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Methodological Knowledge Sharing Framework for a Natural Language Processing Chatbot: Review of dimensions

Pamela Chogo[1], Neema Kassim[2], Elizabeth Mkoba[3]

Research Scholar[1, 3], Professor [2]

[1,3]School of Computational and Communication Sciences and Engineering (CoCSE),

[2]School of Life Sciences and Bio-Engineering (LiSBE),

Nelson Mandela African Institution of Science and Technology,

Arusha,

Tanzania

ABSTRACT

Knowledge sharing is a concept that has been researched for many years. The success of knowledge sharing has been through good organization and consideration of different dimensions affecting the knowledge sharing process. While the majority of the knowledge-sharing dimensions are known, little has been written on the knowledge-sharing dimensions necessary for developing a knowledge-sharing framework that uses Natural Language Processing chatbot technology as the knowledge-sharing technique. The purpose of this article is to present dimensions and the proposed knowledge-sharing framework that use Natural Language Processing chatbot as the knowledge sharing technique. The systematic literature review was done by reviewing 28 peer-reviewed papers from 2014 to 2024 based on the inclusion and exclusion criteria set for the study. The findings revealed twelve (12) knowledge-sharing dimensions where nine (9) among them were selected to be used in the proposed framework. The selected dimensions are (1) knowledge domain, (2) knowledge actor, (3) source of knowledge, (4) knowledge collection, (5) knowledge processing, (6) chatbot creation, (7) knowledge use, (8) behavioural factors, and (9) knowledge owner. The study contributes to the body of knowledge by providing important dimensions for a chatbot development framework. In addition, the study contributes to practitioners by providing a proposed chatbot development framework that can be used during the Chabot development process. Furthermore, the results of this study will be beneficial to knowledge-sharing, and Natural Language Processing researchers.

Articles must include an Abstract of 250 words. The abstract should state briefly the purpose of the research, the principal results and major conclusions. The abstract should not repeat the information which is already present in the title. References should be avoided.

Key Words: Chatbots, Dimensions, Framework, Knowledge sharing, Natural Language Processing.

1. INTRODUCTION

Knowledge sharing (KS) has been made possible due to the existence of various dimensions also referred to as factors, drivers, or components [1,2]. These dimensions are usually combined in a systematic manner allowing the flow of events for effective and efficient knowledge flow [3]. The systematic arrangement and combination of dimensions are usually referred to as frameworks although other scholars identify them as procedures or models [4 - 6]. Currently, many studies have been conducted showing the existence of KS frameworks with diverse dimensions [7, 8]. The diversity depends on the context in which the framework was developed, the theories, and the KS techniques used [9]. Whereby KS techniques are methods or tools used in the knowledge-sharing process. With technological advancements, these KS techniques keep changing [10]. These changes create the need to revisit the available frameworks, review the dimensions, and allow the development of improved KS frameworks that will fit the new techniques.

With improved frameworks allowing the use of advanced technology KS techniques, KS is expected to continue contributing to improved performance in the emerging knowledge economy [11]. This is so because KS is an important component in knowledge management that involves exchanging information, experiences, events, ideas, and stories between individuals in a formal or informal environment [2]. This exchange simplifies problem-solving as solutions come from understanding patterns in existing knowledge and reapplying what worked previously [12]. Furthermore, KS is a people-to-people process meaning that it happens in all aspects of life. Unfortunately, the majority of reported KS success stories are from formal organizations, unlike informal and communities of practice setups [13].

However, with technological advancements, KS is becoming common in community of practice setups [14]. With advancements in technology the use of Natural Language Processing (NLP) Chatbots allows KS on specific issues between people with common interests [15]. Besides, many studies have been conducted to identify KS dimensions for KS frameworks. Unfortunately, there are no specific reviews on dimensions necessary for developing a KS framework that uses NLP chatbot technology as the KS techniques. This is important because, unlike other KS techniques NLP Chatbots are artificial intelligence-based systems that use machine learning approaches in creating conversation with humans [16,17]. These conversations mimic human-to-human conversations allowing one to feel as if they are having a conversation with a human and not a machine [18]. The use of such means in KS requires a KS framework that will address all specific requirements for NLP chatbots.

