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Psychometric analysis of the scale of barriers to sharing knowledge in the Kaizen of a company

Análise psicométrica da escala de barreiras ao compartilhamento de conhecimento no Kaizen de uma empresa

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Abstract: The Kaizen continuous improvement principle encourages employees to use their knowledge to create better solutions. This knowledge, referred to as tacit, is strategically shared through socialization and made explicit through externalization. One department of a multinational metallurgical industry in the state of Santa Catarina, Brazil, has historically had a Kaizen involvement rate of less than 50%. This study set out to identify and analyze the barriers to knowledge sharing, considering the socialization-externalization interface, and how they relate to the company's current Kaizen participation rate. To this end, a literature review was conducted, followed by a documentary analysis of the company and the application of a questionnaire that served as a scale for exploratory factor analysis and validation of the model for the objectives set. The factor analysis confirmed the lack of application of meritocratic means, Ba context, and management involvement, and retained three organizational and three individual factors of barriers to knowledge sharing. It was found that the current rate of employee involvement in Kaizen contrasts with the effects of the socialization-externalization interface and the barriers to knowledge sharing. The method structured in this study has the potential to be applied in other companies and can be improved.

Keywords: *Knowledge management; Knowledge sharing; Tacit knowledge; Continuous improvement; Exploratory factor analysis.*

Resumo: O princípio de melhoria contínua Kaizen incentiva os empregados a usar seus conhecimentos para criar melhores soluções. Esse conhecimento, referido como tácito, é estratégico ser compartilhado, por meio da socialização, e explicitado por meio da externalização. Um departamento de uma indústria metalúrgica multinacional de Santa Catarina, Brasil, tem um índice de envolvimento no Kaizen historicamente inferior a 50%. Este trabalho se propôs identificar e analisar as barreiras ao compartilhamento do conhecimento, considerando a interface socialização-externalização, e como se relacionam ao atual índice de envolvimento no Kaizen da empresa. Para isso, houve a revisão da literatura, uma análise documental sobre a empresa, seguida pela aplicação de um questionário, que serviu de escala para uma análise fatorial exploratória e validação do modelo para os objetivos traçados. A análise fatorial confirmou a falta de aplicação de meios meritocráticos, contexto Ba, e envolvimento da gestão, além de ter retido três fatores organizacionais e três individuais de barreiras ao compartilhamento do conhecimento. Evidenciou-se que atual índice de envolvimento dos funcionários ao Kaizen contrasta significativamente com os efeitos da interface socialização-

externalização e as barreiras ao compartilhamento do conhecimento. O método estruturado neste trabalho tem potencial de aplicação em outras empresas e pode ser aperfeiçoado.

Palavras-chave: Gestão do conhecimento*;* Compartilhamento do conhecimento*;* Conhecimento tácito*;* Melhoria contínua*;* Análise fatorial exploratória.

1 Introduction

In the global market, organizations must be able to understand the factors that influence their performance and act on them, which requires flexibility in the way the company is conducted, which implies involving people with a view to continuously improving results and undergoing adequate management of processes (Nunes et al., 2021; Imai, 1998).

In this sense, the way management is approached becomes a key component of an organization's strategy. One of the management philosophies to be adopted is Lean Manufacturing (LM), and in the case of multinationals, they implement more advanced management concepts such as World Class Manufacturing (WCM) (Andrade, 2019; De Felice et al., 2019).

The company focus on this study uses as a management and process improvement methodology a model adapted from WCM to promote operational excellence considering its values. Considering the company's premise of bringing together the best of knowledge and the recognized rate, lower than the target of 50%, of involvement of manufacturing employees in the continuous improvement of a specific department, this was identified as an opportunity to investigate the factors behind this performance. To achieve this, Kaizen was used as a basis for sharing knowledge and practices to promote engagement with this program.

To access personal knowledge rooted in the experiences, values, and ideals of each individual, called tacit knowledge, we sought to contribute to the knowledge conversion spiral, specifically the stage that assumes the transformation of tacit knowledge into explicit knowledge, known as socialization-externalization (Nonaka & Takeuchi, 1995).

This context, combined with the lack of well-defined sharing processes, results in barriers to disseminating knowledge. As it is a process that involves the use of individual knowledge in actions with a group of people, sharing is mediated by these barriers (Dorow, 2017; Alves & Barbosa, 2010). Identifying these barriers should improve the overall effectiveness of knowledge-sharing activities, reduce the gap between the ideal and current state of sharing practices, and put into effect the values in force (Riege, 2005).

Understanding that one of the bottlenecks in improving the engagement of employees from that department in Kaizen involves recognizing the possible causes that impede them, the present study aimed to highlight how the socialization-externalization interface is processed and the panorama, in loco, of the barriers to knowledge sharing. To achieve this, the study was based on the elaboration, validation, and application of a questionnaire and the use of factor analysis to recognize the main factors involved.

2 Theoretical framework

An analysis of the WCM management system allowed us to identify that the pillars of "Focused Improvement" (Borges & De Oliveira, 2016; De Felice & Petrillo, 2015) and "People Development" act in an articulated way once the execution of methods and techniques, and potential results depend on people, and it is up to this pillar to develop them with a view to knowledge (thinking) and skills (doing). In this way, aspects of WCM can be

related to knowledge management theories to provide resources and support tools in enhancing intellectual capital, in the use of knowledge inventory through qualification and training, in transmission and sharing of knowledge; in people-orientation, and the fundamental role of leadership (Tomadon et al., 2021; Mendes & Mattos, 2017, 2021).

