

FOSTERING KNOWLEDGE EMBRACEABILITY USING THE LEAF APPROACH

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Abstract: *Knowledge sharing is widely recognised as central to successful knowledge management. However, the embraceability of shared knowledge remains a scientific challenge. This paper explores the research topic of knowledge embraceability within the Dutch railway sector. It does so following a structured design science research methodology. Six structured interviews are conducted leading to the identification of five design principles. Two knowledge sharing process models were developed to promote knowledge embraceability. These models provide a structured, user-friendly, and stepwise guide to knowledge sharing. The tasks and activities in these process models are based on the four features (Learnability, Embraceability, Applicability, and Findability) of the LEAF framework. The performance of the process models was measured by calculating their perceived usability using the System Usability Scale (SUS).*

Keywords: *knowledge sharing; railways; LEAF; embraceability; process model*

Resumo: *A partilha de conhecimentos é amplamente reconhecida como um elemento central para a gestão do conhecimento. No entanto, a aceitação do conhecimento compartilhado continua a ser um desafio. Este documento explora o tópico de investigação da capacidade de adoção do conhecimento no setor ferroviário holandês. Para o efeito, segue uma metodologia de investigação estruturada de design science. Foram realizadas seis entrevistas que levaram à identificação de cinco princípios. Foram desenvolvidos dois modelos de partilha de conhecimentos para promover a adoção de conhecimentos. Estes fornecem um guia de fácil utilização para a partilha de conhecimentos. As tarefas e atividades baseiam-se nas quatro características (Learnability, Embraceability, Applicability, e Findability) da estrutura LEAF. O desempenho foi medido através do cálculo da Escala de Usabilidade do Sistema (SUS).*

Palavras-chave: *Partilha de conhecimentos; caminhos-de-ferro; LEAF; capacidade de adoção; modelo de processo*

Resumen: *El intercambio de conocimientos está ampliamente reconocido como un elemento central del éxito de la gestión del conocimiento. Sin embargo, esta asimilación sigue siendo un reto científico. Este artículo explora el tema de investigación de la asimilación del conocimiento en el sector ferroviario holandés. Para ello, se sigue una metodología de investigación científica de diseño estructurado. Se realizan seis entrevistas que conducen a la identificación de cinco principios de diseño. Se desarrollaron dos modelos de procesos de intercambio de conocimientos para promover su asimilación. Estos proporcionan una guía fácil para compartir conocimientos. Las tareas y actividades se basan en las cuatro características (Learnability, Embraceability, Applicability, y Findability) del marco LEAF. El rendimiento se midió calculando su usabilidad percibida mediante la Escala de Usabilidad del Sistema (SUS).*

Palabras clave: *intercambio de conocimientos; ferrocarriles; LEAF; capacidad de acogida; modelo de procesos*

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1 INTRODUCTION

Knowledge management has gained importance in both academic and practical circles since the industrial revolution. A number of important developments have shaped the research study of knowledge management in this period, namely the distinction of knowledge in tacit and explicit forms (Polanyi, 1966), identification of four modes of knowledge conversion between tacit and explicit forms (Nonaka, 1994) and advocacy for shifting the focus of knowledge management research to context and narrative rather than content management (Snowden, 2002). The role and adequacy of both technological solutions and culture in promoting knowledge management have also received due attention in academic and circles. However, it is important to highlight that researchers stress that the introduction of technological solutions alone (Peinl, 2017) or investing in a knowledge culture alone does not guarantee effective knowledge management. Research has shown that there are different cultural prerequisites for knowledge sharing between individuals and project teams (Mueller, 2014). This implies that from a scientific challenge point of view there is a need to support the embraceability of shared knowledge at the individual and organizational levels.

