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Text Mining Approaches Oriented on Customer Care Efficiency

Abstract

In the proposed work is performed a text classification for a chatbot application used by a company working in assistance services of automatic warehouses. industries. Specifically, text mining technique is adopted for the classification of questions and answers. Business Process Modeling Notation (BPMN) models describe the passage from “*AS-IS*” to “*TO BE*” in the context of the analyzed industry, by focusing the attention mainly on customer and technical support services where chatbot is adopted. A two-step process model is used to connect technological improvements and relationship marketing in chatbot assistance: the first step provides the hierarchical clustering able to classify questions and answers through Latent Dirichlet Allocation -LDA- algorithm, and the second one executes the Tag Cloud representing the visual representation of more frequent words contained in the experimental dataset. Tag cloud is used to show the critical issues that customers find in the usage of the proposed service. By considering an initial dataset, 24 hierarchical clusters are found representing the preliminary combination of the couple’s question-answer. The proposed approach is suitable to automatically construct a combination of chatbot questions and appropriate answers in intelligent systems.

Keywords: *Chatbot, Speech Recognition, Natural Language Processing-NLP, Hierarchical Clustering, Business Process Management and Notation-BPMN.*

1. Literature Review

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Authors in (Sari, et al., 2020) consider the use of chatbots to promote business development creating the conditions to improve the customer relationships. The efficacy of chatbots in Business to Business -B2B- is oriented to increase the level of Customer Experience -CX-, which is strictly connected to the ability of customers to use the technology (Kushwaha, et al., 2021) . Chatbots that can apply self-learning are also able to promote a higher degree of CX. If customers increase their trust about chatbot in business services, then it will be diffused in a widespread way (Przegalinska, et al., 2019). The use of chatbot in combination with Customer Relationship Management -CRM- can improve the ability of the company to offer information towards its clients (Setiawan, et al., 2019). The efficacy of chatbots is a function of the Natural Language Processing -NLP- algorithm adopted for the development (Chao, et al., 2021): Convolutional Neural Networks-CNN- and Long Short-Term Memory-LSTM- (Massaro, et al., 2021) algorithms can be applied to optimize the recognition of words and phrases and a combination of questions and answers. The application of NLP in chatbot systems can also improve the efficacy of health assistance as for telemedicine applications (Omogbe, et al., 2020). Chatbots are important also in strategic marketing enforced by sentiment analysis and customer experience (Sidaoui, et al., 2020). Authors in (Dodero, et al., 2020) propose a methodology based on NLP, to augment the ability of chatbots in understanding the context in which the conversation is realized. Chatbot can be adopted as a semi-supervised modality to contextualize responses in the minimization of prior data, by improving customer satisfaction (Paul, et al., 2019). Other software tools can evaluate the chatbot-user dialogue under a qualitative point thus obtaining statistics to be used to augment the efficacy of the customer service (Følstad, et al., 2021). Chatbot is able not only to learn from customers' responses but also to generate inferences about the customers' behaviors, intentions and needs through the dynamic application of knowledge in customer care (Pantano & Pizzi, 2020). Chatbot can also operate as a virtual front-office (Massaro, et al., 2018), and can be optimized by sentiment analysis (Massaro, et al., 2019), (Al Islami, et al., 2020). It is also possible to implement a chatbot system able to recognize words directly in speeches using LSTM algorithms (Massaro, et al., 2020). In human resource sector, chatbots can be used as tools for recruitment (Chou, et al., 2019). In *non-business activities*, chatbot is applied in healthcare (Maeda, et al., 2019), (Kowatsch, et al., 2017), and to assist students in their undergraduate and postgraduate courses (Murad, et al., 2019), (Hien, et al., 2018), (Dharaniya, et al., 2020), (Ashok, et al., 2021), (Qaffas, 2019). The usage of chatbot can solve the question of the scarcity of human resources in medical services in respect to patients' demand (Tjiptomongsoguno, et al., 2020). Chatbot can improve the offering of services in the health industry (Sheth, et al., 2019). Chatbots are efficiently used also in public administration (Lommatzsch, 2018) and transportation (Dharani, et al., 2020). Furthermore, Automatic Speaker Recognition-ASR- tools (Prasad & Ranjith, 2020) are integrable for

voice-based chatbot systems thus providing a technological advance. Chatbots are suitable to interpret the various typologies of emotions in healthcare (Luo, et al., 2021), by improving the ability of medical systems to process health information (Madhu, et al., 2017), (Mathew, et al., 2019), (Yorita, et al., 2020), (Siangchin & Samanchuen, 2019).

Concerning the topic of the paper of the improvement of customer assistance, in (Nagarhalli, et al., 2020) are shown how conversational systems can be used to develop assistance services in various domains. In addition, artificial intelligence is potentially useful in supporting consumers about shopping (Pizzi, et al., 2021). In the manufacturing sector, chatbots can be used for technical assistance (Mantravadi, et al., 2020). By considering e-commerce platforms, the online chatbot is a good channel for customer communication and assistance (Landim, et al., 2021). Chatbot is applied in other industrial sectors such as the luxury fashion sector (Chung, et al., 2020). Different advantages in assistance services for customers can be achieved by chatbot (Behera, et al., 2021). Chatbot has a customer strategic role because it can be based on a conversation strategy and recommendations systems to improve customer assistance (Ikemoto, et al., 2018). The state of the art highlights the importance of chatbot in industrial applications more specifically for customer care processes.

The paper is structured as follows: the second paragraph contains the Business Process Model and Notation-BPMN used to optimize the function of the Chatbot system for the specific case study following economic and financial advantages, the third paragraph describes in detail the two-step process model to connect technological improvements and relationship marketing in chatbot assistance, the fourth paragraph presents the results of hierarchical clustering, the fifth paragraph shows the results of the Latent Dirichlet Allocation-LDA algorithm used to generate the tag cloud.

1. Business Process Model and Notation-BPMN and the Economic and Financial Advantages of the AI-Chatbot

In our analysis, the application of the AI-Chatbot consent to realize the following goals that are valuable in the sense of Customer Process Management:

- *Queries pre-classification through the application of hierarchical clustering:* through the application of the hierarchical clustering it is possible to verify the presence of questions that are recurrent among customers; those questions can shed light on some non-performing elements of the product; that information can be used to promote a process of re-invention and re-industrialization of services that can better serve the necessity of the customer.
- *Answer pre-classification through the application of hierarchical clustering:* the analysis of the answers through the application of the hierarchical clustering is necessary to verify if the

Chabot is effectively able to promote the right answers to customers; specifically, the AI-Chatbot is supposed to learn from the dynamic of questions and answers and so, marginally, its answers should change reflecting relevant modifications in the question of the customers.

- *Automated customer care through the application of the KB Virtual Assistant:* the application of the automated customer care can improve the quality of the relationship with the customer; specifically, the AI-Chatbot does not only reply to questions based on its inner logic, but on the contrary is programmed, through NLP, to learn and offer change-oriented solutions even in the case of very similar questions.

These three elements are associated with the Product Quality Management Process i.e. they have a positive impact on the ability of the product to generate value for customers. The presence of an AI-Chatbot that is oriented to promote services in the context of the company-customer relationships, offers a series of economic and financial advantages such as:

- *Customer Retention:* is the ability of the firm to develop long run relationships with customers. In the case of retention, the customer does not change the firm that supplies products or services, does not buy similar products and services from competitors. In this case the application of the AI-Chabot improves the level of quality of services and creates the condition to develop long run relationships between firms and customers.
- *Customer Care:* is the supply of services to customers during and after the purchase of the goods or services. The application of the AI-Chatbot improves the ability of the firm to generate assistance towards its clients creating the conditions for a more performing ability of customer care.
- *Service Quality Performance > Customer Expectations:* is the definition of quality in the service. The AI-Chatbot based on its ability to learn and understand the questions posed by customers through the application of Natural Language Processing-NLP algorithms can effectively over perform the assistance service in respect to customer expectations.
- *Customer loyalty:* There is a positive impact of the application of AI-Chatbot on customer loyalty since the customer can effectively ask the Chatbot system how to solve its problems in the usage of the automatic warehouses.

