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Forgotten Factors in Knowledge Conversion and Routines: A Fuzzy Analysis of Employee Knowledge Management in Exporting Companies in Boyacá

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Abstract: The department of Boyacá accounts for only 0.93% of national exports, which means that the participation of exporting companies in the region is low. One of the most important factors within these organizations is the knowledge of the collaborators, since it is an asset that contributes to the daily activities carried out within an organization. Hence, the objective of this research was to analyze the incidence of the forgotten factors in knowledge management through the conversion of knowledge and the routines of the personnel in Boyacá's exporting companies, by means of causal analysis using fuzzy methodologies. The participants are exporting activity collaborators in the companies, who were consulted as sources of information for the Boyacá chamber of commerce. For the treatment, the forgotten effects theory, the experton method, and the adequacy coefficient are used. The information collected is processed using FuzzyLog software. The findings highlight that there are forgotten factors between the knowledge conversion and routines related to informal communication and social interactions. It is worth noting that it is important to carry out a more in-depth analysis of each of the individual knowledge spiral pillars in exporting companies in different regions of the country, focusing on social interactions (linguistic expression) and informal communication (electronic meetings).

Keywords: forgotten effects; knowledge; knowledge management; knowledge conversion; human talent; routines

MSC: 03B52

1. Introduction

Knowledge management arises from the need of organizations to know how to create, transmit, and apply knowledge to the processes of each entity [1], which implies the trust and cooperation of the people involved in the organization, who share an organizational vision and develop in an environment that should promote learning [2]. In fact, learning on repeated occasions is centered on transferred knowledge, which is divided into tacit and explicit knowledge. The first refers to personal and subjective knowledge, which is the result of acquired experience; accordingly, it is embedded in people and, thus, difficult to articulate, explain, and learn. The second is objective knowledge that can be codified and systematized, and, for this reason, it is more easily transferable between people [1]. The knowledge management process should include a cyclical development containing the following phases: identification, acquisition (knowledge conversion), classification and storage, distribution, and application. One of the main components of knowledge management is knowledge conversion, which is the process of making available and extending the knowledge created by individuals, as well as crystallizing and connecting it to an organization's knowledge system [3,4]. Here, knowledge is generated by the collaborators (people) themselves, who follow the routines established by the companies. These routines

are transformed into stable patterns of behavior that characterize organizational reactions to internal and external stimuli [5]. In fact, a routine is a repeated action sequence, which may have its roots in algorithms and heuristics on how the enterprise achieves things [6,7].

The main problem with the research is the department of Boyacá's low participation in the country's exports, considering that it only represents 0.93% at the national level [8], showing that the companies in the region are at a disadvantage compared with those in other departments. It is important to keep in mind that human capital is the driver of productive activity, and, for this reason, it is relevant to analyze the features and trends in human talent management, which cannot be disengaged from knowledge management to adapt its systems through the nature of that resource [9]. In the same way, companies can gain and understand knowledge, but may not have the skills to transform and exploit it, thus generating profits [10], which demonstrates the low relevance that organizations have given to the creation, conversion, and management of knowledge in a dynamic way [11]. Therefore, it is essential to study and analyze the incidences of knowledge conversion in the routines of exporting company collaborators in Boyacá to understand the factors that can help to improve the flow of knowledge conversion according to the characteristics and environment of the organization. The knowledge spiral is undoubtedly the model that presents the main variables used to determine the relationships between knowledge management and routines, i.e., socialization, internalization, combination, and externalization [12]. Routines are also classified into operational routines and search routines, which are intended to generate current revenues and increase profits in the future, respectively [5]. In fact, the incidence of knowledge conversion in routines may arise from the elements that compose the conversion of tacit and explicit knowledge, the shared context, and/or the set of possible patterns allowed and constrained by a variety of organizational, social, fiscal, and cognitive structures, on the basis of which organizational members carry out certain actions [13]. In this sense, understanding the relationship between knowledge conversion and routines is a complex problem that involves the interrelation among multiple factors, some of which are generally difficult for organizations to perceive, and are critical to the efficiency of data analysis, since they emphasize organizational and human aspects through the application of knowledge conversion theories [14].

On the basis of the above, this study aims to use subjective information to analyze the incidence of neglected factors in knowledge management through knowledge conversion and routines. The study is carried out on exporting companies in Boyacá registered in the Tunja and Sogamoso chambers of commerce. For the treatment of the data and its validity, fuzzy methods, the experton method [15], the adequacy coefficient [16], and the forgotten effects theory [17,18] are used to analyze the second order incidences between the conversion of knowledge and routines to identify an important interrelation between variables that at first seemed nonexistent (see Appendix A, Appendix B, Appendix C). The results show that the key incidence pathways of informal communication and social interactions, belonging to the socialization dimension, present a fracture in the knowledge management related to the incidences of informal communication and social interactions. Furthermore, the research has limitations related to the sample size and the subjective nature of the dataset. Moreover, when using these methodologies, it should be considered that the results obtained depend on the semantic configuration of the research design, even though they do not accurately capture these semantic nuances; hence, a careful design must be made. Here, it is remarkable that these methods give greater relevance to the meaning of the statements than to the measurement that can be derived from them [19]. Lastly, an analysis of the causes and effects is necessary to obtain a better diagnosis and to guide business decision making. Additionally, it is worth noting that a deeper analysis of each of the knowledge spiral pillars individually focusing on social interactions (linguistic expression) and in informal communication (electronic meetings) aids in understanding the particularities of conversion and routines in knowledge management.

The paper is organized as follows: Section 2 deals with the theoretical framework; Section 3 consists of the methodology, the type of approach, the model for finding second-

generation relationships, case study, data collection, methods, and direct and indirect causal relationships; Section 4 shows the results; Section 5 comprises the discussion; lastly, Section 6 states the conclusions.

2. Theoretical Framework

This section presents a summary of the central characteristics of knowledge management, knowledge conversion, and routines, which were searched for and examined in the Web of Science (WoS) database using the following keywords: knowledge management OR knowledge conversion OR routines. Knowledge management in organizations favors knowledge exchange environments, by means of different models, as well as knowledge conversion, which is based on the relationship between tacit and explicit knowledge that exists in multiple areas of an organization, specifically in the routines of the collaborators that belong to it.

2.1. Knowledge Management

Knowledge management contributes to the creation of environments that allow the organization to develop scenarios conducive to the exchange and implementation of its knowledge in each of its departments [20]. The main objective of knowledge management is to facilitate organizations to create or capture critical knowledge, and, in the same way, to make it perceptible and evident for people to use it in an effective time or place. Hence, additional effort is made to generate an applicable knowledge base in datasets [14].

Knowledge management has become a relevant topic for organizations, since it generally deals with various groups of success factors that are oriented to the human being, the organization, technology, and management processes [21]. With respect to the human-oriented factors, which include culture, people, and leadership, it is worth highlighting the important role that people play in an organization, since the future of organizations depends to a great extent on people. This is because those people possess the knowledge and develop the skills and abilities that generate vital economic value for organizations, allowing companies to gain a greater competitive advantage over their rivals through the mastery of information [21].

In addition, the productive factor of excellence is knowledge, which serves as leverage in growing and rapid technological change, where all the information that an individual possesses in their mind is personalized and subjectively related to elements that may or may not be unique, useful, precise, or structural [22]. To test the concept of knowledge management, there is a model that identifies three main components: the linking of people with knowledge to help others, the structuring of processes to synthesize the process of filtering, legitimizing, and sharing knowledge, and the development of robust and enjoyable technologies to improve communication [14].

Similarly, knowledge management strategies can be described in two dimensions, manifesting the knowledge management approach. The first is the exchange of knowledge through interpersonal interaction, and the second is the ability to help create, store, share, and use an organization's explicitly documented knowledge. These strategies also confirm that knowledge creation is associated with cultural factors, such as collaboration, trust, and learning [23].

The theory of organizational knowledge creation is defined as the process of organizationally extending the knowledge created by individuals and crystallizing it as part of an organization's knowledge system, implying the importance of people in the development of knowledge. This process contemplates the distinction between tacit knowledge and explicit knowledge. The first type of knowledge is a cornerstone in the theory of organizational knowledge creation and covers knowledge that is not articulated but is linked to the senses, movement skills, physical experiences, intuition, or implicit rules. The second type of knowledge is transmissible in a formal and systematic language. Consequently, the two types of knowledge have been developed throughout history by individuals and/or

collaborators. Therefore, the relationship between tacit and explicit knowledge configures the characteristics of the knowledge conversion model [12].

2.2. Knowledge Conversion

Knowledge conversion is based on the fact that human knowledge is created and expanded through the interaction between tacit knowledge and explicit knowledge, which increases both in quality and in quantity through the SECI process, i.e., the four different modes of knowledge conversion: socialization, externalization, combination, and internalization [24,25].

Socialization is the conversion of tacit knowledge to tacit knowledge, which means that it is the process of creating tacit knowledge as shared mental models and technical skills. Externalization is the conversion of tacit knowledge to explicit knowledge, being the process of articulating tacit knowledge into explicit concepts that take the form of metaphors, analogies, concepts, or models. Combination is the conversion of explicit knowledge into explicit knowledge, i.e., the systematization of concepts into a knowledge system, which implies that individuals exchange and combine knowledge through documents, meetings, conversations, or communication networks. Lastly, internalization is the transformation of explicit knowledge into tacit knowledge, which is related to "learning by learning".

The "knowledge spiral" is the interaction between tacit and explicit knowledge, which increases in scale as the ontological levels ascend; the organization must mobilize the tacit knowledge created and accumulated at the individual level, and this is later amplified organizationally through the four modes of knowledge conversion and crystallized at higher ontological levels. Thus, knowledge creation is a spiral process, which starts at the individual level and advances through the expanding community of interactions, overcoming the limits of sections, departments, divisions, and organizations [24].

Individual actions model organizational actions, leading to environmental responses; then, the learning cycle is complete when these environmental responses alter individual representations and, thus, lead to better individual and organizational action [3]. Furthermore, knowledge requires a physical environment and/or context to be created, based on a concept called "Ba" [11], meaning "place", i.e., the interaction space inhabited by different actors, where knowledge is shared, created, and used, in addition to providing the energy and quality to make individual conversions and advance in the spiral of knowledge. This space is not only physical (office, workshop, factory, etc.), but also virtual (email, video calls, etc.) and mental (shared ideals, values, beliefs, etc.) [11].

The authors also describe the four types of Ba. The first is the original Ba, which creates a context for socialization, as it is defined by individual and face-to-face interactions, where experiences, feelings, emotions, and mental models are shared. It is the only way to capture the full range of physical senses and psycho-emotional reactions, which are important elements for sharing tacit knowledge [26]. According to [11], the *socialization dimension* is the process of converting new tacit knowledge through shared experiences. This process derives from group collaborations in which individuals cooperate to share tacit knowledge that has been acquired through the internalization of explicit knowledge gained from information. This correlation results in tacit knowledge that is new to everyone involved (see Table 1) [14].

Table 1. The socialization dimension.

Dimension	Subdimension	Definition
Socialization	Informal communication	Some researchers discussed the importance of informal communication for feedback and socialization [27].
	Social interactions	From an organizational perspective, experiences are perhaps one of the most significant ways of converting tacit knowledge into tacit knowledge [28]. The epistemology of practice perspective suggests that effective knowledge sharing requires extensive and direct social interactions between people, as only during these processes can the tacit component of knowledge be shared [29].

Source: Own elaboration.

The second is the dialog Ba, which provides a context for externalization through collective, face-to-face interaction, where individuals' mental models and skills are shared, converted into common terms, and articulated as concepts. Selecting people with the right combination of specific knowledge and skills is the key to successful knowledge management within the dialog Ba [11]. The *externalization dimension* is the transformation of tacit knowledge into explicit knowledge, being the process of articulating tacit knowledge into explicit concepts, taking the form of metaphors, analogies, concepts, or models (Table 2) [24]. In a multiorganizational context, externalization can become difficult, considering that tacit knowledge is related to culture and context, i.e., it is rooted in individuals [30].

