required. In case the services offered by the ProcessBot are down or not available, then the support teams are advised to follow the regular practice of directly accessing the SharePoint sites for the KB.

Data understanding and preparation

The data taken for this study is mainly the Technical Documents that assist the Platform Support Engineers in troubleshooting and fixing the issues/incidents that they receive while performing the infrastructure platform support duties. The data from the SOPs, vendor websites, and Ticketing tools like ServiceNow are the main source of KB.

Data preparation was performed on the text data to make it more effective on the Language Services in Azure. The different phases in the data preparation part are depicted in Fig. 4. Reviewed all the documents that are to be updated on to the KB in Azure Language Services. Made the changes to the data to have proper questions and detailed answers format. Reviewed all the documents and made the changes accordingly. In the next phase of the study, efforts are to be made to automate this process[7] of adding data to the questions and answers format.

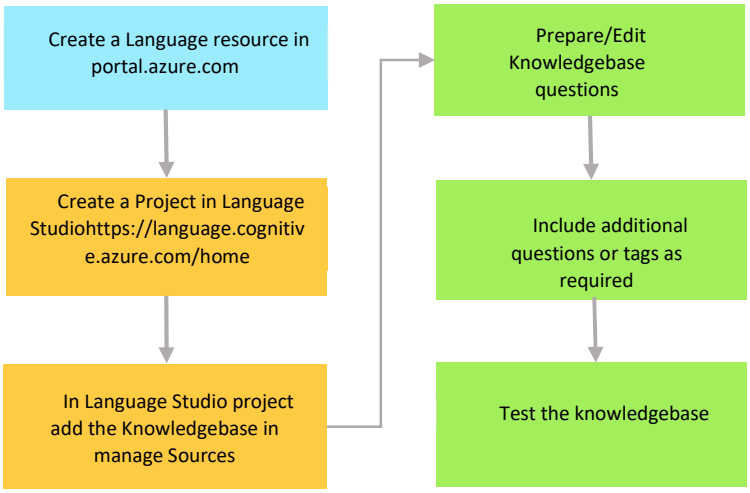

Fig. 4. Process flow of data preparation

Language Resource-Cognitive Service in Azure is a cloud-based service that uses NLP capabilities to understand and analyze data in text format. This service is to build applications that employ the web-based Language Studio, REST APIs, and client libraries. [8]. Language Service resources are created with the custom feature of question-answering. It allows the user to create a natural conversational layer over their data and finds the best answer for any input from the users' custom KB of information. Two key capabilities of Question-answering (QA) are custom QA and prebuilt QA[8]. Custom QA enables the users to customize various aspects like editing question and answer pairs taken out from the content source, defining synonyms and metadata, accepting question suggestions, etc. This enables the users to receive a response by querying a text passage without specific management of the knowledge bases.

Question-answer gives the best results on static information - QA functions the best when static information is in the KB of responses. This custom-made KB can contain documents such as PDFs and URLs. Request, Question, or Command answered with the same response: when the same question is submitted by different users the answer returned is the same. Filter static information based on meta-information; metadata

tags can be added to provide additional filtering options that are relevant to your client's application. Some of the most used metadata information examples are chit-chat, content type or format, content purpose, and content freshness. Conversational Bots with static information. All these enable the KB to provide a response based on users' dialogue-based text or commands.

Data Modeling and Evaluation

6.1 Modeling

As a part of the data modeling of this study, the data is reviewed and prepared to be used with the Bot service. The solution is designed as shown in Fig. 5. Bot is a conversational app that can be used by the end users to interact, using text, graphic images/cards, or speech. Azure offers Bot-Service as a cloud platform, hosting bots and enabling them to be mapped to channels that can be used by the end users to interact like Microsoft Teams, Facebook, or Slack.

