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Yuly Esther Medina Nogueira

Yusef El Assafiri Ojeda

Dianelys Nogueira Rivera

Alberto Medina León

Daylin Medina Nogueira

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Design and Application of A Questionnaire for the Development of the Knowledge Management Audit Using Neutrosophic Iadov Technique

Yuly Esther Medina Nogueira ^{1*}, Yusef El Assafiri Ojeda ², Dianelys Nogueira Rivera ³, Alberto Medina León ⁴ and Daylin Medina Nogueira ⁵

^{1,2,3,4,5} Department of Industrial, Universidad de Matanzas, Matanzas 40 400, Cuba.

¹E-mail: yuly.medina@umcc.cu ²E-mail: yusef.assafiri@umcc.cu ³E-mail: dianelys.nogueira@umcc.cu

⁴E-mail: alberto.medina@umcc.cu ⁵E-mail: daylin.medina@umcc.cu

* Correspondence: Author (yuly.medina@umcc.cu)

Abstract: This paper aims to design a new kind of questionnaire to be applied in the Knowledge Management audit. For illustration purpose, we analyse the knowledge management audit in a grain storage and conservation company. This proposal is based on 18 well-known questionnaires to audit knowledge management. We recommend using neutrosophic Iadov to process the obtained answers. Neutrosophy is combined with Iadov technique to model uncertainty and indeterminacy which characterize the possible answers given by the interviewed persons, as well as to evaluate according to a linguistic scale. Our contribution is that we propose a more generic questionnaire on knowledge management audit which can process indeterminate information and knowledge, and additionally we confirm it with one case study.

Keywords: knowledge management audit, questionnaire, processes, neutrosophic Iadov technique.

1. Introduction

The progress of humanity and its organizations has been associated with the development of knowledge, and has made it possible to obtain the means to survive [1]. That is why, organizations give more and more attention to the solution of problems that arise associated with knowledge management (KM) and its use in processes [2]. The KM contributes to raise the knowledge of the organization through the increase of the capabilities of the employees and the learning that is obtained in the solution of the problems associated with the fulfillment of its strategic objectives [3]. In this sense, authors such as GONZÁLEZ GUITIÁN and PONJUÁN DANTE [4] propose to carry out knowledge audit processes in organizations, given that the information and knowledge resources in the different departments may be duplicated or in deficit and there is not always an awareness about its value [5]. The importance of the knowledge management audit (KMA) is attested by the numerous methodologies that exist in the literature [6] and corroborated by GONZÁLEZ GUITIÁN *et al.* [7] when it relates to applications in the areas of information science, social sciences, business, computing, and finance. Likewise, the absence of a single procedure is recognized as an international reference and a useful tool for the development of KM strategies that identify and describe the organizational knowledge, its use, and also the gaps and duplicities within

the organization. Among the most common methods used to capture data in the KM is the questionnaire. This technique, which obeys different needs and the research problem that originates it, has been used in a large part of the studies on KMA, and this is confirmed by the results obtained in MEDINA NOGUEIRA, YULY ESTHER *et al.* [8], where its use is seen in 43% of the proposals, both in the diagnosis [9] and in the different stages that make up the methodologies analysed [10; 11]. Likewise, it can be affirmed that the questionnaires constitute the main tool for the data collection [12] as a key factor for the development of the KMA [13].

Additionally, from the study of 18 questionnaires for the KMA, MEDINA NOGUEIRA, YULY ESTHER *et al.* [14] identifies little flexibility in the designs analysed, since they are focused on specific purposes in the organization. On the other hand, it denotes some limitations in how the processes are evaluated of the KM (acquire, organize, distribute, use and measure), and that are an indispensable basis for the creation of the knowledge value chain. In this sense, the present research aims to propose and apply a questionnaire for the development of the KMA, based on previous research, which guarantees its use in any organization, and that allows to evaluate the development of the KM processes from of the significant variables for the development of the KMA.

2. Development of the questionnaire

The organization selected as a case study is a national company whose mission is the storage, refrigeration and conservation of grains for animal and human consumption.

Step 1. Sample design

The sample selected was made up of 19 management workers who represent 100% of the members of the board of directors and the leaders of the processes. They are classified into nine (9) Directors: Chief Executive Officer (CEO), Deputy Manager (DM), Chief Technical Officer (CTO), Chief Industrial Officer (CIO), Chief Operating Officer (COO), Control and Analysis Manager (CAM), Chief Financial Officer (CFO), Chief Human Resources Officer (CHRO), Chief of Logistics and Transportation Business Unit (CLT); eleven (11) Process Leaders and two (2) employees who participate in the board of directors and are considered experts within the company. The sampling method to be applied is non-probabilistic. It is based on the researcher's judgment for the selection of an element of the population to be part of the sample. Subsequently, the error of the sample committed is calculated and it is verified that it is in the corresponding limits.