These positive outcomes show the relevance of the application of the AI-Chatbot in the context of the industrial services, to promote a better relationship with customers and create the conditions to improve the Product Quality Management Process. The AI-Chatbot for its ability to learn from questions and answers can promote dynamic dialogue with customers improving either their ability to use efficiently the automatic warehouse, either their trust in the firm, its products, and its customer assistance.

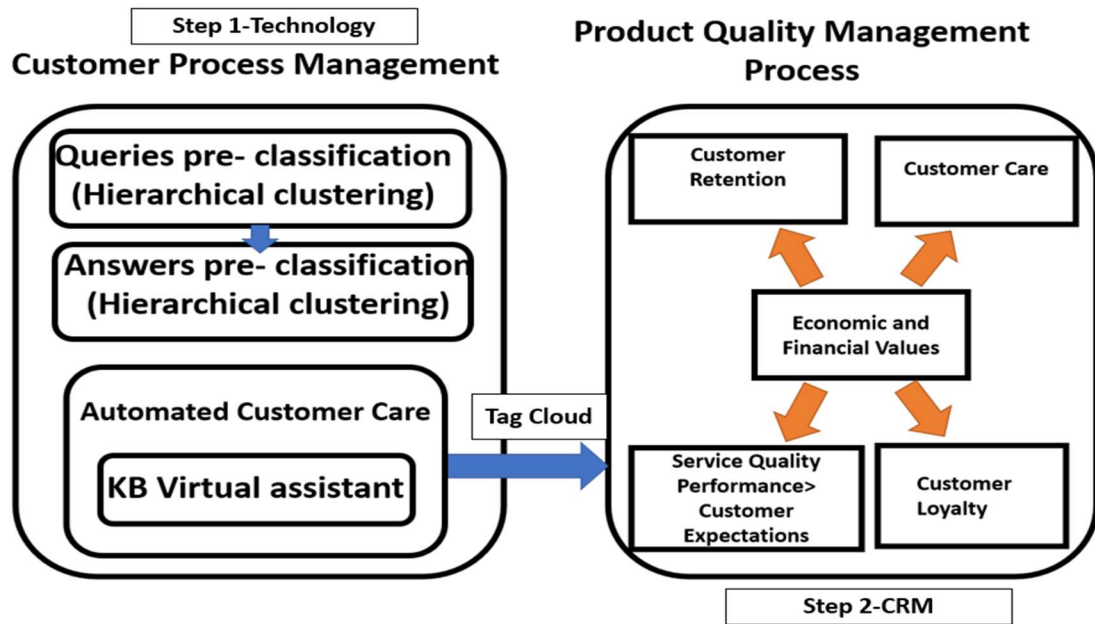


Figure 1. Customer process management and product quality management in the case of AI-Chatbot.

Specifically, the application of the Chatbot in the case of ICAM srl company, either for its impact on the Customer Process Management, either for its ability to improve Product Quality Management, generates an organizational change that is oriented to have significant impacts on the following areas:

- Increase in the number of customers serviced:* the application of the virtual technical assistance improves the ability to serve a greater number of customers with a greater efficiency. The entire customer assistance service is realized using the phone in the AS-IS. The number of customers that a single worker can serve is limited in confrontation with the possibility offered by the application of the AI chatbot. In the “TO BE” version of the service the application of the automated virtual assistance improves the ability to serve a greater number of clients. In this sense ICAM srl can reduce the costs of workers employed in service assistance and increase the number of requests fulfilled. The company can acquire new margins of productivity, improve efficiency, and increase the ability to create a customer relationship management oriented to the promotion of qualitative services.
- Impact on human resources:* in the AS-IS of the firm ICAM the entire process of customer assistance and customer care is offered by human resources that are employed in routinary tasks. The application of the AI-Chatbot in the TO-BE can reduce the human workforce employed in customer care. Workers can be better oriented to realize more complex tasks such as the training of the artificial intelligence and the data analysis oriented to disentangle the customer behavior. In the change from to the “AS-IS” to the “TO-BE” the firm has the

possibility to re-evaluate the human capital and to promote a process of digitalization that can transform a front-end worker into an analyst of customer behavior using data science.

- *Impact on supply chain:* using the AI-Chatbot the firm also can select implicitly the suppliers. In effect when customers complain about the malfunctioning of the product then the firm can recognize recurrent errors in the supply. Using the requests of the clients it is possible to verify the functioning of the automatic warehouse, understanding the more critical issues, and the weaknesses of the system either in the sense of the hardware infrastructure or in the sense of software functionality. The customer experience can offer relevant information to optimize the functioning of the automatic warehouses and can shed light on some functionality that underperform in respect to the customer expectations. Furthermore, it is possible to use the information relative to the customer experience to evaluate the customer's innovativeness and the ability of clients to use the technological infrastructure used to the management of the automated warehouse.

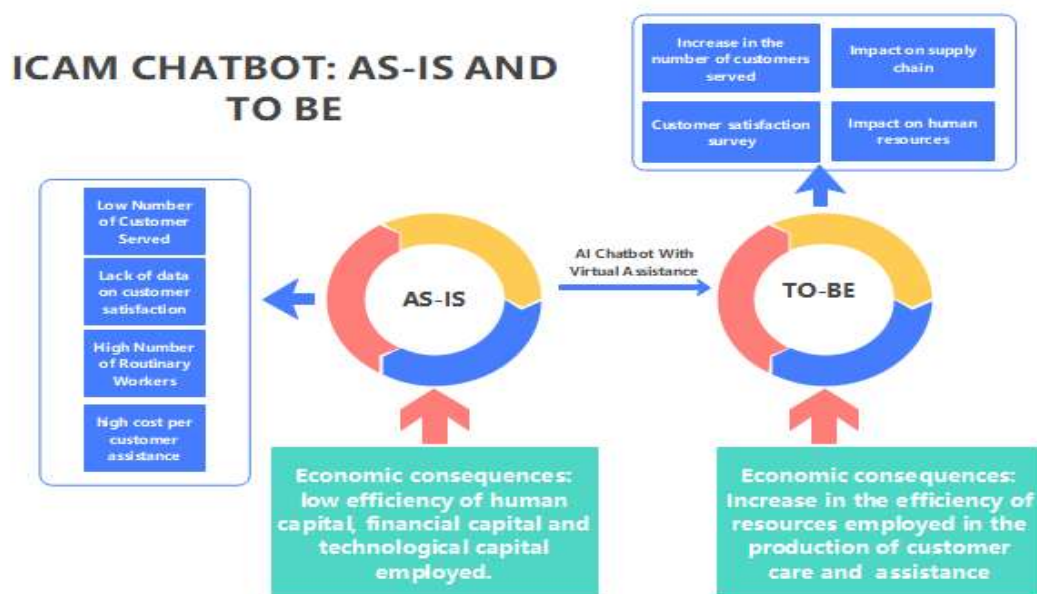
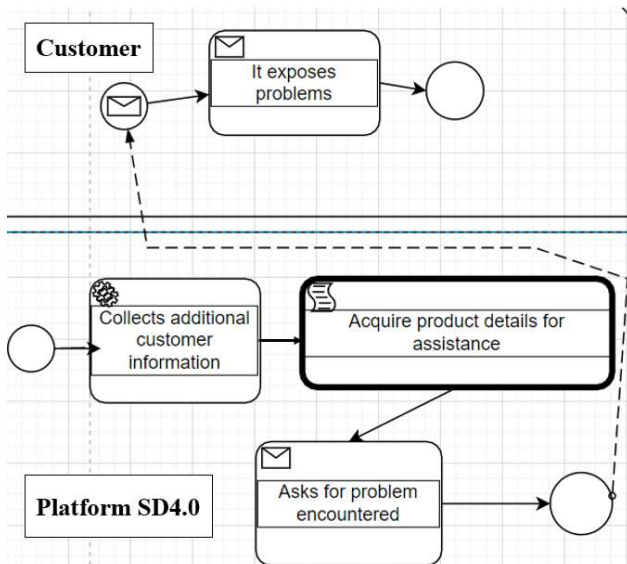


Figure 2. The organizational change between AS-IS and TO-BE in the case of AI-Chatbot for the case study of ICAM.

