Volume XIV Number 4, 2022

Milchbot: App to Support the Process of Feeding and Caring for Dairy Cows in Peru

Kevin Herrera, Juan Miranda, David Mauricio

School of Systems and Computer Engineering, Universidad Peruana de Ciencias Aplicadas (UPC), Lima, Peru

Abstract

At present, Peru's agricultural sector has a shortfall of professionals, so livestock producers cannot be provided with relevant and reliable information to ensure good nutrition and care for dairy cows, which affects productivity. Milchbot is a chatbot that answers queries about the feeding and care of dairy cows based on reliable documentation. To do so, a chatbot model was designed to cover the topics of feeding, care, news and frequently asked questions for the planning, feeding and care processes about dairy cows. The model consists of a friendly interface, a dialog engine and a search engine that allows you to find and provide information from a document storage. This model was implemented employing Watson Assistant and Discovery. Milchbot was used and evaluated by 6 livestock producers and 7 zootechnicians. The results of the usability and satisfaction surveys show a high rating for both livestock producers and zootechnicians, and it should be noted that zootechnicians gave very high ratings on satisfaction.

Keywords

Chatbot, dairy cows, agricultural sector, Watson

Herrera. K., Miranda, J. and Mauricio1, D. (2022) "Milchbot: App to Support the Process of Feeding and Caring for Dairy Cows in Peru", *AGRIS on-line Papers in Economics and Informatics*, Vol. 14, No. 4, pp. 27-37. ISSN 1804-1930. DOI 10.7160/aol.2022.140403.

Introduction

In Peru, the population of dairy cows in 2019 was 905,818, being Cajamarca (17.7%), Puno (11.4%) and Cusco (9.1%) the regions with the largest populations (MINAGRI, 2017), which generated more than 2 million tons of milk per year, with a turnover of 2,771 million dollars and jobs to more than 452,217 producers (MINAGRI, 2019), and with an annual growth rate of 1.9% between 2007 and 2016.

The livestock production process begins with planning, in which the choice of the dairy cow breed and the stages of production are determined; the characteristics of the infrastructure, feed and the quantities that are required for production are defined; and the production parameters that are expected to be produced are established. Then comes the care of the animals in which the production environment is prepared, the physical condition of the cows is reviewed, a sanitary control and handling are carried out to ensure that the exact number of animals is available for production in the barn; at the same time, food and distribution equipment are prepared to feed dairy cows. Last, the milk production process is carried out, to subsequently store and distribute the production to the intermediary companies between the farmer and the final consumer (MINAGRI, 2017). This process can be affected by different factors, such as the experience of the producer, technical assistance, the use of technologies, staff training and sanitary management. The consequences of all these factors are reflected in the mortality rate, milk productivity, production costs among others, being the mortality rate of 9.87%, in 2016, in Puno, one of the regions of Peru (Nacional, Altiplano, 2017).

Livestock activity for small and medium-sized producers, in general, is inefficient, due to information gaps about the correct care and feeding of animals, little access to technology, inadequate infrastructure, poorly trained personnel, among others (MINAGRI, 2017). In addition to this problem, the deficit of professionals in this sector, which only, in 2017, 3.5% of the total of 927,426 university students chose to study Veterinary and Zootechnical Medicine, of which 0.4% are zootechnics, which is insufficient to cover the needs of information, production, care and health in the sector (INEI, 2018). An alternative to provide

adequate, accessible and timely information are chatbots (Symeonaki, 2020). This technology has been used to support processes such as human resources, in which 80% accuracy was obtained in the answers to queries about this process (Majumder et al., 2021).

Chatbots in the livestock sector answer queries about optimal conditions and water care for animals and give information on how to procure a good production outcome (Udin et al., 2020). For the poultry sector, there is a chatbot and a forum to answer queries about poultry feeding and care (Shapa, et al., 2020). For the agriculture sector, there is a chatbot based on IoT sensors that provide information to the farmer about the care of plants (Ekanayake et al., 2020), the improvement of the agricultural production process and the optimization of the resources used for production (Wiangsamut, 2019). In addition, Vijayalaksh, et al. (2019) developed a chatbot to provide relevant information, replicate a conversation, and identify queries with grammatical errors. From the reviewed studies, there is evidence that chatbots have been developed for the agricultural and livestock sector that attend the queries of producers for the care of plants and animals, however, a chatbot focused on the feeding and care of dairy cows has not been identified.