Table 2. The externalization dimension.

Dimension	Subdimension	Definition
Externalization	Learning teams	Tacit knowledge can be made explicit at the organizational level through the organization of the company into learning-based teams, where practical experience based on encouragement and a helping attitude predominates [31]. The best way to convert tacit knowledge to explicit knowledge is to organize the company into teams based on learning, considering practical experience based on drive and a predominantly helpful attitude [31].

Source: Own elaboration.

The other type of Ba is systematization, defined by collective and virtual interactions, mainly providing a context for the combination of explicit knowledge, and generally supported by information technology. The *combination dimension* is the conversion of explicit-to-explicit knowledge, i.e., the systematization of concepts, which implies that individuals exchange knowledge through documents, meetings, conversations, or communication networks (Table 3) [24]. In this process, aggregated knowledge can become a source of value creation, where participants collaborate to promote and communicate new learning to different teams, such that an organizational knowledge asset is developed [30].

Table 3. The combination dimension.

Dimension	Subdimension	Definition
Combination	Information processing	The synthesis and integration of information, whether by means of manuals, documents, and databases, among others, on products, services, processes, etc., in addition to the recovery of material that supports the management or technical information of the entire company [11].
	Dissemination of information	One of the main issues for the management of knowledge resources is the dissemination of knowledge within organizations through computerized communication networks and databases available to the organization. For dissemination to be successful, a process of codification and externalization must first be made [11].

Source: Own elaboration.

The last classification of Ba is that of exercise, which is constituted by individual and virtual interactions, offering an internalization context, where individuals incorporate explicit knowledge that is communicated through virtual media, written manuals, and simulation programs, among others, to later convert it into tacit knowledge [11]. The *internalization dimension* is the process of converting explicit knowledge into tacit knowledge. Through internalization, the explicit knowledge created is shared by the whole organization and converted into tacit knowledge by individuals (Table 4) [11]. This procedure changes to an individual dimension, where professionals and operators take explicit knowledge and interpret it according to their own intuition and professional experience, thus internalizing it as tacit knowledge [14].

Table 4. The internalization dimension.

Dimension	Subdimension	Definition
Internalization	Learning	In traditional learning, individuals learn the tacit knowledge needed in their trade through practical experience or by reading and analyzing manuals or through simulations and experiments that trigger learning by doing [4]. Collective learning occurs when individuals express their opinions and beliefs, engage in constructive confrontations, and challenge the views of others [32].

Source: Own elaboration.

Both tacit and explicit knowledge are important. However, treating them individually, as applied in the process of combination and socialization, can cause problems, since it can result in a superficial interpretation of the existing knowledge that has little to do with the current reality. Furthermore, this knowledge can be limited and difficult to apply in other fields that are different from the specific one in which it was created, respectively [33].

2.3. Routines

Routines are one of the keys to understanding organizational functioning [34]. Routines have qualities of both stability and change, and, by means of an analogy, it is understood that an organizational routine is not a single pattern; on the contrary, it is a set of possible patterns allowed and limited by diverse organizational, social, physical, and cognitive structures from which the members of the organization perform certain actions [35].

Considering the above, routines are understood as flows of ideas, actions, and connected results. First, ideas produce actions; subsequently, actions produce results, so that these produce new ideas, generating change [6]. However, the relationship among ideas, actions, and results is not always close, as ideas can generate actions that, in fact, do not execute the ideas; actions can generate results that make possible or necessary new and different actions [13]. On the other hand, some authors oppose considering routines as rules that are definitively established, and propose that routines be understood as adaptive rationality [36].

Routines are stable patterns of behavior that characterize organizational reactions to various internal or external stimuli, with two types of routines demarcated: organizational and accumulation of experience [7]. The former involves the execution of known procedures with the objective of generating current revenues and profits, while the latter seeks to bring about desirable changes in the existing set of operating routines, with the purpose of increasing profits in the future.

The dimension of operational routines: The application of processes that are known by staff to achieve current goals (Table 5) [5]. Team behavioral interaction patterns (TBIP) are a very important feature of team adaptation, as research affirms that, to make groups effective in the performance of stable or routine tasks, long and complex interaction patterns are required to increase team efficiency [37].

Table 5. Dimension of operational routines.

Dimension	Subdimension	Definition
Operational routines	Operating frequency	Frequency with which the operating routine is activated and executed in a specific time period [5].
	Heterogeneity	The variation in the characteristics of the task, as it is presented in different events, or how novel the task appears each time to the unit that has to perform it [5].

Source: Own elaboration.

The dimension of search routines: The objective of these routines is to elicit and generate desirable alterations to previously established operating routines in such a way as

to increase future profits (Table 6) [5]. These can be found as organizational functions aimed at learning and change in a specific department, such as innovation and development, marketing, or human resources, or as processes that are requested in response to a need or problem, so that an individual, a committee, a working group, or a consultant studies and analyzes them [38].

Table 6. Dimension of search routines.

Dimension	Subdimension	Definition
Search routines	Active search	The search for knowledge can be a time-consuming activity, and managers often end their search for knowledge too early or rely on their own experience [39].
	Knowledge mobilization	Mobilize different knowledge components through the different functions, where several knowledge components are located [40].
	Modification or adaptation	(Re)architecture solutions, which were generated by exploring how to integrate knowledge, leverage, and develop their knowledge architecture competencies, which in turn allows them to design novel solutions [40].

Source: Own elaboration.

The previous theoretical review supports the construction of the instrument, since a theoretical framework was developed, from which the dimensions of knowledge conversion and routines emerged. Subsequently, subdimensions are identified to define the statements according to the practices of the organizations and to consider the knowledge spiral. These are evaluated by means of the semantic scale (see Table 9), to capture the subjective perceptions of the companies' collaborators.

Considering that the objective is to analyze the second-degree incidences of knowledge conversion in the routines of the collaborators who provided subjective information by means of the instrument, fuzzy methods are used for its treatment. These allow an understanding and comprehension of the meaning of the results, beyond generating a measurement of the results [19].

3. Methodology

This research analyzes the forgotten factors between the conversion of knowledge and the routines of collaborators in exporting companies in Boyacá, using subjective information. Thus, the research type and approach, the model of identification of the second-generation relationships, the description of the case study, and the organization of the subjective data are presented. The methods used to analyze the dataset deal with the subjective information of the collaborators, to correct the underestimation of the data and to obtain the accurate estimates.

3.1. Type and Approach

The present research is of an explanatory or causal type since it intends to establish the incidence of the forgotten factors in knowledge management through the conversion of knowledge and the routines of the personnel of the exporting companies of Boyaca. This section presents the model of forgotten or second-generation factors, the description of the case study, the organization of the subjective data and the methods to be used, which are the experton method, the adequacy coefficient, and forgotten effects theory.

3.2. Model for Finding Second-Generation Relationship

The realization of the model considered the theoretical review presented in the theoretical framework and the methods studied for the design (data collection, called criteria), the dimensions, the methods, and the results of the relationships, presented in Figure 1, establishing a logical sequence that allows aggregation for the treatment process. This process (Figure 1) contains three elements that determine how to find and establish the forgotten

factors. The first is the process, which sets out how second-generation relationships can be established. The second is a description that presents the processing of the information and the creation of the working model, where dimensions and the type of information to be collected were defined. The internal processing then considers the proposed methods; lastly, the new relationships found are shown. The third element describes the stages necessary to obtain the findings [41].
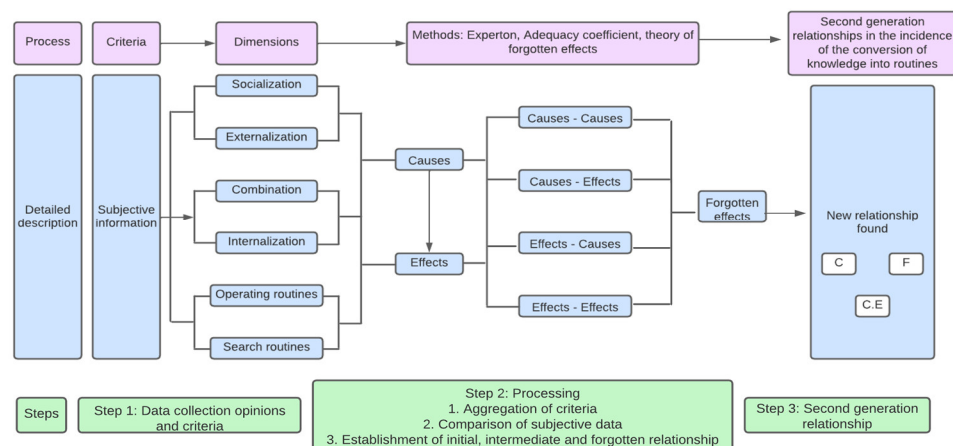

Figure 1. A second-generation relationship model in the incidence of the conversion of knowledge into routines. Source: Own elaboration based on the studies of Blanco-Mesa, Leon-Castro, and Castro-Amado [41].

The methods implement calculations and procedures to understand the variations within semantic scales, which are transformed into numerical values representative of the same, generating approximate relationships and relative explanations, creating a large number of possibilities [41].

Models used to search for ignored effects can generate multiple data, since they are often binary-valued systems (i.e., they are evaluated through numbers in [0,1] or confidence intervals of [0,1]), which represent the meaning given to the relationships and not a measure of the relationships in absolute terms [17]; that is, they do not consider the relationship between incidence and the linkage between different arguments that apparently have nothing in common. Indeed, the incidence of relationships is determined by intensity and linkage. Intensity considers the presence of a connecting agent in the relationships, making it possible to analyze the convergence of the boundary, periodicity, and non-standardized situations reflected in elements such as time, space, and possible connections [42]. On the other hand, linkage shows the direct and indirect connections in the relationships, analyzing variations in the intensities and strengths of the relationships to observe the behavior and the links that strengthen or weaken them, either in a period or in a sequence of stages [42].

3.3. Case Study

The target population of the study consisted of the collaborators in the exporting companies registered in the chamber of commerce of the department of Boyacá, Colombia. Chambers of commerce are private, nonprofit organizations that represent a group of companies and traders in a region, promoting competitiveness, formalization, and regional development, as well as serving as a consultative body on economic issues, among other characteristics [43]. The exporting companies in this study were registered in the chambers of commerce of Tunja and Sogamoso in the department of Boyacá, and were engaged in different economic activities, such as engineering activities, retail and wholesale trade of different products, legal activities, mixed exploitation (agriculture and livestock), data processing, medical activities, call centers, real estate activities, extraction of emeralds, and the processing and preservation of fruits, vegetables, and legumes.

Initially, the research proposed the participation of all the companies registered in the chambers of commerce in the department of Boyacá, but this was not possible due to different limitations. The first limitation was related to the fact that some companies, even though they are registered, had not carried out any commercial movement, i.e., they were never in operation. On the other hand, there were some difficulties in accessing companies registered with outdated data that prevented face-to-face, telephone, or electronic contact. Similarly, when contacted, some companies showed interest in participating in the research, but postponed the application of the instrument. Consequently, the instrument was applied to 40 collaborators in the 40 companies registered in the Tunja and Sogamoso chambers of commerce.

The instrument was applied in three stages. The first stage involved contacting the chambers of commerce to learn about the exporting companies registered in the region. In the second stage, the first contact was made with the collaborators by telephone and email to confirm their participation and to arrange for the link to the instrument to be sent by email or to be applied by telephone. In the third stage, the survey was carried out via telephone and email, where the link was sent and support was provided in resolving doubts and concerns about the instrument, and in person in some cases. Although the population was small, this did not affect the main objective, which was to analyze the incidence of forgotten factors in knowledge conversion in the routines of the personnel. This objective sought to make sense of the information but not to measure it [19]. Therefore, a fuzzy point of view was used to obtain the expected results.

