An Optimisation Approach for Prioritising Actions to Mitigate Collaborative Knowledge Management Barriers

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Abstract: Collaborative Knowledge Management (CKM) initiatives often struggle in practice because organisations face everyday managerial challenges such as limited coordination, misaligned objectives, uneven skills, and unclear documentation practices. Although many studies identify these barriers, managers still lack simple tools that help them decide which improvement actions should be implemented first when time, budget, and organisational capacity are limited. This paper proposes an optimisation-based approach designed to support these decisions. The model helps organisations select the combination of actions that is expected to reduce management-related knowledge barriers the most, while considering real-world constraints such as budget limitations, implementation capacity, feasibility conditions, and logical relationships between actions, including prerequisites and mutually incompatible initiatives. Besides suggesting which actions to implement, the approach also shows how much each barrier is likely to decrease, helping managers clearly understand the expected benefits and making the results easier to explain and discuss in decision-making processes. Finally, a real application illustrates how the proposed approach supports managerial decision-making by identifying practical actions, such as training initiatives, coordination mechanisms, and clear documentation practices, that can simultaneously reduce several management barriers and prepare the organisation for more advanced collaborative knowledge initiatives in later implementation phases. Future research may extend the proposed approach by incorporating uncertainty in the estimation of action effectiveness, multi-period planning considerations, and dynamic learning mechanisms that update decision recommendations as new implementation data becomes available.

Keywords: Collaborative knowledge management, Optimisation, Knowledge barriers, Managerial decision-making, Prioritisation

1. Introduction

In today's global and connected business environment, organisations increasingly collaborate with external partners such as suppliers, customers and sometimes even competitors. In these collaborative networks, knowledge is one of the most valuable resources for innovation, problem solving and improving organisational performance. The ability to share and combine knowledge across organisational boundaries is therefore considered an important capability for modern enterprises and supply chains (Grant, 1996; Cheng et al., 2024). Organisations that are able to manage knowledge effectively are usually better prepared to adapt to changes and remain competitive.

Collaborative knowledge management (CKM) plays an important role in supporting these interactions. Through CKM processes, organisations can share experiences, expertise and information in order to generate new ideas, improve decision-making and respond more effectively to changing market conditions (Li, Ye and Sheu, 2014; Zighan et al., 2024). When knowledge flows easily between organisations, companies can learn from each other and avoid repeating the same mistakes.

However, in practice many CKM initiatives do not achieve the expected results. One of the main reasons is the presence of barriers that make knowledge sharing and collaboration difficult among individuals, organisations and networks (Chua and Banerjee, 2023; Koivisto and Taipalus, 2025). These barriers can appear at different levels. For example, employees may lack motivation to share their knowledge, organisations may have different objectives, or technological systems may not be compatible.

Although previous studies have identified many of these barriers, managers still face difficulties when deciding how to address them in practice. In almost all organisations, resources are limited. Companies often have limited budgets, limited time and limited capacity to implement many initiatives at the same time. For this reason, managers must decide which actions should be implemented first in order to reduce the most important barriers while using the available resources efficiently (Marra, Ho and Edwards, 2012; Danko and Crhová, 2025).

Although that are many research studies focused on CKM, there is still a lack of practical and easy-to-use tools that help managers decide which improvement actions should be implemented to minimise the impact of the barriers and improve the CKM process. In addition, there is also a need for tools that take into account the daily operation of companies, such as budget limitations and organisational constraints.

To address this problem, this paper proposes a mixed-integer linear programming (MILP) model that helps organisations select the most appropriate actions to reduce CKM barriers. The model considers: (i) the effectiveness of different actions to mitigate specific barriers; (ii) the implementation costs of the actions; (iii) the budget that the organisation is willing to invest; and (iv) the organisation's capacity to implement change. In addition, the model also considers the relationships between actions, since there are situations where one action needs another action to be implemented first, and there are also cases where two actions cannot be implemented at the same time.