Step 2. Design of the questionnaire

From the previous studies carried out on 47 definitions of KMA and 28 methodologies, the questionnaire developed by LONDOÑO GALEANO and GARCÍA OSPINA [15] based on the following elements is selected as a basis for its subsequent modification: it is relatively short; the questions are closed type, formulated in a clear, simple and understandable way; the terms used on KM are simple and concise, which facilitates their interpretation and, finally, evaluates the processes of the KM from the components established by Probst (1998). The questionnaire has totally closed questions and 47 items: eight items (8) associated to the process of use, eight (8) to culture, eight (8) to identification, eight (8) to retention, seven (7) to transfer and eight (8) to sources. The questions are formulated on a 4-level Likert scale, with the following assessment:

1 = Never, 2 = Sometimes, 3 = Often, 4 = Always

The modifications that were made were aimed at: simplifying the number of elements of the questionnaire and the magnitude of some questions; achieve its applicability in any organization; evaluate the processes of the KM defined by MEDINA NOGUEIRA, DAYLIN *et al.* [16], as well as the significant variables for the development of the KMA.

The preliminary instrument was submitted to the evaluation of eight researchers on the subject of the KM and according to their suggestions, some questions were eliminated and others added or modified. Likewise, aspects related to the ability to diagnose KM processes based on the criteria of MEDINA NOGUEIRA, DAYLIN *et al.* [16] were specified, hence, the proposed version consists of 38 items: seven items (7) associated to the process of acquiring, eight (8) to organizing, eight (8) to distributing, five (5) to use, nine (9) to measuring and one question that integrates all the processes. According to the type of response, the questionnaire can be classified as mixed; according to the moment of coding: pre-coded and, according to the form of administration: self-administered. Next, in Table 1, the version of the questionnaire used is shown. Next, we proceed to check the presence of the variables evaluated in the questionnaire and check its relevance.

Table 1. Questionnaire used for the Knowledge Management Audit.

Questions		Never	Hardly ever	Sometimes	Usually	Always
1. Do you consider that the company has sufficient human, material, technological and infrastructure resources for activities related to:	The acquisition of new knowledge					
	The organization of new knowledge					
	Knowledge distribution					
	Knowledge use					
	Knowledge measurement					
2. The company, for the improvement of its processes, is an organization that learns from:	The interaction with the environment (customers, suppliers, regulations and regulations)					
	Other organizations					
	Their own procedure and experience					
3. Mark the ways in which you acquire the necessary knowledge for the performance of your job: __ Postgraduate courses __ Search engines on the Internet __ Specialized web publications __ Exchange of experiences (live) __ Exchange of information (e-mail) __ Work meetings __ Use of phone __ Participation in scientific events __ Other. Which?						
4. Does the company verify the effectiveness of the training received by its workers?						
5. Did the training received at the company allow me						

to improve my job performance?					
6. Does the company have established mechanisms to detect the training needs of workers?					
7. Does the company have the knowledge that is required to adequately perform my job?					
8. Does the company have identified the difference between the knowledge I have and the knowledge I should have in order to perform my work optimally?					
9. Mark the routes through which you have identified the knowledge required to adequately perform my job: __ Regulations and manuals __ Tutorial videos __ Knowledge maps __ Web portal __ Data base __ None __ Other what?					
10. Does the company evaluate the future knowledge needs of workers?					
11. Does the company develop plans to meet the future knowledge needs of workers?					
12. All that I know how to do is transferred to other workers within the company?					
13. The company uses the knowledge of workers to:	Design Training programs for other workers				
	The development of new projects				
	The improvement in the processes				
14. Is the information of my process accessible to all interested parties?					
15. Is the knowledge generated in the different processes of the company made available to the entire company?					
16. Mark the ways in which the knowledge generated in the different processes of the company is made available to the entire company: __Scientific sessions in the center __ Specialized web publications __Exchange of experiences (live) __Exchange of information (e-mail) __ Work meetings __Thesis applied in the company __Use of the landline phone __In scientific events developed by the center __Other. Which?					
17. Does my process learn from other processes within the organization?					
18. Is the existing knowledge in the company inventoried?					
19. Are the experts in the various subjects clearly identified in the company to consult them when necessary?					

20. If I have questions to perform the activities in my process I ask to: (Name / Responsibility)					
(1) _____ (2) _____ (3) _____					
21. Does the company have identified external persons or entities that can contribute to the development of knowledge of it?					
22. Does the company use specialized software to share information? Which software?					
23. The evaluation of workers takes into account:	Their contributions to the development of organizational knowledge				
	Training programs				
	Participation in scientific events				
	Scientific publications				
24. Does my immediate boss attend to my training needs?					
25. Does the company motivate the process of sharing knowledge?					
26. Does the management formally recognize the achievements of its workers for making improvements in their process?					
27. Do you consider that the company manages the necessary knowledge for the development and improvement of the activities related to its process?					