This study proposes the development of a chatbot capable of providing information required by the livestock producer, and reliable documentation that allows the improvement of the production processes of feeding and care of dairy cows, so they will be able to have a virtual specialist in real time 24 hours a day, 7 days a week, and, they will also be able to contact with that specialist.

Materials and methods

Chatbots applied in the agricultural sector

Chatbot is a computer program that uses Artificial Intelligence (AI) and natural language in text and/or audio to interact with humans, determine user intent, and answer queries and requests (IBM, 2018).

Its components are the following: (a) Interface, which manages the inputs and outputs of the devices that make the queries to the chatbot, allowing the communication between the user and the chatbot to be through messages or audio, and is carried out through mobile or desktop devices (Rooein, et al., 2020); (b) Controller, which receives the user's message and processes it using natural language, and then classifies it into different intentions that it has been taught to identify (Vijayalaksh, et al., 2019); (c) Dialog manager, divided into two domains, one generic to generate dialogues that resemble a natural conversation, and another specific, to answer specific queries to the user (Shapa, et al., 2021); and (d) User Controller, which sends the answer to the user, which can be a text, images, videos, etc. (Ekanayake et al., 2020).

An inventory of 10 chatbots for the production processes of the agricultural sector are presented in Table 1.

N°	Chatbot	Description	Author
1	Agribot - Sawant	A portable virtual assistant that uses analytics and data mining to help farmers in India with various farming techniques, decide on the most suitable crops, and stay informed about any factors that may affect crop productivity and profits. Unidentified inquiries are redirected to call centers.	Sawant et al., (2019)
2	Plant quality	Gives information about the temperature and the state of the plants, as well as the humidity of the air and the soil, through the chatbot and IoT devices for the improvement of the quality of the plants.	Gunawan et al., (2019)
3	Orchid care	Enables communication between plants and humans, through a chatbot that interacts with plants grown on an automated farm based on IoT and Fuzzy Logic. Tests show the accuracy of the conversation between a user and the information presented of an orchid to be 71%.	Wiangsamut et al., (2019)
4	Agribot - Arora	Provides Indian farmers solutions to various agriculture-related problems and supports decision-making. In addition to this, it helps detect crop diseases through a convolutional network.	Arora et. al., (2020)

Source: Authors processing

Table 1: Chatbots in the agricultural sector. (To be continued).

N°	Chatbot	Description	Author
5	E-Agro	Consists of a chat room and a Chat-Bot to discuss the predominant issues related to agriculture with peers and experience. It also helps farmers make timely decisions about agriculture by contemplating a standard set of questions, intentions and answers from farmers, experts and other stakeholders.	Ekanayake et al., (2020)
6	Integrated crop management	A Virtual Assistant that provides information for the integrated management of crops, and contemplates a set of questions, intentions and answers from agricultural producers of Otuzco, in Peru, experts and other sources. Tests show a reduction in the cost of access to information by up to 90% and reduction of time of 15 minutes per 8-hour day.	Mendo et al., (2020)
7	Water quality monitoring	Tracks the water quality for the aquaculture sector in real time through IoT devices, a cloud system and a chatbot assistant.	Udin et al. (2020)
8	Plants care	Messaging assistant for efficient, secure and easy-to-use interaction for smart agriculture through the integration of conversational user interfaces with IoT devices.	Symeonaki and Arvanitis (2020)
9	Poultry farmers support	A decision support system based on mobile devices through a mobile application integrated with a chatbot assistant to solve various problems related to poultry farming and to simplify decision-making in Tanzania, via interactions in natural language.	Shapa et al. (2021)
10	Adithri	Provides information to the farmer about government policies, weather information, fertilizers, among others, for different types of crops.	Gayathri and Kumar (2021)

Source: Authors processing

Table 1: Chatbots in the agricultural sector. (Continuation).

Milchbot model

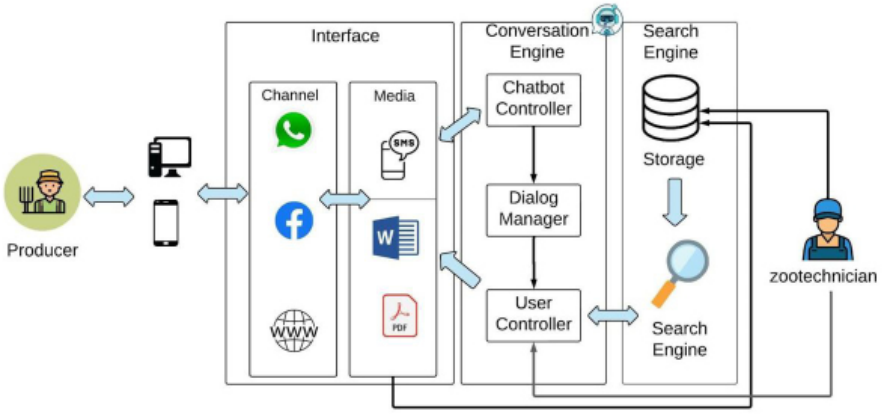
The Milchbot model (acronym for “Milch” and “Bot”) is a model of a chatbot that provides information required by the livestock producer about the feeding and care of dairy cows.