- *Customer satisfaction survey:* introduce a customer satisfaction survey tool, to investigate any causes of dissatisfaction to eliminate them and improve the technical assistance service, minimizing the number of dissatisfied customers. It might be useful to record all interactions between customers and the company through the platform. The possibility to acquire data that can be used to an effective identification of the clients is relevant to produce either better automatic warehouses or to improve the efficiency of the service assistance. Data can show customer behaviors, customer implicit needs, and can reveal the levels of customer

satisfaction and customer experience. Through the usage of data, the company can promote better products and services and can also verify the degree of efficacy of the targeting of the customers realized during the phase of business planning and programming.

We can use analytical tools to describe the characteristics of organizational change produced in



association with the implementation of the ICAM-Chatbot through the application of the Business Process Model and Notation-BPMN (Massaro, 2021), (Massaro & Galiano, 2020).

Two sub-processes are presented either for the Sales Customer Service, the Technical Support Service. In the Figure 3 there is a representation of a subprocess of the Technical Support Service. The sub-process starts with the Platform SD4.0 that collects additional customer information. The Platforms acquires product details for assistance and asks for problem encountered. Then the platform SD4.0 sends a message to customers that replay explaining the problem. Later the sub-process ends. In figure 4 there is a representation of a subprocess of Sales customer service. The platform SD4.0 that verifies the activation of the sub-process. In the following step two alternatives are feasible since there is a macro-process activation:

- *No*: in this case the platform SD4.0 asks for product service information
- *Yes*: in this case the platform SD4.0 collects additional customer information and later asks for product service information.

After having asked for product service information the analyzed sub-process can follow two different paths:

- The platform SD4.0 can acquire information about the service;
- The platform SD4.0 can send a message to the customer that enters information about the service/product and at this point there are two alternatives: firstly the process ends, secondly

the customer sends a message to platform SD4.0 to acquire information about the product service.

In both cases the usage of the Business Process Management and Notation-BPMN helps the firm to describe and activate the analyzed services. The relationship between the Platform SD4.0 and the Customer is relevant to produce the services that the firm has interested to offer to their clients. Specifically, the passage from the “*AS IS*” to the “*TO BE*” shed lights on the ability of the firm to optimize the customer assistance either in the case of “*Sales Customer Service*” either in the case of “*Technical Support Service*”.

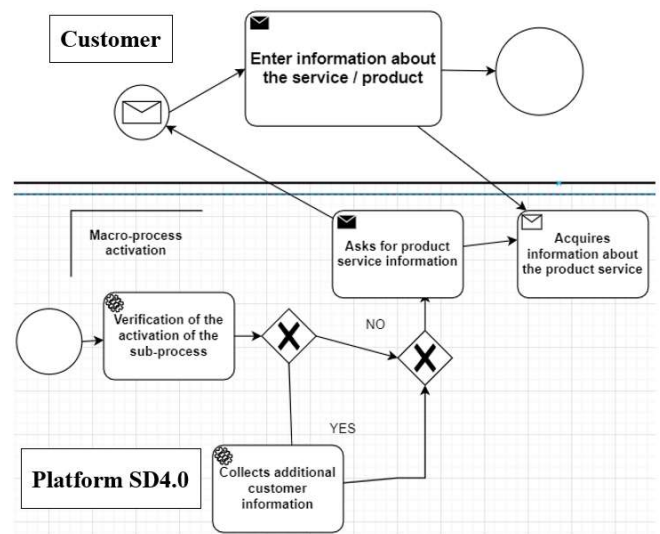


Figure SEQ Figure * ARABIC 4. Sales Customer Service.

2. A Two-Step Process Model to Connect Technological Improvements and Relationship Marketing in Chatbot Assistance

We have realized a two-step process model in which the first step is based on hierarchical clustering and the second step is based on the optimization of relationship marketing through the analysis of Tag Cloud. While in the first step the hierarchical clustering has been used to obtain better technological solutions that are realized through the application of artificial intelligence, machine learning and NLP, in the second step the Tag Cloud has been used to identify the most frequent words in the datasets based on the assumption that these expressions reflect the most relevant question for customers. Tag Cloud is able in this sense to offer a graphical representation of the frequency of words in the dataset. Specifically, through the analysis of the Tag Cloud it is possible to verify which are the parts of the automatic warehouse that are more difficult to use for the customer. The analysis of Tag Cloud offers the possibility to verify the ability of the firm to promote some relevant goods such as customer service, customer care, customer loyalty, and customer retention.

While in the first step through hierarchical clustering are analyzed demands and answers, in the second step only answers are analyzed. In this sense it is possible to verify, through the Tag Cloud, which are the major functionalities that can be implemented to solve customers' problems, or which are the functionalities that customers find harder to understand. For example, the usage of the most frequently used word that is “*PulsanteDiEmergenza*”, that in the first step of hierarchical clustering

is associated with various clusters, in the second step of the process model can suggest the necessity to intervene to improve the level of security of the automated warehouses.

3. Hierarchical clustering

We perform a hierarchical clustering using KNIME and the entire dataset of 65 questions and answers. We compute the hierarchical clustering based on three tools to compute distances that are: Euclidean, Manhattan and Cousin. In our analysis we consider not only the quantitative analysis based on the number of clusters but also the qualitative analysis relative to the association between clusters and questions-answers. Specifically, the workflow used for the hierarchical cluster analysis is based on four different processes i.e.:

- **Data import:** is composed by three different KNIME nodes that are “*Excel Reader*”, “*String to Document*” and “*Column Filter*”;
- **Preprocessing:** is based on seven KNIME nodes and one metanode. The different seven KNIME nodes are “*Markup Tag Filter*”, “*Punctuation Erasure*”, “*N Chart Converter*”, “*Stop Word Filter*”, “*Stanford Lemmatizer*”. The metanode is based on the following “*Extract Table Dimension*”, “*Java Edit Variable*”, “*Bag of Words Creator*”, “*Term to String*”, “*Group By*”, “*Row Filter*”, “*Reference Row Filter*”, “*TF*”.
- **Transformation:** that is based on “*Document Vector*” e “*Category Class*”;
- **Clustering:** that is based on the three different clusters that are repeated three times respectively with Euclidean, Manhattan and Cousin methodology that are: “*Hierarchical Clustering*”, “*Hierarchical Cluster View*”, “*Distance Matrix*”, “*Column Filter*”, “*k-Medoids*”, “*Hierarchical Cluster Assigner*”.

KNIME nodes for hierarchical clustering	
Macro process	Nodes
Data Import	Is the first macro-process that is used to introduce data in KMINE. The Data Import is based on the following nodes that are: “ <i>Excel Reader</i> ”, “ <i>String to Document</i> ”, “ <i>Column Filter</i> ”.
Preprocessing	Is a macro process that is based on 7 nodes and one metanode. The seven nodes are indicated as follows: “ <i>Markup Tag Filter</i> ”, “ <i>Punctuation Erasure</i> ”, “ <i>N Chart Converter</i> ”, “ <i>Stop Word Filter</i> ”, “ <i>Stanford Lemmatizer</i> ”. The metanode is realized with the following

	nodes i.e. " <i>Extract Table Dimension</i> ", " <i>Java Edit Variable</i> ", " <i>Bag of Words Creator</i> ", " <i>Term to String</i> ", " <i>Group By</i> ", " <i>Row Filter</i> ", " <i>Reference Row Filter</i> ", " <i>TF</i> ".
Transformation	Is based on two different nodes that are " <i>Document Vector</i> " and " <i>Category Class</i> ".
Clustering	The clusterization process is based on " <i>Hierarchical Clustering</i> ", " <i>Hierarchical Cluster View</i> ", " <i>Distance Matrix</i> ", " <i>Column Filter</i> ", " <i>k-Medoids</i> ", " <i>Hierarchical Cluster Assigner</i> ".