Table 2 verifies the correspondence between the questions and the processes that evaluates the KM; as well as, the presence of the variables of the KMA.

Table 2. List of questionnaire questions, KM processes and variables present in the definitions of KMA.

Questions		KM process	KMA variables
1. Do you consider that the company has sufficient human, material, technological and infrastructure resources for activities related to:	The acquisition of new knowledge	To acquire	-Firm strategy
	The organization of new knowledge	To organize	-Firm strategy
	Knowledge distribution	To distribute	-Firm strategy
	Knowledge use	To use	-Firm strategy -Use of knowledge
	Knowledge measurement	To measure	- Firm strategy
2. The company, for the improvement of its	The interaction with the environment (customers,	To acquire	-Process approach -Organizational culture

processes, is an organization that learns from:	suppliers, regulations and regulations)		-Sources of knowledge
	Other organizations	To acquire	-Process approach -Organizational culture -Sources of knowledge
	Their own procedure and experience	To acquire	-Process approach -Organizational culture -Sources of knowledge
3. Mark the ways in which you acquire the necessary knowledge for the performance of your job: __ Postgraduate courses __ Search engines on the Internet __ Specialized web publications __ Exchange of experiences (live) __ Exchange of information (e-mail) __ Work meetings __ Use of landline phone __ Participation in scientific events __ Other. Which?		To acquire	-Identification of information -Process approach
4. Does the company verify the effectiveness of the training received by its workers?		To measure	-Firm strategy -KM strategy -Existing knowledge
5. Did the training received at the company allow me to improve my job performance?		To use	-Existing knowledge -Use of knowledge
6. Does the company have established mechanisms to detect the training needs of workers?		To measure	-Knowledge required -Analysis of gaps
7. Does the company have the knowledge that is required to adequately perform my job?		To organize	-Knowledge required
8. Does the company have identified the difference between the knowledge I have and the knowledge I should have in order to perform my work optimally?		To measure	- Analysis of gaps
9. Mark the routes through which you have identified the knowledge required to adequately perform my job: __ Regulations and manuals __ Tutorial videos __ Knowledge maps __ Web portal __ Data base __ None __ Other what?		To organize	-Identification of information -Sources of knowledge -Techniques used in the KMA
10. Does the company evaluate the future knowledge needs of workers?		To measure	- Analysis of gaps -Continuous auditing
11. Does the company develop plans to meet the future knowledge needs of workers?		To organize	-Firm strategy - Analysis of gaps
12. All that I know how to do is transferred to other workers within the company?		To distribute	-Social networks
13. The company uses the knowledge of	Design Training programs for other workers	To use	-Use of knowledge -KM strategy

workers to:	The development of new projects	To use	- KM strategy - Use of knowledge
	The improvement in the processes	To use	-KM strategy -Process approach -Use of knowledge
14. Is the information of my process accessible to all interested parties?		To distribute	-Identification of information
15. Is the knowledge generated in the different processes of the company made available to the entire company?		To distribute	-Process approach -KM strategy -Social networks
16. Mark the ways in which the knowledge generated in the different processes of the company is made available to the entire company: __Scientific sessions in the center __ Specialized web publications __Exchange of experiences (live) __Exchange of information (e-mail) __ Work meetings __Thesis applied in the company __Use of the landline phone __In scientific events developed by the center __Other. Which?		To distribute	-Identification of information
17. Does my process learn from other processes within the organization?		To acquire	-Process approach -Organizational culture -Sources of knowledge
18. Is the existing knowledge in the company inventoried?		To organize	-Existing knowledge -Techniques used in the KMA
19. Are the experts in the various subjects clearly identified in the company to consult them when necessary?		To organize	-Firm strategy -Sources of knowledge -Decision making
20. If I have questions to perform the activities in my process I ask (Name / Responsibility): (1) _____ (2) _____ (3) _____		To acquire	-Sources of knowledge
21. Does the company have identified external persons or entities that can contribute to the development of knowledge of it?		To organize	-Firm strategy -Sources of knowledge
22. Does the company use specialized software to share information? Which software?		To distribute	-Identification of information
23. The evaluation of workers takes into account:	Their contributions to the development of organizational knowledge	To measure	-Firm strategy -Existing knowledge
	Training courses	To measure	-Firm strategy -Existing knowledge

	Participation in scientific events	To measure	-Firm strategy -Existing knowledge
	Scientific publications	To measure	-Firm strategy -Existing knowledge
24. Does my immediate boss attend to my training needs?		To organize	-Organizational culture - Analysis of gaps
25. Does the company motivate the process of sharing knowledge?		To distribute	-Firm strategy -KM strategy -Social networks
26. Does the management formally recognize the achievements of its workers for making improvements in their process?		To distribute	-Firm strategy -Organizational culture
27. Does the management formally recognize the achievements of its workers for making improvements in their process?		Includes the value chain of the KM	-Firm strategy -KM strategy

Step 3. Fieldwork development

The survey, applied in May 2018, was accompanied by an introductory conference on the work to be carried out and all the pertinent information was provided about the instrument to be applied and the guarantee of the confidentiality of the answers. Throughout the process, a member of the audit team was present to directly address the doubts and concerns of the workers involved. The participation was 100% and, at the time of delivery of the questionnaire, it was checked that all the questions were answered; however, some participants left questions unanswered.