WCM uses management tools similar to Lean manufacturing, including Kaizen (Vukadinovic et al., 2019; Satolo et al., 2018). In this study, process Kaizen has direct relevance as it focuses on people and processes for waste elimination at the factory floor level (Tortorella et al., 2019).

In the model called SECI (socialization, externalization, combination, internalization), the knowledge conversion process begins at the individual level and is expanded across communities through interaction, crossing sectional and organizational boundaries at the same time that the interaction between tacit and explicit knowledge grows in a spiral (Nonaka & Takeuchi, 1995, 2008). This is a phase of exchanging experiences, and it is important to develop forms of incentive that motivate individuals to share this knowledge because the "holder" of the knowledge may assume that if they share it, their value (of the individual) will decrease and, as self-preservation, may not cooperate (Nonaka, 2002).

Furthermore, a factor that contributes to the knowledge conversion process involves the environment referred to in KM as *Ba*, which roughly means "place," a time-space nexus, an environment in which the individual absorbs and interprets information and makes it knowledge. It can be a physical, virtual, or mental location. *Ba* is related to the modes of knowledge conversion as it allows sharing of experiences and tacit knowledge through socialization. This socialized knowledge, in turn, can be made explicit through externalization, making it explicit knowledge. This knowledge can be combined with other explicit knowledge, resulting in a combination of shared knowledge that individuals can internalize, making it tacit again (Nonaka & Konno, 1998). In this way, knowledge starts to be created through interactions between individuals or between individuals and their environments, and not by an individual operating alone, which demonstrates that the key concept of *Ba* is interaction (Nonaka & Konno, 1998; Nonaka et al., 2000). Therefore, it is essential to understand the reasons that lead to employee engagement (Jurburg et al., 2016). Although technologies help with sharing, it is people who decide whether or not to share their knowledge (Dorow et al., 2018).

Motivation is considered a fundamental facilitator (Imai, 1986; Jurburg et al., 2016) and is defined as a set of processes that awaken, maintain, and direct human behavior to achieve a given objective (Dorow et al., 2018). Motivation can be considered as one of the factors that determine an individual's behavior at work as it refers to the belief in accepting the goals and values of the organization and the willingness to exert effort in favor of it, making their performance compatible with what the company expects and, consequently, improve the company's performance (Zonatto et al., 2018).

According to the Self-Determination Theory, motivational levels are mapped into three groups: demotivation, extrinsic motivation, and intrinsic motivation (Bizarria et al., 2016; Leal et al., 2013), and follow a continuum of self-determination with various human motivation possibilities (Rufini et al., 2011). This theory addresses human personality and motivation, the capacity for self-regulation inherent to man, which enables them to seek satisfaction of the basic needs of competence, autonomy, relationships, and well-being (Bizarria et al., 2016; Guimarães & Boruchovitch, 2004; Ryan & Deci, 2000).

Since motivation and the perception of reward go hand in hand, different studies argue that the foundation of reward theory lies in motivational theories, whose objective is to motivate the organization's employees and encourage them to act through intrinsic or extrinsic stimuli (Pinho et al., 2018; Bonilla et al., 2012). They are significant factors

of individual creativity, as personal and professional development resides in these systems as a means of applying incentives and having an impact on the organization (Hung et al., 2011; Muñoz-Pascual & Galende, 2017).

The rewards system is a powerful tool to encourage employees to behave in line with the organizational strategy (Adão, 2021) and establish incentives for those committed to the organization (Pinho et al., 2018).

For a rewards system to be effective and achieve the objectives for which it was determined, it must have some characteristics such as alignment with organizational strategic objectives, be accepted by its recipients and perceived as fair and objective, have an equitable operation, and evaluate the contribution of each individual according to clear and uncontroversial criteria (Camaro 2011, *apud* Ferreira et al., 2018).

Since knowledge sharing is a process that depends on people, more specifically, on the interaction and relationships established between them, it comes up against individual beliefs, values, and customs that are part of the organizational culture (Pepulim et al., 2017). Among other factors, there are individuals' attitudes, organizational and cultural contexts, the management model, access and dissemination of technological information and communication resources, and structural, motivational, and human factors (Wons et al., 2018; Queiroz et al., 2017; Zawawi et al., 2011; Riege, 2005).

Table 1 presents an overview of the factors associated with individual and organizational barriers to knowledge sharing, suggested by Riege (2005), and there are also technological barriers. Thus, by identifying and reducing barriers to this process, waste of resources is prevented, making decision-making more consistent for organizational progress (Horta & Barbosa, 2017; Rizzon et al., 2016).

Table 1. Taxonomy of types of barriers to knowledge management.

Barrier	What it is based on
Organizacional	1. Organizational culture;
	2. Organizational values;
	3. Resistance to change from top management and employees;
	4. Level of power in the organization;
	5. Dominant professional standards;
	6. Political aspects of the organization;
	7. Economic aspects of the organization;
	8. Vision of the organization;
	9. Geographical aspects of the organization;
	10. Lack of knowledge of the organization;
	11. Lack of specific knowledge management projects;
	12. Technological tools;
	13. Codification of knowledge;
	14. Information flows in the organization;
	15. Costs;
	16. Integration of KM strategy and sharing initiatives into company objectives and strategies is lacking or unclear;
	17. Shortage of formal and informal spaces for sharing, reflecting and generating (new) knowledge;
	18. Lack of transparent rewards and recognition systems that would motivate people to share more of their knowledge;
	19. Lack of adequate infrastructure to support sharing practices;
	20. Communication and knowledge flows are restricted in certain directions;
	21. The hierarchical structure of the organization inhibits or slows down most sharing practices;
	22. The company's approach is lacking or unclear;
	23. Lack of leadership and management direction in terms of clearly communicating the benefits and values of knowledge sharing practices.