As shown in Figure 1, the model has three components: interface, which contains the channels and formats with which the chatbot and the user communicate; the conversation engine, composed of the chatbot controller that allows the identification of intention and entities within the user's message; and the dialog manager, which classifies such intent and directs it to a specific node and to the user controller that handles the output of the response to the user; and, finally, the search engine that contains the connection to the intelligent search service and the storage to be able to consume documents and categorize information to send it to the user, if necessary.

The Milchbot model (Figure 1) has two user profiles: the livestock producer, who makes queries to the chatbot about the feeding and care of dairy cows using a device, which allows access to the interface; and the zootechnician, who is responsible for managing the information used by the chatbot to provide answers, keeping the document repository updated and, if necessary, engaging in a direct conversation with the farmer, who accesses the application interface through a device (mobile, desktop or any device that allows access to a web browser), making use of WhatsApp, Facebook Messenger and a web page. The livestock producer initiates the interaction with the chatbot through .pdf or .docx documents, and then the chatbot processes the data, identifying the intention and the response to the intention. In case the producer does not find an answer, the chatbot will proceed to make use of the search engine to find an answer (.txt) and documentation (.pdf, .docx) from a repository of documentation on the processes of feeding and caring for dairy cows. It should be noted that the web application allows the farmer to share their documents with the repository.

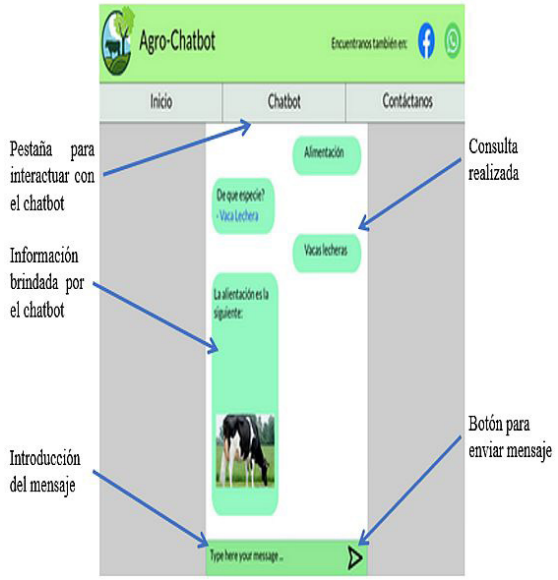
Interface

This component shows in a friendly way the flow of the conversation with the chatbot (text message or a file in Word or PDF format) through channels (WhatsApp and Facebook Messenger for mobile device; and WhatsApp Web, Facebook and Agro-Chatbot web for desktop/laptop), where the message box, a send button, and an image of the chatbot are displayed, as shown in Figure 2. In addition to this, the interface allows the storage of unstructured documents (.docx and .pdf) and categorization into food, care, news and documentation.



Source: Author

Figure 1: Milchbot model.



Source: Author

Figure 2: Chatbot Mockup .

Conversation engine

This component receives the message from the user in order to process it and generate a response. The "chatbot controller" is the first to receive the message from the user, with which, through the previously trained algorithm of natural language understanding, understands and identifies an intention. Then, the generated intention is analyzed and assigned by the "Dialog Manager" component to the corresponding node, which is handled by a flow of unified nodes within a decision tree scheme, resulting in the location of the final node related to the identified intention and entity. At last, the "User Controller" component is responsible for locating the response that can be a text, option, image, audio, video, pause, search, etc., and finishes by sending this message to the "Interface." In case the type of response is a search, the chatbot will generate a request to the "Search Engine" in order to consume the intelligent information search engine and send it to the user.