NLP Chatbots which are sometimes referred to as conversational agents are dialogue systems designed to conduct conversation with humans using natural language [18, 16]. In other words, NLP chatbots are systems that mimic human conversations by using communication channels such as speech, text, facial expressions, and gestures [19, 20]. With this nature, NLP chatbots offer KS advantages brought by other digital KS techniques with the addition of intelligent responses, interaction, being multilingual, and the use of multichannel [21, 22]. With these qualities, NLP chatbots have been used as KS techniques in education, agriculture, health, business, and others [23].

The effective use of NLP chatbots as KS techniques has been because KS is getting the right knowledge, to the right people, at the right time and in a conducive environment [24]. This environment includes knowledge being well organized for it to be useful and have value [25]. Knowledge shared through NLP chatbots needs to be collected systematically from various sources including individuals willing to share. Then the knowledge will be organized into datasets that will be used to train the machine [26]. Before training, the dataset will be validated to ensure it is accurate. With NLP chatbots knowledge can be shared in different formats such as text to text or text to speech or speech to speech conversations [27,28]. These conversations can take place through different channels such as websites, mobile apps, and messaging platforms like social media platforms, voice assistants, text messages, API integrations, and QR codes [28]. With these options, NLP chatbots become a convenient technique for KS [23]. With this convenience, it is important to identify KS dimensions for developing a knowledge sharing framework that uses NLP chatbot as KS technique.

This review paper aimed to answer the following research question:

What are the dimensions necessary for developing a knowledge-sharing framework that uses Natural Language Processing chatbot technology as the knowledge-sharing technique?

The study reviews empirical studies focused on knowledge sharing, knowledge sharing dimensions, knowledge sharing drivers, knowledge sharing frameworks, and knowledge sharing components. This enabled the identification of knowledge-sharing dimensions which were used to develop the proposed knowledge sharing framework.

2. RESEARCH METHODOLOGY

The methodology used in the literature review was the narrative review that used review protocol adopted from [29] and [30].

The review protocol procedure involved 4 steps as shown in Figure 1.

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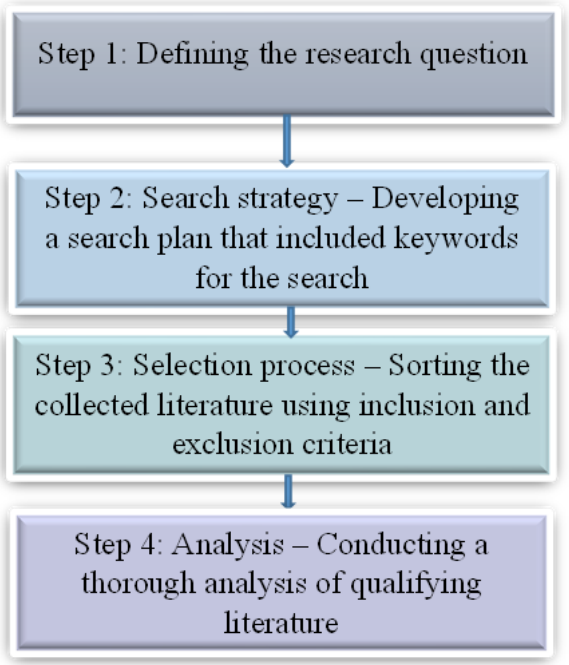

Figure 1: Review protocol [29]

Step 1: Research question

The main objective of the study was to identifying the knowledge-sharing dimensions. These are the ones necessary for developing a KS framework that uses Natural Language Processing chatbot technology as the KS technique. To achieve this objective the following research question was defined.

What are the dimensions necessary for developing a knowledge-sharing framework that uses Natural Language Processing chatbot technology as the knowledge-sharing technique?

Step 2: Search strategy

A search strategy was developed and used to search for articles in various databases. These databases included Emerald Insights, EBSCO host, Science Direct, IEEE and Scopus. The following search string including keywords and Boolean operators was used:

((“Knowledge sharing” OR “knowledge sharing”) AND (“knowledge sharing dimensions” OR “Knowledge sharing dimension”) AND (“knowledge sharing divers”) AND (“knowledge sharing factors”) AND (“knowledge sharing components”) AND (“NLP knowledge sharing”) AND (“Natural Language Processing”) AND (“Chatbot”) AND (“chatbot”) AND (“Chatbot knowledge sharing” OR “chatbot knowledge sharing”) AND (“NLP knowledge sharing”) AND (“Chatbot knowledge sharing”)).