Table 1. Continued…

Barrier	What it is based on
Individual	1. Lack of trust in the organization;
	2. Personal accommodation;
	3. Problems related to the individual's self-image;
	4. Personal motivation;
	5. Lack of trust in peers;
	6. Lack of communication skills;
	7. Cognitive processes;
	8. Culture;
	9. Perception;
	10. Language;
	11. Distance;
	12. Values,
	13. Continuous advancement of existing technological tools;
	14. Codification of knowledge;
	15. General lack of time to share knowledge;
	16. Fear that sharing could reduce or compromise job security;
	17. Lack of time for contact and interaction between sources and recipients of knowledge;
	18. Appropriating intellectual property for fear of not receiving fair recognition and accreditation from managers and colleagues;
	19. Lack of a social network.

Source: Riege (2005), Pepulim et al. (2017), formatted and adapted by authors.

3 Methodology

3.1 Ethical aspects

This research was carried out through a presentation of the aforementioned study and the application of the questionnaire. The respondent had the possibility and freedom to refuse to participate or withdraw their consent, as well as guaranteed the right to confidentiality and personal privacy and data provided. To this end, the research project was evaluated and received a favorable opinion (number 5,476,177) from the Research Ethics Committee (CEP – Univille).

3.2 Research design and instrument validation

The study was methodological, applied, and descriptive-explanatory. Its purpose was to generate knowledge to solve problems, describe a phenomenon's characteristics, and identify factors contributing to its occurrence (Pereira, 2019).

In addition to the literature review, a documentary analysis was conducted to understand the hierarchy of Kaizen guidelines related to the motivation/rewards process in the company, and, based on the literature on the SECI model and barriers to knowledge sharing, a questionnaire divided into two parts was prepared. The first is composed of sociodemographic options to understand the profile of the participants. The second, with items that dealt with the identification of possible barriers. These items were also associated with underlying constructs formed by organizational knowledge-sharing barriers (Table 2), partly related to organizational barriers (OB), and partly to individual barriers (IB). These items were aggregated using a Likert scale from 1- Never to 5- Very Often.

To validate the questionnaire, 40 respondents were randomly selected at the company's main unit, among those who worked at levels equal or similar to those who would be part of

the sample. After application, participants were asked if they found it difficult to understand any statement. In general, participants confirmed the items were written clearly, and there were suggestions for improvement in the syntax of sentences 5, 6, 7, 37, 38, and 39 of the form. At this stage, the reliability analysis of the instrument was carried out. For this, 30 of the 40 forms were used, excluding those partially completed.

Table 2. Relationship between questionnaire items and constructs based on barrier type.

Organizational Barriers		Individual Barriers	
Underlying construct	Questionnaire item	Underlying construct	Questionnaire item
Scarcity	Q1		Q21
space/moment/ hierarchical structure	Q2	Personal motivation	Q22
	Q3		Q23
	Q4		Q24
Information flow	Q5	Lack of communication skills	Q25
	Q6		Q26
	Q7		Q27
	Q8		Q28
Culture	Q9	Identification of benefits	Q29
	Q10		Q30
	Q11		Q31
	Q12		Q32
Reward	Q13	Gaps in knowledge	Q33
	Q14		Q34
	Q15		Q35
	Q16		Q36
Recognition	Q17	Loss of power	Q37
	Q18		Q38
	Q19		Q39
	Q20		Q40

Source: The authors (2023).

3.3 Sampling and data collection period

The sample consisted of n=212 employees of the company under study selected through the stratified sample, which consisted of dividing the population into subgroups, called strata, and as a stratification criterion, proportional sampling was chosen, with the proportionality of the size of each stratum of the population maintained in the sample (Barbetta, 2002). For the sampling design, the sampling unit was defined as sectors and work shifts. Data collection occurred from August to September 2022 in the department of a multinational metalworking industry in Santa Catarina, Brazil.

3.4 Data analysis

Data from physical forms were entered into electronic tables for data analysis using Stata 17® software. Once the data was computed in electronic tables, with the support of the software, the Exploratory Factor Analysis (EFA) technique was applied as we sought evidence of the validity of the scales (underlying constructs) proposed for organizational and individual barriers to sharing information and how the socialization-externalization interface of knowledge was processed in that context.

Conceptually, factor analysis is a method for creating a general intelligence index ("g" factor) based on the results of several tests (scales) that supposedly reflect this aptitude and whose objective is to identify the relationships between the analyzed variables, grouping them into factors, thus summarizing the dataset and identifying the most representative variables or creating a new set of variables (Hongyu, 2018).

The methodological choice of EFA reflects the perception of Bido et al. (2018), who explain that exploratory use should occur when the researcher has little or no knowledge of the latent structure behind the research indicators, i.e., when there is no prior empirical research or when the theory supporting the phenomenon is incipient, it is not known how many dimensions will result and how the structures will be built. In this case, exploratory use allows us to understand the latent structure, bringing us closer to understanding the phenomenon. Additionally, it is believed that the measured variables correlate with each other due to underlying latent dimensions called factors, and the observed variables "belong" to the same factor when and if they share a common variation (influenced by the same underlying construct) (Damásio, 2012; Marley W., 2022).

