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# Use of Wikis in Organizational Knowledge Management

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## Abstract

**This article presents the mapping of wiki tool functions in the organizational processes of knowledge management. Mapping these functions and their individual weights in the overall process will identify opportunities for decision-making and the optimization of knowledge sharing, a recognized asset in differentiation and organizational competitiveness. This is an exploratory-descriptive case study based on data collected from a questionnaire applied to 80 IT workers employed at a multinational company in Brazil. The use of mixed methods in data analysis was complemented by content analysis of the research corpus created. A theoretical model is graphically developed following Nonaka and Takeuchi's knowledge spiral model (1997), a conventional model in knowledge management. In addition, an indicator of the individual contribution of each step in the conversion process of tacit into explicit knowledge is introduced. This case study alone does not enable a generalization of the findings. Therefore, a replication of the process and especially multiple testing of the constructed indicator are indispensable to its validation. Validation of the use of the wiki tool functions will allow the future development of measurements that can be directly employed in the organizational decision-making process. Statistically, a theoretical model is qualitatively discussed, which enables the construction of an initial indicator of the weight of individual contribution of steps in the knowledge generation process using the knowledge spiral model.**

## Keywords

**Wiki, Organizational Knowledge Management, OKM Indicators, Decision-Making Processes**

## 1. Introduction

Knowledge is the most valuable asset of any organization, and its administration is vital [1] [2]. According to [3]

[1] [4] and [5], knowledge is a condensed aggregation of experiences formed by beliefs and commitments accumulated over time, which provide an individual with the skills required to resolve problems while favouring a structure for the evaluation and incorporation of new experiences.

However, according to [4], it is not the organization that creates knowledge, but its members. In other words, "a significant proportion of the knowledge of an enterprise is stored in the minds of its officials" ([5], p. 25). Given the importance of administering this tacit knowledge, knowledge management (KM) attempts to ensure that existing knowledge is not lost and can be used productively by an organization in an effective and efficient manner that allows the company to stand out in the market and provide its customers with excellent service [5].

Reference [6] stated that the main objectives of the implementation of KM are to maximize benefits, improve client service, shorten product-development cycles and increase competitiveness, thus acting as a stimulus for an organization to change its practices. In this context, KM is a conscious strategy of delivering the right knowledge to the right people at the right time in a shared manner [6].

One of the main emerging challenges for companies is how to encourage knowledge sharing within the organization, because knowledge is the major part of the intellectual capital and is of increasing importance in achieving competitive business advantage [7].

Reference [8] stated that although many factors are involved in knowledge sharing, an environment mediated by technology is particularly important. According to ([9], p. 108), "the organization of data and information must be performed by means of a logical project [...] prepared with congruence to the logic of functioning of the enterprise". Following this reasoning, in the beginning of KM, it was believed that knowledge could be stored, transferred and recovered with the help of information technology (IT) [10].

However, more recently, the perception that knowledge is not simply an aggregate of information that can be decoupled from its context has emerged. The creation of knowledge is a process of social construction and information technology, more than a tool for the accumulation and circulation of information, gives extensive support to the mediation of interactions [11].

From this perspective, there has been a discussion about the use of social software and Web 2.0 tools with which users become content publishers rather than simply consumers [10] [12] [13].

The main tools of the Web 2.0 and social software are wikis, web blogs, folksonomies, forums based on the web and really simple syndication (RSS) [12]. Among these tools, wikis stand out because they allow the combination, annotation and editing of material in such a way that a new content is created and used in combination with other authors [12].

The first wiki was developed in 1995 by Ward Cunningham, and its main objective was to share ideas about design patterns [13] [14] According to [13], the ease of use is what differentiates the wiki from other common informatics tools used in KM.

In addition, with typical KM tools, there must be a KM person to translate the knowledge of individuals to the tool. In this sense, KM implementation attempts have performed below expectations [12], thereby making practical studies in this field relevant.

According to [12], the differentiating factor of social software technologies such as the wiki, which is the main focus of this study, is that users become editors rather than simply consumers of information, *i.e.* they can combine, annotate and edit existing material, as already mentioned above. Thus, new content is created and used in combination with others, thereby allowing access to knowledge at any time and decreasing training costs.

The literature suggests that wikis can be the key to a viable and usable KM tool because of their ease of use and collaborative nature. This ultimately leads to time and cost savings. This assertion is marked out, among others, by [12]-[14]; however, bibliometric research bases (e.g. ISI, the SciVerse and Scopus) between 2008 and 2013 did not return data that provided effective proof of the efficiency of the wiki.

Then, starting from a research assumption that the wiki can contribute to organizational knowledge management (OKM), thereby improving the company's knowledge-sharing activities, we map the tool's contributions to the management processes of organizational knowledge by focusing on the learning, storage, retrieval and sharing of knowledge. The focus of our field research was IT infrastructure teams that used a wiki tool. These participants were employees of an organization (total: 18,000 employees) active for 13 years in the tertiary sector of the Brazilian economy. Through mixed research methods, we attempted to identify actions for the generation, maintenance, sharing and dissemination of knowledge by considering the modes of Socialization, Externalization, Combination and Internalization of the SECI model [4].

The article is divided in five sections. Initially we present a short literature revision of OKM, its conceptual

elements and its role in the organization, followed by a direct relation between IT and KM, presenting the wiki tool and culminating it with some KM models. Conversely, the methodology research is treated together with its results, finishing with the main findings of the research.

## 2. Theoretical Framework

The theoretical framework comprises four sections, beginning with the conceptual delineation of KM and the evolution of OKM, followed by an explanation of the role of IT in KM and the function of KM process models and ending with a discussion about the OKM of IT tools concerning the social and interactive nature of the social software.

### 2.1. Organizational Knowledge Management

Knowledge is the processing of personified information that occurs in human minds. Knowledge relates facts, procedures, concepts, interpretations, ideas, observations and judgments [8] [15]. In addition, knowledge is seen as socially built and embedded into a social context in which it takes form and creates sense, *i.e.* it is personal, subjective, socially determined, primarily tacit and connected to daily practices [10]. According to [16], knowledge is intangible, without frontiers. Knowledge is dynamic, and if not used at an appropriate time at a specific place, knowledge is useless, thus is connected to an action.

Conversely, corporate knowledge is conceptualized like a fluid mixture of ideas, experience, intuition and lessons, residing not only in existing information repositories but also in the minds of individuals [4] [17].