Step 3: Selection process

The selection of papers to be reviewed was done based on the inclusion and exclusion criteria of the study. These criteria are:

1. Should be published from 2014 to 2024
2. Should be in the English language
3. Abstract and full text aligned with the research question

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4. Peer-reviewed publication

5. Research methods used qualitative, quantitative, and mixed methods

6. From any part of the world

Based on these inclusion and exclusion criteria, 28 papers were included in this study. To get the 28 papers the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework was used. This is similar to what was used in the study conducted by [31]. The PRISMA diagram is shown in Figure 2.

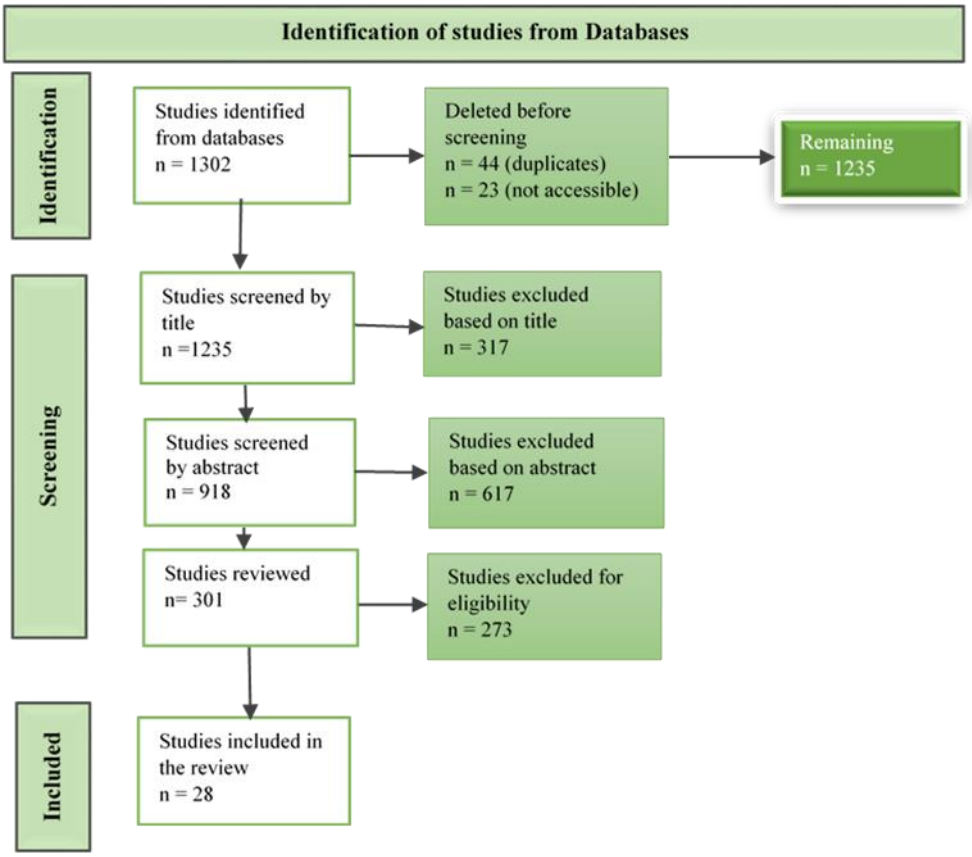

Fig 2: The PRISMA flow diagram

Step 4: Analysis

A thorough review of the 28 remaining studies was done. This review included a full-text review by reading the studies thoroughly and extracting key information. The extracted data included study design, sample characteristics, results obtained (dimensions mentioned and theories used), analysis done, and conclusion. After extracting key information, the data was organized and categorized in a structured manner using tables. The categorization was based on the common themes, trends, and patterns observed. Finally, the findings were synthesized to provide an overview of the study results. This was the identification of KS dimensions. These dimensions are necessary for developing a KS framework that uses Natural Language Processing chatbot technology as the KS technique.