3.4. Data Collection

An instrument was built according to the theory of organizational knowledge creation, which organizationally expands the knowledge created by people and connects it to the knowledge system of an organization, where tacit and explicit knowledge interact dynamically [12]. This instrument was implemented as a scale, considering the forgotten effects theory, since the intention of the study was to establish a causal relationship and to identify forgotten elements that are apparently not related [44–46]. Subsequently, for the treatment of the instrument and its validity, fuzzy methods, the experton method, and the adequacy coefficient were used. The use of fuzzy methods allows us to focus on the meaning of the results rather than on their measurement [19]. The experton method facilitates an understanding of the distribution and trend of the subjective opinions of the individuals, aggregating them to obtain an overall opinion. Lastly, the adequacy coefficient calculates the differences between two elements by neutralizing the real value when it exceeds the ideal value [41]. The causes and effects used in the study are presented below with their respective identifiers and statements (see Tables 7 and 8).

Table 7. Causes in the study.

Dimension	Indicator	Statement	Identifier
Socialization	Informal communication	Extra workspace	CI_EEL
		Spontaneous conversations in workspaces	CI_CEEL
	Social interactions	Business meetings	IS_RE
		After work conversations with bosses	IS_CEJ
		Interactions in different areas and positions	IS_IDAC
Externalization	Learning teams	Willingness to teach peers	EA_DEC
		Conversation of work topics	EA_CTL
		Teamwork	EA_TE
Combination	Information processing	Record of results	TI_RR
		Reports of work completed	TI_ITR
		Supplier knowledge	TI_CP
		Knowledge about clients	TI_CCL
	Dissemination of information	Access to organization information	DI_AIO
		Clear and understandable information	DI_ICE
		Access to information from other areas	DI_AIA

Table 7. *Cont.*

Dimension	Indicator	Statement	Identifier
Operating routines	Operating frequency	Permanent working group	FO_GTP
Internalization	Learning	Database discussion	AP_DBD
		Explanation of functions	AP_EF
Search routines	Active search	Problem communication	BA_CP
		Share doubts	BA_CD
		Ask for help in difficulties	BA_SAD
		Search for continuous improvement	BA_BMC
	Knowledge mobilization	Make some change	MC_RAC
		Interference in a different area	MC_IAD
	Modification or adaptation	Freedom to make changes	MA_LRC
		Agreements with the working group	MA_AGT

Source: Own elaboration.

Table 8. Effects in the study.

Dimension	Indicator	Statement	Identifier
Socialization	Informal communication	Peer relations	CI_RC
		Linguistic expression	CI_EL
		Everyday vocabulary	CI_VC
	Social interactions	Virtual meetings	IS_RV
		Personal conversations with my colleagues	IS_CPC
Externalization	Learning teams	Trainings	EA_C
		Share knowledge to other areas	EA_CCA
		Associate words or images	EA_API
		List of known concepts	EA_RCC
		Database	EA_BD
Combination	Information processing	Use of old reports	TI_UIA
	Dissemination of information	Sharing information with other areas	DI_CIA
		Share changes to collaborators	DI_CCC
Internalization	Learning	Implementation of manuals and documentation	AP_IMD
		Constant practice of functions	AP_PCF
		Problem resolution	AP_RP
Heterogeneity	Operating frequency	Consult the operation manuals	FO_CMO
		Constantly changing roles	FO_CFC
		Change of functions according to the area	FO_CFA
		Change in the way of performing functions	FO_CFRF
	Heterogeneity	Excessive number of tasks	H_CET
		Error anticipation	H_AE
Search routines	Active search	Identify actions to improve	BA_IAM
	Knowledge mobilization	Suggestions are valued	MC_SV
		A change involves all areas	MC_CIA
	Modification or adaptation	Improvements help other areas	MA_MAA
		Training improves my work	MA_CMT
		Adaptation of functions	MA_AF

Source: Own elaboration.

For the evaluation of the elements considered as cause and effect for knowledge conversion, routines and knowledge management are expressed on the scale in Table 9.

Table 9. Semantic scale.

SS	TD	SD	DI	I	AG	SA	TA
SC	0.14	0.29	0.43	0.57	0.71	0.86	1

Source: Own elaboration. SS: semantic scale, SC: standardization criteria, TD: totally disagree, SD: strongly disagree, DI: disagree, I: indifferent, AG: agree, SA: strongly agree, TA: totally agree.

After collecting the information, fuzzy methods, the experton method, and the adequacy coefficient were used for its treatment and validity. The approach was from a fuzzy perspective, using software such as FuzzyLog, which is a calculation program that elaborates and works with models on the basis of uncertainty mathematics to recover the so-called forgotten effects in causality relationships.

To achieve the research aim, three methodological phases are proposed, which give a logical order to the research process. In phase one, a review of the literature on knowledge management is carried out. To observe the context of these topics and their main advances in a holistic way, the Web of Science database is used. The following keywords are used in the search: knowledge creation, routines, and knowledge management. These results are then filtered under the concept of "management" so that the information is closer to the expected field of research. A theory of the creation of organizational knowledge, which has a dynamic model that expands through the interaction between tacit and explicit knowledge, was exposed by Nonaka and Takeuchi. Similarly, Nelson and Winter made important contributions to the concept of routines, which allowed the construction of the theoretical framework and the research methodology. In phase two, a scale instrument is implemented, which is treated with the forgotten effects theory, the experton method, and the adequacy coefficient. The information obtained is analyzed using FuzzyLog software. Lastly, in phase three, with the theoretical review complete, the data treatment is carried out and the preliminary conclusions obtained.

3.5. Methods

The present research employed different methods for data analysis, i.e., the experton method, the adequacy coefficient, and the theory of forgotten effects.

3.5.1. Experton Method

The experton method facilitates the addition of close or distant opinions as subjective uncertainty information [15]. The experton is a tool that uses fuzzy set theory and possibility analysis to unify information from different experts using a cumulative distribution function, which is obtained using linguistic expressions from a group of experts on an endecadary scale [0,1]. The experton method is defined as an extension of the probabilistic set, where the probability of each α-slice is replaced by a probability interval according to the experts. The structure of the formula is as follows:

$$\forall a \in E : \left[a^{j*}(a) \right], \left[a_{j*}(a) \right] \subset [0,1], \tag{1}$$

where $\subset$ is the inclusion set, and j represents the expert.

Derived from the fact that the experton method is an extension of the probabilistic set, it has the same characteristics, as follows:

- Non-strict horizontal increasing monotonicity property (i.e., the membership characteristic function of the positively sloping function is less than or equal to the characteristic function of the negative slope function).
- Non-strict vertical increasing monotonicity property, except at level 0, which always takes the value 1.

Thus,

$$\forall \alpha \in [0,1] : \alpha_1(a) \leq \alpha_2(a) \, en \, \alpha_1 [\alpha_1(a), \alpha_2(a)], \tag{2}$$

$$\forall \alpha \alpha' \in [0,1] : a' > a \Rightarrow (\alpha_1(a)) \le \alpha_1 a', \alpha_2(a) < a_2(a'), \tag{3}$$

$$(a = 0) \Rightarrow (a_1(a) = 1, a_2(a) = 1). \tag{4}$$

The variables must be evaluated, using a number $\alpha \in [0,1]$ or through confidence intervals.

- The individual opinions should be converted into an overall opinion of the group of individuals.
- The statistics are generated and the complementary cumulation law is applied.

The importance of the experton method lies in the fact that the distribution and trend of the subjective opinions can be determined and, in the end, aggregated to generate an overall opinion of the group.

3.5.2. Adequacy Coefficient

The notion of distance in the use of fuzzy subsets is based on the premise that every metric is always a distance, but not every distance is a metric [16]. Considering this premise, the adequacy coefficient is a measure of distance called infradistance, which determines appreciable differences by correcting the overestimation of information without being a given metric.

The adequacy coefficient [47,48] is an index that allows us to calculate the differences between two elements, which neutralizes the result when the comparison shows that the real element has a higher value than the ideal element. For the two elements A and B, the adequacy coefficient weight is defined below.

Definition 1. *A weighted adequacy coefficient of dimension n has a mapping of $K : [0,1]^n - x[0,1]^n \to [0,1]$ which has associated with it a weighting vector w of dimension n with the sum of the weights 1 y $w_j \in [0,1]$, such as*

$$K(\langle x_1, y_1 \rangle, \cdots, \langle x_n, y_n, \rangle) = \sum_{i=1}^{n} w_i [1 \wedge (1 - x_i + y_i)], \tag{5}$$

where x_j, y, and y_j are the i-th arguments of the elements X and Y.

3.5.3. Forgotten Effects Theory

The forgotten effects theory is based on the concept of incidence, which is a subjective notion linked to reasoned action. Incidence is studied based on a network of links that omit several stages and forget conclusions [17].

Therefore, its operation is focused on second-generation effects that make it possible to find the effects forgotten in the first instance. In this way, incidence is a remarkably subjective definition, and its analysis enhances reasoned action and decision making. There is an incidence a_i on b_j. Here, the values of the characteristic function of the pair (a_i, b_j) are valued between [0,1]:

$$\forall (a_i, b_j) \Rightarrow \mathcal{M}(a_i, b_j) \in [0,1]. \tag{6}$$

The direct incidence matrix is defined by the set of pairs of valued elements, which shows the cause–effect relationship that occurs in different degrees between the elements of set a (causes) and the elements of set b (effects):

$$\widetilde{M} = \begin{array}{c|cccc} & b_1 & b_2 & \cdots & b_j \\ \hline a_1 & u_{a_1 b_1} & u_{a_1 b_2} & \cdots & u_{a_1 b_j} \\ a_2 & u_{a_2 b_1} & u_{a_2 b_1} & \cdots & u_{a_2 b_j} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ a_i & u_{a_i b_1} & u_{a_1 b_2} & \cdots & u_{a_i b_j} \end{array}$$

All events show three ways of representing cause–effect relationships, which are denoted within the matrix of direct or first-order events. These relationships are considered when establishing the impact of some elements of one set on those of another.

3.6. Direct and Indirect Causal Relationship

It is possible to obtain hidden cause–effect relationships. Causal relationships are given by

$$\left[\widetilde{M}\right] = \left\{ Ma_jb_i \; \epsilon \; [0,1] \, / \, i = 1, 2, \ldots, n; j = 1, 2, \ldots, m \right\}. \tag{7}$$

According to $M_{a_ib_j}$, the characteristic function of the permanence of the elements of the matrix $[\widetilde{M}]$ is formed by the rows corresponding to the elements of set a (causes) and the columns corresponding to the elements of set b (effects). In fact, the matrix [M] is formed by the effects that the elements of set a have on set b. If $[\widetilde{M}]$ shows the first-generation cause–effect relationships, the next step is to obtain an incidence matrix reflecting the indirect relationships. To do this, it must be considered that the different causes can have effects on themselves, and that the effects can have incidences on themselves. Therefore, two additional relationships are created. Consequently, two auxiliary matrices are formulated and defined as square matrices:

$$[\widetilde{A}] = \left\{ Ma_ia_j \; \in \; [0,1] \; i, j = 1, 2, \ldots, n \right\}, \tag{8}$$

$$[\widetilde{B}] = \left\{ Mb_ib_j \; \in \; [0,1] \; i, j = 1, 2, \ldots, m \right\}, \tag{9}$$

where $[\widetilde{A}]$ collects the incidence relationships between the causes, and $[\widetilde{B}]$ does so on the effects. Both matrices are reflexive, and it is satisfied that $M_{a_ia_j} = 1 \; \forall \; i = 1, 2 \ldots, n$ and that $M_{b_ib_j} = 1 \; \forall \; i = 1, 2 \ldots, m$. This implies that any element, whether cause or effect, indicates with the maximum assumption about itself; thus, neither $[\widetilde{A}]$ nor $[\widetilde{B}]$ is a symmetric matrix. With the three matrices defined, the causal relationships between them must be established. Therefore, the maximum–minimum composition of the three matrices is given by $[\widetilde{A}] \circ [\widetilde{M}] \circ [\widetilde{B}] = [\widetilde{M}^*]$.