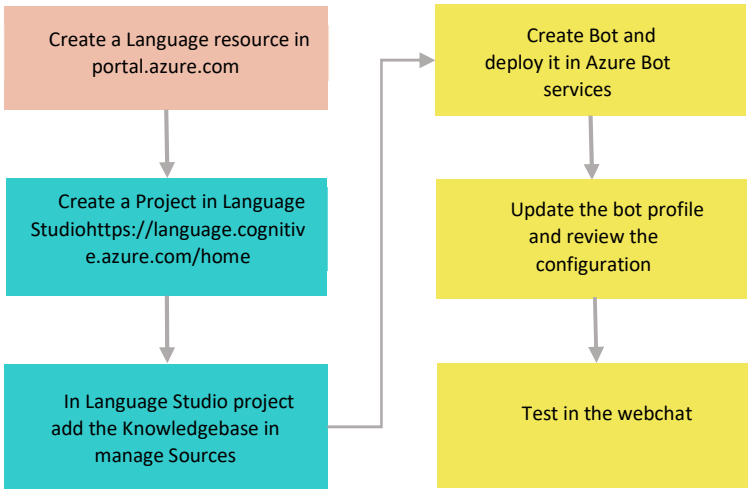

Fig. 5. Flow of the data

The Bot-Framework Service, included in Azure Bot-Service, enables the interaction with the user's bot-connected app and the bot by sending information. The individual channels get more information on the activities they need to perform. Before the bot creation, let us check how a bot engages activity objects to facilitate communication with the users. The Bot-Framework Service initiates a chat request as a user joins the conversation. When a conversation gets started with the Bot Framework Emulator, there are two conversation update events, one from the user who joined the conversation and the other from the bot. It is possible to examine who is included in the members' added attributes of the activity to distinguish between these conversation update jobs. An activity is any conversation between the user or a channel and the bot. 'Structure and turns' in bot applications: In a conversation, users take turns speaking one at a time. A bot frequently responds to user input when used. In the Bot Framework, a turn consists of the user's activity that the bot receives and any interactions it communicates as a prompt response to the user.

6.2 Evaluation

Evaluation of the model involves how to review the whole chat dialogue and their responses to the users' questions, the demonstration of the chatbot's insights, and the evaluation answers provided. ProcessBot got a welcome screen and a greeting message to the user and also provides information on the way that answers the questions. The evaluation is done based on the context of the questions asked and the response. This was closely reviewed by the SMEs who prepare the knowledge base for the team and then reviewed the answers by comparing them with the knowledge base that was given, KBs were updated with detailed answers to different scenarios.

As a part of the model evaluation, the SMEs prepared 100 questions out of which 50 of them were not part of the KB. Processbot was expected to display the answers to the questions asked, if it was unable to answer then to display the message *"Sorry unable to get an answer for the question now, we will add this to our knowledge base soon"*. The following Table 1 gives the summary of the results of the Test

Table 1. Results from the first round of testing

KB Answer as per the Process Doc \ Answer- Azure	Correct answer	No Answer
Correct answer	30	20
No Answer	0	50

30 questions that were already part of the KB returned with the right answers however 20 of them even though the answers were part of the KB returned with no answer. 50 questions that were not part of the KB were returned with no answer as expected. Follow-up actions after the tests were taken, reviewed the KB, and refined the questions in the KB on the Azure language services. Additional tests were carried out to identify other special instances, it was found that even when the answer is a lengthy description, the ProcessBot performed well by collecting the answers as the knowledgebase was designed. Some questions have got multiple turns, users can select more options on the answers rather than giving them in a single lengthy statement, it was giving the option to choose the resolution with the numbers 1, 2, and 3. Once all the issues identified in the first round of testing were addressed, the test was repeated with another set of 100 questions for which 50 of the answer was already added in the KB and the rest of them were not, the results are shown the Table 2.

Table 2. Results from the second round of testing

KB Answer as per the Process Doc \ Answer- Azure	Correct answer	No
Correct answer	45	05
No Answer	0	50

Deployment, Analysis, and Results

Deployment was to make ProcessBot available to the L1 and L2 Support teams. For this step, first reviewed and verified the Azure Services, to confirm that all the resources and applications were ready to go, confirmed that from the home page of Portal.azure.com. Once the bot was ready and tested on the web chat, need to get that on to the MS Teams where this was to be used primarily. On the channels section of the Bot Services process page, this information was available. On the settings checked the Channel section and added Teams from the available list of Channels, this got deployed in a few minutes. The Teams Integration allowed the team members to access and communicate with the bot easily. The proto-type link of the Teams integration was generated from the Channels page on the Bot Framework and the link was shared among the Teams L1/L2 engineers.