Step 4. Database creation and information analysis

Of the 38 questions, 34 are closed and are formulated on a five-level Likert scale (1 = Never, 2 = Almost never, 3 = Sometimes, 4 = Almost always and 5 = Always). The remaining four are: three semi-closed and one open, and were designed to obtain the means by which knowledge is acquired, organized and distributed in the organization; as well as, the people that can be considered as assets of knowledge within it.

Once the 19 surveys were applied, the information was reviewed and entered into the electronic sheet and codified for the creation of the database that was analysed statistically through the SPSS® software.

For the analysis of reliability and validity of the survey, the Cronbach's Alpha test is used, with a value of $\alpha = 0.928$ that indicates consistency, homogeneity and reliability of the results and the Correlation Coefficient (R^2) with a value of 1 indicates a high correlation between the variables, which confirms the validity of the instrument used.

Step 5. Validation of the survey by the Iadov Neutrosophic Technique

Neutrosophy is a new branch that studies the origin, nature and scope of neutralities [17]. Etymologically neutrosophy [French neutre <Latin neuter, neutral, and Greek Sophia, knowledge]

means knowledge of neutral thoughts [18]. The basic definitions of Neutrosophy, which are those of neutrosophic sets and single-valued neutrosophic sets are formally defined in the following:

Definition 1. Let X be a universe of discourse, a space of points (objects) and x denotes a generic element of X . A *neutrosophic set* A in X is characterized by a truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function $F_A(x)$. Where, $T_A(x), I_A(x), F_A(x) \subseteq]0, 1+[$, i.e., they are real standard or nonstandard subsets of the interval $]0, 1+[$. These functions do not satisfy any restriction, that is to say, the following inequalities hold:

$$0 \leq \inf T_A(x) + \inf I_A(x) + \inf F_A(x) \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3.$$

Definition 2. Let X be a universe of discourse, a space of points (objects) and x denotes a generic element of X . A *Single Valued Neutrosophic Set (SVNS)* A in X is characterized by a truth-membership function $T_A(x)$, an indeterminacy-membership function $I_A(x)$, and a falsity-membership function falseness membership function $F_A(x)$. Where, $T_A(x), I_A(x), F_A(x): X \rightarrow [0, 1]$ such that: $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$. A *single valued neutrosophic number (SVNN)* is symbolized by $\langle T, I, F \rangle$ for convenience, where $T, I, F \in [0, 1]$ and $0 \leq T + I + F \leq 3$.

Therefore, $A = \{ \langle x, T_A(x), I_A(x), F_A(x) \rangle : x \in X \}$ or more straightforwardly $A = \langle T_A(x), I_A(x), F_A(x) \rangle$, for every $x \in X$.

Given A and B two SVNSs, they satisfy the following relationships:

1. $A \subseteq B$ if and only if $T_A(x) \leq T_B(x), I_A(x) \geq I_B(x)$ and $F_A(x) \geq F_B(x)$. Particularly, $A = B$ if and only if $A \subseteq B$ and $B \subseteq A$.
2. $A \cup B = \langle \max(T_A(x), T_B(x)), \min(I_A(x), I_B(x)), \min(F_A(x), F_B(x)) \rangle$, for every $x \in X$.
3. $A \cap B = \langle \min(T_A(x), T_B(x)), \max(I_A(x), I_B(x)), \max(F_A(x), F_B(x)) \rangle$, for every $x \in X$.

Definition 3. The *Neutrosophic Logic (NL)* is the generalization of the fuzzy logic, where a logical proposition P is characterized by three components:

$$NL(P) = (T, I, F) \tag{1}$$

Where the neutrosophic component T is the degree of truthfulness, F is the degree of falsehood, and I is the degree of indeterminacy.

Definition 4. Let (T_1, I_1, F_1) and (T_2, I_2, F_2) be elements of NL where the sum of the elements of the triplet is 1. The logical connectives of $\{ \neg, \wedge, \vee \}$ can be defined in the following way:

1. $\neg(T_1, I_1, F_1) = (F_1, I_1, T_1)$,
2. $(T_1, I_1, F_1) \wedge (T_2, I_2, F_2) = (T = \min\{T_1, T_2\}, I = 1 - (T + F), F = \max\{F_1, F_2\})$,
3. $(T_1, I_1, F_1) \vee (T_2, I_2, F_2) = (T = \max\{T_1, T_2\}, I = 1 - (T + F), F = \min\{F_1, F_2\})$.