In practice, organisations have also begun to recognise both the static and flowing nature of organisational knowledge. While previously the emphasis was largely on registration, documentation and compilation of knowledge, the importance of investing in a learning culture and valuing experience in making organisational decisions has slowly become more mainstream. Today, organisations struggle to find the right balance between using sophisticated knowledge management systems for decision-making and embracing the consolidated experiential knowledge of experts. An additional layer of complexity arises when organisations try to introduce new systems to improve organisational learning and capture experiential knowledge, but these systems often end up not being used optimally or do not create the learning impetus originally envisaged when such initiatives were launched. This paper aims to fill this gap of finding the right balance between experience and knowledge management systems by investigating the research topic ‘knowledge embraceability’ and proposing two knowledge-sharing processes to promote the embraceability of shared knowledge. It does so by extending the previously developed LEAF approach (Abbas, Martinetti, Frunt et al., 2022).

The rest of the paper is structured in such a way that Section 2 outlines the theoretical background of knowledge embraceability. Section 3 presents the research methodology followed. The design and development of the proposed knowledge sharing process models are

described in Section 4. Moreover, Section 4 also presents the demonstration and testing process of the developed process models. The perceived usability test results of the proposed process models are provided in Section 5. Section 6 discusses the proposed design, the collected results, and their implications. Finally, Section 7 offers a conclusion and outlines possible areas for future research.

2 THEORETICAL BACKGROUND

The verb “to embrace” is defined according to the Cambridge Dictionary as “to accept something enthusiastically”. The embraceability of knowledge here is seen as the ability of knowledge, shared through digital and non-digital means, to be accepted enthusiastically by the knowledge receivers. Acceptance of knowledge shared through e.g., Knowledge Management Systems (KMSs) is critical to organizational learning and improving employees’ performance (Yoo & Huang, 2013). Several knowledge sharing enablers that influence knowledge embraceability such as trust and motivation at the individual level and management support and learning culture at the organisational level have been outlined in the literature (Abbas, Martinetti, Frunt et al., 2022). Al-ani et al. (2011) reported that trust by knowledge seekers in knowledge owners’ knowledge played a major role in knowledge acceptance. While a lot of attention has been paid by knowledge management researchers to technology acceptance within the context of KMS (Kuo & Lee, 2009; Suroso et al., 2017), research topics of knowledge acceptance and knowledge embraceability are hardly discussed in the literature. Edwards et al. (2003) point out six key factors that require attention to further advance and develop knowledge management research in general that are tasks and processes; structure; people; technology; culture; and performance/measuring outcomes.

Edwards (2022) advocates that these six factors as the intersection points between knowledge management and information management research and outlines future directions of research for each of these aspects. Particular interest from a knowledge embraceability standpoint from Edward’s (2022) suggested direction are the following aspects:

- Processes: stressing the importance of semi-formal and informal processes
- Structure: transferring learnings from one project to another
- People: highlighting the need to pay attention to the needs of knowledge sharer and receiver in inter-organizational setting
- Culture: Investigating the influence of role changes to improve knowledge management

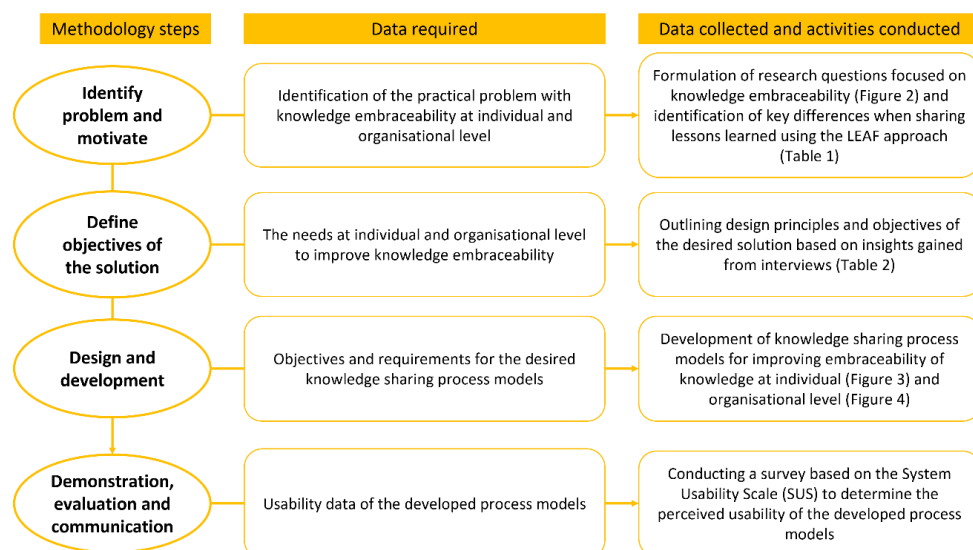
- Performance/measuring outcomes: measuring the impact of knowledge management/information management