To submit the analysis to the factorization process, the Kaiser-Meyer-Olkin (KMO) index was applied, which indicates the proportion of sample variance explained by a latent value variable; values between 0.7 and 0.8 are considered good; greater than 0.8 and 0.9 are considered optimal and excellent, respectively (Damásio, 2012). Additionally, Bartlett's test of sphericity was applied, which evaluates the overall significance of all correlations in a data matrix and employs a significance level of $p < 0.05$, indicating that the matrix is factorable (Damásio, 2012).

When verifying ordinal variables, as in the case of a Likert scale, according to the considerations of Rogers (2022) and Watkins (2018), the polychoric correlation matrix was implemented and, as the main concern is to identify the underlying dimensions and common variance is an element of interest, principal axis factoring was adopted (Malhotra, 2019).

To determine the number of factors, the parallel analysis (PA) method was applied, which is considered an appropriate procedure to determine the number of factors to be retained. To increase accuracy, we considered the 95% confidence interval obtained in the random eigenvalues and followed this with at least a minimum of 100 data sets in the computational calculation method, with an ideal of 500-1000 (Damásio, 2012; Hayton et al., 2004; Marley, 2022; Watkins, 2018).

The choice of rotation was based on the assumption that oblique rotations allow factors to be correlated, and using orthogonal rotation in data from Human and Social Sciences does not seem to make any sense because, in these areas, variables are almost always correlated. In contrast to this assumption, the researcher should have very strong theoretical or empirical evidence the factors are not correlated to opt for orthogonal rotation (Matos & Rodrigues, 2019).

For the Item Retention Criterion, the following were adopted: (i) items with factor loading ≥ 0.5 as it is considered a value with high practical significance; (ii) a construct must be reflected by a minimum of three items, and (iii) the conceptual theoretical similarity between the content of the item and the theory of the underlying construction of the question under analysis (Favacho et al., 2021; Hair et al., 2009).

Considering instruments that provide adequate levels of confidence, Cronbach's alpha coefficient appears as the most used in studies, and in general, α ≥ 0.70 is considered satisfactory (Freitas & Rodrigues, 2005) even though it can decrease to 0.60 in Social Sciences research scenarios (Maroco & Marques, 2006). However,

Cronbach's alpha has several limitations in psychometric studies because it is affected by the number of items, the number of response alternatives, and the proportion of test variance.

As an alternative resource, the Omega coefficient is an option for calculating reliability as it works with factor loadings that are the weighted sum of standardized variables, a transformation that makes more stable calculations and has less risk of overestimating or underestimating reliability. In general, an acceptable Omega coefficient must be ≥ 0.7 (Dunn et al., 2014; Ventura-León & Caycho-Rodríguez, 2017).

4 Results and discussion

4.1 Sociodemographic characterization

Based on the criterion of completely filled-in data, 212 participants were included in the final sample out of the 240 questionnaires administered, meeting the calculated sample. Demographic data presented in Table 3 indicates that the department is made up of people capable of developing within the company, interacting with people they know, and being more immersed in the company's culture. Regarding education level, almost 86% of respondents have complete high school or higher education, which indicates the level of specialization in that department.

Tabela 3. Characteristics of the participants.

Variable	n	%	Variable	n	%
Age group (years)			Schooling		
Up to 20	31	14.62	Incomplete Elementary	3	1.42
21 – 30	90	42.45	Complete Elementary	6	2.83
31 – 40	63	29.72	Incomplete High school	21	9.91
41 – 50	23	10.85	Complete High school	111	52.36
Above 50	5	2.36	Incomplete Technician	15	7.08
Time in business (years)			Complete Technician	23	10.85
Up to 1	71	33.49	Undergrade incomplete	26	12.26
2 – 5	68	32.08	Undergrade Complete	7	3.3
5 – 10	25	11.79			
Above 10	48	22.64			

Source: Research data.

4.2 Dimensionality of the number of factors

The organizational barrier scale presented KMO=0.816 and Bartlett (χ^2 (190)=1974.188; p≤0.001); the individual barrier scale presented KMO=0.841 and Bartlett (χ^2(190)=1974.188; p≤0.001). With these values, see Damásio (2012), the test rejects the null hypothesis, indicating that both the sample correlation matrices and the application of the EFA are adequate, and, therefore, the polychoric correlation matrix was applied for the factorial calculations.

Next, using parallel analysis with 600 repetitions considering the 95% confidence interval to determine the number of factors, the parallel analysis indicated that the best

factorial structure was 4 factors in the adjusted eigenvalue column for organizational and individual barriers (Table 4).

Table 4. Parallel Analysis - Barriers to Knowledge Sharing Scale.