The rest of the paper is organised as follows. Section 2 describes the antecedents of the research focusing on the framework used to analyse CKM barriers. Section 3 presents the optimisation model and the case study used to validate the approach. Section 4 presents and discusses the results obtained. Finally, Section 5 summarises the main conclusions of the study and suggests possible directions for future research.

2. Antecedents

CKM has been investigated in recent years in order to improve the process through which knowledge is shared. Currently, organisations work together with other partners, and it is necessary to share a large amount of knowledge in order to remain competitive and continue improving their performance.

However, collaborating to share knowledge among organisations is complex. Current research shows that when different companies try to collaborate to share knowledge they usually face difficult problems. These problems can be of different types and nature, ranging from diverse organisational cultures to differences in objectives between individuals and organisations (Chua and Banerjee, 2023; Koivisto and Taipalus, 2025).

To better understand these CKM barriers, different frameworks have been proposed to classify and analyse them. Sanchis, Sanchis-Gisbert and Poler (2020) proposed a three-dimensional framework that structures CKM barriers according to three main dimensions: perspectives, levels of collaboration and barrier blocks.

The perspectives represent different viewpoints from which the barriers can be analysed, and they are divided into human, organisational, technological, contextual, and informational aspects. The human perspective involves the people who perform the collaboration and covers the skills, abilities, attitudes, or fears that influence the CKM process. The organisational perspective involves the internal structure and management of organisations, with elements such as leadership, communication flows, strategies, and organisational culture. The technological perspective considers the tools and systems used to support CKM, such as artificial intelligence, information technologies, communication platforms, or data systems that facilitate the exchange and storage of knowledge. The contextual perspective concerns the external conditions of the organisations, such as environmental, social, cultural, or regulatory factors. Finally, the informational perspective focuses on the characteristics of the information and knowledge being shared, such as its accuracy, relevance, availability, and uncertainty, among others.

The levels define where the CKM process takes place, covering from individuals to collaboration within entire supply chains. The framework considers four main levels. The individual one that focuses on knowledge interactions between people. The intra-collaborative level that covers the collaboration inside the same organisation (between departments, teams, or functional units). The inter-collaborative level, which refers to collaboration between different organisations within a supply chain. Finally, the framework defines a novel level, called extra-collaborative level, which involves the knowledge exchanges that go beyond a single supply chain, involving multiple networks, institutions, or broader collaborative ecosystems. This level of collaboration is the most complex due to the large number of actors involved in the CKM process and also due to the variety of interests, structures, and objectives.

With regard to the barriers blocks, they are divided into four: trust, management, environment, and means, which help organise the different barriers that may affect CKM initiatives. In this study, we focus on the management barriers block, which includes the barriers related to how knowledge collaboration is organised, coordinated, and managed, as shown in Table 1. While the structure follows the three-dimensional framework proposed by Sanchis et al. (2020), some barriers have been slightly updated to better reflect current challenges related to digital collaboration and the increasing use of knowledge-sharing technologies.

Table 1: Management barriers block adapted from Sanchis et al. (2020)

Perspective	Individual	Intra-collaborative	Inter-collaborative	Extra-collaborative
Human	Differences in abilities and skills. Lack of motivation.	Differences in knowledge domains and professional backgrounds.	Strong contrasts in expertise, disciplines and professional cultures.	High diversity of knowledge domains and skills across actors.
Organisational	Self-interest of individuals. Incompatibility between personal objectives.	Prevalence of departmental objectives over organisational goals.	Dominance of individual organisational interests over network goals.	Dilution of shared objectives and strategic misalignment among networks.
Technological	Lack of technological training strategies.	Lack of coordination and management of technological systems.	Technological imbalance between organisations.	Lack of common technological initiatives and low interoperability between digital collaboration platforms.
Contextual	Fear of becoming redundant. Lack of awareness of knowledge strategies and tools.	Conflicts of interest and weak collaborative knowledge culture.	Differences in organisational size and power imbalance between partners.	Confusing interests between networks and lack of shared governance structures.
Informational	Lack of knowledge recording practices.	Lack of documentation policies and knowledge management standards.	Insufficient mechanisms to externalise and structure knowledge.	Complex and dense knowledge externalisation strategies and information overload in digital collaboration environments.