This Neutrosophic Logic is denoted by NL_1 .

To analyse the result, a *scoring function* is established to order alternatives:

$$S(V) = T - F - I \tag{2}$$

Where V is the valuation of proposition P in the NL_1 .

The use of questionnaires as a tool for validation or obtaining information always has the characteristic that the information obtained is permeated or affected by the mental models and internal representations of the external reality of each participating individual. It means this, before

the same external reality, each individual could have varied internal representations. These representations are modelled preferably by means of causal representations in the presence of uncertainty [17], make it easy to understand them and explain why a conclusion is reached? [19].

The Iadov Neutrosophic Technique, as it raises the original technique, the related criteria of answers to intercalated questions whose relation the subject does not know, at the same time the unrelated or complementary questions serve as introduction and sustenance of objectivity to the respondent who uses them to locate and contrast the answers [20]. The inclusion of the Neutrosophy allows to deal with the non-determination in the answers [19].

The introduction of Neutrosophic estimation seeks to solve the problems of indeterminacy that appear universally in the evaluations of surveys and other instruments, taking advantage of not only the opposing and opposing positions, but also the neutral or ambiguous ones. Part of that every idea $\langle A \rangle$ tends to be neutralized, diminished, balanced by the ideas, in clear rupture with the binary doctrines in the explanation and understanding of the phenomena [17]. To measure satisfaction and assess satisfaction with the instrument created, a questionnaire is used that includes open and closed questions. The closed ones are related by the Iadov procedure. The scale used is represented by the form, where a valuation as programming techniques to structure propositional formulas to, and consider each proposition P . The usual fuzzy operators utilized to solve Group Decision problems are the aggregation operators. This notion can be extended to the neutrosophic framework. Neutrosophic Aggregation Operators are formally defined in Definition 5.

Definition 5. Let X be a universe of discourse, a space of points (objects) and x denotes a generic element of X . A is a *Single Valued Neutrosophic Aggregation Operator (SVNAO)* if it is a mapping

$A: \cup_{n \in \mathbb{N}} ([0, 1]^3)^n \rightarrow [0, 1]^3$. One example of SVNAO is the *Weighted Average operator (WA)*, which is shown in Equation 3.

$$WA(a_1, a_2, \dots, a_n) = \sum_{i=1}^n w_i a_i \quad (3)$$

Where, $a_i = (T_i, I_i, F_i)$ are SVNNs and $w_i \in [0, 1]$ for every $i = 1, 2, \dots, n$; which satisfy the condition $\sum_{i=1}^n w_i = 1$. The a_i s are the values obtained for the i^{th} alternative assessment, and w_i denote the weight which represents the importance given to the alternative a_i .

Where w_i represents the importance / relevance of the data source a_i . In order to achieve the verification of the necessary elements in decision-making, the single-valued neutrosophic numbers were presented; to increase the quantitative analysis in the comprehension models of suggestions to clearly assess the indeterminacy (Table 3). In the case of the undefined result, the de-neutrosophication process is used, as it was proposed by SALMERON and SMARANDACHE [21]. In this case, $I \in [-1, 1]$, is replaced by its maximum and minimum values. Finally, we work with the average of the extreme values to obtain a single value, see Equation (4).

Table 3. Iadov Scale

Semantic indicator	SVN Number	Score
Satisfied	(1, 0, 0)	1
More satisfied that dissatisfied	(1, 0.25, 0.25)	0.5
Neutral	I	0
More dissatisfied that satisfied	(0.25, 0.25, 1)	-0.5
Total satisfied	(0,0,1)	-1
Opposites	(1,0,1)	0

Source: SALMERON and SMARANDACHE [21].

$$\lambda([a_1, a_2]) = \frac{a_1+a_2}{2} \tag{4}$$

We can rank the variables by the using Equation 5.

$$\text{Then } A > B \Leftrightarrow \frac{a_1+a_2}{2} > \frac{b_1+b_2}{2} \tag{5}$$

The application of the questionnaire is done to the 19 people to whom the instrument was applied and three academics with research experience in the subject are added for a total of 22. The survey was developed with seven (7) questions, three closed questions interspersed in four open questions; of which one (1) fulfilled the introductory function and three functioned as reaffirmation and support of objectivity to the respondent. Table 4 shows the logical process of Iadov.

Table 4. Iadov Logical Process.

5- Does the design of the designed questionnaire meet your expectations and do you consider that it responds to the processes of knowledge management?	6- Would it be feasible to dispense with the development of knowledge management in the organization as a way to achieve strategic objectives?								
	Not (N)			I don't know (IDK)			Yes (Y)		
	7- Do you consider that the development of knowledge management audit processes and the use of surveys in them would favor the determination of existing knowledge, the necessary knowledge and, therefore, the gaps to be overcome?								
	Y	IDK	N	Y	IDK	N	Y	IDK	N
Very satisfied	1(14)	2(3)	6	2	2	6	6	6	6
Partially satisfied	2 (12)	2(2)	3	2 (1)	3	3	6	3	6
Does not matter to me.	3	3	3	3	3	3	3	3	3
More in	3	3	6	3	4	4	3	4	4

satisfied than satisfied									
Not satisfied at all.	6	6	6	6	4	4	6	4	5
I do not know what to say.	2	3	6	3	3	3	6	3	4

In this case, the following results are obtained (Table 5).