$$
\begin{array}{cccccc}
\rightarrow & a_1 & a_2 & \cdots & a_n \\
a_1 & 1 & u_{a_1a_2} & \cdots & u_{a_1a_n} \\
a_2 & u_{a_2a_1} & 1 & \cdots & u_{a_2a_n} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
a_n & u_{a_na_1} & u_{a_na_2} & \cdots & 1 \\
& & \left[\widetilde{A}\right]
\end{array}
\quad
\begin{array}{cccccc}
\rightarrow & b_1 & b_2 & \cdots & b_m \\
a_1 & 1 & u_{a_1b_2} & \cdots & u_{a_1b_m} \\
a_2 & u_{a_2b_1} & 1 & \cdots & u_{a_2b_m} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
a_n & u_{a_nb_1} & u_{a_nb_2} & \cdots & 1 \\
& & \left[\widetilde{M}\right]
\end{array}
\quad
\begin{array}{cccccc}
\rightarrow & b_1 & b_2 & \cdots & b_n \\
b_1 & 1 & u_{b_1b_2} & \cdots & u_{b_1b_m} \\
b_2 & u_{b_2b_1} & 1 & \cdots & u_{b_2b_m} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
b_m & u_{b_mb_1} & u_{b_mb_2} & \cdots & 1 \\
& & \left[\widetilde{B}\right]
\end{array}
$$

$$
= \quad
\begin{array}{ccccc}
\rightarrow & b_1 & b_2 & \cdots & b_m \\
a_1 & u_{a_1b_1} & u_{a_1b_2} & \cdots & u_{a_1b_m} \\
a_2 & u_{a_2b_1} & u_{a_2b_2} & \cdots & u_{a_2b_m} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
a_n & u_{a_nb_1} & u_{a_nb_2} & \cdots & u_{a_nb_m} \\
& & \left[\widetilde{M}^*\right]
\end{array}
$$

The degree of neglect of some causal relationships is given by the difference between the matrix of second-generation effects and the matrix of direct incidences: $\left[\widetilde{O}\right] = \left[\widetilde{M}^*\right] - \left[\widetilde{M}\right]$. Therefore, if the value of the characteristic function of the matrix elements $[\widetilde{O}]$ is high, the degree of forgetting in the initial incidence ratio is the highest.

$$
\left[\widetilde{O}\right] =
\begin{array}{c}
 \\
a_1 \\
a_2 \\
\vdots \\
a_n
\end{array}
\begin{array}{cccc}
\begin{array}{c} \rightarrow \end{array} & b_1 & b_2 & \cdots & b_m \\
& u^*_{a_1 b_1} - u_{a_1 b_1} & u^*_{a_1 b_2} - u_{a_1 b_2} & \cdots & u^*_{a_1 b_m} - u_{a_1 b_m} \\
& u^*_{a_2 b_1} - u_{a_2 b_1} & u^*_{a_2 b_2} - u_{a_2 b_2} & \cdots & u^*_{a_2 b_m} - u_{a_2 b_m} \\
& \vdots & \vdots & \vdots & \vdots \\
& u^*_{a_n b_1} - u_{a_n b_1} & u^*_{a_n b_2} - u_{a_n b_2} & \cdots & u^*_{a_n b_m} - u_{a_n b_m}
\end{array}
$$

4. Results

4.1. Knowledge Conversion

Figure 2 describes incidences C14 (the information provided by the company is clear and understandable) and E16 (the information provided by the company has allowed me to solve problems and create solutions), which have a forgotten effect equal to one, indicating that there is no direct relationship between cause and effect. The entry of collaborators into companies implies the transfer of explicit knowledge in a clear and understandable way, which requires time, especially in the detailed description of the functions of each collaborator, with the purpose that this becomes tacit knowledge in the future. This is a challenge for organizations; therefore, by structuring the company in teams based on learning, strategies are implemented that relate the thoughts and concepts known by each of the collaborators. It is possible to have a mutual understanding that allows a process to be executed whereby tacit knowledge becomes explicit and permits this information to contribute to problem solving. This is a strategic competitive factor for the exporting companies in Boyacá, in which tacit knowledge plays a fundamental role [14].

Figure 2. Incidence between information dissemination and learning $C_{14} \rightarrow E_{16}$. Source: Own elaboration. C_{14} DI_ICE: The information provided by the company is clear and understandable; C_{17} AP_EF: Upon joining the organization, they took the time to clearly explain my functions to me; E_9 EA_RCC: I relate known concepts to express what I know; E_{16} AP_RP: The information provided by the company has allowed me to solve problems and create solutions. Initially estimated value: 0.99. Accumulated value cause–effect: 1. Difference of values (forgotten effect): 1. Relevant interposed key relationship: AP_EF.

Figure 3 describes incidences C16 (I am motivated to discuss databases, documentation, and manuals, among others, with my colleagues) and E2 (sometimes I do not know how to express what I think in words), which have a forgotten effect equal to one, indicating that there is no direct relationship between cause and effect. The starting point is based on the internalization process, where collaborators could transfer explicit knowledge to tacit knowledge through the discussion of codified knowledge [11]. Therefore, the key relationship is the recording of improvements in a database. However, the effect of this

process refers to the difficulty for employees to express their thoughts in words, constituting a disadvantage in socialization [12].

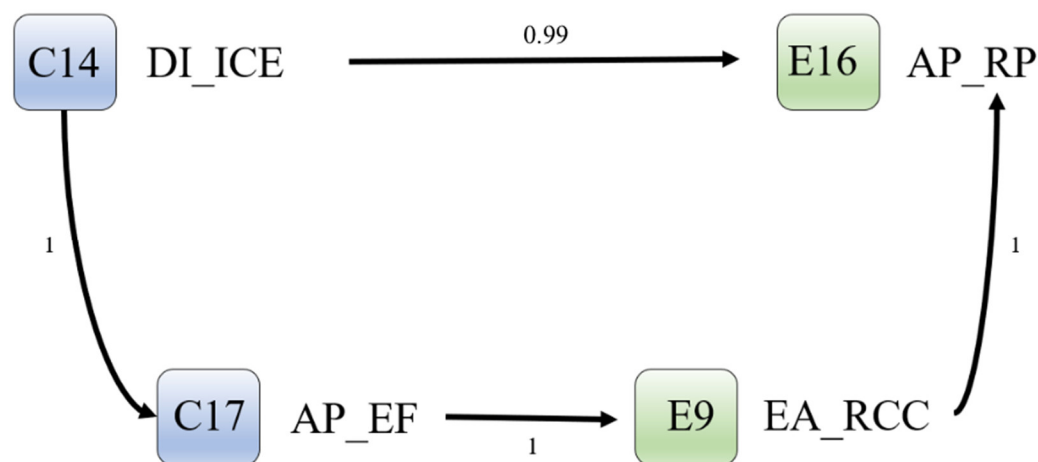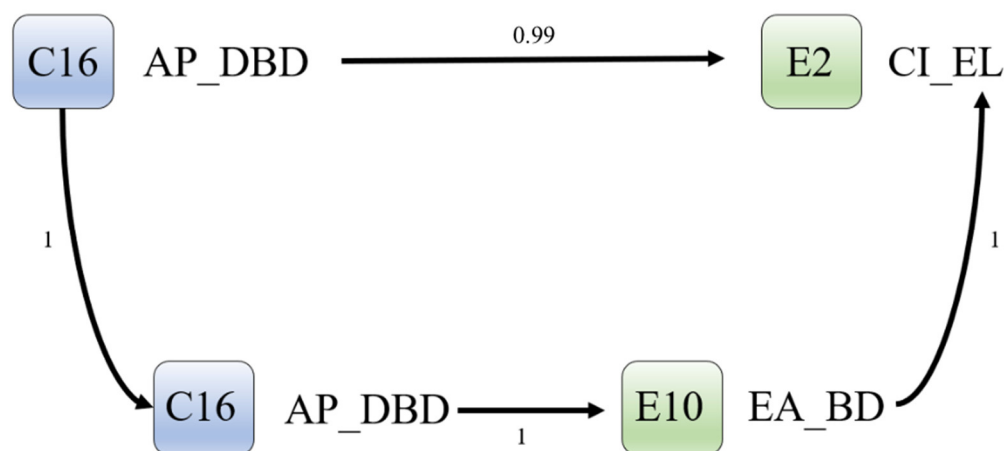**Figure 3.** Incidence between information dissemination and learning $C_{16} \rightarrow E_2$. Source: Own elaboration. C_{16} AP_DBD: They motivate me to discuss databases, documentation, and manuals, among others, with my colleagues; E_{10} EA_BD: My work team records improvement ideas in a database; E_2 CI_EL: Sometimes I do not know how to express what I think in words. Initially estimated value: 0.99. Accumulated value cause–effect: 1. Difference of values (forgotten effect): 1. Relevant interposed key relationship: AP_DBD.

4.2. Routines

Figure 4 describes incidences C1 (my work group is always the same) and E9 (when making a change in each area, the company involves all its personnel), which have a forgotten effect close to one (0.8), indicating that there is no direct relationship between cause and effect. The starting point is the high operational frequency of the work group; that is, generally, the collaborators keep the same team in the long term. In this case, when there is freedom to make changes, either because the execution of the routines is not achieving an expected or desired result, or because such results do not reveal new possibilities, the collaborators will try to repair or improve the routine, affecting other areas of the company. This can expand the repertoire of modification or adaptation, considering that there are more environments involved [5].