Our results show that there are 24 hierarchical clusters that preset the following characteristics:

- *One cluster with 14 singular element;*
- *Six clusters with two elements;*
- *One cluster with three elements;*
- *One cluster with seventeen elements;*
- *One cluster with ten elements;*
- *One cluster with seven elements.*

In Figure 5 we have the representation of the workflow that has been used to run the hierarchical cluster analysis. As we can see in the green part of the workflow that is named "*clustering*" are present three similar series of nodes that in effect are oriented to compute the hierarchical clustering using three different typologies of distances that are:

- *Euclidean Distance;*
- *Manhattan Distance;*
- *Cosine Distance:*

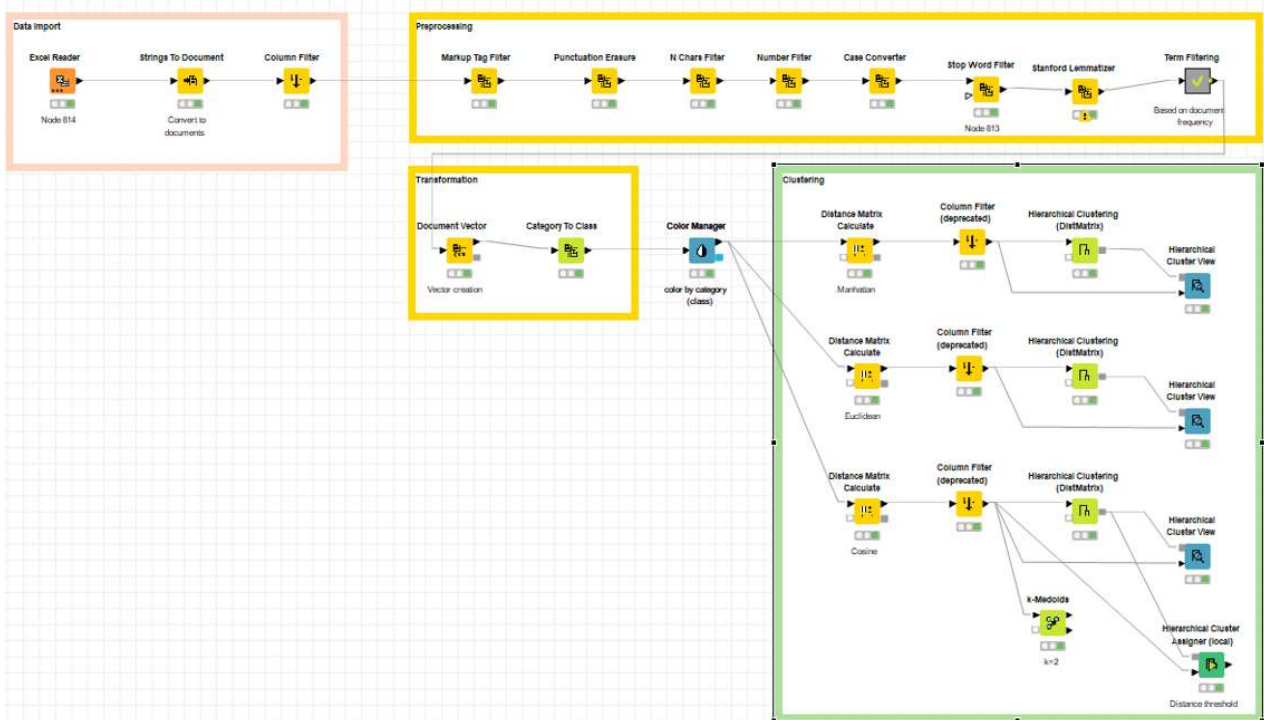


Figure 5. Workflow of hierarchical clustering.

In the following analysis we consider the relationship between questions and answers in connection with hierarchical clusters.

As we can see in Figure 6 and Figure 7 there are clusters with only one question-answer and clusters with multiple questions-answer. Specifically, we have that the following order of clusters based on the number of questions-answer:

- *Clusters with only one question-answer:* 11, 12, 13,14,15,16,17,18,19,20,21,22,23,24;
- *Clusters with two questions-answers:* 1,3,5,6,10;
- *Clusters with three questions-answers:* 8;
- *Clusters with seven questions-answers:* 4;
- *Clusters with ten questions-answers:* 7;
- *Clusters with eighteen questions-answers:* 2;

The more populous clusters are the cluster 2, 7, 4 and 8. These clusters contain the 38 questions-answers of the total amount of 65 i.e., the 58,4%.

Cluster	Question	Answer
Cluster 1	Come ripristinare l'extracorsa Y basso?	ModalitàManuale
	Come ripristinare l'extracorsa X software?	ModalitàManuale

Question	Answer
Come risolvere l'incongruenza fisica?	PremereIconZero
Come risolvere l'incongruenza logica?	PremereIconZero
Come ripristinare il pieno su pieno posteriore?	PulsanteGiallo
Come ripristinare il pieno su pieno anteriore?	PulsanteGiallo
Come ripristinare il vuoto su vuoto anteriore?	PulsanteGiallo
Come ripristinare il vuoto su vuoto posteriore?	PulsanteGiallo
Come ripristinare il timeout sequenza deposito?	PulsanteGiallo
Come ripristinare il timeout sequenza prelievo?	PulsanteGiallo
Come ripristinare il timeout sequenza syncro?	PulsanteGiallo
Come risolvere la rilevazione di vassoio assente a bordo?	PulsanteDiEmergenza
Come ripristinare il timeout freno asse Y?	PulsanteDiEmergenza
Come risolvere il fault azionamento asse X?	PulsanteDiEmergenza
Come risolvere il fault azionamento asse Y?	PulsanteDiEmergenza
Come risolvere il fault azionamento asse Z?	PulsanteDiEmergenza
Come sganciare il fungo di emergenza sul gruppo baia?	PulsanteRossoEGiallo
Come sganciare il fungo di emergenza sulla pulsantiera a filo?	RipristinareMacchina
Come ripristinare la barriera di sicurezza baia?	RimuovereOggetto
Come ripristinare il peso massimo superato in baia?	RidurrePeso

Cluster	Question	Answer
Cluster 3	Come risolvere l'errore Ethercat asse F?	PulsanteDiEmergenza
	Come risolvere l'errore Ethercat asse X?	PulsanteDiEmergenza

Cluster	Question	Answer
Cluster 4	Come risolvere l'errore Ethercat asse Y?	PulsanteDiEmergenza
	Come ripristinare il magnetotermico freno asse Y?	QuadroElettrico
	Come ripristinare l'asse Z bloccato?	PulsanteDiEmergenza
	Come risolvere il guasto encoder asse Y?	Syncro
	Come ripristinare il vassoio fuori posto sull'elevatore ad altezza baia?	ModalitàManuale
	Come ripristinare un vassoio fuori sagoma?	RilurriAltezza
	Come ripristinare il timeout chiusura sportello automatico baia?	ModalitàManuale

Cluster	Question	Answer
Cluster 5	Quali dati è possibile scambiare mediante procedura di interfacciamento?	Gestionale
	Come ripristinare il timeout rientro dispositivo di estrazione baia?	EstrazioneBaia

Question	Answer
Come ripristinare l'asse D bloccato?	PulsanteDiEmergenza
Come ripristinare il fault inverter asse D?	PulsanteDiEmergenza

Figure 6. The composition of clusters. On the left side with the indication of Row there are the elements of the clusters. For each row there is a correspondent set of questions-answers.