Against this background, to advance the topic of knowledge embraceability, this research presents two knowledge sharing processes (i.e., at individual and organizational levels) that pay attention to the importance of a semi-formal process, facilitate learning from one project to another, pay heed to needs of knowledge sharers and receivers, clarify the role of knowledge sharer/receiver and management/organizational personnel. The performance of proposed processes is also evaluated by determining the perceived usability of developed processes.

3 RESEARCH METHODOLOGY

To identify the knowledge sharing processes needed to foster knowledge embraceability, the research followed the Design Science Research Methodology (DSRM) prescribed by Peffers et al. (2007). The choice of design science approach for investigating the research topic of knowledge embraceability was made because of its previous use in designing KMS (e.g. (Sarnikar & Deokar, 2017)). Figure 1 provides an overview of the data collected and activities conducted following the DSRM methodology. A detailed description of each of these steps is explained next to ensure research reliability.

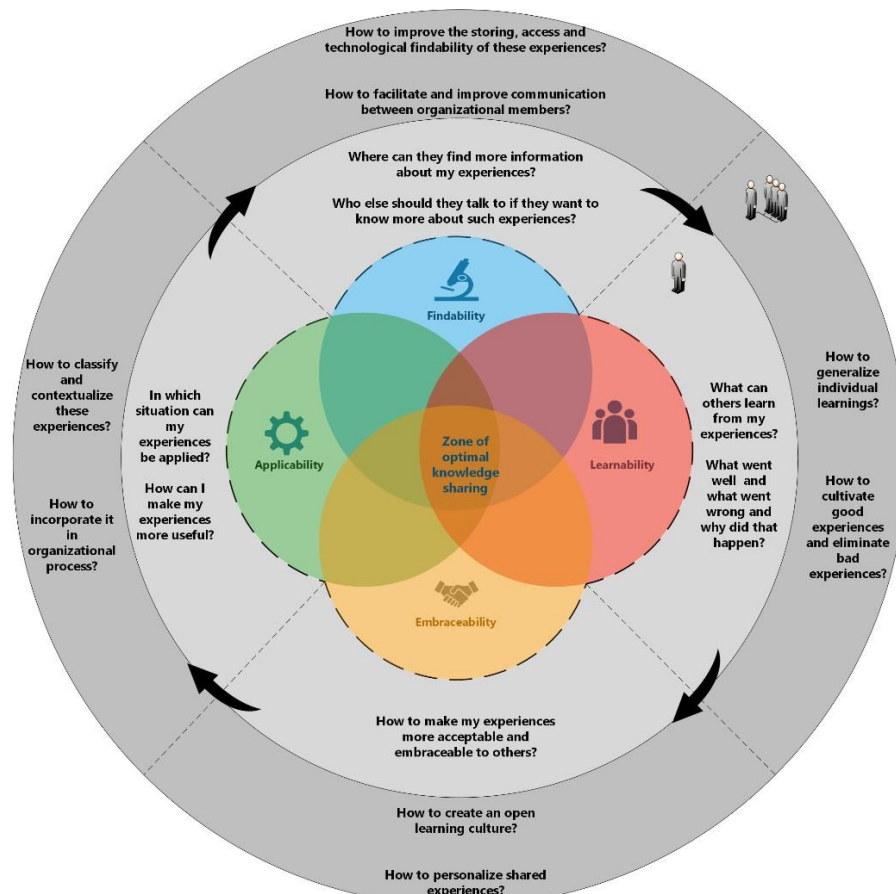
Figure 1 – Overview of the methodological steps followed based on DSRM.