3. RESULT AND DISCUSSION

3.1 Results

From the reviewed studies, the researchers managed to identify KS dimensions (drivers, factors, or components) that have been used in various contexts. The similar dimensions are then grouped and given a common name as indicated in Table 1. In addition to the KS dimensions, theories used in the reviewed studies are also shown in Table 2.

3.1.1 Identified Knowledge-Sharing Dimensions

Table 1: The knowledge-sharing dimensions identified from the analyzed studies

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SNo.	Reference	Identified KS Dimensions	Combined KS Dimensions
1	[7, 32, 33, 15, 34, 35, 36]	• Knowledge to be shared • Knowledge creation • Online sources • Ongoing conversations (chatbots) • Documents	Source of knowledge
2	[32, 2, 37, 38, 39]	• Degree of formality • Facts, opinions, ideas, theories, principles. • Tacit and explicit knowledge • Questions and answers • Type of knowledge • Primary or secondary	Type of knowledge
3	[7, 37, 40, 33, 41, 14, 42, 4, 13, 43, 44, 45, 1, 32, 41, 9]	• Donating knowledge • Environment - individuals involved • People • Individual • Employees, • Keepers of knowledge • Sender • Knowledge and expertise • Knowledge, experience and skills • Virtual team • Platform owners and developers • Creative • Diversity • Knowledge user • Top management support • Organizational culture • Organizational or environmental Traits • Organizational climate • Organizational culture and governance • Organization • Organizational structure • Governance and leadership • The efficiency of official channels • The efficiency of informal channels • Leadership and teams • Teams and people	knowledge actor (Individual, organization, community of practice)

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		• Learning Communities	
4	[32, 33, 35, 36, 7]	• Collecting knowledge • Acquiring • knowledge acquisition • Identification of needs • Knowledge collection process • Online chats	Knowledge collection
5	[2, 33, 15, 32, 42]	• Quality of shared knowledge, • Relatedness to curricular • The business processes concerned • Quantity and quality • Knowledge base design • Common language • Organizing • Exchange or transfer process, • Dialogue flow design	Knowledge domain/ knowledge base
6	[1, 32, 40, 41, 33, 7, 37, 42, 39, 13, 4, 46, 47, 48, 9, 49, 50]	• Personal Characteristics (Referring To Knowledge Owner's Characteristics • Organization or Group Characteristics (Referring to the Organization Environment Which Influences the Willingness to Share Knowledge). • Culture • Motivation • Behavior, social interaction and culture) • Willingness to share • Commitment • Loyalty • Trust • Job satisfaction • Social values (reciprocity, trust and respect) • Reliability and trustworthy • Personality (Willingness or unwillingness) • Rewards (financial and non-financial), • Culture, psychosocial • Friendship • Experience, beliefs, or values	Behavioural factors
7	[41, 14, 1, 40, 33, 38, 15, 13, 46, 50]	• ICT • Technologies and Innovations • Technology	Technology

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		• ICT-based tools - social media tools, and collaborative tools • Accessibility • Training and testing of BOT • Social Networks	
8	[15, 32]	• Knowledge base design • Knowledge refinement and storage	Knowledge processing
9	[41, 33, 37, 13, 39]	• Process- (exchange or transfer process, • Time, place and context • Process • Procedures/process (policies and procedures) • Opportunity to share	Knowledge Sharing Process
10	[33, 13]	• knowledge use • Knowledge outcome	Knowledge use
11	[4, 51]	• Knowledge owner • Initiation • Platform owners	Knowledge Owner
12	[15]	• Identification of needs • Knowledge base design • Dialogue flow design • Training and testing of BOT • Iterative Improvements	Chabot creation

3.1.2 Description of the dimensions

1. Source of knowledge

Many studies have shown that knowledge originates from a source. This could be an individual offering independent knowledge or knowledge from an organization or community of practice [52]. This knowledge could be from physical conversations, documented materials or digital (online) content [34].

2. Type of knowledge

Knowledge comes in different types and forms. According to the studies reviewed, there are two types of knowledge. These are tacit and explicit knowledge [39]. Sharing of these two types of knowledge could be different depending on the context. On the other hand, knowledge can come in different forms such as facts, opinions, ideas, theories, principles, or questions and answers [38] Knowledge also differs in the degree of formality.