Figure 5 describes incidences C6 (forbidden to make any change, both in the tasks I perform and in the way I execute them) and E9 (a change involves all the personnel in the area), which have a forgotten effect close to one (0.8), indicating that there is no direct relationship between cause and effect. In organizations, there is an established routine, which does not allow employees to make changes in their functions. However, often, there are both small and large disturbances. The former is absorbed by the different members of the company, and the latter highlights the differences that exist in the interpretations of the routine in each area, considering that these bring with them understandings and motivations. Therefore, interferences, interactions, and the dynamics of knowledge in the different areas are necessary. In addition, organizations have exceptions at specific times and moments, since these changes can shape the adoption, persistence, or mobilization of routines, resulting in improvements that can be useful in other areas and, in the same way, involve the collaborators who interact in them [5].
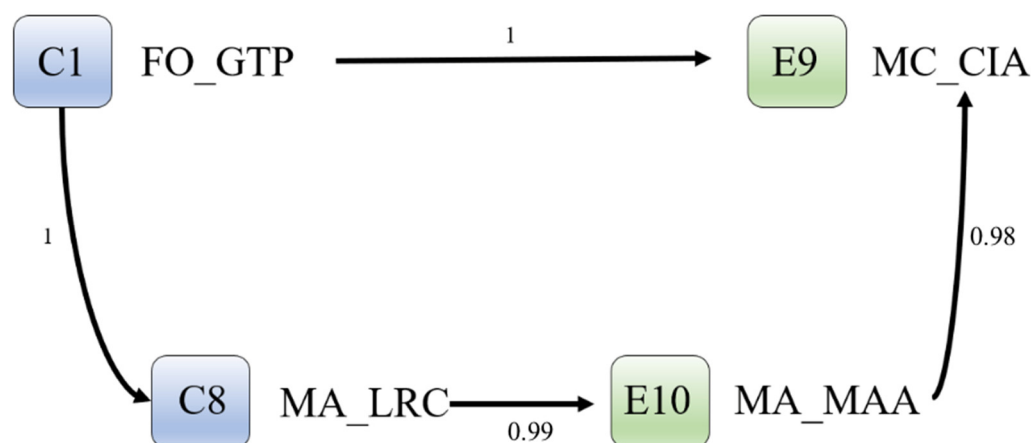
Figure 4. Incidences between operating frequency and mobilization of knowledge $C_1 \rightarrow E_9$. Source: Own elaboration. C_1 FO_GTP: My working group is always the same; C_8 MA_LRC: I am free to make changes to my process when I deem it necessary; E_{10} MA_MAA: The improvements that I implemented in my work helped other areas of the company; E_9 MC_CIA: When making a change in a certain area, the company involves all its personnel. Initially estimated value: 1. Cumulative cause–effect value: 0.98. Value difference (forgotten effect): 0.8. Relevant interposed key relationship: MA_LRC.
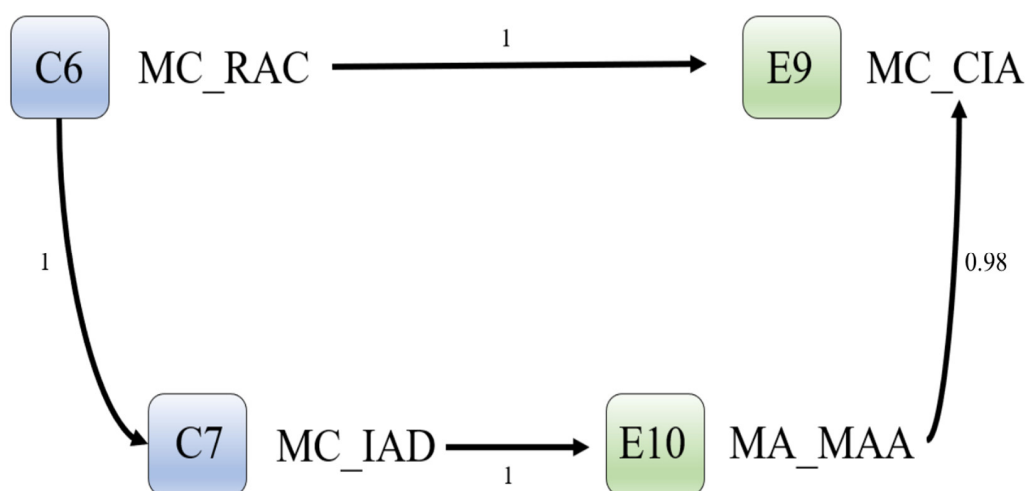
Figure 5. Incidence of knowledge mobilization $C_6 \rightarrow E_9$. Source: Own elaboration. C_6 MC_RAC: I am prohibited from making any changes, both in the tasks I perform and in the way I execute them; C_7 MC_IAD: I cannot interfere in an area other than mine, unless the company allows me to; E_{10} MA_MAA: The improvements that I implemented in my work helped other areas of the company; E_9 MC_CIA: When making a change in a certain area, the company involves all its personnel. Initially estimated value: 1. Cumulative cause–effect value: 0.98. Value difference (forgotten effect): 0.8. Relevant interposed key relationship: MC_IAD.

4.3. Knowledge Management

On the basis of the theoretical concepts and different tests performed in the FuzzyLog program, the dimensions of socialization, internalization, and search routines are found as cause and effect, specifically the variables of informal communication, social interactions, learning, and active search (Table 10). Among them, the causal relationships between knowledge conversion and routines that presented forgotten effects the most are E_2 (sometimes I do not know how to express what I think in words) and E_4 (in virtual meetings, I feel it is more difficult to express myself than personally).

Table 10. Causes and effects of knowledge management.

Causes						
V	D	I	S	Id	T	Ex
Knowledge conversion	Socialization	Informal communication	Extra workspace	CI_EEL	C1	0.759
			Spontaneous conversations in workspaces	CI_CEEL	C2	0.763
		Social interactions	Business meetings	IS_RE	C3	0.806
			After work conversations with bosses	IS_CEJ	C4	0.753
			Interactions in different areas and positions	IS_IDAC	C5	0.791
	Internalization	Learning	Database discussion	AP_DBD	C6	0.716
			Explanation of functions	AP_EF	C7	0.825
Routines	Search routines	Active search	Problem communication	BA_CP	C8	0.806
			Share doubts	BA_CD	C9	0.803
			Ask for help in difficulties	BA_SAD	C10	0.781
			Search for continuous improvement	BA_BMC	C11	0.797
Effects						
V	D	I	S	Id	T	Ex
Knowledge conversion	Socialization	Informal communication	Peer relations	CI_RC	E1	0.781
			Linguistic expression	CI_EL	E2	0.672
		Social interactions	Everyday vocabulary	CI_VC	E3	0.781
			Virtual meetings	IS_RV	E4	0.663
			Personal conversations with my colleagues	IS_CPC	E5	0.800
	Internalization	Learning	Implementation of manuals and documentation	AP_IMD	E6	0.759
			Constant practice of functions	AP_PCF	E7	0.859
			Problem resolution	AP_RP	E8	0.822
Routines	Search routines	Active search	Identify actions to improve	BA_IAM	E9	0.806

Source: Own elaboration. V: variable; D: dimension; I: indicator; S: statement; Id: identifier; T: type; Ex: expert.

Consequently, the fractured routes of incidence were identified for each of the effects, i.e., one was chosen for socialization, another for internalization, and one for search routines for both informal communication and social interactions, considering that this is where the greatest number of forgotten effects occurred.

In informal communication, with respect to socialization, case 32 was selected, where the causes are IS_RE and AP_DBD, and the effects are AP_IMD and CI_EL. In the case of internalization, case 33 was chosen, where the causes are AP_DBD and BA_CD, and the effects are AP_RP and CI_EL. In search routines, case 19 was chosen, where the causes are BA_SAD and BA_CD, and the effects are AP_RP and CI_EL. In social interactions, case 4 was selected for socialization, with IS_RE as cause, and IS_CPC and IS_RV as effects. For internalization, case 6 was chosen, in which the cause is AP_DBD, and the effects are AP_IMD and IS_RV. For the search routines, case 4 was chosen, in which the causes are BA_SAD and BA_CD, and the effects are IS_CPC and IS_RV.

5. Discussion

The results show the most relevant factors in the knowledge conversion and routines of the collaborators in exporting companies in Boyacá. The incidences between the causes

and effects of both knowledge conversion and routines were observed using mathematical tools based on fuzzy models, which establish second-generation relationships between factors that apparently had no evident relationship. The research revealed the incidences in knowledge management by means of the forgotten factors between knowledge conversion and routines, evidencing that the effects that most presented forgetfulness are part of informal communication and social interactions, i.e., that these indicators represent the key route of the incidence, which manifested a fractured route for knowledge management in the Boyacá exporting companies, specifically in the capacity to express linguistically and in a virtual way. This fracture refers to the difficulty of sharing and disseminating tacit knowledge electronically, once it has been produced and appropriated by collaborators. In other words, one of the elements that characterizes tacit knowledge is that people are not aware of its full range, as, once it is internalized, it becomes a natural part of one's behavior or way of thinking [48]; hence, it is more difficult to specify and to express.

Knowledge Management

The knowledge management model showed that the effects presenting the highest number of forgotten effects were part of informal communication (E_2) and social interactions (E_4), and that in these variables, there was a fractured route in the incidences, which hinders the process of knowledge creation. By virtue of this, it can be observed that the system presented 129 alternative routes for E_2 and 29 for E_4 (see Table 11).

Table 11. Number of alternative routes for knowledge management.

	Socialization	Internalization	Search Routines	Total
Informal communication (E_2)	55	44	30	129
Social interactions (E_4)	13	10	6	29

Source: Own elaboration.

According to the FuzzyLog results, one case was selected for socialization, one for internalization, and one for search routines, and, both for informal communication and socialization, considering the cases that were most consistent with the theoretical framework (see Tables 12 and 13). These relationships show that, in informal communication, the causes are part of socialization, internalization, and search routines, which are positive statements, since they refer to situations where employees have the freedom to express their opinions and doubts, discuss codified information, and feel confident enough to ask for help. These causes generated common effects, which are part of learning and informal communication. The effects of learning are favorable, considering that they are based on improvement and problem solving, while the effects that are part of informal communication represent a disadvantage, as it is difficult for employees to express what they think to their colleagues.

This means that organizations have tried to apply collaborative exchange mechanisms that promote the capture, representation, and application of knowledge, improving individual learning [49]. However, the effect of informal communication presented a disadvantage in the linguistic expression of tacit knowledge, evidencing the difficulty of externalizing the level of understanding with words. Consequently, even though the collaborators have the capacity and ability to solve problems, no practices have been developed in socialization for individuals to communicate their ideas, confirming the definition that Michael Polanyi gave to tacit knowledge: "We can know more than we can say" [31].

With respect to relationships in social interactions, the causes reflected are part of social interactions, learning, and active search, showing that there is a deepening in the behavior, emotion (socialization), and cognition (internalization) of the collaborators, which allows an understanding of the daily implementation of routines in the different areas [50]. These causes triggered effects that promoted knowledge conversion and others that limited it. On one hand, the understanding of routines, the discussion of explicit information, and group

interactions made possible the connection of individual capabilities with those of employees and managers, resulting in improved functions and spontaneous collaborative exchanges. However, the common effect in the three dimensions reflected the difficulty for employees to express themselves virtually, proving one of the most debated characteristics of tacit knowledge, which states that sharing tacit knowledge through information technology systems is extremely difficult, considering that disseminating tacit knowledge in an explicit and objective way prevents it from being shared electronically [29].

Table 12. Alternate routes of informal communication.

Informal Communication		
Socialization	Internalization	Search routines
Causes		
IS_RE In business meetings, they allow me to express my opinions and share my experiences	AP_DBD They motivate me to discuss databases, documentation, manuals, among others with my colleagues	BA_SAD I ask my bosses for help when I have difficulties in carrying out my work
AP_DBD They motivate me to discuss databases, documentation, manuals, among others with my colleagues	BA_CD I share my doubts with colleagues from other departments to resolve them	BA_CD I share my doubts with colleagues from other departments to resolve them
Effects		
AP_IMD Through the implementation of manuals and documentation, among other reports, I have improved the execution of my functions	AP_RP The information provided by the company has allowed me to solve problems and create solutions	AP_RP The information provided by the company has allowed me to solve problems and create solutions
CI_EL Sometimes I do not know how to express what I think in words	CI_EL Sometimes I do not know how to express what I think in words	CI_EL Sometimes I do not know how to express what I think in words

Source: Own elaboration.

Table 13. Alternate routes of social interactions.

Social Interactions		
Socialization	Internalization	Search routines
Causes		
IS_RE In business meetings, they allow me to express my opinions and share my experiences	AP_DBD They motivate me to discuss databases, documentation, and manuals, among others, with my colleagues	BA_SAD I ask my bosses for help when I have difficulties in carrying out my work
		BA_CD I share my doubts with colleagues from other departments to resolve them
Effects		
IS_CPC Personal conversations with my colleagues allow me to give my opinions in a more open and relaxed way	Through the implementation of manuals and documentation, among other reports, I have improved the execution of my functions	IS_CPC Personal conversations with my colleagues allow me to give my opinions in a more open and relaxed way
IS_RV In virtual meetings, I feel that it is more difficult to express myself than personally	IS_RV In virtual meetings, I feel that it is more difficult to express myself than personally	IS_RV In virtual meetings, I feel that it is more difficult to express myself than personally

Source: Own elaboration.