3.1 PROBLEM IDENTIFICATION AND MOTIVATION

Based on the described definition of knowledge embraceability, the researcher formulated several interview questions to identify the current problem with knowledge embraceability at individual and organizational levels. Figure 2 presents the interview questions for each of the LEAF features. Structured interviews were conducted with six experts from the principal passenger railway operator of the Netherlands (Netherlands Railways). In these interviews, the interviewees were first presented with the research goal: Define a process that can effectively facilitate the sharing of lessons learned. Afterwards, the interviewees were provided with Secchi et al.'s (1999) definition of lessons learned, which describes them as knowledge gained from experience that can be positive or negative, is significant enough to have a real or presumed impact on operations and is valid and applicable. After that, the interviewees were asked to share a lesson of their choice in their way. Once the interviewee shared their lesson learned, they were presented with Figure 2 which describes the questions formulated for the individual and organizational levels for fostering knowledge embraceability.

Figure 2 – Interview questions for each feature of the LEAF framework to investigate knowledge embraceability.



The interviewees were asked to share the same lessons learned again, but this time by also answering the questions in Figure 2. The lessons shared by the interviewees and the main differences identified in the sharing of these lessons based on the interview questions are shown in Table 1.

Table 1 - Shared lessons learned in the interviews and differences identified when sharing lesson learned using the LEAF approach.

No.	Shared Lessons learned	Key differences identified
1.	For contract management it is critical to introduce informal knowledge sharing activities to improve cooperation <u>between the client and the contractor.</u>	<ul style="list-style-type: none"> • The interview questions helped the interviewees to share their lesson in a more structured and detailed manner.
2.	Assign proper roles and responsibilities and ensure early engagement between those roles to have <u>successful project implementation.</u>	<ul style="list-style-type: none"> • By focusing on learnability, embraceability, applicability, and findability one by one the interviewees were able to better understand the needs of the knowledge receiver and share their lesson accordingly.
3.	Ensure that the used contract and cooperation form are right for the project. Spend extra time to get familiar with new methods and ways of working if they are going to be used for first time in the project.	<ul style="list-style-type: none"> • The interview questions helped interviewees in coming up with wider applicability of their lessons.
4.	For successful project implementation, it is important to have clear governance structure and <u>cooperation between stakeholders.</u>	<ul style="list-style-type: none"> • While reflecting on ways to improve embraceability of shared lessons, the interviewees realized the importance having more tacit knowledge sharing services available.
5.	In new technology introduction projects pay special attention to taking perspective of the end users and operational training program developers into account during project implementation.	<ul style="list-style-type: none"> • The interviewees noted that the LEAF approach helped capture contextual knowledge about their lesson learned on a deeper level. In addition, the interviewees noted that currently used systems did not have such a structured approach to capture contextual knowledge.
6.	When deploying a tendering strategy make sure its fits with the culture and environment of the	

As the differences in Table 1 show, the sharing of lessons learned using the interview questions made the interviewees realise that there is a need for a more structured approach for sharing lessons learned in a comprehensive way. An approach that focuses on the four LEAF features and that can guide the knowledge-sharer in the knowledge-sharing process.

3.2 OBJECTIVES OF THE SOLUTION

The identified differences led to the design principles needed to design and develop knowledge sharing processes to foster the embraceability of knowledge at individual and

organisational levels. The formulated design principles and the respective objectives of the desired solution are shown in Table 2.

Table 2 - Design principles and objectives of the desired solution.

Design principles	Objectives of the solutions
Structured	The solution should provide a structured approach to sharing lessons at the individual level and managing them at the organisational level.
Easy	The solution has to be easy to apply, both at individual and organisational level.
Focused	The solution should focus on promoting the four features of the LEAF framework.
Helpful	The solution should be helpful to both the knowledge receiver and knowledge sharer at the individual level and the management and organisational staff at the organisational level.
Insightful	The solution must be insightful to both the knowledge-sharer and the knowledge-receiver at the individual level, and to management and organisational staff at the organisational level, in order to improve the embraceability of knowledge.

As shown in Table 2, the process models should be structured, easy, focused, helpful, and insightful. The following section presents the design and development process for the proposed knowledge sharing process models.