Table 5. Results using the Iadov scale.

Semantic Indicator	Total	Percentage
Satisfied	14	64
Very satisfied that dissatisfied	8	36
Neutral	0	0
Very dissatisfied that satisfied	0	0
Total satisfied	0	0
Opposites	0	0

Source: (Mesa Mariscal and Ordoñez Lago, 2010).

The calculation of the score is made and the calculation of Iadov is determined in this case each one is assigned a value in the weight vector equal to: $w_1 = w_2 = \dots = w_{22} = 0.055$. The final result that shows a high level of satisfaction yields the value of: ISG = 0.818 (Figure 1).

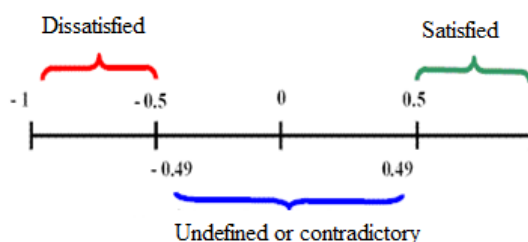


Figure 1. Iadov Scale.

Step 6. Interpretation of the results and final report

The average total result by items is recommended to be determined by the sum of the scores obtained in it and its division by the total of respondents. To obtain the average total result by category (KM processes), the sum of the average scores obtained in the items that comprise it and its division among the total of questions by category is performed. The scale of valuation of the instrument is established in the 1 in approximation to the processing carried out by LONDOÑO GALEANO and GARCÍA OSPINA [15] (Table 6).

Table 6. Scale of the values considered low, acceptable and good.

Assessment	Low	Acceptable	Good			
Scale	1	1,8	2,6	3,4	4,2	5

To obtain the valuation scale, the major and minor values of the scale (5) and (1) are subtracted and the result (4) is divided by the number of divisions in which the scale is to be fragmented. In this case, it is divided by 5 to obtain higher valuation ranges, for a result of 0.8. This value is added to the lowest value of the scale (1) until reaching the highest value of the scale (5). As a result, a rating scale of Low (from 1 to 2.6), Acceptable (from 2.6 to 4.2) and Good (from 4.2 to 5) is obtained. As a result of the application of the questionnaire, table 3 shows the value obtained and the scale in which each process of the KM is located, as well as the percentage of questions in each of the scales. Figure 1 summarizes these results and compares them with good standards and reflects values of: 4.31 and 4.35 with evaluation of good to acquire and use; 4.07, 4.17 and 4.01 evaluation of acceptable to organize, disclose and measure respectively. In turn, the company's knowledge management has an average of 4.18; so its assessment is acceptable. Question 27 that evaluates all the processes of the KM has an average of 4.21; when compared with the general average obtained (4.18), it can be seen that they do not differ, so the veracity of the answers obtained is evident. Next, an analysis is shown in each of the processes by the respective questions that evaluate it.

Figure 2 shows the evaluation obtained in the process of acquiring according to the behavior of the measured variables of the KMA. (Green: Minimal value for a good evaluation of each KM process).

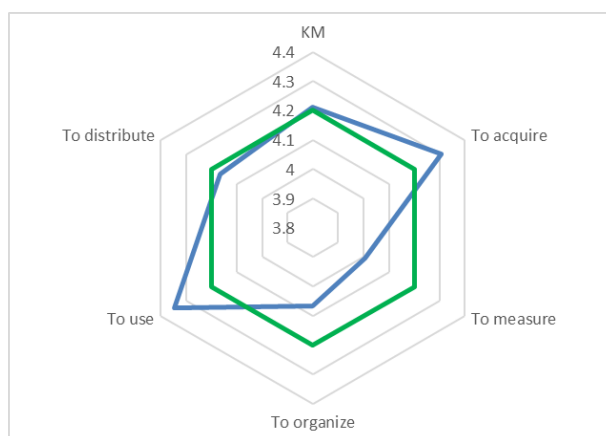


Figure 2. Summary of the results of the questionnaire for each KM process.



Figure 3. Scales obtained in the five KM processes.

Table 7. Improvement actions for each knowledge management process.

KM processes	Improvement actions
To Acquire	Recognize the sources of knowledge external to the organization and allow the improvement of processes. Apply knowledge management tools in at least one of the productive organizations for later generalization to the rest of the country. Among the tools to apply are: questionnaire, social network analysis, knowledge maps.
To organize	Make individual improvement plans to meet the needs detected. Formalize (document and standardize) the knowledge inventory in the organization. This inventory is the basis for the field work to be performed. It allows to establish the knowledge-competence relationship and its insertion in the manual of functions through the occupational description method (DACUM).