3. Optimisation-based Approach

The optimisation model proposed in this paper aims to support managers when selecting actions to reduce CKM barriers. In many organisations, there are several possible actions that could improve knowledge sharing. However, due to limited resources, it is usually not possible to implement all of them at the same time.

For this reason, managers need to decide which actions should be prioritised. Some actions may have a strong impact on several barriers, while others may only affect a small number of them. At the same time, each action has a cost and requires organisational effort to be implemented. The optimisation model evaluates different combinations of actions and identifies the set of actions that produces the greatest reduction of the barriers while respecting organisational constraints. These constraints include the available budget, the organisation's capacity to implement change and possible relationships between actions.

In addition, the model allows managers to monitor how much each barrier is reduced by the selected actions. This helps decision-makers better understand the results and identify which barriers still require additional attention.

3.1 Model Formulation

The notation used in the optimisation model is summarised in Table 2.

Table 2: Notation of the CKM barriers mitigation optimisation model

Set of indices	
I	Set of candidate solutions (indexed by *i*, *k*)
J	Set of barriers (indexed by *j*)
Subsets of indices	
D	Set of dependency pairs (*i*, *k*) where solution *i* requires solution *k* to be implemented
E	Set of exclusion pairs (*i*, *k*) where solutions *i* and *k* cannot be selected simultaneously

Parameters	
c_i	Implementation cost of solution *i*
e_{ij}	Effectiveness of solution *i* in mitigating barrier *j*
w_j	Importance weight assigned to barrier *j*
B	Total available budget for implementing solutions
K	Organisational change capacity. Maximum number of solutions that can be implemented simultaneously
α_j	Minimum desired mitigation level for barrier *j*. Threshold parameter
Decision variables	
x_i	Binary decision variable equal to 1 if solution *i* is selected, 0 otherwise
Output variables	
m_j	Achieved mitigation level of barrier *j*, where $m_j \in [0,1]$

The objective function (1) maximises the overall mitigation impact of the identified barriers. This impact is calculated as the weighted sum of the mitigation levels achieved for each barrier, where the weights reflect their relative importance. One of the main challenges of this model is to make the results easier to interpret for managers, as many of the companies that could use this type of tool do not have strong technical backgrounds. For this reason, the model includes a variable that represents the mitigation level achieved for each barrier. This value is limited to a maximum of one, which corresponds to full mitigation.

$$\max \sum_{j \in J} w_j \cdot m_j \tag{1}$$

The model is subjected to different constraints. The budget constraint (2) ensures that the total cost of the selected solutions does not exceed the available budget. The change capacity constraint (3) limits the total number of solutions that can be implemented at the same time, reflecting that organisations cannot implement multiple initiatives simultaneously.

$$\sum_{i \in I} c_i \cdot x_i \leq B \tag{2}$$

$$\sum_{i \in I} x_i \leq K \tag{3}$$

The mitigation level achieved for each barrier depends on the effectiveness of the selected solutions. For this reason, the model links the effectiveness of the selected solutions with the variable that represents the mitigation level of each barrier (4). In this sense, the model represents the combined effect of multiple solutions taking into account that the mitigation level cannot exceed full coverage, i.e. 1 (5). In addition, the model also includes coverage constraints, which require a minimum mitigation level to be reached for specific barriers that are considered particularly important (6).

$$m_j \leq \sum_{i \in I} e_{ij}\, x_i \qquad \forall j \in J \tag{4}$$

$$0 \leq m_j \leq 1 \qquad \forall j \in J \tag{5}$$

$$m_j \geq \alpha_j \qquad \forall j \in J \tag{6}$$

Finally, the model also considers relationships between solutions. Dependency constraints ensure that some solutions can only be implemented if other solutions are also selected (7). At the same time, exclusion constraints prevent the simultaneous selection of solutions that are incompatible (8). All the variables that represent the selection of solutions are binary, meaning that each solution is either implemented or not (9).

$$x_i \leq x_k \qquad \forall (i,k) \in D \tag{7}$$

$$x_i + x_k \leq 1 \qquad \forall (i,k) \in E \tag{8}$$

$$x_i \in \{0,1\} \tag{9}$$

3.2 Case Study

The case study was conducted in an engineering and information and communication technologies consulting company specialised in the design of intelligent transport systems (ITS) for public and private organisations. The company develops technological solutions related to traffic monitoring, mobility management and transport data analysis.