Considering the above relationships, Figure 6 is presented, which exemplifies the second-order incidences for knowledge management. Area one (A1) shows the incidences between knowledge conversion and routines, and the key route of incidence, through informal communication and social interactions. On the other hand, area two (A2) presents a fractured route for knowledge management, i.e., the different constraints found in Boyacá's exporting companies.
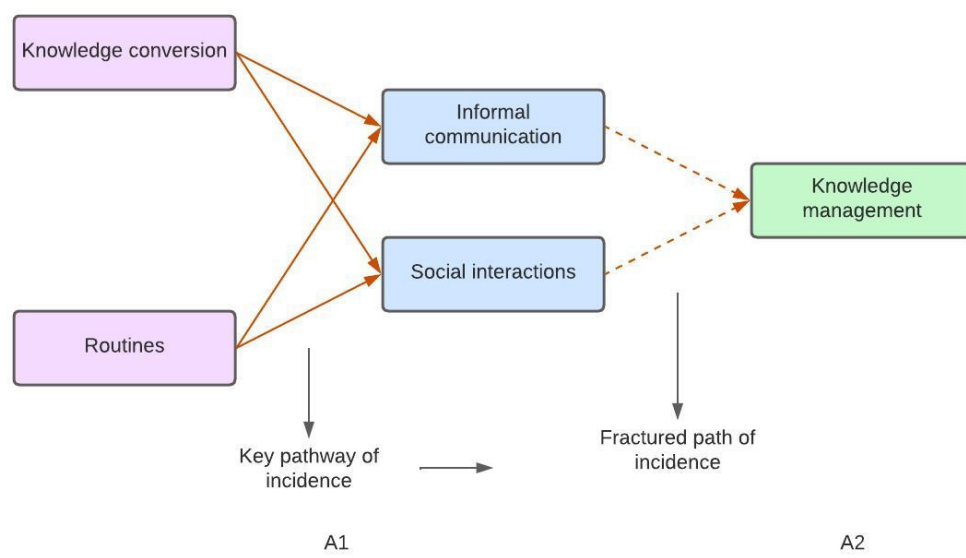
Figure 6. Second-order incidents for knowledge management. Source: Own elaboration.

6. Conclusions

This research summarizes the theory related to knowledge management, knowledge conversion, and routines. A model is applied to identify the second-degree relationships between knowledge conversion and routines in exporting companies. This model deals with subjective information by means of internal processing, considering the proposed methods, which are the experton method, the adequacy coefficient, and the forgotten effects theory [17]. The notion of expertons contributes to foresight in situations where there is a lack of information [51]. The notion of distance used in the adequacy coefficient, called infradistance, makes it possible to determine the appreciable differences, correcting the overestimation of information without a given metric. The notion of incidences facilitates study of the basis of a network of links that omit several stages and forget the conclusions [17]. In this sense, the methods used make it possible to aggregate the subjective criteria of the collaborators, correct the underestimation of the data to obtain the true estimates, and determine the second-generation incidences.

The case study focused on exporting companies registered with the Tunja and Sogamoso chambers of commerce. The collaborators occupy different positions, reflecting the diversity and heterogeneity in the instrument. The findings allow us to observe incidences in the conversion of knowledge, which show that, in the causes, the four pillars of the knowledge spiral are present. Meanwhile, in the effects generated and the alternative route proposed, socialization, externalization, and internalization prevail in a positive way, specifically informal communication, social interactions, learning teams, and learning.

The relationships found in the routines were revealed as causes of the operational frequency in the routines and the mobilization of knowledge. These triggered favorable common effects that are part of the search routines dimension, showing that the improvements implemented by the collaborators helped other areas and, in the same way, involved the personnel who produced the change. For these relationships, different alternative routes were projected, where the indicators of modification or adaptation, knowledge mobilization, and operational frequency prevailed.

The results obtained can help us to understand both the virtues and the fractures that exist in the knowledge management process, offering a vision of knowledge spiral development within organizations. Thus, the practical implications of the research can help to guide the practices of socialization, externalization, combination, and internalization in the routines of individuals to foster knowledge creation. On the other hand, the theoretical implications of the study refer to the findings of incidence among knowledge management, knowledge conversion, and routines, where a relationship was found among the four components of the SECI model, search routines, and operational routines, showing that knowledge creation is a daily organizational issue, and that it is present in each area of the company.

The advantage of using the proposed method is that it is an effective alternative for dealing with subjective information, which is complex for traditional methods to process. For this reason, this method enables the implementation of subjective criteria, and correction of the overestimates that may occur when comparing the values given with those established to obtain the true estimates. Lastly, it makes it possible to determine second-generation cause–effect incidences to find and analyze hidden relationships.

The limitations of the research are associated with the size of the sample, as the number of respondents was small; therefore, being subjective data, the results are based on the subjective perceptions of the employees, focusing on a specific reality that cannot be generalized. Consequently, the population that could be contacted and that applied the instrument totaled 40 employees in the 40 exporting companies.

When using these methodologies, it should be remembered that the results obtained depend on the semantic configuration of the research design, where academic, cultural, and social aspects influence the manner in which we communicate. In this sense, the methods do not allow us to accurately capture these semantic nuances, and a careful prior design must be made. Similarly, it should be considered that fuzzy methods allow us to deal with soft data; thus, their results are flexible in their interpretation with a solid formal methodological structure. Hence, these methods give greater relevance to the meaning of the statements than to the measurement that can be derived from them [19].

Lastly, as recommendations for future research, from a methodological point of view, an analysis of the causes and effects is necessary to achieve a better diagnosis and guide to business decision making. From an academic perspective, it is important to carry out a deeper analysis of each of the pillars of the knowledge spiral individually in exporting companies belonging to different regions of the country, especially in socialization, social interactions (linguistic expression), and informal communication (electronic meetings).

Appendix A Experton Method Calculus

Table A1. Experton method.

FT	α	CI1	CI2	CI3	CI4	CI5	IS1	IS2	IS3	IS4	IS5	EA1	EA2	EA3	EA4	EA5	EA6	EA7	EA8	TI1	TI2	TI3	TI4	TI5	DI1	DI2	DI3	DI4	DI5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.14	1	1	0	5	0	0	3	1	2	1	1	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	1
2	0.29	2	1	0	0	0	1	3	0	0	1	0	0	0	0	0	0	2	0	1	0	1	0	0	0	0	0	0	0
3	0.43	0	1	2	4	1	0	2	0	1	0	4	0	0	0	0	0	1	0	3	1	4	3	0	0	0	0	0	0
4	0.57	0	1	1	3	1	2	10	0	3	1	1	0	1	0	2	0	6	0	7	6	5	6	2	0	1	0	2	0
5	0.71	28	25	25	22	29	21	16	25	24	24	20	8	12	26	26	25	24	17	21	21	19	25	22	22	18	20	24	22
6	0.86	5	8	9	6	5	9	5	8	6	5	8	23	20	8	6	7	3	11	3	6	3	5	12	9	16	12	9	12
7	1	4	3	3	0	4	7	1	6	4	8	6	9	7	6	6	8	3	10	5	6	8	1	4	9	5	8	4	5
		40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
RFT	α	CI1	CI2	CI3	CI4	CI5	IS1	IS2	IS3	IS4	IS5	EA1	EA2	EA3	EA4	EA5	EA6	EA7	EA8	TI1	TI2	TI3	TI4	TI5	DI1	DI2	DI3	DI4	DI5
0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1	0.1428	0.025	0.025	0.000	0.125	0.000	0.000	0.075	0.025	0.050	0.025	0.025	0.000	0.000	0.000	0.000	0.000	0.025	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.025	0.025
2	0.2856	0.050	0.025	0.000	0.000	0.000	0.025	0.075	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.000	0.025	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.4284	0.000	0.025	0.050	0.100	0.025	0.000	0.050	0.000	0.025	0.000	0.100	0.000	0.000	0.000	0.000	0.000	0.025	0.000	0.075	0.025	0.100	0.075	0.000	0.000	0.000	0.000	0.000	0.000
4	0.5712	0.000	0.025	0.025	0.075	0.025	0.050	0.250	0.000	0.075	0.025	0.025	0.000	0.025	0.000	0.050	0.000	0.150	0.000	0.175	0.150	0.125	0.150	0.050	0.000	0.025	0.000	0.050	0.000
5	0.714	0.700	0.625	0.625	0.550	0.725	0.525	0.400	0.625	0.600	0.600	0.500	0.200	0.300	0.650	0.650	0.625	0.600	0.425	0.525	0.525	0.475	0.625	0.550	0.550	0.450	0.500	0.600	0.550
6	0.8568	0.125	0.200	0.225	0.150	0.125	0.225	0.125	0.200	0.150	0.125	0.200	0.575	0.500	0.200	0.150	0.175	0.075	0.275	0.075	0.150	0.075	0.125	0.300	0.225	0.400	0.300	0.225	0.300
7	1	0.100	0.075	0.075	0.000	0.100	0.175	0.025	0.150	0.100	0.200	0.150	0.225	0.175	0.150	0.150	0.200	0.075	0.250	0.125	0.150	0.200	0.025	0.100	0.225	0.125	0.200	0.100	0.125
AFT	α	CI1	CI2	CI3	CI4	CI5	IS1	IS2	IS3	IS4	IS5	EA1	EA2	EA3	EA4	EA5	EA6	EA7	EA8	TI1	TI2	TI3	TI4	TI5	DI1	DI2	DI3	DI4	DI5
0	0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1	0.1428	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	0.2856	0.975	0.975	1.000	0.875	1.000	1.000	0.925	0.975	0.950	0.975	0.975	1.000	1.000	1.000	1.000	1.000	0.975	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.975	0.975
3	0.4284	0.925	0.950	1.000	0.875	1.000	0.975	0.850	0.975	0.950	0.950	0.975	1.000	1.000	1.000	1.000	1.000	0.925	0.950	0.975	1.000	0.975	1.000	1.000	1.000	1.000	1.000	0.975	0.975
4	0.5712	0.925	0.925	0.950	0.775	0.975	0.975	0.800	0.975	0.925	0.950	0.875	1.000	1.000	1.000	1.000	1.000	0.900	0.950	0.900	0.975	0.875	0.925	1.000	1.000	1.000	1.000	0.975	0.975

Table A1. *Cont.*

AFT	α	CI1	CI2	CI3	CI4	CI5	IS1	IS2	IS3	IS4	IS5	EA1	EA2	EA3	EA4	EA5	EA6	EA7	EA8	TI1	TI2	TI3	TI4	TI5	DI1	DI2	DI3	DI4	DI5
5	0.714	0.925	0.900	0.925	0.700	0.950	0.925	0.550	0.975	0.850	0.925	0.850	1.000	0.975	1.000	0.950	1.000	0.750	0.950	0.725	0.825	0.750	0.775	0.950	1.000	0.975	1.000	0.925	0.975
6	0.8568	0.225	0.275	0.300	0.150	0.225	0.400	0.150	0.350	0.250	0.325	0.350	0.800	0.675	0.350	0.300	0.375	0.150	0.525	0.200	0.300	0.275	0.150	0.400	0.450	0.525	0.500	0.325	0.425
7	1	0.100	0.075	0.075	0.000	0.100	0.175	0.025	0.150	0.100	0.200	0.150	0.225	0.175	0.150	0.150	0.200	0.075	0.250	0.125	0.150	0.200	0.025	0.100	0.225	0.125	0.200	0.100	0.125
Exp		0.759	0.763	0.781	0.672	0.781	0.806	0.663	0.800	0.753	0.791	0.772	0.878	0.853	0.813	0.800	0.822	0.722	0.822	0.741	0.781	0.759	0.734	0.806	0.834	0.828	0.838	0.784	0.806

AP1	AP2	AP3	AP4	AP5	FO1	FO2	FO3	FO4	FO5	H1	H2	BA1	BA2	BA3	BA4	BA5	MC1	MC2	MC3	MC4	MA1	MA2	MA3	MA4	MA5
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	2	3	0	4	2	2	0	0	0	0	0	3	1	5	1	0	0	0	1	7
0	0	1	0	0	3	6	3	1	6	6	6	0	0	0	1	1	3	1	1	2	0	0	0	0	5
3	0	3	1	1	14	20	21	13	21	19	17	0	0	0	0	1	4	0	1	3	1	2	0	0	19
7	0	10	1	0	11	7	7	7	7	7	6	0	0	1	1	0	16	11	8	4	17	3	0	7	1
20	14	19	15	18	9	5	6	13	1	5	8	28	28	25	29	25	9	15	21	23	11	23	24	23	8
4	17	6	19	17	1	0	0	4	1	1	0	6	7	9	4	6	1	5	3	3	5	6	10	4	0
6	9	1	4	4	0	0	0	2	0	0	1	6	5	5	5	7	4	7	1	4	6	6	6	5	0
40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40