Reference [4] have stated that the creation of knowledge must be seen as a process by which the knowledge produced by individuals is amplified and internalized as part of an organization's knowledge base. Thus, knowledge created and shared by the interaction between individuals at several levels of an organization must receive the qualifier term Organizational, thereby differentiating it from other types of produced knowledge. In other words, organizations cannot create organizational knowledge without individuals and groups [7]. The members of the organization capture, store, use and modify the knowledge that they use during their daily work activities [7].

According to [7] and [10], knowledge sharing is essentially the act of making knowledge available to others within an organization. The sharing of knowledge between individuals is the process by which knowledge created by an individual is converted into a format that can be understood, absorbed and used by others, *i.e.* the sharing is a process influenced by social dynamics that results in learning, which in turn can contribute to organizational learning [10].

Reference [4] stated that knowledge is a dynamic human process of justifying personal belief regarding the "truth"; therefore, knowledge is related to actions, attitudes, approaches, specific intents, ideas, values and emotions, *i.e.* it is always knowledge for a goal, thereby fundamentally tacit. Also, according to [4], both information and knowledge are context specific and relational, in that they depend on a situation and are created dynamically through social interaction between people. The explicitation of tacit knowledge occurs via a relational process.

Reference [18] said that humans construct knowledge by actively creating and organizing their own experiences. Author [18] had foreseen human knowledge, in the beginning, as tacit (individual, semantic, personal, based in values and beliefs, intangible), but capable of being outsourced by many process in an explicit knowledge. Explicit knowledge is better spread by formal and systematic language, *i.e.* using words, numbers, raw data, scientific formulas and codified procedures, and can be processed easily by a computer and transmitted electronically or stored in a database [4]. Thus, according to [4], organizational knowledge is created from the conversion of tacit knowledge to explicit knowledge and again back to tacit—**Figure 1**. This way, the SECI model is born from **S**ocialization, Externalization, Combination and Internalization, which are the modes proposed for the conversion of tacit knowledge to explicit, the latter being manageable. We deepen the SECI Model in Section 2.3 KM process models.

In the last decade, the growing awareness of the value of expertise in its various forms has been recognized in the emerging discourse known as Knowledge Management—KM [19]. KM is a conscious strategy to provide the right knowledge to the right people at the right time [6], thus reducing the barriers inherent in the sharing of this vital input.

According to [7] [19]-[21], KM refers to processes and practices for the development of an organization that involves a systematic management of vital knowledge resources and associated processes such as creating, ac-

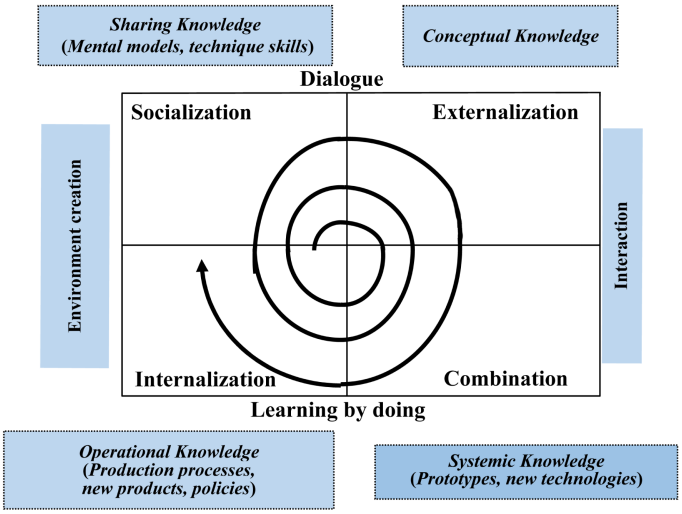


**Figure 1.** Creation knowledge—modes.

quiring, capturing, storing, maintaining, identifying, disclosing, categorizing, retrieving, sharing, collecting, organizing, disseminating, using and exploiting knowledge throughout an organization. The production of knowledge workers is often intangible, and organizations struggle to remember why decisions were made or how projects were completed in the past; thus, an organization can often lose the formula to maintain and improve its strategic advantages [22].

The role of KM is not only to influence the sharing of knowledge directly but also to stimulate and create the conditions necessary for this process to occur by mitigating barriers and, above all, by creating context that enables the generation of organizational knowledge [10] [16]. For a solid KM implementation, organizations must emphasize the basis of explicit and tacit knowledge, as well as internal and external, individual and organizational knowledge [23].

## 2.2. The Role of Information Technology in Organizational Knowledge Management

The IT infrastructure includes data processing, storage, technologies, communication systems and information management [20]. An effective information and communication technology (ICT) infrastructure positively influences OKM. Often, its role in sharing knowledge is to facilitate interaction through personal yellow pages (experts), knowledge maps and social network, among others, which are considered KM tools [10].

Although the contribution of ICT to OKM is a subject of much discussion, there is general consensus that they should and can play a supporting role [10] because technologies are key elements of KM implementation, as observed by [20]. Rapid changes in the OKM field have largely been the result of dramatic progress in IT [20] and many KM tools and techniques have been discussed and employed over the years [24].

Traditional KM systems are described by [25] as IT-based systems whose functions include encoding and sharing of best practices in a repository of knowledge and the creation of corporate knowledge directories and networks. Although these technologies have certainly changed the way knowledge is shared among organizations, the technologies primarily deal with explicit knowledge rather than tacit knowledge [24].

The differentiating factor of technologies with the bias of social software is that users become publishers rather than simply being consumers of information. This means that they can combine, edit and publish existing material; therefore, new content is created and used in association with others, thereby stimulating people with similar interests to share ideas and contribute to debate and the negotiation of differences collaboratively [11] [12]. In fact, social software would precisely have the function of assisting in the explanation process of tacit knowledge, thereby contributing to the spiral of knowledge and SECI model [4].

Nevertheless, collaborative work is interactive and non-structured; therefore, the appropriated technologies for such environments are predominantly knowledge repositories and other collaborative aids, which should be used in a voluntary form [24] [26].

These emergent behaviours reveal a trend known as the social web, whereby Internet-based technology users

are involved in information sharing in a collaborative process [26].

Social software is made up of a set of tools that allows a certain group to register "collective memory around a common problem" ([11], p. 398). Social software is not just a tool for the accumulation and circulation of information. It also promotes interaction, sharing, reflection and composition of new ideas [11].

According to [13] [24] [26]-[28], the terms Social Web, Web 2.0 and Enterprise 2.0 were created to distinguish such activities from traditional static and passive pages. These terms represent the second generation of web-based technologies and a networking platform in which peers contribute to the development of tools that can be used to create dynamic and interactive content in communities on the Internet [13] [26].