PA - Organizational Barriers (OB)				PA- Individual Barriers(IB)			
Component or Factor	Adjusted eigenvalue	Unadjusted eigenvalue	Estimated bias	Component or Factor	Adjusted eigenvalue	Unadjusted eigenvalue	Estimated bias
1	5.132	5.684	0.552	1	5.488	5.992	0.504
2	2.270	2.748	0.478	2	1.248	1.714	0.466
3	1.628	1.978	0.350	3	1.032	1.441	0.409
4	*1.020	1.336	0.315	4	*1.057	1.361	0.304
5	0.851	1.107	0.255	5	0.818	1.103	0.285
6	0.745	0.969	0.224	6	0.777	0.986	0.210
7	0.567	0.755	0.189	7	0.718	0.865	0.147
8	0.622	0.747	0.124	8	0.740	0.825	0.085
9	0.566	0.642	0.076	9	0.742	0.794	0.052
10	0.635	0.616	-0.019	10	0.681	0.685	0.005
11	0.635	0.578	-0.056	11	0.644	0.619	-0.025
12	0.648	0.512	-0.137	12	0.613	0.540	-0.074
13	0.600	0.452	-0.148	13	0.615	0.503	-0.111
14	0.569	0.412	-0.157	14	0.674	0.464	-0.210
15	0.591	0.365	-0.227	15	0.680	0.446	-0.233
16	0.607	0.310	-0.297	16	0.664	0.419	-0.245
17	0.595	0.274	-0.322	17	0.745	0.387	-0.358
18	0.590	0.239	-0.351	18	0.682	0.319	-0.364
19	0.602	0.202	-0.400	19	0.670	0.276	-0.394
20	0.526	0.075	-0.451	20	0.713	0.261	-0.451

*Criterion: retain > 1.

4.3 Factorial analysis of organizational barriers

After the dimensionality of the scales defined in the parallel analysis, factor analyses following the method of principal factor axes and oblique rotation (promax) indicated that 17 of 20 items met the stipulated factor loading ≥0.5 of high practical significance, according to Hair et al. (2009), and three remaining items (Q6, Q19, and Q20) did not reach the determined factor loadings, receiving indication for elimination according to established criteria.

About the loading of observable variables by latent variables, specifically in relation to the discriminative nature of the underlying constructs, item Q5 was indicated for elimination according to the established criterion of lack of theoretical relevance of the item with the factor on which it was loaded (Favacho et al., 2021). Finally, Q7 and Q8 were indicated for elimination as they were loaded on a common factor, not meeting the minimum of three items (Hair et al., 2009).

As recommended by Hair et al. (2009), these points were identified, the exclusion was applied, and the factorial model was respecified, resulting in Table 5.

Table 5. Factor Loadings - Organizational Barriers to Knowledge Sharing.

	Variable	Factor 1	Factor 2	Factor 3	Sing.	Comun.
Meritocracy Organizational Barrier (Financial/non-financial reward)						
Q14	I collaborated with ideas for improvement, but received no recognition in the form of a reward such as a "salary increase".	*0.952*	0.018	0.054	0.089	0.912
Q15	I collaborated with ideas for improvement, but received no recognition in the form of a reward such as a "promotion".	*0.942*	-0.017	-0.001	0.128	0.872
Q13	I collaborated with ideas for improvement, but received no recognition in the form of a "profit-sharing bonus".	*0.878*	0.003	0.058	0.237	0.763
Q17	I wasn't given the opportunity to present my improvement work at a recognition seminar.	*0.731*	-0.056	0.001	0.501	0.499
Q18	I wasn't given the opportunity to present my improvement work to my section colleagues in a formal meeting.	*0.693*	0.015	-0.105	0.480	0.520
Q16	In my work environment, I believe there is a lack of fair criteria for rewarding suggested improvements.	*0.545*	0.180	-0.060	0.560	0.440
Organizational Culture Barrier						
Q9	I stopped suggesting improvements to my work because I wasn't listened to by my coworkers or the company's management.	0.011	*0.912*	0.159	0.224	0.777
Q10	I've stopped suggesting improvements to my work because of resistance from colleagues or even from the company's management.	0.039	*0.874*	0.072	0.237	0.763
Q11	I've stopped suggesting improvements in my work because I've experienced the term "there's no point in suggesting improvements at work because things won't move forward."	-0.044	*0.760*	-0.120	0.382	0.618
Q12	I've stopped suggesting improvements to my work because I lack the support to put improvement ideas into practice.	0.012	*0.720*	-0.139	0.391	0.609
Organizational Barrier of Scarcity of space/momentum/leader support						
Q1	There is little or no space (such as a meeting room) for employees to raise individual suggestions for improving their work.	0.024	0.093	*0.769*	0.446	0.555
Q2	There is little or no coordination of a problem survey so that improvements can be suggested.	0.089	0.032	*0.723*	0.495	0.505
Q3	In the section meeting, there is little or no time for me to make suggestions for improving my work environment.	-0.044	0.020	*0.706*	0.502	0.498
Q4	There is little or no mutual collaboration between employees and managers when it comes to potential improvements at work.o.	-0.009	-0.122	*0.521*	0.672	0.328
(α) Alfa de Cronbach (0.844)		0.876	0.848	0.747		
(ω) Omega de McDonald (0.956)		0.919	0.896	0.778		
	Explained variance	0.570	0.232	0.148		
	Total explained variance	0.570	0.802	0.950		

Source: Research data.

The first factor grouped the observable variables of the scales of the underlying construct of the reward and recognition system. This grouping is because, by observing the literature in Ferreira et al. (2018), a dichotomous typology of rewards is financial and non-financial rewards.

Items Q13, Q14, and Q15 are rewards of an extrinsic-financial nature of motivation generated by external regulation (Ferreira et al., 2018; Leal et al., 2013; Rufini et al., 2011) and point to a well-defined structure (target reference of FA), with factor loading ≥0.7, as explained by Hair et al. (2009). Helping to compose the dimension of this scale, these items allow us to observe employees who did not receive rewards from the meritocratic model suggested by the Kaizen principle. Similarly, the inclusion of item

Q16 in this scale contributes to the perception of the failure to adopt fair criteria regarding the act of attributing rewards.