Projects in this sector usually involve multidisciplinary teams composed of engineers, software developers and technical specialists. In this context, knowledge sharing is very important because experiences and solutions developed in previous projects can help improve future projects.

As part of its digital transformation strategy, the organisation aims to improve its CKM practices. The company is particularly interested in improving the way knowledge generated during projects is captured, stored and shared across teams.

To identify the most relevant barriers and possible improvement actions, three professionals from the organisation participated in the evaluation process. These participants included one senior manager responsible for innovation strategy, one engineer working on ITS design projects and one technical specialist responsible for system implementation. These experts evaluated 12 barriers from the three-dimensional framework proposed by Sanchis et al. (2020). Only barriers related to management were assessed as it is shown in Figure 1.

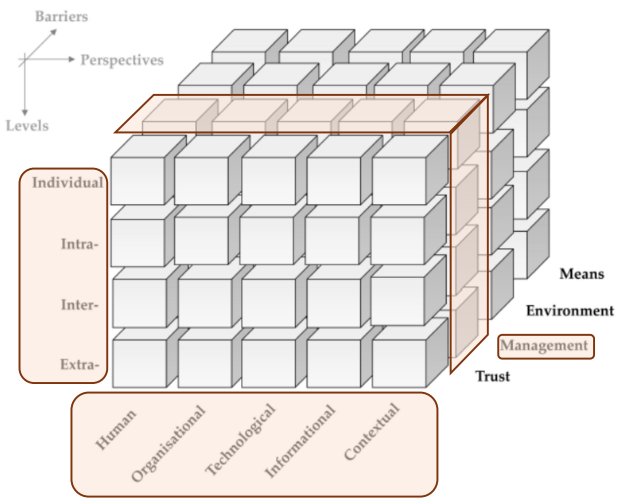

Figure 1: Coverage of the optimisation model based on the three-dimensional framework of CKM barriers proposed by Sanchis et al. (2020)

The company defined the importance of each barrier by assigning a weight on a scale from 1 to 10, where 1 represents a low level of importance and 10 represents a very high level of importance. In addition, the participants were asked to indicate the percentage of mitigation they would like to achieve for each barrier. Table 3 presents both the importance weights (w_j) of each barrier analysed and the coverage thresholds (α_j).

Table 3: Set of barriers analysed in the case study with its importance (weight) and coverage threshold.

Barrier	Description	Weight (w_j)	Threshold (α_j)
B1	Lack of skills and abilities	8	0.4
B2	Self-interest and incompatibility	7	0.3
B3	Lack of knowledge registers	6	0.15

Barrier	Description	Weight (w_j)	Threshold (α_j)
B4	Differences in knowledge fields	7	0.4
B5	Functional *vs* organisational objectives	9	0.5
B6	Lack of technological coordination	7	0.25
B7	Differences in skills between organisations	6	0.3
B8	Conflicting organisational interests	9	0.5
B9	Weak knowledge culture	8	0.4
B10	Disorder in knowledge structures	6	0.1
B11	Strategic misalignment	10	0.5
B12	Difficulty externalising knowledge	7	0.25

Based on this, the company considered eight possible actions that could improve CKM as shown in Table 4. These actions represent initiatives that could be implemented within a short pilot period of two to three months.