Users, content and technology interact; thus, the Social Web is similar to some principle ideas of OKM, including the unrestricted sharing of knowledge, information and data [13] [28]. Social Web tools are defined, therefore, as a new generation of collaborative web-based tools that change the way people work as well as the information is created and shared [13] [25] [27].

To facilitate the development of OKM systems that are monolithic, centralized and controlled, the Social Web offers more interactive and collaborative framework technologies, emphasizing the social interaction of the team in order to generate a collective intelligence [27] [29]. Thus, besides the generation of individual knowledge, a Social Web platform becomes a viable channel of knowledge construction for communities in general as well as specific disciplines [26].

Reference [13] analyzed the principle of the Social Web from a KM perspective and came to a simple conclusion: the principles of the Social Web are very close to those of KM. However, there are differences, primarily in regards to the centralizing attitudes and control of KM in contrast to the decentralized and uncontrolled Social Web attitude [13].

Wiki technology exemplifies the dynamic and collaborative features of social software by expanding Internet-based computing capacity to improve communication and collaboration over time and distance [30].

References [12], [13], [28], [29] and [31] define a wiki as a set of online pages that are created collaboratively with instant revision capability. A wiki can be altered gradually by several users using a web browser, thereby developing an efficient repository of new information.

In a corporate environment, wikis can promote two-way communication between users. They are useful for highly collaborative publishing efforts, such as the creation of technical documentation, policies, proceedings and knowledge bases [14].

Reference [14] claims that the wiki can capture explicit and migratory knowledge, as well as the tacit and embedded knowledge that is fundamental for intensive business knowledge. Wikis differ from other sites because they allow users to contribute, modify and update the content automatically, *i.e.* anyone can create a new page, as well as add, edit or delete the content within the existing page, thereby creating an expansive collection of interconnected web pages [28].

Companies can benefit from social software applications because they allow various types of content, thereby evolving a wide range of collaborative processes [27]. Wiki technology has the potential to address some specific KM needs, including the capture of distributed knowledge, as well as unstructured and dynamic change of content [28]. With wiki technology, some executives see a way to capture institutional knowledge and attract younger workers [32]. Wikis can take advantage of collective wisdom to create an effective source of knowledge [30].

### 2.3. KM Process Models

As mentioned in Section 2.1—Organizational Knowledge Management and corroborated by [33], the goals of KM are to provide a favourable environment for the creation and use of knowledge in order to enable context or collaborative space. According to ([33], p. 11), KM "focuses on knowledge processes that support organizational processes such as innovation, individual learning, collective learning and collaborative decision-making".

Conversely, KM process-oriented models decrease the barriers to share and use knowledge, such us lack of knowledge, lack of absorptive capacity and limited social networks. Reference [34] supported by [35] claims that process-oriented KM models analyze the variables that affect the development, dissemination, modification and use of knowledge processes.

Recurring models in the literature have been explored by [5], [36] and especially [4]. From the main theoretical models, eight similar cases with different nomenclature emerge. Reference [34] summarized seven of these classical processes—**Table 1**:

**Table 1.** KM process models.

| Author | Knowledge processes |
|---|---|
| Nonaka and Takeuchi (1997) | Socialization, externalization, combination, internalization |
| Rastogi (2000) | Identification, mapping, capturing, acquiring, storing, sharing, applying, creating |
| Probst, Raub and Rombhart (2002) | Identification, acquisition, development, distribution, utilization, preservation |
| McElroy (2002) | Production, integration |
| Alavi and Leidner (2001) | Creation, storage and retrieval, transfer/distribution and application |
| Mishra (2009) | Capture and/or creation, sharing and dissemination, acquisition and application |
| Mertins *et al.* (2003) | Generation, storage, distribute, apply |

The SECI model [4] differs from others by the taxonomy it uses, which was derived from Polanyi's studies [18]. The SECI Model is based on the conversion process of tacit knowledge and explicit knowledge, creating four modes [4], as quoted in Section 2.1.—Organizational Knowledge Management:

1) Socialization (tacit to tacit): The process of sharing experiences through observation, imitation and practice, thereby generating shared knowledge (mental models and technical skills).

2) Externalization (tacit to explicit): The process of articulating tacit knowledge to explicit concepts, creating new concepts and producing conceptual knowledge.

3) Combination (explicit to explicit): The process of developing explicit knowledge; joining explicit knowledge from several sources; making use of several platforms, including virtual ones, and creating systemic knowledge.

4) Internalization (explicit to tacit): The process of incorporating explicit knowledge by making use of documents, manuals or oral histories, especially to produce operational knowledge.

The Socialization and Internalization processes are directly relate to knowledge creation and its uses, by individuals, emphasizing personal contact and dialogue. Externalization and Combination are linked to interaction among groups—**Figure 1** [4].

Note that the process proposed by the Japanese authors [4], known as spiral of knowledge, initially exists at an individual level (epistemological)—which is expanded ontologically when social interaction occurs, thereby breaking sectorial barriers and spreading through the organization and to others in a virtuous cycle of creating, disseminating, sharing, storing and expanding knowledge.

In this scenario, a field study was conducted to correlate the questions of KM and information management in order to support tools mediated by IT but with a social interactive approach that focuses on Web 2.0 tools and does not favour the technical aspects of IT.

## 2.4. Wiki—Social Software, Web 2.0 and the Management of Organizational Knowledge

According to [13] [24] [26] [28] and [29], many technologies, including wikis, web blogs, folksonomies, web-based forums, RSS and social networking sites (e.g. MySpace, Facebook, LinkedIn, Youtube and Flickr), fit the category of social software. Such technologies allow users to participate according to several forms and models.

As the Social Web supports a personal learning process and social dynamics, this can facilitate the cycle of knowledge creation that follows the SECI model [4] whereby explicit and tacit knowledge interact in a continuous process [26].

Thus, it is possible to compare the SECI model, Web 2.0 and the concept of social software.

- Socialization: This takes place when individuals or groups share methods, understanding, experience and skills from observation, imitation and practice within different social communities.
- Externalization: This takes place through several modes of representation, including words, images, video and music, *i.e.* in different platforms and different languages. Some technologies such as VoIP, e-mail, tagging, video conference and instant message support this process because they allow sharing of created knowledge.
- Combination: The platform itself combines several components of explicit knowledge to systematize it and insert it in a community knowledge system. Some Social Web technologies such as RSS, folksonomies and mashups are good examples of combining knowledge to form new knowledge for a community.
- Internalization: This is a process of systematic reflection of individual and collective knowledge through actions and practices.