Items Q17 and Q18, in the recognition model taken as extrinsic non-financial generated by external regulation (Ferreira et al., 2018), also contributed to the validity of the scale. A lack of application of the recognition model established in Kaizen guidelines was observed.

Thus, factor 1 was called the Organizational Barrier of Meritocracy (Financial/non-financial reward), the most relevant factor with an explained variance of 57%, with reliability ω=0.919 and α=0.876, meeting the minimum reliability values indicated by literature (Dunn et al., 2014; Freitas & Rodrigues, 2005; Ventura-León & Caycho-Rodríguez, 2017).

Since knowledge results from individual investments and, therefore, reflects personal interests (Nonaka et al., 2006) and, given that the biggest challenge of knowledge management is its capture and integration, an effective way to establish the motivation to share knowledge is through reward and incentive mechanisms (Alavi & Leidner, 1999).

Along this conceptual line, the contrast of the scenario validated by the respective factor is seen in the literature; the assumption of the success of a rewards system encourages actions and behaviors aligned with the company's objectives, serving as a critical component in motivating employees and recognizing their contributions to the organization (Amorim et al., 2008). Thus, to be effective and have the potential to achieve preset goals, the rewards system must be perceived as fair and objective by recipients (Camaro 2011, apud Ferreira et al., 2018; Pinho et al., 2018). If these concepts of justice/injustice are poorly administered, they may cause problems when it comes to rewarding fairly (Freitas, 2020). In addition to the validity of this scale, the presence of the Organizational Barrier of Meritocracy factor (financial/non-financial rewards) is verified.

The second factor grouped variables from the scale in which the organizational barrier is verified in the face of the culture that, according to Pepulim et al. (2017), is pertinent regarding the resistance of members to changes in an organizational culture that does not promote knowledge management and the lack of real knowledge of the potential for the organization. Furthermore, cultural factors are fundamentally seen as inhibitors of knowledge transfer (Rizzon et al., 2016).

Reflecting on the context (syntax) of items Q9, Q10, Q11, and Q12 in the aforementioned factor, the validity of resistance and the lack of interest/support/care in the context of cultural barriers was noted. Additionally, all variables of the underlying construct were presented in the factor table with factor loadings ≥ 0.7, indicating a well-defined structure (Hair et al., 2009).

Factor 2 is now named Organizational Barrier of Culture, the second most relevant factor, with 23.3% of the explained variance and 80.2% of the total explained variance. Its reliability presented values ω=0.896 and α=0.848, meeting the minimum reliability values indicated by the literature (Dunn et al., 2014; Freitas & Rodrigues, 2005; Ventura-León & Caycho-Rodríguez, 2017).

Organizational culture has a significant impact on employee attitudes toward knowledge sharing, and if the culture does not support knowledge sharing, it makes little difference which channel is used (Rizzon et al., 2016). In contrast to this theoretical scenario, organizational culture must, among other things, promote the sharing of information and knowledge, guarantee the engagement and collaboration of people, promoting their integration since these must be incorporated as a value of the organization (Pepulim et al., 2017).

After presenting the main points that guide the discussion of the contrast of the scenario identified in this scale, organizations must make an effort to foster a culture that stimulates the development of organizational knowledge, as this is a factor that can help them to achieve better results in knowledge management (Centenaro et al., 2016).

The third factor of the scale grouped the variables that bias the basis of the creation of organizational knowledge, concrete knowledge that someone possesses, which becomes represented, and whose representation the organization becomes the owner of. The items of this latent variable constitute the verification of the validity of the deficiency of the "Ba" context (time-space nexus), leadership engagement/support as an agent for promoting SECI, and, as such, may limit knowledge sharing practices (Moraes et al., 2014; Nonaka & Takeuchi, 2008; Nonaka et al., 2006; Nonaka & Konno, 1998; Nonaka & Takeuchi, 1995; Riege, 2005). Checking the items retained in the aforementioned factor Q1*, Q2*, Q3*, and Q4, all variables of the underlying construct were presented in the factor table, and there are items (*) with factor loadings ≥ 0.7, indicating a well-defined structure (Hair et al., 2009).

In the context of the variables, item Q1 asks whether a formal space is available for surveying improvements; item Q3, similarly, asks whether a time/space is provided in a sector meeting for pointing out suggestions for improvement. With the loading of these variables on the retained factor, the validity of the lack of a "Ba" context is identified; thus, a lack of understanding that a shared space should be provided as a foundation for the creation of knowledge is perceived. Therefore, based on the theoretical framework, this scenario must be treated as a framework due to the limits of space and time in which knowledge is activated as a resource for creation (Nonaka et al., 2006; Nonaka & Konno, 1998), being essential for the development of new knowledge and social interaction (Queiroz et al., 2017). The Q2/Q4 variables present in the scale had the specific objective of checking the focus on evaluating improvements that the manager must make together with the employee, and this is through coordination and mutual collaboration in socialization-externalization dynamics, according to the Kaizen guideline. The validity evidence based on the structure between the content of the instrument (what the retained items address) and the domain evaluated identified the validity that there is a lack of coordination and mutual collaboration of the leader in this aspect.

Considering the theoretical relevance, factor 3 is now renamed Organizational Barrier of Scarcity of Space/Moment/Leader Support, the third most relevant factor with 14.8% of the explained variance and 95% of the total explained variance. Its reliability had values $\omega=0.778$ and $\alpha=0.747$, meeting the minimum reliability values indicated by the literature (Dunn et al., 2014; Freitas & Rodrigues, 2005; Ventura-León & Caycho-Rodríguez, 2017).