AP1	AP2	AP3	AP4	AP5	FO1	FO2	FO3	FO4	FO5	H1	H2	BA1	BA2	BA3	BA4	BA5	MC1	MC2	MC3	MC4	MA1	MA2	MA3	MA4	MA5
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.075	0.000	0.100	0.050	0.050	0.000	0.000	0.000	0.000	0.000	0.075	0.025	0.125	0.025	0.000	0.000	0.000	0.025	0.175
0.000	0.000	0.025	0.000	0.000	0.075	0.150	0.075	0.025	0.150	0.150	0.150	0.000	0.000	0.000	0.025	0.025	0.075	0.025	0.025	0.050	0.000	0.000	0.000	0.000	0.125
0.075	0.000	0.075	0.025	0.025	0.350	0.500	0.525	0.325	0.525	0.475	0.425	0.000	0.000	0.000	0.000	0.025	0.100	0.000	0.025	0.075	0.025	0.050	0.000	0.000	0.475
0.175	0.000	0.250	0.025	0.000	0.275	0.175	0.175	0.175	0.175	0.175	0.150	0.000	0.000	0.025	0.025	0.000	0.400	0.275	0.200	0.100	0.425	0.075	0.000	0.175	0.025
0.500	0.350	0.475	0.375	0.450	0.225	0.125	0.150	0.325	0.025	0.125	0.200	0.700	0.700	0.625	0.725	0.625	0.225	0.375	0.525	0.575	0.275	0.575	0.600	0.575	0.200
0.100	0.425	0.150	0.475	0.425	0.025	0.000	0.000	0.100	0.025	0.025	0.000	0.150	0.175	0.225	0.100	0.150	0.025	0.125	0.075	0.075	0.125	0.150	0.250	0.100	0.000
0.150	0.225	0.025	0.100	0.100	0.000	0.000	0.000	0.050	0.000	0.000	0.025	0.150	0.125	0.125	0.125	0.175	0.100	0.175	0.025	0.100	0.150	0.150	0.150	0.125	0.000

AP1	AP2	AP3	AP4	AP5	FO1	FO2	FO3	FO4	FO5	H1	H2	BA1	BA2	BA3	BA4	BA5	MC1	MC2	MC3	MC4	MA1	MA2	MA3	MA4	MA5
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table A1. *Cont.*

AFT	α	CI1	CI2	CI3	CI4	CI5	IS1	IS2	IS3	IS4	IS5	EA1	EA2	EA3	EA4	EA5	EA6	EA7	EA8	TI1	TI2	TI3	TI4	TI5	DI1	DI2	DI3	DI4	DI5
1.000	1.000	1.000	1.000	1.000	0.950	0.950	0.925	1.000	0.900	0.950	0.950	1.000	1.000	1.000	1.000	1.000	0.925	0.975	0.875	0.975	1.000	1.000	1.000	0.975	0.825				
1.000	1.000	0.975	1.000	1.000	0.875	0.800	0.850	0.975	0.750	0.800	0.800	1.000	1.000	1.000	0.975	0.975	0.850	0.950	0.850	0.925	1.000	1.000	1.000	0.975	0.700				
0.925	1.000	0.900	0.975	0.975	0.525	0.300	0.325	0.650	0.225	0.325	0.375	1.000	1.000	1.000	0.975	0.950	0.750	0.950	0.825	0.850	0.975	0.950	1.000	0.975	0.225				
0.750	1.000	0.650	0.950	0.975	0.250	0.125	0.150	0.475	0.050	0.150	0.225	1.000	1.000	0.975	0.950	0.950	0.350	0.675	0.625	0.750	0.550	0.875	1.000	0.800	0.200				
0.250	0.650	0.175	0.575	0.525	0.025	0.000	0.000	0.150	0.025	0.025	0.025	0.300	0.300	0.350	0.225	0.325	0.125	0.300	0.100	0.175	0.275	0.300	0.400	0.225	0.000				
0.150	0.225	0.025	0.100	0.100	0.000	0.000	0.000	0.050	0.000	0.000	0.025	0.150	0.125	0.125	0.125	0.175	0.100	0.175	0.025	0.100	0.150	0.150	0.150	0.125	0.000				
0.759	0.859	0.716	0.825	0.822	0.578	0.522	0.531	0.663	0.494	0.531	0.550	0.806	0.803	0.806	0.781	0.797	0.638	0.753	0.663	0.722	0.744	0.784	0.819	0.759	0.494				

FT: Frequency table; RFT: Relative Frequency Table; AFT: Accumulated Frequency Table; Exp: Experton.

Appendix B Adequacy Coefficient Method to Find Cause–Effect, Cause–Cause, and Effect–Effect Matrices to Conversion Knowledge and Routines

Table A2. Cause–effect matrix to conversion knowledge.

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
C1	1	0.9	1	0.90	1	1	1	1	1	1	1	1	1	1	1	1
C2	1	0.9	1	0.90	1	1	1	1	1	1	1	1	1	1	1	1
C3	1	0.9	1	0.9	0.99	1	1	0.99	1	0.9	1	1	1	1	1	1
C4	1	0.9	1	0.9	1	1	1	1	1	1	1	1	1	1	1	1
C5	1	0.9	1	0.9	1	1	1	1	1	0.9	1	1	1	1	1	1
C6	0.90	0.8	0.90	0.8	0.92	0.9	1	0.92	0.9	0.8	0.90	1	0.9	0.9	1	0.9
C7	1	0.9	1	0.9	0.99	1	1	0.99	1	0.9	1	1	1	0.9	1	1
C8	1	0.9	1	0.8	0.98	1	1	0.98	1	0.90	1	1	1	0.9	1	1
C9	1	0.9	1	0.9	1	1	1	1	1	1	1	1	1	1	1	1
C10	1	0.9	1	0.90	1	1	1	1	1	1	1	1	1	1	1	1
C11	1	0.9	1	0.9	1	1	1	1	1	1	1	1	1	1	1	1
C12	1	0.9	1	0.9	0.99	1	1	0.99	1	0.9	1	1	1	1	1	1

Table A2. *Cont.*

	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E7**	**E8**	**E9**	**E10**	**E11**	**E12**	**E13**	**E14**	**E15**	**E16**
C13	0.9	0.8	0.9	0.8	0.97	0.9	1	0.97	1	0.9	0.9	1	1	0.9	1	1
C14	1	0.8	1	0.8	0.97	0.9	1	0.97	1	0.9	1	1	1	0.9	1	1
C15	1	0.9	1	0.9	0.99	1	1	0.99	1	0.9	1	1	1	1	1	1
C16	1	1	1	0.9	1	1	1	1	1	1	1	1	1	1	1	1
C17	1	0.8	1	0.8	0.98	0.9	1	0.98	1	0.90	1	1	1	0.9	1	1

Table A3. Cause–effect matrix to routines.

	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E7**	**E8**	**E9**	**E10**	**E11**	**E12**
C1	0.9	0.9	0.9	0.8	0.87	0.9	1	1	1	1	1	1
C2	0.8	0.7	0.7	0.7	0.73	0.7	1	0.95	0.9	0.9	1	1
C3	0.8	0.7	0.7	0.7	0.73	0.7	1	0.95	0.9	0.9	1	1
C4	0.80	0.7	0.8	0.7	0.75	0.8	1	0.97	0.9	1	1	1
C5	0.8	0.7	0.7	0.70	0.73	0.8	1	0.96	0.9	0.9	1	1
C6	0.9	0.9	0.9	0.9	0.89	0.9	1	1	1	1	1	1
C7	0.9	0.9	0.9	0.8	0.87	0.9	1	1	1	1	1	1
C8	0.8	0.8	0.8	0.7	0.77	0.8	1	0.99	1	1	1	1
C9	1	1	1	1	1	1	1	1	1	1	1	1

Table A4. Cause–cause matrix to conversion knowledge.

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**	**C17**
C1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C3	1	1	1	0.9	1	1	1	1	0.9	1	0.9	1	1	1	1	0.9	1
C4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A4. *Cont.*

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17
C5	1	1	1	1	1	1	1	1	1	1	0.9	1	1	1	1	0.9	1
C6	0.9	0.89	0.9	0.9	0.9	1	0.9	0.9	0.9	0.9	0.9	0.9	1	1	0.9	0.8	0.9
C7	0.9	1	1	0.9	1	1	1	1	0.9	0.9	0.9	1	1	1	1	0.90	1
C8	0.9	0.94	1	0.9	1	1	1	1	0.9	0.9	0.9	1	1	1	1	0.9	1
C9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C12	1	1	1	0.9	1	1	1	1	0.9	1	0.9	1	1	1	1	0.9	1
C13	0.9	0.93	1	0.9	1	1	1	1	0.9	0.9	0.90	1	1	1	1	0.9	1
C14	0.9	0.94	1	0.9	1	1	1	1	0.9	0.9	0.9	1	1	1	1	0.9	1
C15	1	1	1	0.9	1	1	1	1	0.9	1	0.9	1	1	1	1	0.9	1
C16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C17	0.9	0.94	1	0.9	1	1	1	1	0.9	0.9	0.9	1	1	1	1	0.9	1

Table A5. Causes–cause matrix to routines.

	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	1	1	1	1	1	1	1	1	0.8
C2	0.9	1	1	1	1	0.8	0.9	1	0.7
C3	0.9	1	1	1	1	0.8	0.9	1	0.7
C4	0.9	1	1	1	1	0.9	0.9	1	0.7
C5	0.9	1	1	1	1	0.8	0.9	1	0.70
C6	1	1	1	1	1	1	1	1	0.9
C7	1	1	1	1	1	1	1	1	0.8
C8	0.90	1	1	1	1	0.9	0.90	1	0.7
C9	1	1	1	1	1	1	1	1	1

Table A6. Effect–effect matrix to conversion knowledge.

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
E1	1	0.89	1	0.9	1	1	1	1	1	0.9	1	1	1	1	1	1
E2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
E3	1	0.89	1	0.9	1	1	1	1	1	0.9	1	1	1	1	1	1
E4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
E5	1	0.87	1	0.9	1	1	1	1	1	0.9	1	1	1	1	1	1
E6	1	0.90	1	0.9	1	1	1	1	1	1	1	1	1	1	1	1
E7	0.9	0.82	0.9	0.8	0.95	0.9	1	0.95	1	0.9	0.9	1	0.9	0.9	1	1
E8	0.98	0.87	1	0.9	1	1	1	1	1	0.9	1	1	1	1	1	1
E9	1	0.85	1	0.8	0.98	1	1	0.98	1	0.90	1	1	1	0.9	1	1
E10	1	1	1	0.9	1	1	1	1	1	1	1	1	1	1	1	1
E11	1	0.89	1	0.9	1	1	1	1	1	0.9	1	1	1	1	1	1
E12	0.9	0.83	0.9	0.8	0.96	0.9	1	0.96	1	0.9	0.9	1	0.9	0.9	1	1
E13	1	0.89	1	0.9	1	1	1	1	1	0.9	1	1	1	1	1	1
E14	1	0.91	1	0.90	1	1	1	1	1	1	1	1	1	1	1	1
E15	0.9	0.81	0.9	0.80	0.94	0.9	1	0.94	1	0.9	0.9	1	0.9	0.90	1	1
E16	1	0.85	1	0.8	0.98	1	1	0.98	1	0.90	1	1	1	0.9	1	1

Table A7. Effect–effect matrix to routines.