Some authors, such as [12] and [14], argue that wikis offer more opportunities for collaboration than other Social Web tools. This collaboration is due to the unique characteristics of wiki technology, such as coherent information repository, information retrieval, collaborative authorship, instant publication, authorship simplicity, information sharing, time savings, online information, availability and culture of trust [37].

Thus, according to ([38], p. 49), wiki technology can create favourable environments for "the manifestation and release of tacit knowledge". Such environments receive denominations as an enabling context or "ba", either physical or virtual that favour the sharing of information, experiences and problem solutions, as well as the creation of knowledge at the epistemological and ontological levels [16] [38].

The enabling context assumes that four dimensions are connected to the knowledge conversion processes [16]: a) originating ba—a context in which knowledge originates through face-to-face interaction whereby individuals share feelings, emotions, experiences and mental models); b) dialoguing ba—individuals share their experiences and skills, thereby converting them into common terms and concepts); c) cyber ba or systemizing ba—collective or virtual interaction that offers a context for the combination of new explicit knowledge by producing knowledge bases in an organization, e.g. databases, documents, specifications, manuals, patents and licenses); d) exercising ba—facilitates the conversion of explicit knowledge into tacit again, whereby knowledge assets are created, such as know-how, organizational routines and new behaviour standards). It is also where the individual is required to identify relevant knowledge for both groups and the organization.

Is verifies that some wiki characteristics have very close relation to the SECI model.

- Collaborative authorship, culture of trust and Socialization (confidence relation between the master and the apprentice).
- Availability, information sharing and Externalization (methodical description of how a determined activity must be performed).
- Collaborative authorship, previous versions and Combination (improvement of knowledge from revision).
- Information sharing, online information and Internalization (knowledge accessibility at any moment).

**Table 2** [37] shows the relations between the stages of the SECI model, the mediation spaces (ba) and the main features of the wiki tool. Some wiki features are repeated in the stages of the SECI model because the wiki allows, within the same characteristic, employees to socialize, outsource, combine and internalize documentation and procedures in wiki pages.

**Table 2.** Comparison of the characteristics of the wiki and the SECI Model.

| **Enabling Context (*ba*)—SECI Model** | |
|---|---|
| **Socialization (Originating ba)**<br>• Collaborative authorship<br>• Instant publication<br>• Previous versions are stored<br>• Authorship simplicity<br>• **Information sharing**<br>• Coherent repository information<br>• Online information<br>• Availability<br>• Time economy<br>• Culture of trust<br>• Information recuperation | **Externalization (Dialoguing ba)**<br>• Authorship Collaborative<br>• Instant publication<br>• Online information<br>• Availability<br>• Previous versions are stored<br>• Authorship simplicity<br>• **Information sharing** |
| **Internalization (Exercising ba)**<br>• Previous versions are stored<br>• **Information sharing**<br>• Time savings<br>• Coherent repository information<br>• **Online information**<br>• Availability<br>• Less traffic of internal e-mail<br>• Control of access<br>• Culture of trust<br>• Low training cost<br>• Information recuperation | **Combination (Systemizing ba)**<br>• **Collaborative authorship**<br>• Previous versions are stored<br>• Authorship simplicity<br>• **Information sharing** |

From the above data and an extensive literature review, we have developed a guidance questionnaire for the present survey, where methodological developments are described in the following section.

## 3. Methodological Principles and Hypotheses

This section describes processes and methods used in bibliometric, bibliographical and field research to identify the contributions of the wiki tool to OKM models.

### 3.1. Methodology

Regarding the methods used for data processing and analysis, this was a mixed research methods, as data from both a quantitative and qualitative perspective was collected and analyzed. A combination of methods is practical because it enables the use of both words and numbers, thus combining inductive and deductive thoughts ([39], p. 28). In the qualitative approach, we used mostly content analysis and in the quantitative approach we used statistical techniques commonly seen in social research. These approaches and its tools are going to be presented in the course of both this section and Section 4—Resulting and Discussions.

The present study outlined a bibliometric research with keywords Wiki, Knowledge and Infrastructure Management and Information Technology with their possible combinations in three different journal databases to build an updated review of the literature. This was followed by a systemic analysis to compose a reasoned theoretical corpus based mainly in [10] [12] [13] [24] and [28]. Studies that involved searching Brazilian and Portuguese thesis and dissertation databases were also added [37] [40].

The resultant methodological tool was a questionnaire that was applied to test four statistical hypotheses to validate whether a wiki can contribute to OKM and improve the sharing activities of the company. The statistical hypotheses were derived from the researchers' tacit knowledge; however, they are supported by analyses reported in the literature. The hypotheses are:

- H1: The use of wiki does not contribute directly to the socialization process (SECI Model).

Socialization process implies strong social interaction, especially face-to-face, and wiki as a software tool, especially online, does not provide this type of activity.

- H2: Wiki contributes to the process of Externalization (SECI Model).

Externalization uses several types of media and various forms of languages for sharing and the use the created knowledge. At this stage of knowledge conversion process it is presupposed that the wiki would strongly favour the interaction.

- H3: Wiki contributes to the process of Combination (SECI Model).

Combination, par excellence, demands different sets of explicit knowledge favoured by different ways of sharing, actual or virtual, again, proceeding on the assumption that the wiki tool would provide the stage.

- H4: Wiki is predominantly used for the internalization (SECI Model).

By promoting the individual and collective reflection in this stage and also by favouring virtual environment.

### 3.2. Sample Characteristics

The sample was intentionally nonprobabilistic. This choice is justified because we did not have access to a minimum sample of respondents, for it was not possible to safely identify the population of IT experts from the infrastructure area in Brazil.

The inexistence of an association for this group of professionals, from which reliable data could be obtained, contributed to the definition of an intentional sample. Although this sample is not representative of the research universe, it has been reported to have "validity within a specific" ([41], p. 38).

The company chosen for the application of the questionnaire has been active in the national tertiary sector for nearly 13 years. Currently, it has 18,000 employees throughout Brazil. Approximately 600 employees work in IT and 126, all of whom have access to the wiki, work in IT infrastructure.

Within the organization, the IT infrastructure area is responsible for the creation and maintenance of databases, servers, networks, telephony and IT infrastructure projects and processes.

### 3.3. Data Collection

The questionnaire (31 questions) included closed (dichotomous and multiple choice) and open questions. A

five-point Likert scale was used for the multiple-choice questions. Two sets of Likert values were used: 1) never, rarely, few times, sometimes, often and almost always, and 2) strongly disagree, disagree in part, neither agree or disagree, partially agree and strongly agree.