To distribute	To expose all the investigations carried out in the company, both in the national office and in the UEB, silos and mills of the country and through a repository or digital library.
To use	Take actions so that process leaders rely on the sources of knowledge detected to implement the organization's strategies.
To measure	Evaluate in the company future knowledge needs to eliminate the gaps between existing and required knowledge. Develop continuous auditing to acquire, organize, disseminate, use and measure (through AGC techniques) the required and existing knowledge for continuous improvement in the company's processes.

The improvement actions to be carried out are outlined below: (1) to carry out knowledge inventories in a systematic way, to determine the existing knowledge, the required knowledge and the gaps between them; (2) perfect the bank of problems detected by the company and propose solutions based on investigations carried out through consultancies or continue the link with the university. In addition, Table 3 shows other actions to be taken that are more specific and directed to each process of knowledge management. Likewise, improvement actions for each of the KM processes are established and an analysis of the values obtained for each variable of the KMA is made. Table 4 shows the 16 variables evaluated and the percentage of questions in each of the scales: nine variables presented good, six acceptable and the variable identification of the information presented a low value.

3. Considerations about KMA results

The firm needs to apply knowledge identification tools to locate the existing and requiring knowledge for the development of their processes. Developing the KMA process continuously for each of the KM processes: acquire, organize, distribute, use and measure and the continuous improvement of the processes of the company.

The main forms in which knowledge is acquired were determined: postgraduate courses, meetings and exchange of experiences live and via e-mail. The means by which the knowledge generated by the processes is distributed to all workers are mainly: the exchange of experiences, work meetings, the exchange of information using e-mail and the investigations (thesis) applied in the company.

The knowledge acquisition is achieved in work meetings (mainly), live exchange and the use of the telephone. However, it is recognized what the regulations, manuals and databases provide, which is where the knowledge required to adequately perform the work is identified. The people who are most consulted in the company and can be considered valuable assets of knowledge are: the CEO, the CTO and the CFO.

Table 4. Variables evaluated and the percentage of questions in each of the scales.

KMA Variables	Value	Scale		
		GOOD	ACCEPTABLE	LOW
Firm strategy	4.26	GOOD		
KM key factors	4.18		ACCEPTABLE	
KM strategy	4.37	GOOD		
KM value chain	4.18		ACCEPTABLE	
Process approach	4.36	GOOD		
Organizational culture	4.50	GOOD		
Knowledge required	4.08		ACCEPTABLE	
Existing knowledge	4.02		ACCEPTABLE	
Use of knowledge	4.39	GOOD		
Identification of information	2.46			LOW
Sources of knowledge	4.37	GOOD		
Social networks	4.35	GOOD		
Analysis of gaps	4.42	GOOD		
Techniques used in the KMA	3.21		ACCEPTABLE	
Decision making	4.74	GOOD		
Continuous auditing	3.63		ACCEPTABLE	

4. Conclusions

The KMA is a useful tool for the development of KM strategies and identifies and describes organizational knowledge, its use, gaps and duplication within the organization. The existing methodologies for the KMA are characterized by the use of questionnaires as a common method of acquiring data in the KM. In this paper we designed a questionnaire and applied it to assess the knowledge management audit in a grain storage and conservation company. Usually, the possible answers to the questionnaire can contain uncertainty and indeterminacy, thus, we applied the neutrosophic Iadov technique for processing the survey, where the undefined or contradictory information are also included. Moreover, neutrosophic Iadov contains linguistic terms for evaluating, which facilitates to answering the questions. The proposed questionnaire is composed of 38 items and the correspondence between the proposed questions is achieved with all the processes and the significant variables of knowledge management. It was successfully applied to 100% of people to be surveyed, its reliability and validity are demonstrated; where it is concluded that: the company presents an acceptable KM performance with a value of 4.18; the use and purchase categories obtained better scores and are considered to be in good condition; while the categories to show, organize and measure obtained results considered acceptable.

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Conflicts of Interest

The authors declare no conflict of interest.