Search engine

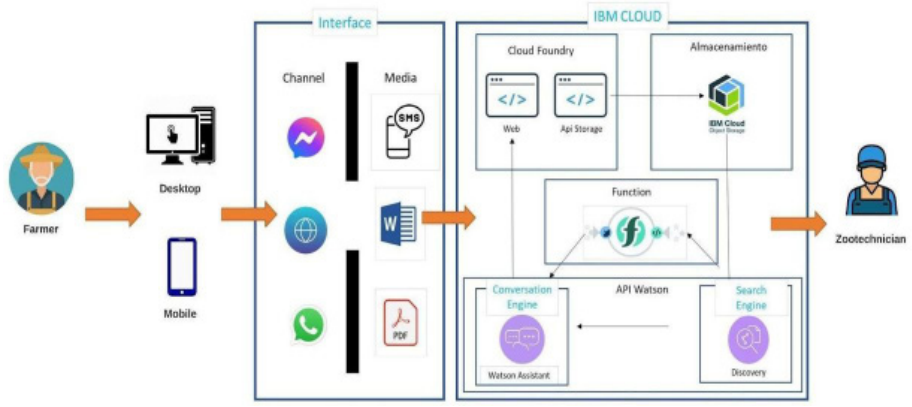
This component receives the request from the "User Controller" and proceeds to perform an intelligent search of the required information from a document repository. This is achieved based on the application of natural language understanding that provides different metadata from the fragments of text that have been found in the previously registered documents, and that relate to the message of the request. After performing the search and extracting the required information, the chatbot proceeds to send the response and a link of the documentation to the "User Controller," to respond to the user.

Milchbot

The following is a description of the Milchbot application that implements the Milchbot model to support dairy cow care information to the dairy producer.

Architecture

The architecture solves the functionality related to the Milchbot model. The components are created using IBM Cloud provider services. As can be seen in Figure 3, the technologies involved are Object Storage, for document storage; Watson Assistant, as a chatbot development platform; Discovery, as an intelligent search engine to perform a powerful response integration for the chatbot; a Function, as a service to take advantage of multiple Discovery features; and finally, Cloud Foundry,



Source: Author

Figure 3: Milchbot's logical architecture.

which is the platform as a service that was used for the deployment of the web and storage service. This architecture allows the model to comply with the flow proposed in the Milchbot.

Modules

Interface module

The interfaces were prepared for the web, Facebook and WhatsApp channels (Figure 4), for a dialogue. In addition, the interface contains the presentation of Milchbot, a tutorial to manage the chatbot, a file manager so that users can share documents, and information about food, care and news. The website channel was developed using the Node js a language with the express framework and the vue.js framework and for its integration with the chatbot the script provided by IBM Cloud was used. On the other hand, the integration of the chatbot with Facebook was done using the Watson Assistant platform, and its integration with WhatsApp was done using Twilio.

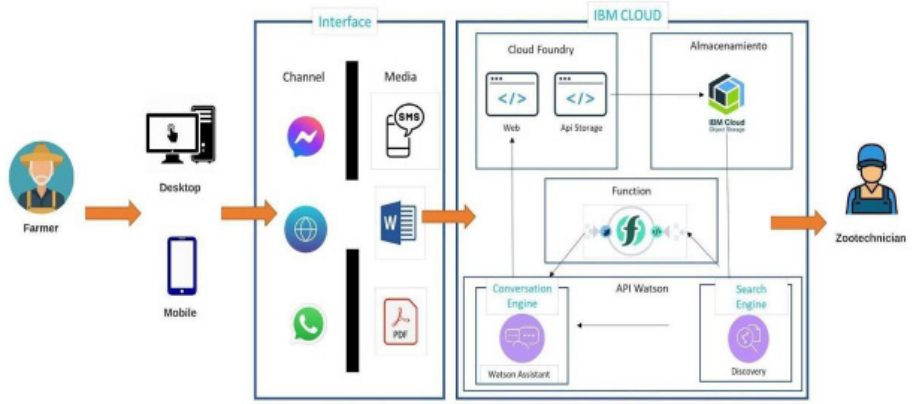
Conversation engine module

The Watson Assistant chatbot development platform was used to design the decision tree that the chatbot follows to manage the conversation flow covering the topics of documentation, feeding, care, news, and frequently asked questions (Figure 5).

The chatbot was trained considering 112 examples of seven intentions (Table 2) and six entities (Table 3). The intentions together with the entities allow the chatbot to improve understanding and obtain better responses.