The questions used in the questionnaire were created based on those used in [40]. However, the contents seen in the literature review contributed by authors such as [27] [28] and [30], among others, were added.

The principal objective of the questions was to verify if a wiki can be incorporated into the SECI model and identify actions for the generation, maintenance, sharing and diffusion of knowledge, considering the stages of Socialization, Externalization, Combination and Internalization. In addition to questions pertaining to the specific knowledge domain, seven socio-demographic questions were included, *i.e.* age, gender, position, academic credentials, professional experience, time working in the team and time using the wiki.

## 4. Resulting and Discussion

This section presents the main results of analysis of the data collected and some of the findings and inferences.

### 4.1. Descriptive Results

The questionnaire was administered to 80 employees who worked in IT infrastructure. Most (85%) participants were male, with ages ranging from 19 to 47 years (30.63 average). Of them, 92.5% had higher education, 28.8% held senior positions and 21.3% held junior positions. The largest contributors to the wiki were senior employees (50%).

In terms of professional experience, some participants were recent hires (less than a year), while others had 26 years of service. The average length of employment was 9.26 years, with an average of 2.40 years in the current team. Wiki usage time ranged from never used to five years of use, with an average of 1.21 years.

By comparing the time worked in the team and the use of wiki, it is interesting to note that the participants with up to two years in the team contributed more (60.4%). This could be related to the organization's culture, which assumes that new employees must gain enough knowledge to be able to document proceedings and routine activities.

In accordance with the SECI model, **Table 3** describes the responses associated with the four conversion forms of knowledge: Socialization, Externalization, Combination and Internalization.

From an analysis of the information presented in **Table 3**, it is evident that 50% of the participants "frequently, almost always and always" use the wiki as a source of contact information for people involved in projects, as a tool to share knowledge with the team or as an information repository for the company. In addition, 38% of the participants "Frequently, almost always and always" create new pages, add content to existing pages or add small comments to the wiki pages.

From **Table 3**, 66% of the respondents "Frequently, almost always and forever" report browsing the wiki as a first source of information to solve immediate problems similar to those described in the wiki and to learn how to perform a particular procedure. It can also been seen that 30% of the respondents "often, almost always and always" integrate ideas on other pages, rearrange a set of pages, rewrite sections/complete paragraphs, replace earlier versions or make minor corrections to improve the accuracy of the wiki.

In addition, 88% of the respondents "Frequently, almost always and always" indicate that the wiki is an easy tool to use; 41% report that they were satisfied with the wiki.

**Table 3.** Description of the questionnaire responses to the SECI model.

| | Always almost always frequently | Sometimes never |
|---|---|---|
| Questions: socialization | 50% | 50% |
| Questions: externalization | 38% | 62% |
| Questions: internalization | 66% | 34% |
| Questions: combination | 32% | 69% |
| Wiki: use easiness | 88% | 12% |

### 4.2. Survey Consistency and Hypotheses

After analyzing the answers to the questionnaire for the conversion stages of knowledge established in the SECI model, internal consistency measures of the variables' group involved were taken to validate the questionnaire.

Here, Cronbach's alpha (CA) was used. CA is widely used to value the consistency of questionnaire respondents [42] [43]. It measures the similarity in the assessment profiles of the experts involved, indicating which of the trials were inconsistent with the rest of the expert panel. CA takes values from 0.0 to 1.0 and quantifies the degree by which the questions are correlated [44] [45].

There are different acceptable cut-off values for CA, which can vary from 0.7 to 0.9. Note that CA is strongly connected to the number of questions and may vary according to the area of study. A satisfactory level of reliability for CA depends on how the measure is used. Reference [46] proposed a standard cut-off point (greater or equal to 0.70) specifically for the initial stages of the inquiry, predictor tests or tests of hypothesis construction [47].

As seen in **Table 4**, the CA calculation yielded values greater than 0.7 for all questions, thus inferring consistency for the sets of variables checked in the four stages of the conversion process, as well as demonstrating the viability of the implemented instrument.

The average obtained was calculated for the SECI model using the Likert scale (1 (never) to 5 (always)). The Socialization index was 0.757, with an average of 2.746. It was then verified that the use of the wiki did not contribute directly to the Socialization process, thereby **confirming hypothesis H1** (using the wiki does not contribute directly to the process of socialization (SECI model)). However, the results suggest that the wiki is sometimes used in this process.

Externalization with an index rate of 0.815 has lower average than Socialization (2.350), which indicates that not all collaborators contribute to the explanation of tacit knowledge, thereby **rejecting hypothesis H2** (the wiki contributes to the process of Externalization (SECI model)).

The lowest average was obtained for the Combination process (2.013), thereby **rejecting hypothesis H3** (the wiki contributes to the Combination process (SECI model)). Internalization is the conversion of explicit knowledge to tacit, where the wiki is used more frequently by the collaborators (3.270), thereby **confirming hypothesis H4** (the wiki is predominantly used for Internalization (SECI model)).

The relatively low evaluation for Externalization and Combination indicates that only a few collaborators contribute to the wiki and that there may be several content consumers. This indicates the need for leader presence in collaborative processes, which emphasizes the importance of collaboration and building a collective memory [11]. This may be because only a few teams in the studied group incorporated the processes of adding content to a wiki in their daily work.

### 4.3. SECI Model Analysis

One analyzed question was related to the dependence relations between the dimensions representing the different stages of knowledge conversion. This question was used to verify the principles of the systemic integration of the SECI model and its correlations.

The analysis was based on Spearman's nonparametric coefficient Rho according to the nonobservance of the supposed normality of the studied dimensions. Spearman's Rho is mathematically less sensitive than the Pearson correlation coefficient for distant values. The results are shown in **Table 5**.

Strong and straight correlation stands out between all conversion stages of knowledge, which validates the systematic conception between the established phases in the SECI model, from its interdependences and contri-

**Table 4.** Internal consistency from Cronbach's Alpha coefficient.

| SECI model stages | Questions | Average | Cronbach's alpha |
|---|---|---|---|
| Socialization | 3 | 2.746 | 0.757 |
| Externalization | 3 | 2.350 | 0.815 |
| Combination | 5 | 2.013 | 0.873 |
| Internalization | 14 | 3.270 | 0.931 |

**Table 5.** Spearman's Rho correlation between the forms of knowledge conversion.

| | Socialization | Externalization | Combination | Internalization |
|---|---|---|---|---|
| Socialization | | | | |
| Externalization | 0.714** | | | |
| Combination | 0.716** | 0.816** | | |
| Internalization | 0.757** | 0.650** | 0.717** | |

Note: **The correlation is significant at the level 0.01 (2 extremities).

butes for the management of knowledge. Note that the correlations were always significant at a high level of trust (equivalent to 99%), which shows strong connections between the phases.