In contrast to this scenario and congruent with the theoretical framework adopted, leadership must create a climate that encourages improvement initiatives (Mogaramedi et al., 2020). Furthermore, the essence of leadership is to promote the process of the SECI spiral (socialization, externalization, combination, internalization), and, consequently, by interpreting, nurturing, and supporting the vision of knowledge, these individuals promote organizational knowledge by facilitating the conversion of knowledge and, its most significant contribution is to the externalization of knowledge in "Ba" (Nonaka et al., 2006). Thus, the validity of this factor in the aforementioned scale is a way of reporting how the socialization-externalization interface of knowledge is currently processed in the organization.

4.4 Factor analysis of individual barriers

The analysis of individual barriers to knowledge sharing; therefore, verification of the data obtained revealed that 17 out of the 20 items that make up the factor loading table met the loading requirement ≥0.5 in terms of practical significance. The remaining three items, Q24, Q35, and Q36, did not reach the determined loading and were eliminated based on the established criteria. Also, not meeting specified criteria, items Q23 and Q32 did not meet the minimum loading of three observable variables per factor and were indicated for elimination (Hair et al., 2009).

In terms of verifying the variables retained by factor, items Q21, Q22, Q25, Q33, and Q34 are indicated for elimination due to the lack of theoretical relevance of the item to the factor in which it was allocated (Favacho et al., 2021). To achieve a more satisfactory factorial solution in the individual barriers after the applied exclusions (Hair et al., 2009), the factor model was respecified, and the factor table model was recalculated and presented in Table 6.

Table 6. Factor Loadings - Individual Barriers to Knowledge Sharing.

Variable		Factor 1	Factor 2	Factor 3	Sing.	Comun.
Individual barrier Lack of communication skills						
Q27	I've stopped contributing ideas for improving my work because I've had experiences where my colleagues or boss didn't understand my suggestion.	**0.897**	-0.043	0.011	0.222	0.779
Q28	I've stopped contributing ideas for improving my work because my colleagues or boss had different interpretations of what I was proposing.	**0.804**	0.116	-0.102	0.325	0.675
Q26	I stopped contributing ideas for improving my work because I didn't succeed in convincing my coworkers with my suggestion.	**0.626**	-0.066	0.224	0.480	0.521
Individual Barrier of Loss of Power						
Q37	I've already stopped contributing ideas for improving my work because I preferred to keep "my method" of working a secret.	-0.162	**0.712**	0.257	0.405	0.595
Q40	I've stopped contributing ideas for improving my work because I believe that "knowledge is power" and so I've used my experience to stand out.	0.094	**0.653**	-0.178	0.580	0.421
Q38	I've stopped contributing ideas for improving my work because I preferred to suggest them at more appropriate times, when I could be sure of receiving recognition or reward.	0.031	**0.619**	0.003	0.597	0.404
Q39	I've already stopped contributing ideas for improving my work because I was afraid that such an improvement might jeopardize my job or my activity	0.245	**0.577**	0.119	0.386	0.614
Individual barrier of identifying benefits						
Q29	I've stopped contributing ideas for improving my work because I don't know all the details of the operation.	-0.054	0.122	**0.741**	0.406	0.594
Q30	I've stopped contributing ideas for improving my work because I'm not fully aware of the benefits that a suggestion can generate for the company and its employees.	0.070	0.000	**0.696**	0.468	0.532
Q31	I've stopped contributing ideas for improving my work because sometimes they're ideas that I believe are too simple and have no potential.	0.046	0.023	**0.506**	0.712	0.288
(α) Alfa de Cronbach (0.776)		0.787	0.679	0.671		
(ω) Omega de McDonald (0.911)		0.841	0.769	0.704		
	Explained variance	0.322	0.161	0.133		
	Total explained variance	0.322	0.483	0.616		

Source: Research data.

The first factor grouped observable variables Q26, Q27, and Q28 in the scale of the underlying construct that constitutes the investigation of the validity of the deficiency in verbal/written communication and interpersonal skills for this, according to aspects of this barrier (Riege, 2005), with emphasis on Q27/ Q28 with factor loadings ≥ 0.7 indicating a well-defined structure (Hair et al., 2009).

Regarding the topic of communication in individual barriers to knowledge sharing, the presence of such a factor is related to the intrinsic nature of knowledge sharing, which requires involvement and communication between people (Queiroz et al., 2017). When taking into account the theoretical relevance of the factor, the topic of communication clearly illustrates how difficult it can be to make tacit knowledge explicit and transfer it fluently and quickly (Davenport & Prusak, 2003).

Due to the aforementioned characteristics, factor 1 is now renamed Individual Barrier of Lack of communication skills, being the most relevant factor with 32.2% of explained variance, with reliability $\omega=0.841$ and $\alpha=0.787$, meeting the minimum values of reliability indicated in literature (Dunn et al., 2014; Freitas & Rodrigues, 2005; Ventura-León & Caycho-Rodríguez, 2017).