Question	Answer
Come ripristinare l'errore di conteggio asse Z?	PulsanteDiEmergenza
Come ripristinare l'errore sportelli aperti?	PulsanteRossoEGiallo
Come ripristinare l'intervento relè controlli fasi?	PulsanteDiEmergenza
Cosa fare in caso di sottotensione?	QuadroElettrico
Come Ripristinare la macchina in caso di Blackout durante la movimentazione dell'elevatore?	Alimentazione
Come Ripristinare la macchina in caso di Blackout durante la movimentazione delle catene di prelievo/deposito	Alimentazione
Cosa fare in caso di blocco di IconZero?	IconZero
Cosa fare nel caso in cui il proiettore si spegne dopo pochi minuti dall'accensione?	Proiettore
Cosa fare se il fascio del proiettore non è perfettamente centrato sul vassoio?	FascioLuminoso
Come ripristinare il magazzino se non completa la syncro?	Syncro

Question	Answer	
Cluster 8	È possibile segnalare un articolo sotto scorta?	OptionalDiGestione
	È possibile stabilire quale lista eseguire prima nel caso in cui ce ne fossero più di una?	Priorità
	È possibile cambiare verso (causale) a una lista di carico per farla diventare di scarico?	Lista

Question	Answer	
Cluster 10	È possibile decidere dove caricare per primo un articolo associato a due UDS?	Vassoio
	Quali tipologie di interfacciamento con gestionali esterni esistono?	InterfacciaConGestionale

Cluster	Question	Answer
Cluster 11	Come ripristinare le catene non a riposo?	ModalitàManuale
Cluster 12	Come ripristinare l'extracorsa Y alto?	ModalitàManuale
Cluster 13	Come risolvere l'errore Ethercat asse Z?	PulsanteDiEmergenza
Cluster 14	Come risolvere l'errore Ethercat di comunicazione PLC?	PulsanteDiEmergenza
Cluster 15	Come risolvere l'intervento del termico ventilatori?	QuadroElettrico
Cluster 16	Come ripristinare il timeout apertura sportello automatico baia?	ModalitàManuale
Cluster 17	Come ripristinare lo sportello automatico baia aperto?	ModalitàManuale
Cluster 18	Come ripristinare l'asse F bloccato?	PulsanteDiEmergenza
Cluster 19	Come ripristinare il timeout uscita dispositivo di estrazione baia?	ModalitàManuale
Cluster 20	Come ripristinare il fault azionamento asse F?	PulsanteDiEmergenza
Cluster 21	Cosa fare in caso di spegnimento azionamenti causa inutilizzo?	PulsanteDiEmergenza
Cluster 22	Come ripristinare il dispositivo di prelievo non al centro?	ModalitàManuale
Cluster 23	È possibile cancellare un articolo?	CancellazioneArticolo
Cluster 24	È possibile cambiare verso (causale) a una lista di carico per farla diventare di scarico?	Lista

Figure 7. The composition of clusters. On the left side with the indication of Row there are the elements of the clusters. For each row there is a correspondent set of questions-answers.

4. Tag Cloud as a Tool to Optimize Relationship Marketing

In addition to the hierarchical clusters, we realize a representation of the dataset with the usage of tag clouds. Specifically, the workflow to obtain the outputs of tag cloud is based on the following workflows:

- *Inputs*: is a macro process based on two different nodes that are “*Excel Reader*” and “*Strings to Document*”.
- *Text Elaboration*: is the main part of the workflow that is based on the following nodes that are “*Punctuation Erasure*”, “*Number Filter*”, “*N Chars Filter*”, “*Stop Word Filter*”, “*Stanford Tagger*”, “*Stanford Lemmatizer*”, “*Case Converter*”, “*Tagged Document Viewer*”;
- *Regulator*: is composed of a single node that is “*Topic Extractor-Parallel LDA*”;
- *Outputs*: is the macro-process that can be used to verify the presence of outputs that is “*Color Manager*” and “*Tag Cloud*”.

The main objective of the realization of a workflow based on tag cloud consists in the final plotting of a word cloud as a graphical representation of the answers.

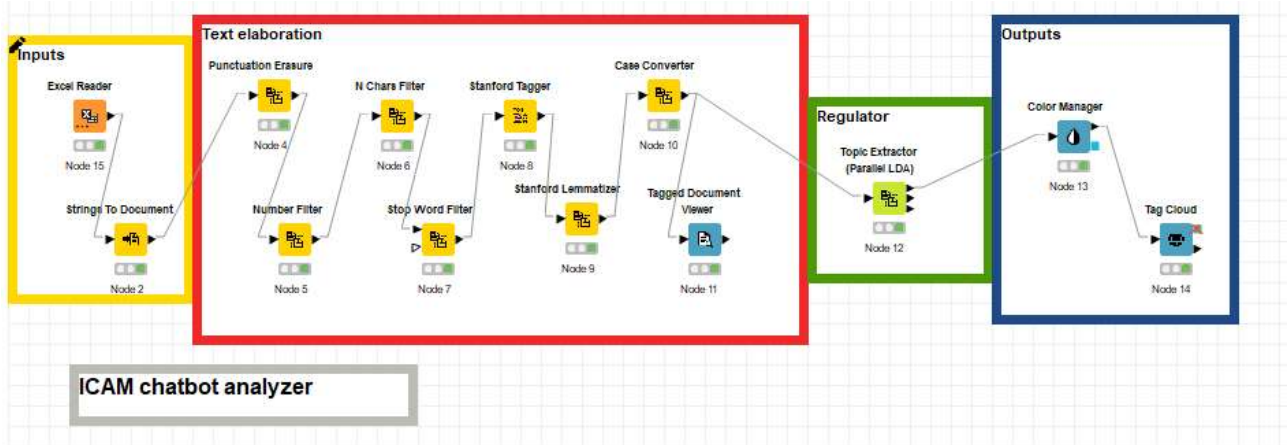


Figure 8. ICAM Chatbot Analyzer.

KNIME Nodes for Tag Cloud	
Macro Process	Nodes
Inputs	Is the initial process of the workflow that is oriented to import data. The macro-process input is based on two different nodes that are “ <i>Excel Reader</i> ” and “ <i>Strings to Document</i> ”.
Text Elaboration	Is the main macro-process of the workflow oriented to analyze the tag cloud. The text elaboration macro-process is based on the following nodes that are “ <i>The Punctuation Erasure</i> ”, “ <i>Number Filter</i> ”, “ <i>N Chars Filter</i> ”, “ <i>Stop Word Filter</i> ”,

	"Stanford Tagger", "Stanford Lemmatizer", "Case Converter", "Tagged Document Viewer"
Regulator	IS "Topic Extractor-Parallel LDA"
Outputs	"Color Manager", "Tag Cloud"

In the following picture we have analyzed the relationship between “Term” on the y-axis and “Weight” on the x-axis. We found that the following results:

- The answer “PulsanteDiEmergenza” has a weight equal to 36;
- The answer “ModalitàManuale” has a weight equal to 20;
- The answer “PulsanteGiallo” has a weight equal to 14;
- The answer “QuadroElettrico” has a weight equal to 6;
- The answers “Lista”, “Alimentazione”, “Syncro”, “Pulsanterossoegiallo”, “Premereiconzero” have a weight equal to 4;
- The answer “Gestionale” has a weight equal to 2.

The weight effectively can be considered as the frequency of the single word in a distribution of words. In our analysis, we have chosen to put together two or three words in a single expression to obtain a graphical representation in the Tag Cloud that can be useful for the reader. In effect if we would have chosen not to merge two or three words in a single expression, we would have not had the possibility to plot a Tag Cloud effectively readable.