4 DESIGN AND DEVELOPMENT

The process models are designed to describe the activities that must be conducted chronologically in order to promote the general embraceability of shared knowledge.

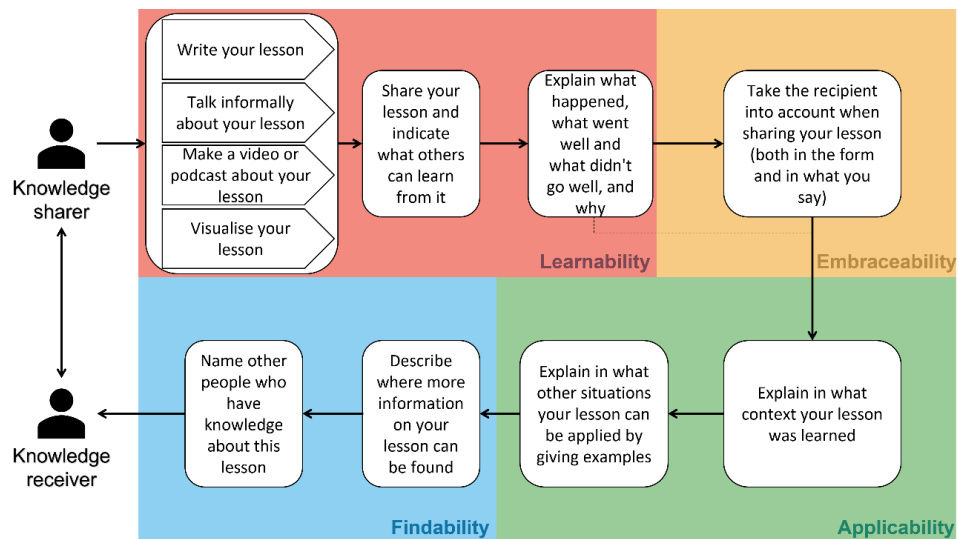
4.1 KNOWLEDGE SHARING PROCESS MODELS AT INDIVIDUAL LEVEL

Recognising that there are different ways of learning (Abbas, Martinetti, Frunt et al., 2022), the process model on an individual level asks the knowledge sharers to choose an appropriate way of sharing knowledge before sharing one's personal experience or lesson learned. Then the model invites the knowledge sharers to share their experiences / lessons learned and also describe the learning points for others across different roles. This is crucial in order for the experiences or lessons to be shared in such a way that they are easily understood and applicable to knowledge receivers. In order to provide the necessary context for the knowledge receivers, the process model also explicitly asks the knowledge sharers to describe not only what went well and what went badly during that experience/lesson, but also the why (rationale) behind it.

In terms of embraceability, the process model emphasises taking into account the perspective of the knowledge recipients at an individual level. This can be done, for example,

by using previous personal knowledge about the knowledge recipients' preferred way of sharing knowledge and telling stories. In a similar way, the applicability aspect has been addressed by stressing the need to describe the context when sharing experiences and explicitly giving examples of the situation in which the shared knowledge can be applied. This is consistent with previous findings that showed that employees preferred the storytelling form of knowledge sharing and liked to derive their own lessons from the shared lesson (Abbas, Martinetti, Frunt et al., 2022). Finally, the findability aspect of the process model emphasises describing where the shared information can be found within the organisation and mentioning experts who have knowledge on the topic. An overview of the designed process model for knowledge sharing at the individual level is shown in Figure 3.

Figure 3 – Knowledge sharing process model at individual level.