3. Knowledge actors

Knowledge actor refers to individuals, organisations and community of practice members producers and consumers of knowledge [37]. The majority of the studies showed that a person or people are an important dimension in KS [42]. The individuals or people are responsible for donating the knowledge. They could be knowledge keepers, employees, experts, or experienced in a certain knowledge area. Furthermore, individuals or people are the knowledge recipients or consumers [4]. However, majority of studies on KS focus on KS within an organization. Very few have paid attention to communities of practice and knowledge communities [24]. For this case, this dimension has been titled

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knowledge actors to represent all organs managing knowledge as per reviewed studies. In this dimension, organs (organizations or communities) are seen to be affected by leadership, culture, climate, governance, structure, communication channels, teams, and formal and informal setups in KS.

4. KNOWLEDGE COLLECTION

Knowledge collection is an important component in KS [36]. For knowledge to be shared it has to be collected. Knowledge collection involves the knowledge collection process which requires identification of knowledge source, knowledge needs and knowledge collection tools [35].

5. KNOWLEDGE DOMAIN/ KNOWLEDGE BASE

In the KS process, what is being shared is one of the most important dimension. The reviewed literature showed the importance of what is being shared, in the KS process. This includes the knowledge being related to the selected area (curricular) or the business process [2, 11]. In this aspect, the quality and quantity of the knowledge are also important. Furthermore, the knowledge needs to be organized, refined, and stored. Procedures need to be in place for the knowledge base and dialogue flow design [27].

6. BEHAVIOURAL FACTORS

Almost all reviewed studies had behavioural aspects in their KS dimensions. These behavioural aspects have a high influence on the willingness to share knowledge. Some of the shared behavioural aspects are culture, rewards system, motivation, commitment, loyalty, trust, job satisfaction, reciprocity, trust, respect, beliefs, friendship, and values [7].

7. TECHNOLOGY

The KS process is known to end with the KS techniques. The majority of the studies reviewed mention information and communication technology (ICT), technology innovations, ICT-based tools (social media and collaborative tools), Social networks, and Chatbots as KS techniques [40]. No much details were given on the technologies used as KS techniques.

8. KNOWLEDGE PROCESSING

To enable KS, collected knowledge need to be processed and organised. The processing depends on the knowledge sharing technique to be used [32].

9. KNOWLEDGE SHARING PROCESS

This is the whole activity of exchange and transfer of knowledge. This works hand in hand with the KS techniques to ensure that timing, place, and context are considered [33]. Furthermore, the process also considers other issues such as policies and procedures meant to ensure KS's success.

10. KNOWLEDGE USE

The purpose of knowledge sharing is to enable knowledge use. Although this dimension was mentioned in a few of the reviewed studies such as Edwards (2016) [33]. It is an important aspect.

11. KNOWLEDGE OWNER

Sustainability in KS can be made possible by having a custodian of the knowledge [4]. This could also be the one who initiates the KS process or the platform owner [51].

12. CHABOT CREATION

Among the KS dimensions identified from the literature review, those shared by [15] had special attention. This is because these dimensions are directly related to the focus of this study. The dimensions proposed by Mleczko (2021)

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[15] in the chatbot creation process are an important building block for developing a framework for NLP-based KS chatbot development.

3.1.3 Theories and models used in the reviewed studies

Table 2: Theories and models used in the reviewed studies

SNo.	Reference	Theory	Dimensions
1	[48]	Theory of Reasoned Action	Knowledge-sharing behavior is influenced by Attitude and Subjective Norms
2	[48, 38]	Theory of Planned Behavior	Intention and behavior are influenced by attitude, behavior intention, subjective norms, perceived power, perceived behavioral control
3	[48, 47]	Social Exchange Theory	Cost vs Benefit
4	[14, 13]	SECI Model	Socialization, externalization, combination, and internalization
5	[50, 46]	Technology Acceptance Model	Perceived usefulness Perceived ease of use Intention to use Usage behavior

From the reviewed studies five theories and models are seen to be used. They include the Theory of Reasoned Action, the Theory of Planned Behavior, the Social Exchange Theory, the SECI Model, and the Technology Acceptance Model. The use of these theories and models creates a strong foundation for the existence and relevance of identified dimensions. However, the identified theories are seen to mostly associate with behavioral aspects. This indicates that behavioural aspects have an important role to play in KS.