Table 4: Possible improvement actions that could improve CKM

Action	Description	Cost (€)
A1	Training workshops on knowledge sharing practices	4,500
A2	Incentive programme for knowledge contributions	3,000
A3	CKM collaboration platform (software licences and configuration)	8,500
A4	CKM governance committee	1,200
A5	Knowledge repository system	6,000
A6	Document management policy and templates	2,000
A7	Strategic alignment workshop	2,500
A8	Internal culture programme promoting knowledge sharing	3,500

Based on the weights given to the selected barriers (Figure 2), the intra-collaborative level has the highest importance (34.4%). This is followed by the inter-collaborative level (24.4%), the individual level (23.3%), and finally the extra-collaborative level (17.8%). This means that most of the important barriers identified by the company are mainly related to collaboration inside the organisation, that has sense as the company works based on projects, and previous company projects may serve as knowledge basis for future ones.

If we analyse the barriers from the perspective dimension (Figure 2), organisational barriers represent the largest part of the total weight (38.9%). Human barriers are the second most important (30.0%). Technological, contextual and informational barriers have a smaller importance. These results indicate that the main difficulties for CKM in the analysed company are more related to organisational alignment and coordination than to technological problems.

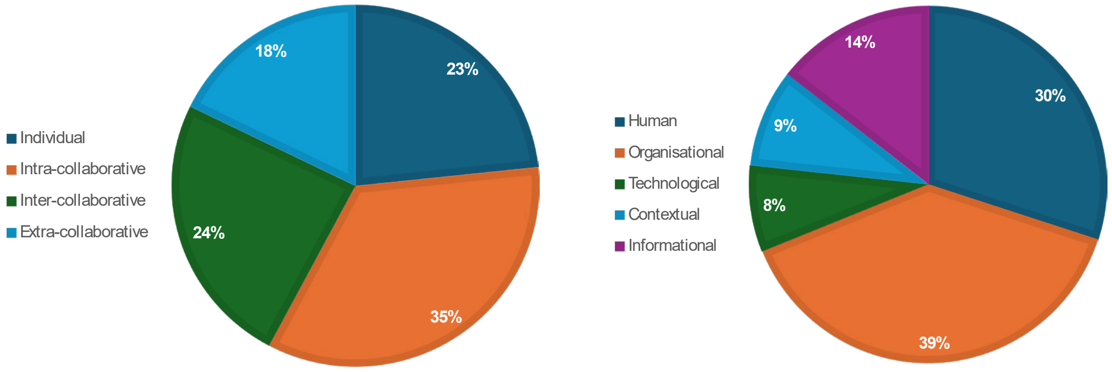

Figure 2: Distribution of barrier weights across collaboration levels and perspectives

The most difficult information for the company to define was the estimation of the effectiveness of each action in reducing the different barriers (Table 5). In addition, it should be noted that this represents a limitation of the study, since the assessments were based only on the information provided by a small group of participants from the company, as well as on their professional experience and knowledge of the organisation's processes. This limitation could be improved in future research by involving a larger number of experts or stakeholders.

Table 5: Effectiveness matrix e_{ij}

Barrier \ Action	A1	A2	A3	A4	A5	A6	A7	A8
B1	0.70	0.10	0.10	0.10	0.05	0.05	0.15	0.20
B2	0.10	0.50	0.05	0.20	0.00	0.00	0.10	0.30
B3	0.10	0.00	0.40	0.05	0.45	0.50	0.05	0.00
B4	0.60	0.05	0.05	0.10	0.00	0.00	0.20	0.30
B5	0.05	0.05	0.05	0.30	0.00	0.10	0.60	0.10
B6	0.05	0.00	0.50	0.20	0.30	0.25	0.05	0.00
B7	0.50	0.05	0.05	0.10	0.00	0.00	0.15	0.20
B8	0.00	0.10	0.00	0.25	0.00	0.00	0.60	0.15
B9	0.15	0.20	0.05	0.20	0.00	0.00	0.10	0.50
B10	0.10	0.00	0.30	0.05	0.35	0.50	0.00	0.10
B11	0.00	0.05	0.00	0.20	0.00	0.05	0.70	0.10
B12	0.10	0.00	0.35	0.10	0.40	0.45	0.05	0.00

The company defined a maximum budget of €15,000 to implement the CKM improvement actions. In addition, there was a constraint related to the organisation's change capacity. The company established a maximum of $K = 3$, which means that only three CKM improvement actions can be implemented at the same time.