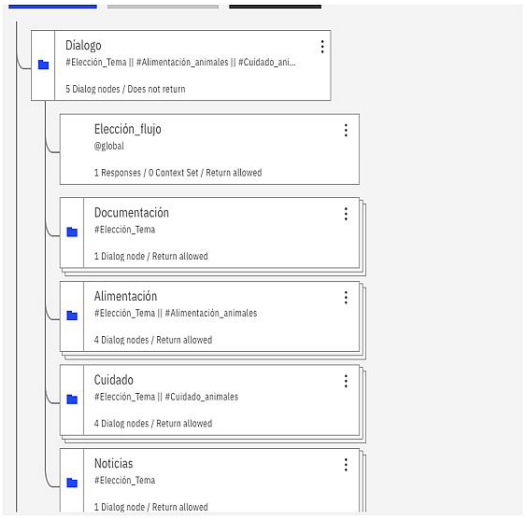
Search engine module

For the engine, Discovery was used, which allows connection to a document repository and trains the service to extract relevant information for the user. In addition, a serverless connection was used to integrate the chatbot with the intelligent search engine using the Discovery SDK. To manage file input from the web and have a repository to feed Discovery, the Api Storage was programmed using Node js.



Source: Author

Figure 4: Milchbot interfaces per channel: A) Facebook; B) Website; C) WhatsApp.



Source: Author

Figure 5: Watson chatbot decision tree.

Intents	Description	N.º Examples
Animal feed	Generate direct inquiry for animal feeding	8
Human contact	Request a human agent	35
Animal care	Generate direct inquiry for animal care	8
Choice of topic	Theme options: Food, Care, Documentation and News	19
Frequently Asked Questions (FAQ)	Set of frequently asked questions that can be asked to the chatbot (stages, regions, etc.)	4
Dialogue greeting	Greetings to the Bot	18
End of dialogue	End of conversation	20

Source: Author

Figure 5: Watson chatbot decision tree.

Entities	Type	Values
Animals	Synonyms	Chicken, Dairy cow, Dual-purpose cow
Continue to	Synonyms	Yes, No
Global	Synonyms	Subject, Cow
Country	Synonyms	Peru, Colombia, Argentina, Venezuela, etc.
Frequently Asked Questions (FAQ)	Synonyms	Stage, Regions
Topic	Synonyms	News, Documentation, Care, Food, Region, Age

Source: Author

Table 3: Entities used in the chatbot.

Results and discussion

Milchbot usability and satisfaction

Participants

Six producers with two to 19 years of experience, and seven animal technicians with two to three years of experience, all from 13 different farms (Table 4) located in Lurín, in the province of Lima, participated. The cattle in each of the farms are in open spaces, in general, with no grass, fed with five to seven kilos per day on average with dry matter such as forage and supplements (for instance, antioxidants), with 70 liters of water per day on average. In addition, on average each farm has 30 cows for milk production, which produces approximately 40 liters of milk per cow per day. The producers plan their production according to their experiences, considering the breed, the animal's life stage and the available infrastructure, then generating feeding and care plans, which are later executed and supervised.

ID	Participant	Sex	Experience
P1	Livestock Producer	Male	19 years
P2	Livestock Producer	Male	17 years
P3	Livestock Producer	Male	5 years
P4	Livestock Producer	Male	2 years
P5	Livestock Producer	Male	14 years
P6	Livestock Producer	Male	3 years
Z1	Zootechnician	Female	2 years
Z2	Zootechnician	Female	2 years
Z3	Zootechnician	Female	2 years
Z4	Zootechnician	Female	2 years
Z5	Zootechnician	Female	2 years
Z6	Zootechnician	Female	2 years
Z7	Zootechnician	Female	3 years

Source: Author

Table 4: Profiles of participating livestock producers and animal producers.

Evaluation instrument

To evaluate the usability and satisfaction (Villena, 2016) of Milchbot, an instrument of 10 questions was used (Table 5): five questions about usability, three about satisfaction and two others, based on the User Experience Questionnaire (UEQ) and applied through Google Forms to the participants.

Category	Id	Question
Usability	Q01	How well did the chatbot answer your queries about feeding and/or care about dairy cows?
	Q02	Do you consider that the process improves the time it takes to answer your questions?
	Q03	Did the information provided seem relevant?
	Q04	Do you consider that the information provided could benefit micro, small and medium-sized producers?
	Q05	How effective was the chatbot for direct responses?
Satisfaction	Q06	How friendly do you rate the chatbot?
	Q07	Do you agree with the type of language used for the chatbot?
	Q08	How fluent was the conversation?
	Q09	Did you have any problems using any of the 3 channels via an Android device?
	Q10	Which channel do you think you would use most often?