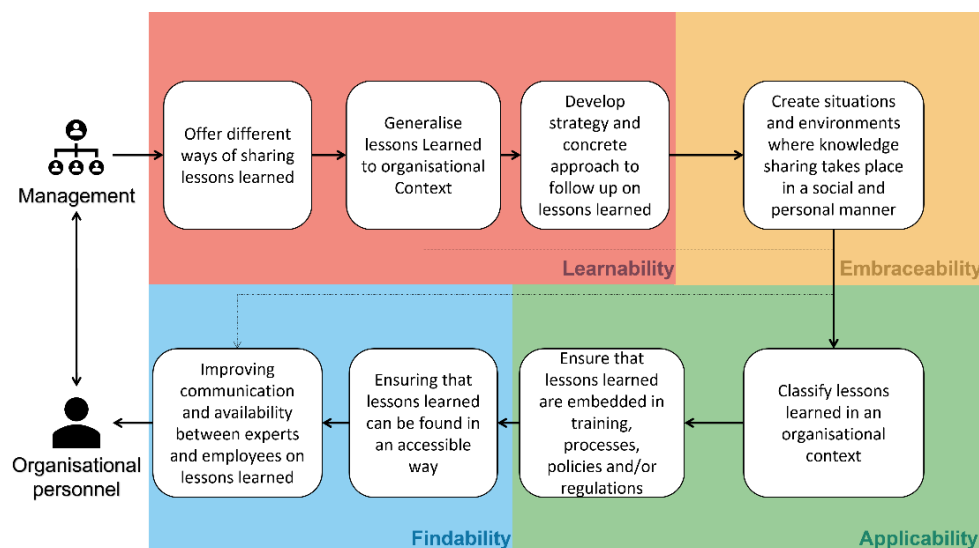


4.2 KNOWLEDGE SHARING PROCESS MODELS AT ORGANISATIONAL LEVEL

The focus of the developed process model is to assist the management in improving the embraceability of shared knowledge and consequently to improve organisational learning. Similar to the individual process model, activities and tasks are outlined for each LEAF feature in this process model to facilitate the overall embraceability of shared knowledge. Regarding the learnability aspect, the process model encourages management to offer different ways of knowledge sharing to their employees. It also recommends management to ensure generalisation of shared lessons and to develop a concrete organisational approach for the follow-up of shared lessons. Regarding the embraceability aspect, the process model points to the need to create a culture and environment in which knowledge sharing among the organisation's staff can take place in a social and personal way.

In terms of applicability, the process model calls for management to ensure classification of shared lessons according to organisational context and commonly used terminology. This will help to structure the shared lessons and make it easy for the organisation's employees to find the desired knowledge. Similarly, the process model recommends that management embed shared lessons in training, organisational processes, policies and/or regulations. This is necessary to demonstrate that management recognises the importance of knowledge sharing and is serious about promoting the embraceability of shared knowledge by taking concrete steps. Finally, for the findability feature, the process model emphasises ensuring easy and quick accessibility of shared knowledge in used knowledge management systems within the organisation. Previous research has shown that a reduction in file search time and having a lessons-learned system in KMSs can lead to improved collaboration and the fostering of tacit knowledge sharing (Abbas, Martinetti, Rajabalinejad et al., 2022). The process model also emphasises improving communication between experts and employees by ensuring that they are available to share their experiences with the organisation's staff. Figure 4 provides an overview of the designed process model for knowledge sharing at the organisational level.

Figure 4 – Knowledge sharing process model at organisational level.



4.3 DEMONSTRATION AND TESTING OF DEVELOPED PROCESS MODELS Measuring

the impact of knowledge management/information management is central to the advancement of knowledge management research (Edwards, 2022). The impact of the proposed process models for knowledge sharing was assessed by testing the developed process models in the Dutch railway sector and measuring their perceived usability through the System

Usability Scale (SUS). SUS was chosen because of its prior use in measuring the perceived usability of learning managing systems (Orfanou et al., 2015), making it a strong candidate also for measuring the perceived usability of developed knowledge sharing process models. SUS is a commonly used standardized questionnaire for assessing perceived usefulness (Lewis, 2018b), where respondents rate ten items with five response options: strongly agree, somewhat agree, neither agree nor disagree, somewhat disagree, and strongly disagree, as shown in Appendix A. The system usability scale was shared with the participants through an online password-protected survey.