Analyzing the effectiveness of the knowledge management solution was done by verifying its usage, and the feedback received from the team members. Changes based on these were later added to the knowledgebase management design. The team had a very positive reception of the solution. There was 90% positive feedback on this solution and then constructive criticism to improve the solution further. Awareness meetings were scheduled to talk about the intention, the capabilities of the solution, and its limitations. This solution was even shared with the Customer, the Sr Director was informed of the solution and presented with a demo of it, she shared her appreciation for the thoughtful initiative and liked the way the knowledgebase was organized and also recommended improvements and new features that can be added in the future iterations. With furthermore feedback, the necessary enhancements can be added to the solution.

To make the communication flow appear more human and genuine, additional interactive sentences and discussion dialogues were added. Chit Chat is an option offered by Azure Language Services that can improve the personality of the bot interface, this had helped in offering more engagement with the end users. More in-depth inquiries and error choices were included along with the round-up navigation dialogues. Review Suggestions, another fantastic feature of Azure 'language-services'. The 'active-learning-suggestions' feature gives the edge to the users to further improve the quality of the knowledge base, as it recommends alternative questions that are based on user submissions, to question-and-answer pairs. Following the evaluation of these ideas, a decision can be made on whether to include them or not in the existing questions. The knowledge base doesn't change with the recommendations but is to be accepted by the owner for these modifications to go into effect. These suggestions just add more questions but never change or remove existing questions[11].

As chatbot analytics can estimate the success of the chatbot and the knowledge management solution implemented, they can also offer excellent insights into business growth opportunities and strategic retention. It is crucial to be aware of the chatbot's advantages and potential by continuously observing and evaluating its performance. Also track the main chatbot metrics, which is an integral part of the business success[12]. Refer to the Fig. 6 for monitoring metrics

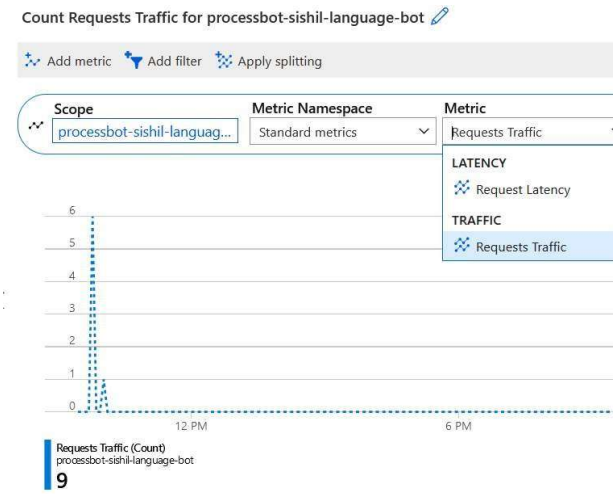

Fig. 6. Monitoring Metrics of the Bot usage [13]

Conclusion and Future scope

The chatbot is being used by L1 and L2 Engineers. There is a visible improvement in the MTTR, the data is being collected to understand trends post the solution implementation. Also working on getting approval for the cost case from upper management for the full-fledged implementation. Reviewing the solution provided and understanding the limitations, and scope of further improvements that Process Bot required as an assistant to the Platform support team.

The feedback received from the technical teams, SME and Architect did help to improve the tool and then identify the scope of further enhancements, the Chat responses and solutions received from the bot were as good as those updated on the KB, the challenge is to get all the questions being asked and add them alternative questions if those are addressed already on the KBs.

In the next iteration, it is planned to have this rolled out to other supporting teams, including AIX, LINUX, and Multi-Cloud support teams. There's a vast amount of information on the ServiceNow ticketing tool, need to explore the options of getting that information and coordinating that through this communication channel. One of the challenges that are experienced as of now is Governance and Document control, need to identify a process in place to review the knowledge base that is getting added to the Language Service Managed Source KBs.

The documents updated on SharePoint are compliant with the approved process in place for Document control and governance. Automation needs to be employed wherever possible to reduce human effort in this. The limitation of a free version of the Azure services prevented us from exploring more options to customize the knowledge management solution. One of the biggest gains through this endeavor was the realization that certain tasks that are handled by the L2 support can be shared with L1 with the help of this knowledge management solution- Process bot. This would further help us to optimize the human effort and manage the staffing accordingly.

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