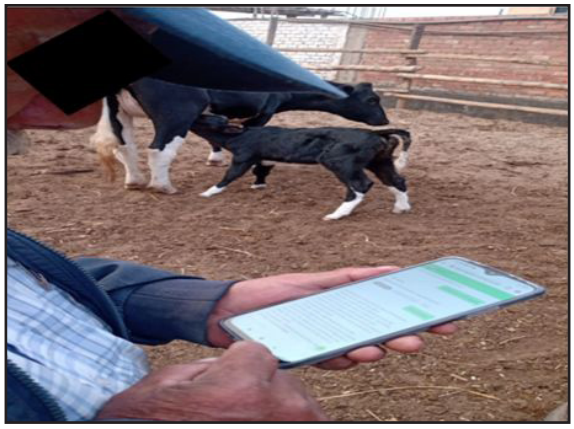
Source: Author

Table 5: Usability and satisfaction questionnaire.

The answers to the questions were measured through the Likert scale (5: Very High, 4: High, 3: Moderate, 2: Little and 1: Not at all) as pointed out in several studies such as "An Attitudinal Scale in Relation to the Scientific-Social Research Process" (Zulia, 2005). Questions Q09 and Q10 have response alternatives of Yes/No and Facebook/WhatsApp/webpage, respectively. In addition, an open-ended question on recommendations and opportunities for improvement was included.

Experiment

Each participant was introduced to the software, at the following link: https://web-agrochatbot-empathic-ardvark-kt.mybluemix.net. In approximately 60 minutes, the participants were presented with the software's benefits, functionsand facilities through videoconference; then they performed a sequence of tasks (initiating a dialog, document entry, document request, dairy cow care and feeding questions, and frequently asked questions) using the three Milchbot channels (Figure 6); next, they freely interacted with the software. At the end of the tasks, the usability and satisfaction survey in Table 5 was applied.



Source: Author

Figure 6: Livestock producer interacting with the chatbot.

Results

The results of the usability satisfaction questionnaire for livestock producers (Table 6) show an average score of 4.06, high in terms of usability and satisfaction for Milchbot. In usability, it was rated very high for correct information (Q01), and high for the other questions, i.e., it improves consultation times (Q02), offers relevant information (Q03), presents benefits to farmers (Q04), and is effective in generating direct answers (Q05). In satisfaction, a high score was obtained in respect to friendliness (Q06), use of appropriate language (Q07) and fluency of conversation (Q08). On the other hand, only one livestock producer expressed delay in communication due to the poor internet signal present on the farm (Q09), in addition, the channel with the highest preference is WhatsApp for being the most used by livestock producers (Q10).

The results of the usability satisfaction questionnaire for zootechnicians (Table 7) show a high score of 4.06 for usability and a very high score of 4.23 for satisfaction. In usability, a very high score was obtained for correct information (Q01), and a high score for the rest of the questions, improving consultation time (Q02), giving relevant information (Q03), providing benefits to livestock producers (Q04) and being efficient in supplying direct answers (Q05). In the satisfaction aspect, a very high score was obtained for friendliness (Q06) and fluency in conversation (Q07), and a high score was obtained on the use of appropriate language (Q08). In addition, none of the respondents presented a problem in the use of the chatbot through the three channels (Q09), and the channel with the highest preference is WhatsApp, as it is the application most used by zootechnicians (Q10).

In response to the open-ended question "What recommendations or opportunities for improvement would you give for the chatbot?" livestock producers stated four recommendations and opportunities for improvement (Table 8).

Category	Questions	P1	P2	P3	P4	P5	P6	Average	Average
Usability	Q01	5	4	5	3	4	5	4.3	4.06
	Q02	5	4	5	3	4	4	4.2	
	Q03	4	4	4	3	4	3	3.6	
	Q04	5	4	5	3	4	4	4.2	
	Q05	4	3	4	4	4	5	4	
Satisfaction	Q06	4	4	4	4	5	4	4.2	4.06
	Q07	4	4	3	5	4	4	4	
	Q08	5	3	4	4	4	4	4	
	Q09	No	No	No	No	Yes	No	No	
	Q10	Wp[1]	Ws[3]	Fb[2]	Wp[1]	Wp[1]	Wp[1]	Wp[1]	

Note: [1] WhatsApp; [2] Facebook; [3] Website

Source: Author

Table 6: Results of the usability and satisfaction questionnaire for livestock producers.