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E1	1	0.94	1	0.9	0.95	1	1	1	1	1	1	1
E2	1	1	1	1	1	1	1	1	1	1	1	1
E3	1	1	1	1	1	1	1	1	1	1	1	1
E4	1	1	1	1	1	1	1	1	1	1	1	1
E5	1	1	1	1	1	1	1	1	1	1	1	1

Table A7. *Cont.*

	E1	**E2**	**E3**	**E4**	**E5**	**E6**	**E7**	**E8**	**E9**	**E10**	**E11**	**E12**
E6	1	1	1	1	1	1	1	1	1	1	1	1
E7	0.8	0.72	0.7	0.7	0.73	0.7	1	0.95	0.9	0.9	1	1
E8	0.8	0.77	0.8	0.7	0.78	0.80	1	1	1	1	1	1
E9	0.9	0.80	0.8	0.8	0.81	0.8	1	1	1	1	1	1
E10	0.8	0.78	0.8	0.8	0.79	0.8	1	1	1	1	1	1
E11	0.8	0.74	0.7	0.7	0.75	0.8	1	0.97	0.9	1	1	1
E12	0.8	0.70	0.7	0.7	0.71	0.7	1	0.93	0.90	0.9	1	1

Appendix C Forgotten Effects Matrices to Conversion Knowledge and Routines

Table A8. Forgotten effects matrices.

Matrix $[\widetilde{M}]$: conversion knowledge															
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
C1	1	0.91	1	0.9	1	1	1	1	1	0.96	1	1	1	1	1	1
C2	1	0.91	1	0.9	1	1	1	1	1	0.96	1	1	1	1	1	1
C3	0.98	0.87	0.98	0.86	0.99	0.97	1	0.99	1	0.92	0.98	1	0.98	0.95	1	1
C4	1	0.92	1	0.91	1	1	1	1	1	0.97	1	1	1	1	1	1
C5	0.99	0.88	0.99	0.87	1	0.98	1	1	1	0.93	0.99	1	0.99	0.97	1	1
C6	0.90	0.79	0.90	0.79	0.92	0.89	0.98	0.92	0.94	0.84	0.90	0.96	0.91	0.88	0.98	0.94
C7	0.97	0.86	0.97	0.85	0.99	0.96	1	0.99	1	0.91	0.97	1	0.97	0.95	1	1
C8	0.96	0.85	0.96	0.84	0.98	0.95	1	0.98	1	0.90	0.96	1	0.96	0.94	1	1
C9	1	0.93	1	0.92	1	1	1	1	1	0.98	1	1	1	1	1	1
C10	1	0.91	1	0.90	1	1	1	1	1	0.96	1	1	1	1	1	1
C11	1	0.94	1	0.93	1	1	1	1	1	0.99	1	1	1	1	1	1
C12	0.98	0.87	0.98	0.86	0.99	0.97	1	0.99	1	0.92	0.98	1	0.98	0.95	1	1

Table A8. *Cont.*

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
						Matrix $[\widetilde{M}]$: conversion knowledge										
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
C13	0.95	0.84	0.95	0.83	0.97	0.94	1	0.97	0.99	0.89	0.95	1	0.95	0.93	1	0.99
C14	0.95	0.84	0.95	0.84	0.97	0.94	1	0.97	0.99	0.89	0.95	1	0.96	0.93	1	0.99
C15	0.98	0.87	0.98	0.86	0.99	0.97	1	0.99	1	0.92	0.98	1	0.98	0.95	1	1
C16	1	0.96	1	0.95	1	1	1	1	1	1	1	1	1	1	1	1
C17	0.96	0.85	0.96	0.84	0.98	0.95	1	0.98	1	0.90	0.96	1	0.96	0.93	1	1
						Matrix $[\widetilde{A}] \circ [\widetilde{M}]$ conversion knowledge										
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
C1	1	0.96	1	0.95	1	1	1	1	1	0.98	1	1	1	1	1	1
C2	1	0.95	1	0.95	1	1	1	1	1	0.98	1	1	1	1	1	1
C3	1	0.93	1	0.93	1	1	1	1	1	0.96	1	1	1	1	1	1
C4	1	0.96	1	0.95	1	1	1	1	1	0.98	1	1	1	1	1	1
C5	1	0.94	1	0.93	1	1	1	1	1	0.96	1	1	1	1	1	1
C6	0.95	0.89	0.95	0.89	0.96	0.95	0.98	0.96	0.96	0.92	0.95	0.96	0.95	0.94	0.98	0.96
C7	1	0.93	1	0.92	1	1	1	1	1	0.96	1	1	1	1	1	1
C8	0.98	0.92	0.98	0.92	0.99	0.97	1	0.99	1	0.94	0.98	1	0.98	0.97	1	1
C9	1	0.96	1	0.95	1	1	1	1	1	0.99	1	1	1	1	1	1
C10	1	0.96	1	0.95	1	1	1	1	1	0.98	1	1	1	1	1	1
C11	1	0.96	1	0.95	1	1	1	1	1	0.99	1	1	1	1	1	1
C12	1	0.93	1	0.93	1	1	1	1	1	0.96	1	1	1	1	1	1
C13	0.97	0.92	0.97	0.91	0.98	0.97	1	0.98	0.99	0.93	0.97	1	0.97	0.96	1	0.99
C14	0.98	0.92	0.98	0.91	0.99	0.97	1	0.99	1	0.94	0.98	1	0.98	0.96	1	1
C15	1	0.93	1	0.93	1	1	1	1	0	0.96	1	1	1	1	1	1
C16	1	0.96	1	0.95	1	1	1	1	1	1	1	1	1	1	1	1
C17	0.98	0.92	0.98	0.92	0.99	0.97	1	0.99	1	0.94	0.98	1	0.98	0.97	1	1

Table A8. *Cont.*

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
						Matrix $[\widetilde{A}] \circ [\widetilde{M}] \circ [\widetilde{B}]$ conversion knowledge										
C1	1	0.98	1	0.96	1	1	1	1	1	0.98	1	1	1	1	1	1
C2	1	0.98	1	0.95	1	1	1	1	1	0.98	1	1	1	1	1	1
C3	1	0.96	1	0.94	1	1	1	1	1	0.96	1	1	1	1	1	1
C4	1	0.98	1	0.96	1	1	1	1	1	0.98	1	1	1	1	1	1
C5	1	0.96	1	0.94	1	1	1	1	1	0.96	1	1	1	1	1	1
C6	0.96	0.92	0.96	0.92	0.96	0.96	0.98	0.96	0.97	0.95	0.96	0.98	0.96	0.96	0.98	0.97
C7	1	0.96	1	0.94	1	1	1	1	1	0.96	1	1	1	1	1	1
C8	0.98	0.94	0.98	0.94	0.99	0.98	1	0.99	1	0.96	0.98	1	0.98	0.98	1	1
C9	1	0.99	1	0.96	1	1	1	1	1	0.99	1	1	1	1	1	1
C10	1	0.98	1	0.96	1	1	1	1	1	0.98	1	1	1	1	1	1
C11	1	0.99	1	0.96	1	1	1	1	1	0.99	1	1	1	1	1	1
C12	1	0.96	1	0.94	1	1	1	1	1	0.96	1	1	1	1	1	1
C13	0.98	0.93	0.98	0.93	0.98	0.97	1	0.98	0.99	0.96	0.98	1	0.98	0.97	1	0.99
C14	0.98	0.94	0.98	0.94	0.99	0.98	1	0.99	1	0.96	0.98	1	0.98	0.98	1	1
C15	1	0.96	1	0.94	1	1	1	1	0	0.96	1	1	1	1	1	1
C16	1	1	1	0.96	1	1	1	1	1	1	1	1	1	1	1	1
C17	0.98	0.94	0.98	0.94	0.99	0.98	1	0.99	1	0.96	0.98	1	0.98	0.98	1	1
						Matrix $\left[\widetilde{O}\right]$ conversion knowledge										
C1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C3	1	0	1	0	1	1	0	1	0	0	1	0	1	1	0	0
C4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C5	1	0	1	0	0	1	0	0	0	0	1	0	1	1	0	0
C6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A8. *Cont.*

	Matrix $[\widetilde{O}]$ conversion knowledge															
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
C7	1	0	1	0	1	1	0	1	0	0	1	0	1	1	0	0
C8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C12	1	0	1	0	1	1	0	1	0	0	1	0	1	1	0	0
C13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C14	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
C15	1	0	1	0	1	1	0	1	0	0	1	0	1	1	0	0
C16	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Matrix $[\widetilde{M}]$ routines											
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
C1	0.92	0.86	0.87	0.83	0.87	0.89	1	1	1	1	1	1
C2	0.77	0.72	0.73	0.69	0.73	0.74	1	0.95	0.92	0.94	0.98	1
C3	0.78	0.72	0.73	0.69	0.73	0.75	1	0.95	0.92	0.94	0.98	1
C4	0.80	0.74	0.75	0.71	0.75	0.77	1	0.97	0.94	0.96	1	1
C5	0.78	0.73	0.73	0.70	0.73	0.75	1	0.96	0.93	0.95	0.99	1
C6	0.94	0.88	0.89	0.86	0.89	0.91	1	1	1	1	1	1
C7	0.92	0.86	0.87	0.83	0.87	0.89	1	1	1	1	1	1
C8	0.82	0.76	0.77	0.74	0.77	0.79	1	0.99	0.96	0.99	1	1
C9	1	1	1	1	1	1	1	1	1	1	1	1

	Matrix $[\widetilde{A}] \circ [\widetilde{M}]$ routines											
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
C1	0.94	0.88	0.89	0.86	0.89	0.91	1	1	1	1	1	1

Table A8. *Cont.*

	Matrix $[\widetilde{A}] \circ [\widetilde{M}]$ routines											
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
C2	0.86	0.86	0.86	0.83	0.86	0.86	1	0.97	0.95	0.96	0.99	1
C3	0.86	0.86	0.86	0.84	0.86	0.86	1	0.97	0.96	0.96	0.99	1
C4	0.88	0.86	0.87	0.86	0.87	0.88	1	0.98	0.96	0.98	1	1
C5	0.87	0.86	0.87	0.84	0.87	0.87	1	0.97	0.96	0.96	0.99	1
C6	0.94	0.88	0.89	0.86	0.89	0.91	1	1	1	1	1	1
C7	0.94	0.88	0.89	0.86	0.89	0.91	1	1	1	1	1	1
C8	0.90	0.88	0.88	0.86	0.88	0.89	1	0.99	0.96	0.99	1	1
C9	1	1	1	1	1	1	1	1	1	1	1	1
	Matrix $[\widetilde{A}] \circ [\widetilde{M}] \circ [\widetilde{B}]$ routines											
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
C1	0.94	0.94	0.94	0.92	0.94	0.94	1	1	0.98	1	1	1
C2	0.86	0.86	0.86	0.86	0.86	0.86	1	0.97	0.97	0.97	0.99	1
C3	0.86	0.86	0.86	0.86	0.86	0.86	1	0.97	0.97	0.97	0.99	1
C4	0.88	0.88	0.88	0.88	0.88	0.88	1	0.98	0.98	0.98	1	1
C5	0.87	0.87	0.87	0.87	0.87	0.87	1	0.97	0.97	0.97	0.99	1
C6	0.94	0.94	0.94	0.92	0.94	0.94	1	1	0.98	1	1	1
C7	0.94	0.94	0.94	0.92	0.94	0.94	1	1	0.98	1	1	1
C8	0.90	0.90	0.90	0.90	0.90	0.90	1	0.99	0.98	0.99	1	1
C9	1	1	1	1	1	1	1	1	1	1	1	1
	Matrix $[\widetilde{O}]$ routines											
	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
C1	0	0	0	0	0	0	0	0	0,8	0	0	0
C2	0	0	0	0	0	0	0	0	0	0	0	0
C3	0	0	0	0	0	0	0	0	0	0	0	0
C4	0	0	0	0	0	0	0	0	0	0	0	0

Table A8. *Cont.*

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
						Matrix $\left[\tilde{O}\right]$ routines						
C5	0	0	0	0	0	0	0	0	0	0	0	0
C6	0	0	0	0	0	0	0	0	0.8	0	0	0
C7	0	0	0	0	0	0	0	0	0.8	0	0	0
C8	0	0	0	0	0	0	0	0	0	0	0	0
C9	0	0	0	0	0	0	0	0	0	0	0	0

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