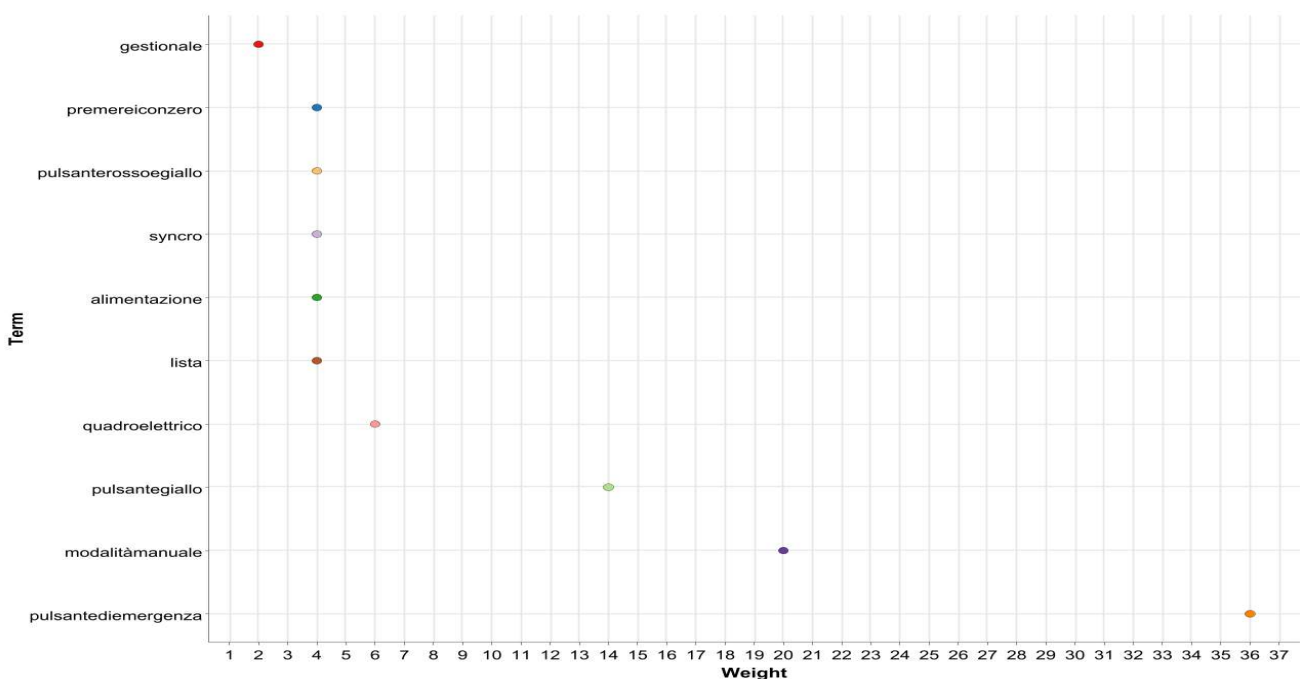


Figure 9. The relationship between Term and Weight.

After the analysis we can effectively plot the tag cloud using four different algorithms. We have created an order of algorithms based on their ability to give the maximum possible representation to the maximum number of words in the tag cloud. Specifically, we have ordered the various functions that can be used in KNIME to plot the Tag Cloud based on their ability to promote readability not only for the words with a greater frequency but also for words with minor frequency. The order we obtained is as follows:

1. *Logarithmic*: by choosing this function in KNIME it is possible to give a representation to a greater number of words even. In effect, as it is shown in Figure 10, the logarithmic representation of the Tag Cloud can plot each word with a good visual result. It is possible to recognize the more frequent word, but also less represented words are visible even if with a smaller dimension.
2. *Square Root*: is at the second rank in the sense of algorithm that give the maximum representation to the maximum number of words. In effect, as it is possible to see in the Figure 10, the more frequent word is well represented, but also other words with minor frequency are visible even if with a dimension smaller than the Logarithmic function.
3. *Linear*: is at the third rank in terms of visual representation of words in the Tag Cloud as shown in the Figure 10. Specifically, the most frequent word i.e., “*PulsanteDiEmergenza*” is well visible at the center of the Tag Cloud, while the other words that have lower frequency are less visible and some are not readable at all. The level of readability of the Linear algorithm applied to the Tag Cloud is lower than the Square Root and the Logarithmic option.
4. *Exponential*: is at the fourth rank in terms of readability of the maximum number of words. In effect in this case only the most represented word is readable, while the other words are represented in the background, and are essentially not useful for the reader. For this reason, the use of the option Exponential can be considered at the lowest rank in respect to Logarithmic, Square Root and Linear.

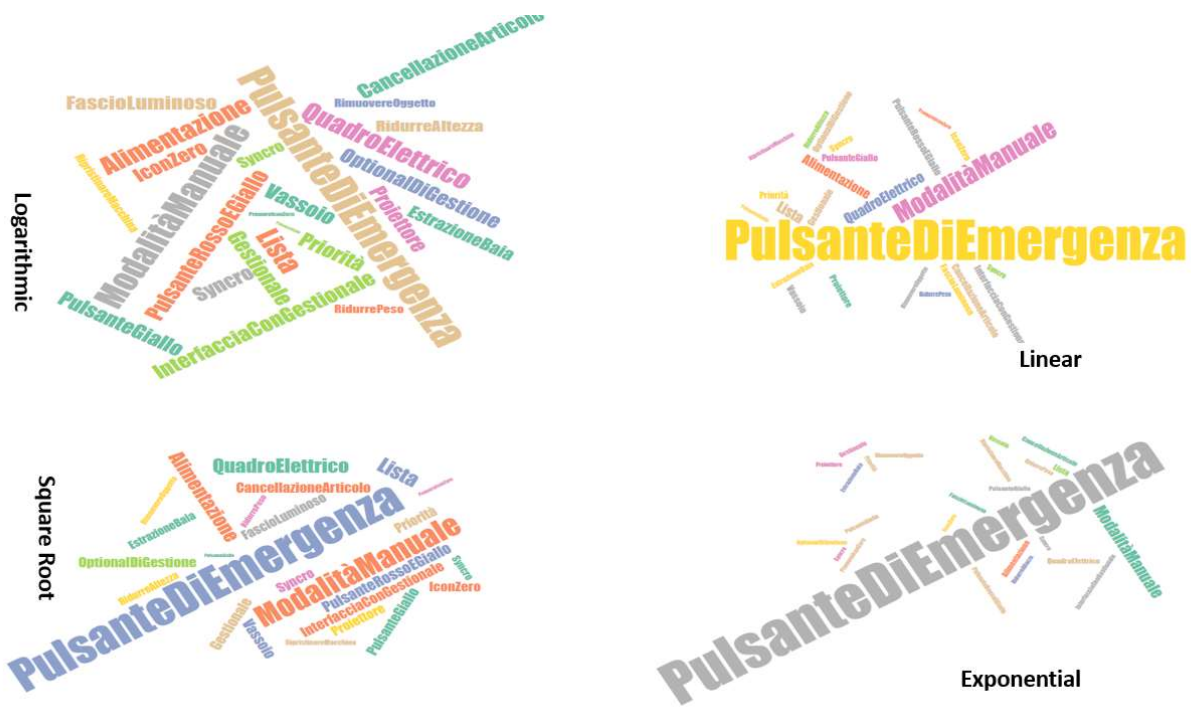


Figure 10. Various typologies of cloud tags.

As we can see from the Figure 10 it is possible to create the following order of algorithm for Tag Cloud i.e.: *Logarithmic* > *Square Root* > *Linear* > *Exponential*. It should be clear that this order is based on the idea of readability i.e., the possibility to offer the maximum representation in the Tag Cloud also for words that have a lower frequency in the distribution.