The highest correlation was obtained between Combination and Externalization (0.816), followed by Internalization and Socialization (0.757), Internalization and Combination (0.757), Combination and Socialization (0.716), Externalization and Socialization (0.714) and Internalization and Externalization (0.650). The close and high correlation between Combination and Externalization values was explained from the confirmation that only with an effective process of clarification and sharing of tacit knowledge can one create new knowledge, thereby expanding the spiral of knowledge proposed by [4]. Conversely, one can effectively externalize or make explicit (Externalization/Combination) what has been learned (Internalization).

A path diagram was built from the collected data. According to [48], the path diagram is a visual representation of a theoretical model and a complete set of relations between the constructs of this model. Dependence relations are represented by straight arrows pointing to the variable predictor, the variable or to the construct-dependent. Curved arrows correspond to correlations between constructs or indicators; however, no causality is implied.

To construct the path diagram of causal relationships the Structural Equation Modeling (SEM) was used. The SEM refers to a set of techniques and statistical procedures, specifically multiple regression and factor analysis, that tries to explicit the relationships between multiple variables, e.g., questions for questionnaires [48].

The diagram—**Figure 2**—is directly derived from the questionnaire formulation, which presents four factors, or latent dimensions, represented by circles or ellipses (Socialization, Externalization, Combination and Internalization). These factors are each associated with variable indicators, *i.e.* observed variables, which are the questions in the questionnaire (represented by rectangles). Comprehensively, we used 25 of 31 questions distributed in:

- Socialization Factor: measured by questions 1 to 3.
- Externalization Factor: measured by questions 5 to 7.
- Combination Factor: measured by questions 8 to 12.
- Internalization Factor: measured by questions 13 to 26.

**Figure 2** [37] presents the hypothetical model derived from our literature review. From the generated diagram, it is possible to visualize the spiral of knowledge with the tacit knowledge shared in the Socialization process, moving to the Externalization process, then the Combination process and finally Internalization, as proposed in SECI Model [4].

With the results obtained using CA, which confirm the high internal consistency between the sets of dimensions studied in the different stages of knowledge conversion and the high values obtained by Spearman's Rho correlations (all are significant at 99% confidence level), a procedure was created to calculate the coefficients of knowledge. For this, a procedure was performed to estimate the so-called "Socialization coefficient—Sc", "Externalization coefficient—Oc", "Combination coefficient—Cc" and "Internalization coefficient—Ic", as well as a "Vector Global Knowledge coefficient", formed from the contributions of their respective Sc, Oc, Cc and Ic.

First, the sum of the evaluations for each respondent was obtained in the four steps, generating a matrix of 320 observations. The main problem was associated with the fact that the steps had several different questions. Here, the corresponding value of the relative frequency was used, *i.e.* the specific weight of each sum formed according to the relation between the evaluation obtained in accordance with the maximum possible rating. A new matrix was formed with an equal number of relative values.

We then normalized to sum 1 the new matrix considering the fact that the summation obtained for each respondent would have to represent a measure of weight. Thus, the sum of each vector needed to be 1.

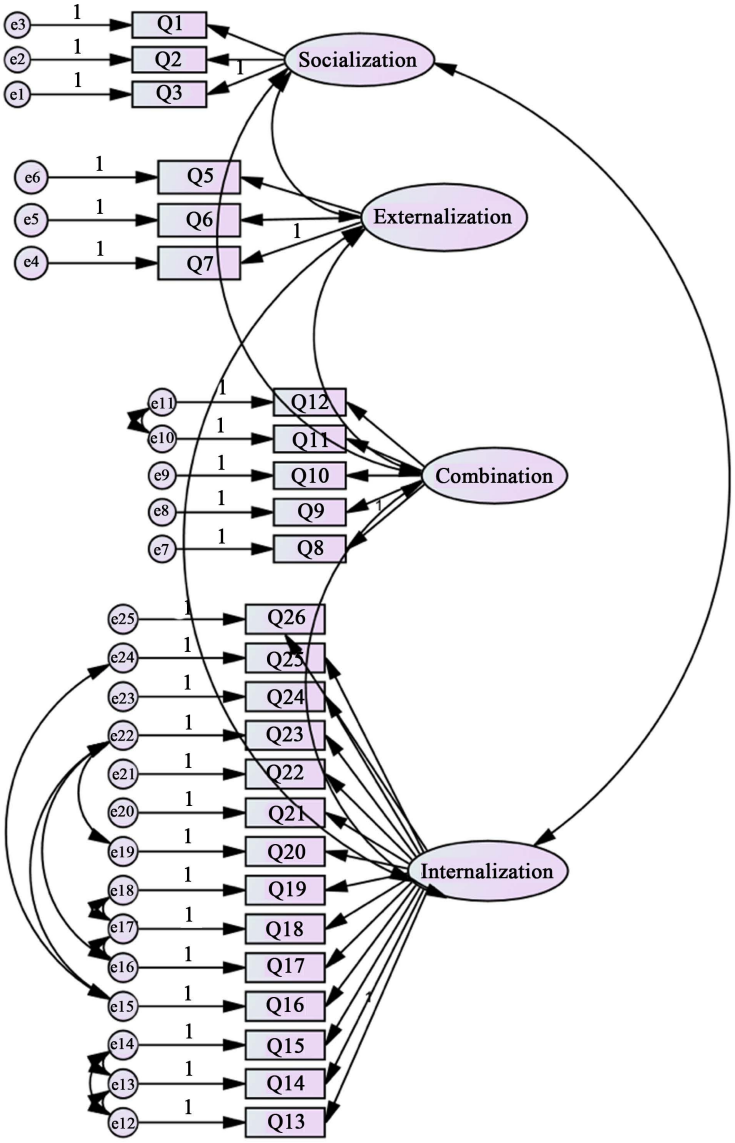


**Figure 2.** Path diagram of causal relations.

According to the previous steps, the research resulted in 80 individual vectors that correspond to the weights of each respondent (**Appendix 1**). **Figure 3** presents the behaviours of the knowledge coefficient of the respondent for each conversion stage, *i.e.* a graphical representation of the respective individual vectors.