References

1. Bravo Macías, Columba C., «Contribución a la gestión del comportamiento organizacional con enfoque a las competencias organizacionales. Caso PYMES comercializadoras de productos lácteos.», [Tesis en opción al grado científico de Doctor en Ciencias Técnicas], Matanzas, Universidad de Matanzas, Facultad de Ciencias Empresariales. Departamento de Ingeniería Industrial, 2018.
2. Solano Bent, Edwin A.[et al.], «La Gestión del Conocimiento y el Proceso de Auditoría en las Entidades del Sector Salud», [Tesis en opción al título de Especialista en Gerencia de la Calidad y Auditoría en Salud], Medellín, Colombia, Universidad Cooperativa De Colombia, Facultad De Ciencias Económicas, Administrativas Y Afines. Especialización En Gerencia De La Calidad Y Auditoría En Salud, 2016.
3. González Pérez, Danelis, «Formulación de estrategias de conocimiento orientadas a competencias distintivas en el Centro de Información y Gestión Tecnológica (CIGET) de Villa Clara», [Tesis en opción al título de Ingeniero Industrial], Santa Clara, Cuba, Universidad Central "Marta Abreu" de Las Villas, Facultad de Ingeniería Mecánica e Industrial 2016.
4. González Guitián, María Virginia and Ponjuán Dante, Gloria «Metodologías y modelos para auditar el conocimiento Análisis reflexivo» Información, cultura y sociedad, 2016, 1851-1740
5. Broumi, Said[et al.], «Energy and Spectrum Analysis of Interval Valued Neutrosophic Graph using MATLAB» Neutrosophic Sets and Systems, 2019, 24, 46-60,
6. Ahmad, Mohd Sharifuddin[et al.], «An Integrated Framework for Knowledge Audit and Capture», en Proceedings of Knowledge Management 5th International Conference Kuala Terengganu, Malaysia, 2010, [consulta: Disponible en: <http://www.kmice.cms.net.my/prockmice/>]
7. González Guitián, María Virginia[et al.], «Auditoría de información y auditoría de conocimiento: acercamiento a su visualización como dominios científicos» Revista Cubana de Información en Ciencias de la Salud, 2015, 26, 1, 48-52, 2307-2113.
8. Medina Nogueira, Yuly Esther[et al.], «Metodología para el desarrollo de la auditoría de la gestión del conocimiento», en Universidad de Matanzas, VIII Convención Científica Internacional "Universidad Integrada e Innovadora" CIUM 2017 Varadero, Matanzas, 2017, [consulta: 978-959-16-3296-8. Disponible en:
9. Handzic, M.[et al.], «Auditing knowledge management practices: model and application» Knowledge Management Research & Practice, 2008, 6, 2, 90-99, 1784-6580.
10. Antonova, Albená and Gourova, Elissaveta, «Business patterns for knowledge audit implementation within SMEs», [en línea], 2009, 566, [consulta: 24/2/2018], Disponible en: http://ceur-ws.org/Vol-566/C2_KnowledgeAudit.pdf
11. Pérez Soltero, Alonso, «La auditoría del conocimiento en las organizaciones» Revista Universidad de Sonora, 2007, 25-28,

12. Liebowitz, Jay[et al.], «The knowledge audit» Knowledge and Process Management, 2000, 7, 1, 3-10,
13. Choy, SY.[et al.], «A systematic approach for knowledge audit analysis: Integration of knowledge inventory, mapping and knowledge flow analysis» Journal of Universal Computer Science, 2004, 10, 6, 674-682, 674-682.
14. Medina Nogueira, Yuly Esther[et al.], «Aplicación de un cuestionario para auditar la gestión del conocimiento» Revista de divulgación científica y tecnológica del Instituto Tecnológico de Matamoros, 2018, III, 16-24, 2448-7104.
15. Londoño Galeano, María Isabel and García Ospina, Andrés Felipe, «Diagnóstico de la Gestión del Conocimiento en el personal de confianza y manejo de la empresa Coats Cadena Andina s.a. ubicada en la ciudad de pereira», [Tesis en opción al grado científico de Máster en Administración del Desarrollo Humano y Organizacional], Colombia, Universidad Tecnológica de Pereira, Facultad de Ingeniería Industrial, 2015.
16. Medina Nogueira, Daylin[et al.], «Modelo conceptual para la gestión del conocimiento mediante el observatorio » Ingeniería Industrial, 2018, XXXIX, 3, 283-290, 1815-5936.
17. ElWahsh, Haitham[et al.], «Intrusion Detection System and Neutrosophic Theory for MANETs: A Comparative Study» Neutrosophic Sets and Systems, 2018, 23, 16-23,
18. Edalatpanah, S. A. and Smarandache, Florentin, «Data Envelopment Analysis for Simplified Neutrosophic Sets» Neutrosophic Sets and Systems, 2019, 29, 215-226,
19. Vasantha, W.B.[et al.], «Algebraic Structure of Neutrosophic Duplets in Neutrosophic Rings $(Z \cup I)$, $(Q \cup I)$ and $(R \cup I)$ » Neutrosophic Sets and Systems, 2018, 23, 85-95,
20. Mohana, K[et al.], «An Introduction to Neutrosophic Bipolar Vague Topological Spaces» Neutrosophic Sets and Systems, 2019, 29, 62-70,
21. Salmeron, J.L. and Smarandache, F. , «Redesigning Decision Matrix Method with an indeterminacy-based inference process. Multispace and Multistructure» Neutrosophic Transdisciplinarity (100 Collected Papers of Sciences), 2010, 4, 151,

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