5. Conclusions

In this article we have analyzed the role of chatbots in the context of industrial services. Specifically, we propose the case study of ICAM, a firm that operates in the context of automatic warehouses. The usage of AI-Chatbot in the context of industrial services is very popular. In our analysis we use the Business Process Model and Notation-BPMN to investigate the change from the “*AS-IS*” to “*TO-BE*” with a particular application to “*Sales Customer Service*” and “*Technical Support Service*”. The BPMN models put in evidence the various steps and passages of the proposed processes to verify the efficacy of the solution. BPMN models are very useful in the context of process design and process application. We show how the change from the traditional methodology of customer assistance to the AI-Chatbot improves the ability of the firm to generate value for its customers, improving customer care, customer assistance and customer loyalty. Specifically, we have found that the introduction of the AI-Chatbot has positive impacts on Customer Process Management or on Product Quality

Management Process with significant impact on customer relationship management. In our analysis the passage from a customer assistance offered by phone and to the AI-Chatbot may generate a relevant impact in terms of relationship marketing with a positive effect on market reputation and brand value.

In the following part, a two-step process model is used to connect technological improvements and relationship marketing in chatbot assistance: the first step provides the hierarchical clustering able to classify questions and answers through Latent Dirichlet Allocation -LDA- algorithm, and the second one executes the Tag Cloud representing the visual representation of more frequent words contained in the experimental dataset. Using a set of questions and answers generated in the relation between the AI-Chatbot and the customer, we determine the structure of the demand based on the hierarchical clustering. Using KNIME, we find that there are 24 hierarchical clusters of which 14 with a singular element, 6 with 2 elements, 1 with 3 elements, 1 with 18 elements, 1 with 10 elements, 1 with 7 elements. Finally, we realize the representation of a Tag Cloud optimized with four different functions i.e., linear, logarithmic, square root, exponential. We order the different typologies of algorithms based on their ability to offer a clear representation not only of the expressions with greater frequency but also of expressions with minor frequency. We prefer readability of the entire set of the expressions present in the dataset. Based on this assumption we find that the logarithmic option offers the best solution for Tag Cloud, and we obtain the following order: *Logarithmic*>*Square Root*> *Linear*> *Exponential*.

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8. Appendix

The BPMN of Technical Support Service. The Business Process Management and Notation-BPMN of the ICAM AI-Chatbot is shown in the figure 11. The BPMN is composed of four different pools that are interrelated.

The entire process starts with the platform smart district 4.0 that collects information about customers. Subsequently the platform acquires details of the products to assist the client. The platform sends a message to the client with the indication of the problem encountered. The client exposes the problem to the platform SD40 with a message. The platform SD4.0 analyzed the question and verified the necessity to open a ticket. At this point the platform evaluate if the ticket is already opened and two options are feasible:

- *Yes, the ticket was already opened:* in this case the platform re-opens the existing ticket;
- *No, the ticket was not already opened:* in this case the platform acquire data for the opening of the ticket and effectively open a new ticket;

At this point the platform Smart District 4.0 sends a ticket opening notification to the operator and two news possibilities are feasible since the proposed request was already known:

- *Yes, the problem was already known:* in this case the platform acquires information, sends the solution, closes the ticket, stores the conversation, sends the conversation at the list of distribution, and then closes the sub-process. In sending the solution to the customer two alternatives are feasible based on whether the assistance was provided or not:
 - *Yes, the assistance was provided:* in this case the customer analyzes the answer. And two new states are possible since the question was solved:
 - *Yes, the problem was solved:* the customer closes the procedure of assistance and later the process ends;
 - *No, the problem was not solved:* the customer improves details at the problem encountered and later closes the ticket.
 - *No, the assistance was not provided:* the customer stores are taking charge and later the process ends.
- *No, the problem wasn't already known:* the SD40 platform verifies the presence of economic coverage. At this point two different stages are feasible base on the presence of economic coverage:
 - *Yes, there is economic coverage:* the platform checks the availability of the operator. At this point two different stages are feasible base on the availability of the operator:
 - *No, the operator is not available:* the platform acquires contacts with the customer, communicates taking charge, stores the conversation, sends the conversion to the distribution list, and the process ends.
 - *Yes, the operator is available:* the platform sends the problem to the Icam operator. The Icam operator analyzes the problem. At this point two different stages are feasible since it is necessary to carry out a maintenance intervention.
 - *No, the maintenance intervention is not necessary:* in this case the Icam operator sends the solution to the smart district 4.0 platform. Later the platform submits a solution, stores information, updates knowledge base, stores conversation, sends conversation to distribution list. But during the phase of the submission of the solution to the customer two new states become feasible:
 - *Yes, the assistance was provided:* in this case the customer analyzes the answer. And two new states are possible since the question was solved:
 - *Yes, the problem was solved:* the customer closes the procedure of assistance and later the process ends;
 - *No, the problem was not solved:* the customer improves details at the problem encountered and later closes the ticket.

- *No, the assistance was not provided:* the customer stores are taking charge and later the process ends.
- *Yes, the maintenance intervention is necessary:* at this point two different stages are feasible based on the following question “*Is it advisable to outsource the maintenance intervention?*”:
 - *No, the outsource intervention is not advisable:* Notify date of assistance, store appointment, close the ticket on SageX3 and the process ends.
 - *Yes, the outsource intervention is advisable:* Notify date of assistance, store appointment, close ticket on SAGE X3. The external operator analyzes the question, stores an appointment, and later the process ends.
- *No, there isn't economic coverage:* the platform updates the ticket on SAGEX3, activates the sales customer service and finally the process ends.