The highest contribution in the individual vectors of the knowledge coefficient was the Internalization mode, which always shows higher values. This is followed by Socialization, Externalization and the lowest, *i.e.* the Combination mode. The Internalization mode is one whereby, after reflection and individual or collective action, acquisition of knowledge is achieved. In the case studied, the wiki tool was assessed relative to the creation of individual knowledge. Higher individual knowledge gives trust to the sharing processes, *i.e.* Socialization and Externalization. However, it is up to the individual or group to determine whether to use this new knowledge to create other knowledge (Combination).

For better understanding and meeting the research aims, an aggregation procedure was performed in order to obtain the Global Vector Knowledge Coefficient. We used the geometric mean criteria as a measure of aggregation, justified by the existence of relative values, characterized as weights or weightings. The Global Knowledge Vector Coefficient obtained was again normalized to sum 1, to obtain the same previous effect and to rely on the weightings of each coefficient to the global vector.

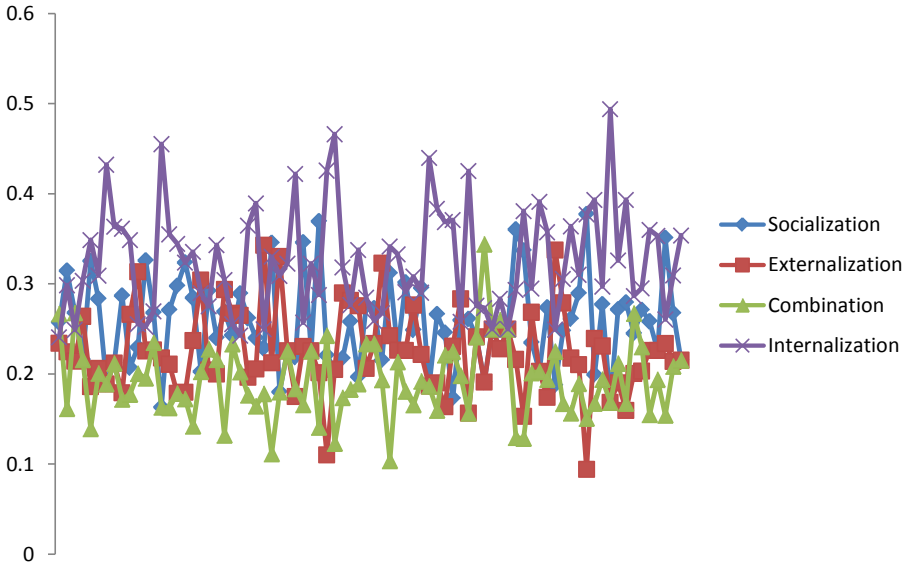


**Figure 3.** Individual vectors knowledge for involved respondents.

The results obtained with the procedure used were the following:

$$K_c = \begin{pmatrix} S_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.2518 \\ E_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.2201 \\ C_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.1887 \\ I_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.3206 \end{pmatrix}, \quad K_{c_{NORM}} = \begin{pmatrix} S_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.2567 \\ E_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.2243 \\ C_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.1923 \\ I_c \Big/ \sum_{j=1}^{4} \omega_i^j = 0.3267 \end{pmatrix}$$

It is possible to distinguish that the greatest contribution in "Global Vector Knowledge Coefficient" was precisely the contribution of "Internalization Coefficient", with a weight of 32.67%, followed by the "Socialization coefficient" with a contribution of 25.67%, the "Externalization Coefficient", with 22.43% and finally the "Socialization Coefficient", with a significance of 19.23%. We again verify that the tool helps individual knowledge creation (Internalization) and favours those processes that may be created by observation, imitation and practice (socialization). The processes that depend on decision-making to share (or not) the knowledge (Externalization and Combination) are totally dependent on the social interaction actions.

## 5. Conclusions

The objective of this paper was to map the contributions of a wiki tool to the management processes of Organizational Knowledge Management, in order to learn, store, retrieve and share knowledge generated in organizations. We began from an assumption and assertions from previous research, which sustained four hypotheses, that a wiki could contribute to OKM and improve the sharing activities of a company. After collection and analysis of the results, it was observed, concerning the confirmation or rejection of the following hypothesis:

| Hypothesis | Results |
|---|---|
| The use of wiki does not contribute directly to the process of Socialization (SECI Model)—Hypothesis 1 | Confirmed |
| Wiki contributes to the process of Externalization (SECI Model)—Hypothesis 2 | Rejected |
| Wiki contributes to the process of Combination (SECI Model)—Hypothesis 3 | Rejected |
| Wiki is predominantly used for the Internalization (SECI Model)—Hypothesis 4 | Confirmed |

These results corroborate, among others, previous studies (e.g. [40]). The following can be inferred from our statistical analysis.

- The wiki is predominantly used for Internalization.
- Only a few employees contribute (add content) to the wiki in Externalization actions.
- Socialization is restricted to observation and imitation actions.
- Combination is the least common form of knowledge conversion.

At first, it could be said that the initial assumption was rejected. However, analyzing the questionnaire results, we conclude that 50% of employees actually use the wiki as a Socialization tool, that 38% use the wiki as Externalization tool and 30% as Combination tool. When considering Internalization, 88% of employees agree that the wiki increases both their efficiency and effectiveness in developing activities and that 66% use the wiki to solve immediate problems.

In summary, there is little contribution by collaborators; however, most employees access the wiki when searching knowledge (Internalization), which encourages the use of the tool. Thus, effective actions to strengthen the enabling environment and increase the explicitness of OKM actions are required from middle and senior management.

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**Appendix 1.** Normalized matrix of individuals vectors of knowledge.