Category	Questions	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Average	Average
Usability	Q01	4	5	5	5	4	4	4	4.3	4.06
	Q02	3	4	5	5	4	4	3	4	
	Q03	4	4	4	5	4	3	3	3.9	
	Q04	3	4	5	5	4	4	3	4	
	Q05	4	5	4	5	3	4	4	4.1	
Satisfaction	Q06	4	5	4	5	4	4	4	4.3	4.23
	Q07	5	5	5	5	3	4	3	4.1	
	Q08	4	5	5	5	4	3	4	4.3	
	Q09	No	No	No	No	No	No	No	No	
	Q10	Wp[1]	Ws[3]	Fb[2]	Wp[1]	Wp[1]	Wp[1]	Wp[1]	Wp[1]	

Note: [1] WhatsApp; [2] Facebook; [3] Website

Source: Author

Table 7: Results of the usability and satisfaction questionnaire for zootechnicians.

ID	Recommendations and improvement opportunities
R01	Information on prices of products, inputs and others related to livestock farming.
R02	Focus on the management of other breeds and animals.
R03	Enhance images for better user guidance.
R04	Extending to healthcare issues such as treatments and medications.

Source: Author

Table 7: Results of the usability and satisfaction questionnaire for zootechnicians.

Conclusion

A chatbot model was designed to provide information about the planning, feeding and care processes of dairy cows, as well as to provide news, and to display frequently asked questions. The model consists of a friendly natural language interface, a dialog engine and a search engine that allows finding information from a document container, and was implemented using Watson Assistant and Discovery, giving Milchbot as a result. Unlike other chatbots for the agricultural sector, Milchbot is specialized and unique to dairy cows, and integrates a search engine that facilitates access to documentation.

The results of the usability and satisfaction surveys applied to six livestock producers and seven zootechnicians who used Milchbot show high usability and satisfaction for both livestock producers and zootechnicians, yet satisfaction was rated very high for zootechnicians. However, these results are limited to the perception of the respondents.

As future work, we intend to add other functionalities to Milchbot that will allow the monitoring of each individual cow, so that it can be integrated to trace the development of each cow and its products.

Acknowledgments

The authors would like to thank Universidad Peruana de Ciencias Aplicadas (UPC) for partially funding this research. They would also like to thank R. Cristina Coppa, an English & American Literature graduate from New York University, for editing and proofreading our writing.

Corresponding authors:
David Mauricio
School of Systems and Computer Engineering, Universidad Peruana de Ciencias Aplicadas (UPC)
Lima, Peru
Phone: +51 971509987, E-mail: pcsidmau@upc.edu.pe

References

[1] Al Rasyid, M. U. H., Sukaridhoto, S., Dfzulqornain, M. I. and Rifai, A. (2020) "Integration of IoT and chatbot for aquaculture with natural language processing", *Telecommunication, Computing, Electronics and Control*, Vol. 18. No. 2, pp. 640-648. DOI 10.12928/telkomnika.v18i2.14788.

[2] Arora, B., Yadav, M., Chaudhary, D. S., Satsangi, M., Yadav, M., Singh, L. and Sudhish, P. S. (2020) "Agribot: A Natural Language Generative Neural Networks Engine for Agricultural Applications", In *International Conference on Contemporary Computing and Applications 2020*, IEEE, Lucknow, India; pp. 28-33. DOI 10.1109/IC3A48958.2020.233263.

[3] Ekanayake, J. and Saputhanthri, L. (2020) "E-AGRO: Intelligent chat-bot. IoT and artificial intelligence to enhance farming industry", *AGRIS on-Line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 15-21. ISSN 1804-1930. DOI 10.7160/aol.2020.120102.

[4] Gayathri, S. and Kumar, S. (2020) "Adithri–(F2) The Farmer's Friend", In *Proceedings of the 3rd International Conference on Communications and Cyber Physical Engineering*, ICCCE 2020, Springer, Singapore; pp. 225-232. DOI 10.1007/978-981-15-7961-5.

[5] Gunawan, R., Taufik, I., Mulyana, E., Kurahman, O. T. and Ramdhani, M. A. (2019) "Chatbot Application on Internet of Things (IoT) to Support Smart Urban Agriculture", In *2019 IEEE 5th International Conference on Wireless and Telematics (ICWT)*, IEEE, Yogyakarta, Indonesia. DOI 10.1109/ICWT47785.2019.8978271.

[6] IBM (2018) "*Watson Assistant: Agente virtual inteligente*", Watson Assistant. [Online]. Available: https://www.ibm.com/pe-es/products/watson-assistant [Accessed: Sept. 16, 2022].

[7] INEI (2018) "Profesiones o Carreras Universitarias". [Online]. Available: https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1680/cap05.pdf. [Accessed: Sept. 16, 2022]. (In Spanish).