The company was also asked whether some of the proposed improvement actions were incompatible with each other or whether some actions needed to be implemented before others. In this regard, the interviewees indicated that actions A3 and A5 require action A6 ($x_{A3} \leq x_{A6}$ and $x_{A5} \leq x_{A6}$). This is because a knowledge repository or a collaboration platform should not be implemented without a basic document management policy. Without clear rules regarding document naming, validation, metadata and document structure, knowledge repositories or CKM platforms can quickly become disorganised.

In addition, the participants identified a dependency between actions A2 and A4 ($x_{A2} \leq x_{A4}$). Specifically, the incentive programme requires the existence of a governance structure. If incentives are introduced without a governance mechanism, several problems may occur, such as employees uploading irrelevant documents only to obtain rewards or conflicts arising regarding the fairness of the incentive system.

Finally, the company was also asked about possible exclusion relationships between actions. The participants stated that actions A3 and A5 are mutually exclusive ($x_{A3} + x_{A5} \leq 1$). This means that the company can implement either the collaboration platform or the repository system, but not both at the same time. Implementing both solutions would increase costs unnecessarily and could also create confusion about where knowledge should be stored.

4. Results

The optimisation model identifies A1, A4, and A7 as the best set of actions to implement. Since the organisation decided that only three actions could be introduced at the same time, the model searches for the combination that produces the greatest reduction of the barriers while keeping costs under control and meeting the minimum mitigation levels defined for each barrier.

Action A1 that consists of training workshops on knowledge sharing practices supports employees to improve their knowledge and skills. This helps to overcome the barriers related to capabilities and differences in expertise. Action A4 involves the creation of a CKM governance committee which will be in charge of coordinate and monitor the CKM process. In this sense, this action supports the management and organisation of collaborative activities and the better understanding between teams. Action A7, that is the implementation of the strategic alignment workshop, is focused on trying to make that all the members the companies have the same objectives and guaranteeing that all the departments of the company are working to achieve common goals.

It is worth noting that this solution does not include technological tools such as platforms or repositories but the model prioritises actions related to an organisational viewpoint to create the appropriate context to promote knowledge sharing. Considering that the company has a limited budget and its capacity to implement changes is also constrained, the resulting actions seem to be the most efficient ones to reduce the identified CKM barriers.

The total cost of implementing these actions is €8,200, that is the sum of the cost of actions A1, A4 and A7 and it is lower than the budget of €15,000 that the company was willing to invest. This means that the organisation can achieve great mitigation without using all the planned investment what can be addressed to other issues.

Another important aspect of the optimisation model is that it allows the company to evaluate the overall effectiveness of the selected actions. If the mitigation level achieved for each barrier (m_j) is multiplied by its corresponding importance weight (w_j), the resulting value is 55.95, which represents the overall level of barrier reduction achieved by the selected actions. Figure 3 shows the mitigation level achieved for each barrier after implementing the selected actions (A1, A4, and A7). For every barrier, the minimum mitigation threshold defined in the model (α_j) is compared with the mitigation level actually obtained (m_j). As it is illustrated, the selected actions allow the model to reach the minimum required mitigation level for all the barriers considered.

From a managerial perspective, it is worth mentioning that the model selected actions related to training, governance and strategic alignment instead of technological solutions such as, for example actions A3 and A5: knowledge platforms or repositories.

This result suggests that organisations maybe first need to reinforce their organisational aspects instead of investing in advanced and more complex technological tools. If the employees' skills are improved, the company creates coordination mechanisms and aligns organisational objectives, all this can help a lot to improve knowledge collaboration.

In addition, the optimisation model can help managers when they evaluate different improvement alternatives. Instead of relying only on intuition or personal judgement, managers can use the model to analyse different possible actions and see which combination can generate the greatest benefit under the existing constraints.