3.2 Discussion

The study reviewed the literature to identify the necessary dimensions for developing a KS framework that uses NLP chatbot technology as the KS technique. The results revealed the knowledge sharing dimensions as (1) Source of knowledge, (2) type of knowledge, (3) knowledge actor, (4) knowledge collection, (5) knowledge domain/knowledge base, (6) bahavioural factors, (7) technology, (8) knowledge processing, (9) knowledge sharing process, (10) knowledge use, (11) knowledge owner and (12) chatbot creation. Moreover, in the same reviewed literature the study found that the Theory of Reasoned Action, the Theory of Planned Behavior, the Social Exchange Theory, the SECI Model, and the Technology Acceptance Model [48, 38, 47, 14, 13, 50, 46] were the most used theories.

This means the identified dimensions have a strong theoretical base. Whereby, theories help standardize practices and make them replicable [50]. They also provide a guide on how dimensions should interact or be structured. Dimensions developed from well-established theories can be easily understood and adopted across different contexts.

From the identified dimensions, the study proposes a KS framework by selecting and organizing the dimensions in Table 1. The proposed KS framework includes 9 out of the 12 identified dimension. These are (1) knowledge domain, (2) knowledge actor, (3) source of knowledge, (4) knowledge collection, (5) knowledge processing, (6) chatbot creation, (7) knowledge use, (8) behavioural factors, and (9) knowledge owner. The selection of the 9 dimension does not ignore the remaining 3 dimensions. However, these 3 dimensions are made part of some of the selected ones. The

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remaining 3 dimensions include the (1) type of knowledge: this is made part of the source of knowledge dimension, (2) technology: this is the KS techniques used and on the proposed framework it is the chatbot, and (3) knowledge sharing process which is represented by the framework itself.

The dimensions of the proposed framework are presented in the form of boxes and connection lines showing the direction of the process flow [6]. In this case, the proposed framework is a simplification framework as defined by Partelow, (2023) [6] which is similar to a methodological framework as defined by [53]. Whereby a methodological framework is a structured guide to completing a process or procedure [53]. The proposed simplification or methodological framework was developed using the empirical generalization approach proposed by Partelow, 2023 [6].

3.2.1 Proposed KS framework for NLP-based chatbot technology as the KS techniques

The Fig 3 shows the proposed KS framework for NLP-based chatbot technology as the KS techniques.

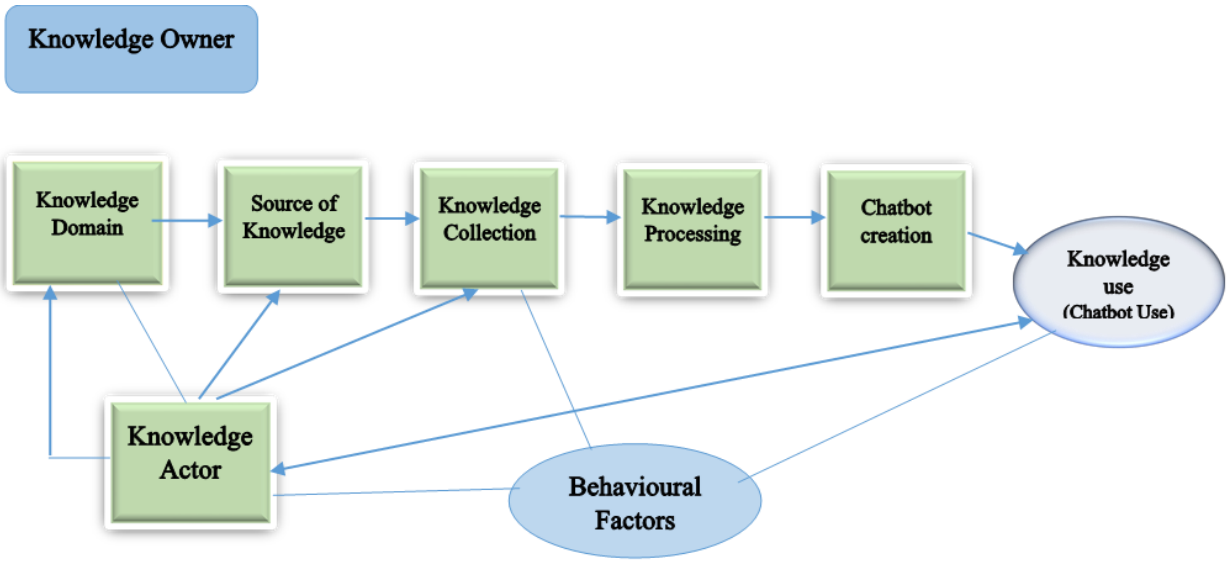

Fig 3: KS framework for developing an NLP-based chatbot used as the KS techniques