[8] INEI (2018) "*Educación Universitaria*", Instituto Nacional de Estadística e Informática. [Online]. https://m.inei.gob.pe/estadisticas/indice-tematico/university-tuition. [Accessed: Sept. 20, 2022]. (In Spanish).

[9] Majumder, S. and Mondal, A. (2021) "Are chatbots really useful for human resource management?", *International Journal of Speech Technology*, Vol. 24, pp. 969-977. E-ISSN 1572-8110, ISSN 1381-2416. DOI 10.1007/s10772-021-09834-y.

[10] Mamani (2017) "Mortalidad de vacunos del centro de investigación de Chuquibambilla", Professional thesis, Universidad Nacional del Antiplano. (In Spanish).

[11] Mendo-Jara, J. R., Cuestas-Alva, J. M. and Castillo-Dominguez, P. G. (2020) "Virtual assistant in information management for integrated crop management", In *Engineering, Integration, and Alliances for a Sustainable Development. Hemispheric Cooperation for Competitiveness and Prosperity on a Knowledge-Based Economy: Proceedings of the 18th LACCEI International Multi-Conference for Engineering, Education and Technology*. ISBN 978-958-52071-4-1. DOI 10.18687/LACCEI2020.1.1.145.

[12] MINAGRI (2017) "*Plan Nacional de Desarrollo Ganadero*". [Online]. Available: https://www.midagri.gob.pe/portal/download/pdf/especiales/plan-nacional-ganadero.pdf. [Accessed: Sept. 20, 2022]. (In Spanish).

[13] MINAGRI (2019) "Producción Ganadera y Avícola". [Online]. Available: https://siea.midagri.gob.pe/portal/phocadownload/datos_y_estadisticas/anuarios/pecuaria/pecuario_2019.pdf.[Accessed: Sept. 20, 2022]. (In Spanish).

[14] Neligia, B and Alvarado, M. (2005) "Escala de actitud hacia el proceso de investigación científico social", *Revista de Ciencias Sociales*, Vol. 11, No. 3, pp. 537-544. ISSN 1315-9518. (In Spanish).

[15] Rooein, D., Bianchini, D., Leotta, F., Mecella, M., Paolini, P. and Pernici, B. (2020) "Chatting about processes in digital factories: A model-based approach", *Enterprise, Business-Process and Information Systems Modeling*, Vol. 387, LNBIP, Grenoble, France. ISBN 978-3-030-49417-9. DOI 10.1007/978-3-030-49418-6_5.

[16] Sawant, D., Jaiswal, A., Singh, J. and Shah, P. (2019) " AgriBot - An intelligent interactive interface to assist farmers in agricultural activities", *2019 IEEE Bombay Section Signature Conference (IBSSC), 2019*, pp. 1-6. DOI 10.1109/IBSSC47189.2019.8973066.

[17] Shapa, M., Trojer, L. and Machuve, D. (2021) "Mobile-based Decision Support System for Poultry Farmers: A Case of Tanzania", *International Journal of Advanced Computer Science and Applications*, Vol. 12, No. 2, pp. 584-590. ISSN 21565570. DOI 10.14569/IJACSA.2021.0120273.

[18] Symeonaki, E. and Arvanitis, K. (2019) "Conversational User Interface Integration in Controlling IoT Devices Applied to Smart Agriculture: Analysis of a Chatbot System Design", *Proceedings of the 2019 Intelligent Systems Conference (IntelliSys),* Vol. 1, London, United Kingdom, pp. 1071-1088. DOI 10.1007/978-3-030-29516-5.

[19] Vijayalakshmi, J., and Pandimeena, K. (2019) "Agriculture talkbot using AI", *International Journal of Recent Technology and Engineering*, Vol. 8, No. 2S5, pp. 186-190. ISSN: 2277-3878. DOI 10.1007/978-3-030-29516-5_80.

[20] Villena, J. and Leon, J. (2016) "Modelo De Diseño Web Para El Sistema De Gestión De Puntos De Venta De La Empresa Compured S.a.C. Bajo El Estándar Iso 9241-210 Y La Especificación Wai-Aria 1.0.", Professional thesis. Universidad Privada Antenor Orrego. (In Spanish).

[21] Wiangsamut, S., Chomphuwiset, P. and Khummanee, S. (2019) "Chatting with Plants (Orchids) in Automated Smart Farming using IoT, Fuzzy Logic and Chatbot", *Advances in Science, Technology and Engineering Systems*, Vol. 4, No. 5, pp. 163-173. ISSN 24156698. DOI 10.25046/aj040522.