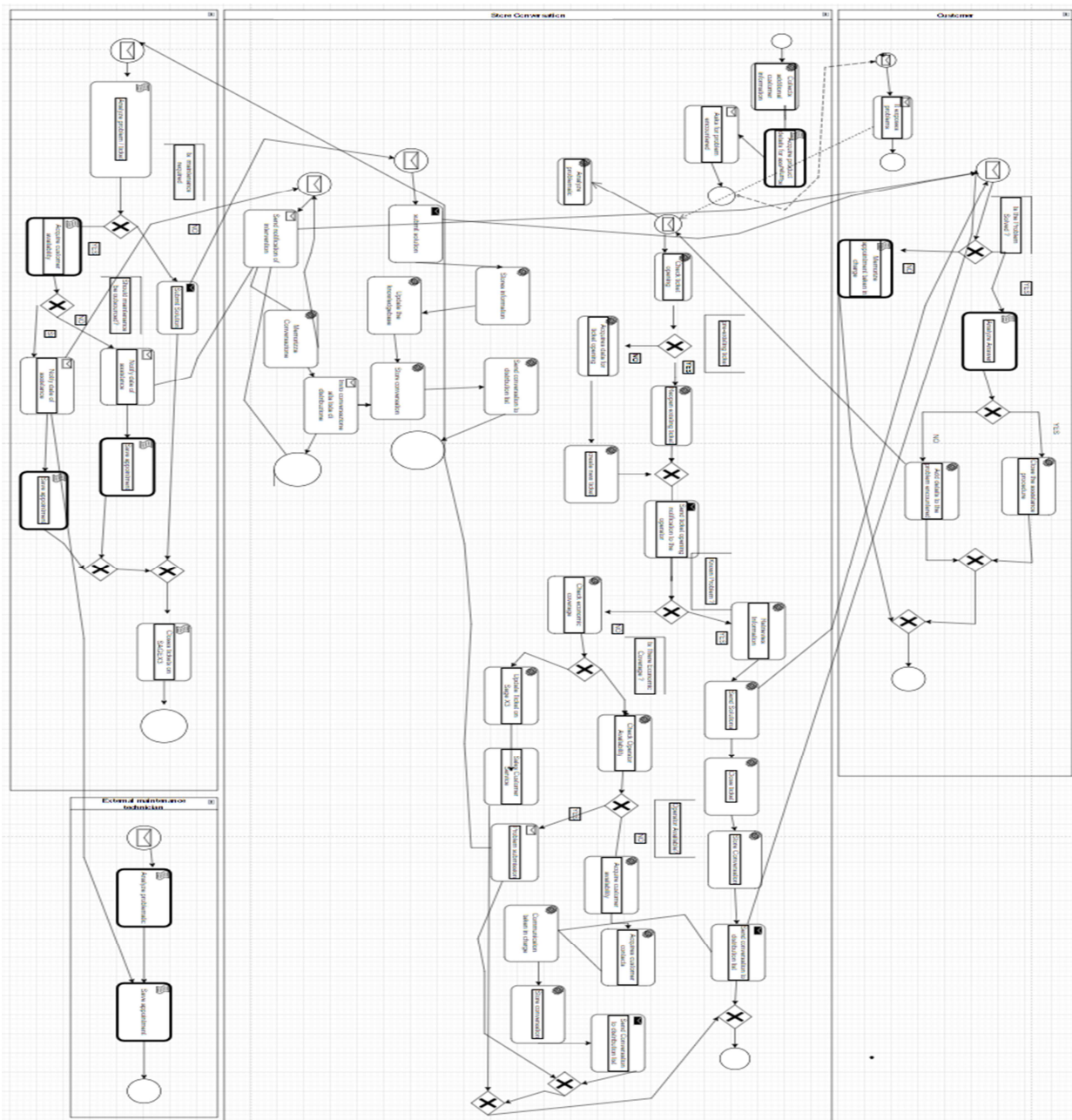


Figure 11. BPMN model to describe the chatbot functionality of ICAM.

The BPMN of Sales Customer Service. The Business Process Management and Notation-BPMN of the Sales Customer Service has the following process:

- The process starts in the SD. 40 platform with the verification of activation of the sub-process. At this point there are two options that are feasible based on the question “*There is an activation of the macro process?*”
- *Yes, there is an activation of the macro process:* in this case the platform “*Collects additional customer information*” and later asks for product and service information;

- *No, there is not an activation of the macro process:* in this case the platform asks for product and service information. In this case there are two options: the platform can either send a message to the customer that later enters information about the service / product and sends a message to the platform to acquire information on the product / service, or alternatively can acquire information relative to the product/service.
- In the following steps the platform acquires information relative to the product/service and later realizes the following stages: identifies product / service, opens business opportunity, and notifies the business opportunity to the commercial operator. At this point two different possibilities are feasible based on “*is the product / service known?*”:
- *Yes, the product/service is known:* in this case the platform retrieves information, sends draft commercial offers, updates business opportunity, notifies the assistance taken in charge, stores conversation, sends conversation to distribution list. And later the process ends. The platform during the phase of sending commercial offer drafts also sends a commercial offer to the ICAM commercial operator that operates the following steps: analyzes request, identifies product / service, sends commercial offer, updates business opportunity. During the sending of the commercial offer the ICAM operator also can send a message to the platform SD4.0 that realizes the following steps: sends the commercial offer, stores the information, updates the knowledge base, stores the conversation, sends the conversation to the distribution list, and ends the process. But during the phase of sending the commercial offer it is possible that the platform sends a message to the customers. At this point two different options are feasible based on the following question: “*Has the commercial offer been received?*”:
- *Yes, the commercial offer has been received:* in this case the customer analyzes the answer and later two new stages become feasible based on the following question “*Has the offer been accepted?*”:
- *Yes, the offer has been accepted:* in this case the customer sends an order and later the process ends.
- *No, the offer has not been accepted:* in this case two new steps are feasible based on the following question “*Was the service slot communication received?*”:
- *Yes, the service slot communication was received:* in this case the customer stores the assistance slot and later the process ends.
- *No, the service slot communication was not received:* in this case the process ends.
- *No, the commercial offer has not been received:* in this case the process ends.

- *No, the product/service is not known:* in this case the platform realizes the following steps: agrees assistance slot, updates business opportunity, reports assistance slot, stores assistance slot, stores conversation, sends conversation to distribution list and ends the process.

The BPMN of the Sales Customer Service is represented in Figure 12.

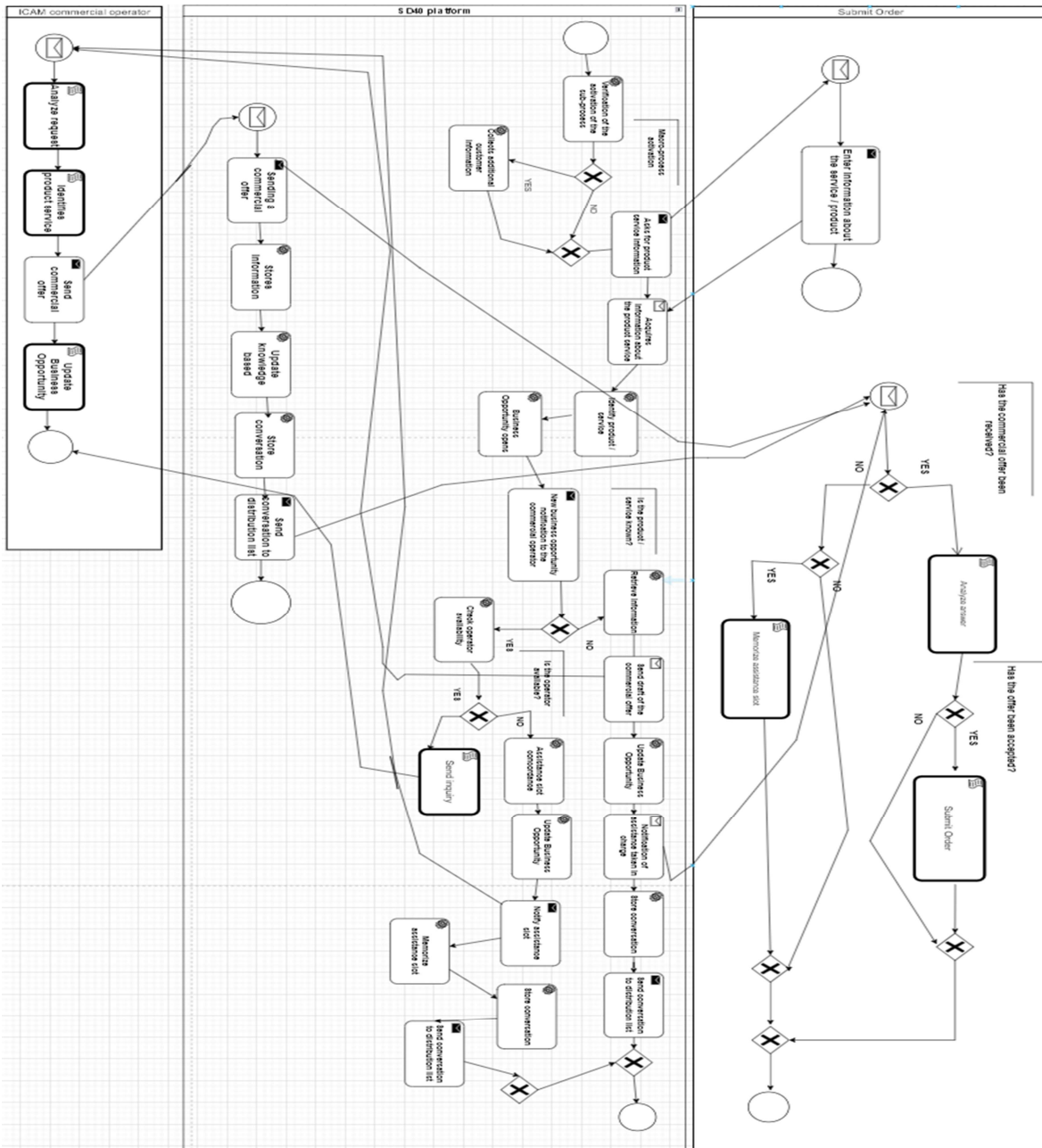


Figure 12. BPMN of the Sales Customer Service.