The process models were demonstrated and tested within the railway industry in two ways. Firstly, an online survey was distributed via e-mail to the members of the New Rolling Stock (NRS) and ERTMS department of Netherlands Railways (see e-mail text in Appendix B). As members of the NRS and ERTMS department already participated in an earlier study on the development of LEAF (Abbas, Martinetti, Frunt et al., 2022), they were an appropriate audience to test the developed knowledge sharing process models. To familiarise the participants with the developed process models, a link to the video explaining these models was shared with the participants (see Appendix B). A total of twenty-eight responses were received after the prescribed three-week period. After removing the incomplete responses, sixteen complete responses were included in the final analysis.

Second, to demonstrate and test the perceived usability of the developed process models in an inter-organizational context, the process models were also presented to a team of sixteen experts in a workshop. These experts were from the principal railway infrastructure manager of the Netherlands (ProRail) and the Dutch Ministry of Infrastructure and the Environment (Rijkswaterstaat) who jointly work on innovations in the rail infrastructure. Before the distribution of the survey, these experts were given a presentation on the LEAF approach and the developed process models were introduced in detail. The presentation was followed by a short question round where the experts could ask questions about the presented concepts. Finally, to assess the impact of these process models, experts were asked to evaluate their perceived usefulness by filling out the SUS scale shared through the online survey. As a result of the workshop, an additional sixteen responses were collected, resulting in a total of thirty-two complete responses. These responses were used to measure the SUS score for the developed process models for knowledge sharing. A detailed description of the results found is provided next.

5 RESULTS AND EVALUATION

To determine the SUS score, the responses collected for each of the ten items of the SUS scale were scaled from 1 to 5, where 1 was the score for strongly disagree and 5 was the score for strongly agree. In order to interpret the scores properly, a standard method for normalising the SUS score was followed. The following formulas were used to calculate the SUS score for each participant, where X_i represents the odd-numbered items and X_y represents the even-numbered items of the ten-item SUS questionnaire:

$$SUS_{raw_ind} = (X_i - 1) + (5 - X_y) \quad (1)$$

$$SUS_{final_ind} = SUS_{raw_ind} * 2.5 \quad (2)$$

After the final SUS scores of each participant were calculated, the overall final SUS score (for thirty-two participants) was determined by calculating the average of each individual final SUS score.

$$SUS_{final_overall} = \frac{\sum_{x=0}^n SUS_{final_ind}}{n} \quad (3)$$

The calculated overall final SUS score for thirty-two participants after following these steps was 69.69. For the interpretation of the final SUS score, the authors used the alternative curved grading scale (CGS) published by (Sauro & Lewis, 2016). CGS is an empirically based approach for the interpretation of average SUS scores obtained in industrial usability studies (Lewis, 2018a). Based on CGS, the SUS score of 69.69 represents a grade of 'C' and a percentile in the range of '41-59'.

6 DISCUSSION

Knowledge embraceability continues to be an important research topic within the information management and knowledge management communities. Its importance is evident when one considers the future directions of research on six factors that, according to Edwards (2022) form the intersection points between knowledge management and information management research. Whether it is research into the knowledge management processes and the need to reiterate the importance of semi-formal processes or the structural transfer of project learnings or understanding the needs of knowledge sharers or receivers, the underlying issue of the embraceability of knowledge is at the core of these research challenges. This paper reiterates these points by emphasising that the bottleneck to both successful knowledge sharing and implementation of consolidated lessons in the Dutch railway sector is the embraceability of knowledge at the individual and organisational levels.

The conducted research followed a DSRM-structured approach by Peffers et al. (2007) to first identify and motivate the research problem related to knowledge embraceability. Six structured interviews were conducted with experts from the Netherlands Railways. This led to the identification of five design principles for the desired knowledge sharing process models. A closer look at these design principles shows that promoting knowledge embraceability requires a solution with a clear structure, focused activities, helpful procedures, and easy-to-use and insightful elements for the knowledge sharer and receiver. These principles formed the basis for defining the corresponding five objectives for the desired knowledge sharing process models. Two process models were developed which function as a chronological step-by-step guide for knowledge sharers (at the individual level) and organizational management (at the organizational level) to improve the embraceability of shared knowledge. The models were demonstrated and tested for perceived usability in both intra-organisational and inter-organisational contexts.