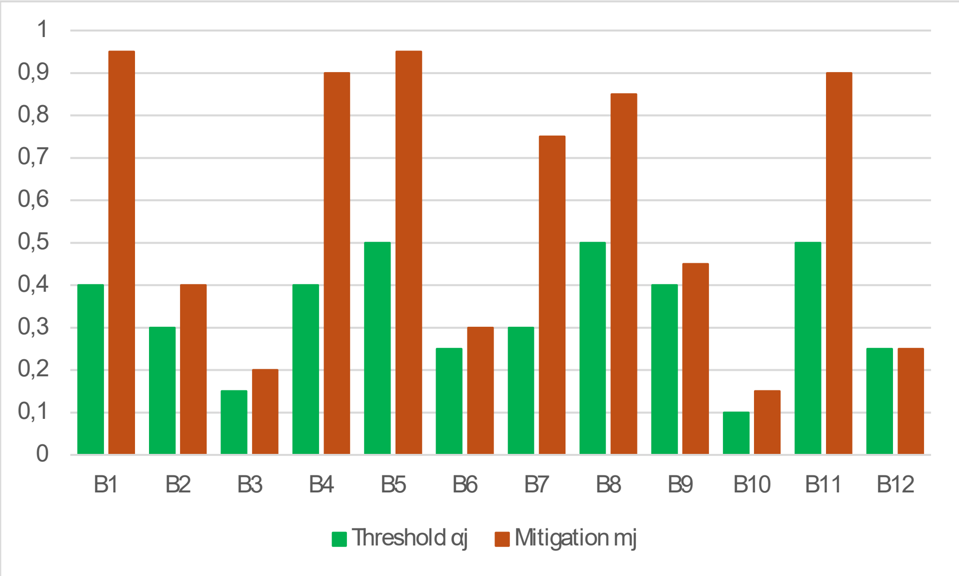

Figure 3: Mitigation level achieved and mitigation threshold

5. Conclusions

This paper proposed an optimisation-based approach to select the optimal improvement actions to reduce CKM barriers. In many organisations, knowledge sharing initiatives face practical difficulties because managers must make decisions with limited resources, limited time, and limited organisational capacity to implement new initiatives. For this reason, it is a very complex task to choose which actions should be implemented.

To solve this, the paper proposed a MILP model that supports company managers to decide about the combination of the most efficient set of actions that can reduce CKM barriers. The model considers the different real aspects that organisations usually face daily, such as implementation costs, budget limitations, organisational capacity to change, and the relationships between actions, i.e. if there is a need for previous actions to be implemented before or if there are actions that cannot be implemented together at the same time. Moreover, the model offers the level of mitigation achieved for each barrier, which makes that managers without expertise in complex mathematical models can understand and interpret easily the results obtained.

The model was validated through a case study of an engineering and ICT consulting company specialised in intelligent transport systems. The results show that the optimisation approach can help organisations identify a small set of actions that produce a significant reduction in the most important CKM barriers. In the analysed case, the model prioritised three actions related to training, governance, and strategic alignment. These actions focus on strengthening the organisational foundations that support knowledge sharing before introducing more complex technological solutions.

Another important aspect to highlight is that the selected actions comply with the minimum mitigation thresholds defined by the organisation. Moreover, the set of actions selected does not achieve the total amount of budget that the company was willing to invest. This evidences that, sometimes, it is not necessary to invest expensive solutions.

The proposed model provides a practical and easy-to-use decision-support tool that can help managers select actions aimed at improving CKM.

However, the study also presents some limitations. In particular, the estimation of the effectiveness of the improvement actions was based on the opinions of only three experts from the company. Future research could involve a larger group of stakeholders in order to obtain more accurate estimates. In addition, future studies could extend the model by incorporating uncertainty in the estimation of action effectiveness, analysing multi-period implementation strategies, or testing the approach in different organisational contexts and industries.

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Ethics Declaration: This study did not require formal ethical approval. The data used in the case study were based on professional assessments provided voluntarily by three employees of the participating company. No personal or sensitive data were collected.

AI Declaration: AI tools were used only to assist with language editing and grammar improvement. The research design, model development, analysis, and interpretation of the results were carried out by the authors.

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