| | Socialization | Externalization | Combination | Internalization |
|---|---|---|---|---|
| 1 | 0.257697456 | 0.234270415 | 0.267068273 | 0.240963855 |
| 2 | 0.314707771 | 0.224791265 | 0.161849711 | 0.298651252 |
| 3 | 0.268199234 | 0.214559387 | 0.268199234 | 0.249042146 |
| 4 | 0.216123499 | 0.264150943 | 0.216123499 | 0.303602058 |
| 5 | 0.325581395 | 0.186046512 | 0.139534884 | 0.348837209 |
| 6 | 0.283505155 | 0.206185567 | 0.201030928 | 0.309278351 |
| 7 | 0.189189189 | 0.189189189 | 0.189189189 | 0.432432432 |
| 8 | 0.212121212 | 0.212121212 | 0.212121212 | 0.363636364 |
| 9 | 0.287032291 | 0.179395182 | 0.172219375 | 0.361353152 |
| 10 | 0.207188161 | 0.266384778 | 0.177589852 | 0.348837209 |
| 11 | 0.230056767 | 0.313713774 | 0.200776815 | 0.255452644 |
| 12 | 0.326048011 | 0.225725546 | 0.195628807 | 0.252597635 |
| 13 | 0.268199234 | 0.226937813 | 0.235190097 | 0.269672856 |
| 14 | 0.163424125 | 0.217898833 | 0.163424125 | 0.455252918 |
| 15 | 0.271201033 | 0.210934137 | 0.16272062 | 0.35514421 |
| 16 | 0.29787234 | 0.178723404 | 0.178723404 | 0.344680851 |
| 17 | 0.323741007 | 0.179856115 | 0.172661871 | 0.323741007 |
| 18 | 0.284745763 | 0.237288136 | 0.142372881 | 0.33559322 |
| 19 | 0.202898551 | 0.304347826 | 0.202898551 | 0.289855072 |
| 20 | 0.292153589 | 0.204507513 | 0.2278798 | 0.275459098 |
| 21 | 0.2402746 | 0.200228833 | 0.21624714 | 0.343249428 |
| 22 | 0.269419174 | 0.293911826 | 0.132260322 | 0.304408677 |
| 23 | 0.243309002 | 0.267639903 | 0.233576642 | 0.255474453 |
| 24 | 0.289355839 | 0.265242852 | 0.202549087 | 0.242852222 |
| 25 | 0.261927035 | 0.196445276 | 0.176800748 | 0.364826941 |
| 26 | 0.240078393 | 0.20578148 | 0.164625184 | 0.389514944 |
| 27 | 0.228683437 | 0.343025155 | 0.178373081 | 0.249918327 |
| 28 | 0.345482156 | 0.212604404 | 0.111617312 | 0.330296128 |
| 29 | 0.180257511 | 0.330472103 | 0.180257511 | 0.309012876 |
| 30 | 0.225806452 | 0.225806452 | 0.225806452 | 0.322580645 |
| 31 | 0.218886804 | 0.175109443 | 0.183864916 | 0.422138837 |
| 32 | 0.346077785 | 0.230718523 | 0.166117337 | 0.257086355 |
| 33 | 0.225806452 | 0.225806452 | 0.225806452 | 0.322580645 |
| 34 | 0.369481766 | 0.201535509 | 0.141074856 | 0.287907869 |
| 35 | 0.220820189 | 0.110410095 | 0.242902208 | 0.425867508 |
| 36 | 0.205278592 | 0.205278592 | 0.123167155 | 0.46627566 |
| 37 | 0.217503884 | 0.290005179 | 0.174003107 | 0.31848783 |
| 38 | 0.258302583 | 0.281784636 | 0.183160013 | 0.276752768 |
| 39 | 0.197072072 | 0.275900901 | 0.189189189 | 0.337837838 |
| 40 | 0.275049116 | 0.206286837 | 0.233791749 | 0.284872299 |

**Continued**

| | | | | |
|---|---|---|---|---|
| 41 | 0.272980501 | 0.233983287 | 0.233983287 | 0.259052925 |
| 42 | 0.215384615 | 0.323076923 | 0.193846154 | 0.267692308 |
| 43 | 0.311881188 | 0.242574257 | 0.103960396 | 0.341584158 |
| 44 | 0.226641998 | 0.226641998 | 0.213691027 | 0.333024977 |
| 45 | 0.301724138 | 0.226293103 | 0.181034483 | 0.290948276 |
| 46 | 0.249011858 | 0.276679842 | 0.166007905 | 0.308300395 |
| 47 | 0.295670539 | 0.221752904 | 0.19218585 | 0.290390707 |
| 48 | 0.186666667 | 0.186666667 | 0.186666667 | 0.44 |
| 49 | 0.266449157 | 0.190320827 | 0.159869494 | 0.383360522 |
| 50 | 0.245901639 | 0.163934426 | 0.221311475 | 0.368852459 |
| 51 | 0.173124485 | 0.230832646 | 0.22506183 | 0.370981039 |
| 52 | 0.259871752 | 0.283496456 | 0.198447519 | 0.258184273 |
| 53 | 0.26119403 | 0.156716418 | 0.156716418 | 0.425373134 |
| 54 | 0.24137931 | 0.24137931 | 0.24137931 | 0.275862069 |
| 55 | 0.191256831 | 0.191256831 | 0.344262295 | 0.273224044 |
| 56 | 0.25 | 0.25 | 0.25 | 0.25 |
| 57 | 0.228161669 | 0.228161669 | 0.260104302 | 0.28357236 |
| 58 | 0.25 | 0.25 | 0.25 | 0.25 |
| 59 | 0.360453141 | 0.216271885 | 0.129763131 | 0.293511843 |
| 60 | 0.337127846 | 0.15323993 | 0.128721541 | 0.380910683 |
| 61 | 0.23501199 | 0.268585132 | 0.201438849 | 0.294964029 |
| 62 | 0.202898551 | 0.202898551 | 0.202898551 | 0.391304348 |
| 63 | 0.273923871 | 0.17431519 | 0.194236926 | 0.357524013 |
| 64 | 0.18766756 | 0.337801609 | 0.225201072 | 0.249329759 |
| 65 | 0.248007086 | 0.279007972 | 0.167404783 | 0.305580159 |
| 66 | 0.261356565 | 0.217797138 | 0.156813939 | 0.364032358 |
| 67 | 0.28958255 | 0.210605491 | 0.189544942 | 0.310267018 |
| 68 | 0.377358491 | 0.094339623 | 0.150943396 | 0.377358491 |
| 69 | 0.1995439 | 0.23945268 | 0.167616876 | 0.393386545 |
| 70 | 0.277410832 | 0.231175694 | 0.194187583 | 0.297225892 |
| 71 | 0.168674699 | 0.168674699 | 0.168674699 | 0.493975904 |
| 72 | 0.27173913 | 0.190217391 | 0.211956522 | 0.326086957 |
| 73 | 0.27936146 | 0.15963512 | 0.167616876 | 0.393386545 |
| 74 | 0.24522293 | 0.200636943 | 0.267515924 | 0.286624204 |
| 75 | 0.271055179 | 0.203291384 | 0.230396902 | 0.295256534 |
| 76 | 0.25854109 | 0.226223453 | 0.155124654 | 0.360110803 |
| 77 | 0.226327945 | 0.226327945 | 0.193995381 | 0.35334873 |
| 78 | 0.350935829 | 0.233957219 | 0.154411765 | 0.260695187 |
| 79 | 0.267584098 | 0.214067278 | 0.208715596 | 0.309633028 |
| 80 | 0.215384615 | 0.215384615 | 0.215384615 | 0.353846154 |