The perceived usability of these process models was determined by an online survey based on SUS scale. The derived results from thirty-two participants led to the final overall SUS score of 69.69 for the developed knowledge sharing process models. Based on the widely accepted rating of CGS this employs that the participants reported the perceived usability of developed process models to be in a percentile in the range of '41-59'. This shows that further development of the proposed processes is necessary to improve their perceived usability. Considering that knowledge embraceability is highly influenced by cultural and contextual constraints, the authors suggest future research should use the proposed processes as building blocks for promoting knowledge embraceability and further develop and fine-tune these models in different industrial settings by for instance investigating the utility of check lists and informal meetings in fostering knowledge embraceability. Moreover, the authors also encourage future research to embed the proposed process models in KMS and test the actual usability and performance of the presented process models.

7 CONCLUSION

This research contributes to the knowledge management research community by presenting two knowledge sharing process models to promote the embraceability of shared knowledge. The paper argues that the topic of knowledge embraceability is at the core of key research challenges within both the knowledge management and information management research communities.

The research conducted follows DSRM to investigate the topic of knowledge embraceability within the Dutch railway sector. As a result, the five design principles that formed the basis of the developed process models for knowledge sharing were identified. These process models provide a step-by-step chronological guide to promoting knowledge embraceability at both individual and organisational levels. The process models extend the previously developed LEAF framework (Abbas, Martinetti, Frunt et al., 2022) by defining process tasks and activities to promote each of the four LEAF features (learnability, embraceability, applicability and findability) at both individual and organisational levels. The results of perceived usability based on the SUS scale for these process models show that further development of these models is needed in different industrial settings. In conclusion, the paper provides the building blocks for promoting knowledge embraceability by presenting easy-to-use, structured, focused process models for knowledge sharing.

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APPENDIX A

Following are the ten items of SUS: (1) I think that I would like to use this feature frequently. (2) I found the feature unnecessarily complex. (3) I thought the feature was easy to use. (4) I think that I would need the support of a technical person to be able to use this feature. (5) I found the various functions in this feature were well integrated. (6) I thought there was too much inconsistency in this feature. (7) I would imagine that most people would learn to use this

feature very quickly. (8) I found the feature very cumbersome to use. (9) I felt very confident using the feature. (10) I needed to learn a lot of things before I could get going with this feature.

These ten items are scored based on following scale: Strongly agree (1). Somewhat disagree (2). Neither agree nor disagree (3). Somewhat agree (4). Strongly agree (5).

APPENDIX B

The original email was sent in Dutch. The redacted translated version of the sent email is shown as follows: Dear colleague, within our department of New Rolling Stock and ERTMS, Yawar Abbas is conducting his PhD research as a student of the University of Twente in the field of optimal knowledge sharing. Based on his research, Yawar makes recommendations on how the knowledge sharing approach within our organisation can be improved in daily practice, fitting the learning organisation that we want to be. To validate his findings, he needs your feedback. The best way to give this feedback is to familiarise yourself with the LEAF concept and then fill in the survey. This survey is designed to test the usefulness of the LEAF process models that were developed after several interviews and workshops with colleagues to improve, among other things, the management of lessons learned at individual and organisational level. The LEAF process models are explained in detail in the following video between the times 5:19-20:37. <https://www.youtube.com/watchxyz>. The results of this research can help us to form solid conclusions about the LEAF process models and to improve knowledge sharing practices within NS Engineering. Furthermore, this survey will give us more insight into how employees like to learn within the programmes, whether we as a department of New Rolling Stock and ERTMS have set up a good environment for this and possibly bring forward useful suggestions to promote knowledge sharing within the department. Would you please fill in the survey by clicking on the link below? Participation will take approximately 10 minutes. The password is: LEAF2021 https://utwentebbs.eu.qualtrics.com/jfe/form/SV_6VyBrCFlyPggUNE. The more responses, the more representative the survey will be. Therefore, your input is highly appreciated. Would you like to respond within three weeks (by 11 November)? If you have any questions about the survey, please contact Yawar at yawar.abbas@ns.nl.