In this way, employees' ability to share knowledge in the first place is inferred to be dependent on their communication skills, and, thus, the contrast is that effective communication, both verbal (the most common means of sharing tacit knowledge) and written, are fundamental for the effective sharing of knowledge in organizations and largely defines success as a whole, providing agility and reliability in accessing information for the production and sharing of knowledge, making organizations more competitive in the market. Given the importance of communication, companies should allocate part of the resource development budget reserve to train employees in communication skills (Luccas & Damian, 2021; Riege, 2005; Santos, 2018)

The second factor grouped observable variables in the scale of the underlying construct, Q37 to Q40, which contributes to verifying the validity of the loss of power attributed to the act of sharing knowledge. It is congruent that issues of power permeate relationships between individuals engaged in knowledge exchanges and influence how knowledge is shared. This aspect is an intentional attempt by the individual to retain or hide knowledge by accumulating for themselves, which may or may not be shared in the future but can be used as a competition device by an individualistic mentality due to a perception of lack of job security or even because they believe that this accumulation can benefit career advancement or status within the organization (Dorow et al., 2018; Riege, 2005; Rizzon et al., 2016).

Due to the aforementioned characteristics, the factor is now renamed Individual Barrier of Loss of Power and this latent variable presents 16.1% of explained variance, 48.3% of the total explained variance and referring to reliability, values $\omega=0.769$ and $\alpha=0.679$, meeting the minimum reliability values indicated by the literature (Dunn et al., 2014; Freitas & Rodrigues, 2005; Ventura-León & Caycho-Rodríguez, 2017).

The validity of the latent variable of loss of power is well contrasted with the phenomenological scenario of this study because, consistent with the theoretical framework discussed, knowledge is often synonymous with power given its importance in organizations, and this, in a way, has been fostering the value attributed to individuals who possess it, which encourages the notion of power around knowledge. In this way, if power is perceived by individuals as coming from the knowledge they possess, they tend to accumulate it instead of sharing it without being clear that by sharing, the exchange process will increase everyone's knowledge. Therefore, the absence of this discernment makes them use it for some control or protection. Furthermore, individuals

may have internal resistance and will protect their knowledge when they believe it is not common and has value (Dorow, 2017).

In an organization, the way information is handled determines whether it will be an obstacle or a facilitator for knowledge sharing. Knowledge sharing is more than technology, business strategy, or a transition from the industrial age to the information age; it is about people; thus, to share, it is necessary to break the idea that information/knowledge is power and change the way we people think about it. For this to happen, people can be encouraged through appreciation and recognition for sharing knowledge, and those who are unsure of the value of their knowledge must have the support of managers and team leaders through the creation of an environment of collaborative work (Barros et al., 2010).

The third factor grouped the observable variables, Q29, Q30, and Q31 of the underlying construct that aims to collaborate with the verification of the validity of the individual barrier of lack of knowledge of the benefits, which from the perspective of knowledge management, is treated as a barrier to the achievement of knowledge sharing. This connotation addressed by the researcher is essential as members of the organization must understand the benefits that knowledge sharing can bring (mutually). Contrary to this, they can retain knowledge due to low awareness and perception of the value and benefit of the knowledge possessed, and, adjacently, when they do not realize what the benefits are in sharing, they feel devalued (Dorow et al., 2018; Riege, 2005; Rizzon et al., 2016).

Due to the above, the factor came to be named Individual Barrier of Benefit Identification; the respective latent variable presented 13.3% in explained variance, 61.6% in total explained variance, and reliability ω=0.704 and α=0.671, meeting the minimum reliability values recommended by the literature (Dunn et al., 2014; Freitas & Rodrigues, 2005; Ventura-León & Caycho-Rodríguez, 2017).

Understanding the potential benefits of knowledge sharing highlights how companies can better develop a knowledge-based business vision and provide an emphasis on creating and incubating integrated, employee-supported knowledge-sharing cultures, which is essential to maintain the competitiveness of their business (Riege, 2005).

To achieve this, organizations can use various means to encourage knowledge sharing among their employees but regardless of the method chosen, sharing must be incorporated as a value in the organization's culture, and individuals must feel good about exchanging knowledge and recognize the benefits involved, both for their professional career and for the organization. As a result, the sharing action is amplified given the perception of these benefits since such action is motivated by the prospect of obtaining these (Pepulim et al., 2017; Pereira de Melo et al., 2022).

4 Final considerations

Considering the problem identified in the company and based on the articulation of the adopted theoretical framework, it was possible to extract that the current rate of employee involvement in Kaizen contrasts significantly with the barriers to knowledge sharing. The framework was based on knowledge management, especially the socialization-externalization process, Kaizen, on WCM, aligned with the information coming from the Self-Determination Theory, from knowledge about reward systems and barriers to knowledge sharing. Arguments that connect appropriately to explain this scenario were identified by grouping them into factors and allowed the creation of

adjacent constructs to outline the scale of barriers to knowledge sharing in the industrial environment.

The validity of the EFA scales about the constructed factor models, according to the adopted theoretical framework, indicates that the most significant contribution of this work was in the theoretical-methodological field. The highlight points of the theoretical framework were articulated to develop, validate, and apply a robust research instrument that was relatively simple and easy for participants to understand. Additionally, the selection of the statistical analysis method used to evaluate the results facilitated the identification of obstacles to knowledge sharing, and it was possible because the Kaizen guidelines utilized by the researched company were previously examined.

Comparing the statistical analysis results with the guidelines provided easy-to-recognize notes to solve the problem. Thus, this study contributed to advancing the WCM process management philosophy strategy and Kaizen participatory management in the company studied.

Statement on Data Availability

The statistical data generated in greater detail and the stata software database can be obtained via the figshare repository
link: https://figshare.com/articles/dataset/OFICIAL_Trabalho_Disserta_a_dta/22728485.

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