Description of dimensions used in the KS framework:

1. Knowledge Owner: This is the person/organization/community initiating and managing the KS process. This is also the custodian of the knowledge or the platform owner.
2. Knowledge Domain: This is the knowledge coverage area or subject matter (what knowledge is being shared). The knowledge domain determines the knowledge source and the knowledge actors.
3. Knowledge source: Indicates where the knowledge is coming from and state of the knowledge. Is it scattered and unprocessed form (primary data) or is it organized by someone else and available for use (secondary data)? Source of knowledge also includes the form of knowledge that is text, sound, images, physical or digital. Knowledge source is determined by the knowledge domain. Once knowledge source is identified then knowledge collection can be done. Knowledge source will influence the choice of knowledge collection methodology. Knowledge source could also be the knowledge actor.
4. Knowledge actors: Represents the one who is currently in possession of the knowledge and the one who uses the knowledge. This could be an individual, an organization, or a community of practice. Knowledge actor originates from the knowledge domain. It is also linked to the knowledge source, knowledge collection and knowledge use.
5. Behavioral factors: KS is affected by behavioural factors. The effect is towards the knowledge actors (individuals, an organization, or a community of practice) and hence affects the knowledge collection and knowledge use dimensions.

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6. Knowledge collection: The process of collecting knowledge from the knowledge source. It involves the selection of the knowledge collection process including the tools to be used. Collected knowledge is then moved to knowledge processing. Knowledge collection is also affected by behavioural factors.
7. Knowledge processing: The collected knowledge needs to be processed and formatted in a form that can be used by a chatbot. This process results in the creation of the knowledge dataset. The dataset is then used in developing the chatbot.
8. Chatbot creation: This involves all the technical aspects of developing a chatbot. Some of them are the dialogue flow design which represents the process of creating and structuring the interaction between a user and the system. The other one is the training and testing of the Bot. Chatbot creation happens after knowledge processing is done. Once the chatbot is ready, knowledge actors can access the knowledge and use it.
9. Knowledge use: The user of the knowledge accessible through the chatbot. Knowledge actor is the one accessing the knowledge for use. Thereafter, feedback from the knowledge actor allows continuous improvement of the chatbot.

4.0 CONCLUSION

NLP chatbots are gaining popularity as KS techniques. Unfortunately, the dimensions necessary for developing a KS framework that uses NLP chatbot technology as the KS technique were not known. This review enabled the identification of 12 KS dimensions namely, (1) source of knowledge, (2) type of knowledge, (3) knowledge actor, (4) knowledge collection, (5) knowledge domain/knowledge base, (6) bahavioural factors, (7) technology, (8) knowledge processing, (9) knowledge sharing process, (10) knowledge use, (11) knowledge owner and (12) chatbot creation. Out of these dimensions 9 were used to come up with a proposed KS framework where the development of KS chatbots will be simplified. This will be beneficial to developers and other stakeholders wishing to use NLP chatbots as KS techniques.

4.1 Contribution of the Study

The study makes a theoretical contribution by providing KS dimensions that are necessary for the development of an NLP chatbot that is used as the KS techniques. In addition to this, the study contributes to the body of knowledge by providing chatbot developers with a KS framework that can be used during the development process. Lastly, the results of this study will benefit KS, and NLP researchers.

4.2 Limitations of the Study

This study was limited by the small sample size due to the limitation of studies fitting the selection criteria used. In addition to this, not many studies have been conducted on NLP chatbot use in KS.

5. Future Research

The proposed KS framework will then be validated and applied in the development of NLP based Chabot for KS in different contexts. Future research could focus on assessing the impact of this framework on knowledge sharing.

Declaration of competing interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Correspondence author : chogop@nm-aist@ac.tz

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