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Unlocking the Potential of Knowledge Management and Sharing in Knowledge Intensive Companies' Maintenance Departments: Barriers, Enablers, and Recommendations

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Abstract

In contemporary knowledge intensive industries, the efficient management and sharing of knowledge within maintenance departments are crucial for maintaining a competitive edge. This case study delves into the complex landscape of knowledge management (KM) and knowledge sharing (KS) in the context of a maintenance departments within three prominent knowledge intensive organizations. The study synthesizes insights from both the end-users of knowledge, represented by the maintenance employees, and the experts in KM embedded within the organizations. Through a comprehensive series of in-depth interviews, this research provides a multifaceted exploration of the barriers and enablers of KM and KS. The findings of this study unearth an array of barriers that impede the effective management and sharing of knowledge within maintenance departments. These barriers encompass not only technological and structural issues but also cultural aspects, including resistance to change and information silos. Additionally, the study identifies enablers that can promote effective KM and KS. Leadership support, comprehensive training programs, and a robust technological infrastructure emerge as pivotal facilitators in enhancing these critical processes. The significance of this research lies not only in its comprehensive examination of the multifaceted challenges surrounding KM and KS but also in its ability to bridge the gap between knowledge users and experts. By incorporating the perspectives of maintenance employees and KM specialists, this study provides a holistic view of the intricacies within the maintenance departments. Furthermore, this paper extends beyond identifying issues and solutions to offer practical recommendations for the improvement of KM and KS practices. The collective wisdom of knowledge users and experts converges to present a roadmap for organizations in the knowledge intensive sector seeking to enhance their maintenance department's KM and KS capabilities. In conclusion, this research contributes significantly to the field of KM, shedding light on the unique challenges faced by maintenance departments in knowledge intensive industries. It offers a comprehensive understanding of the barriers and enablers of KM and KS and, most importantly, provides actionable insights for organizations striving to optimize their KM and KS practices in the dynamic landscape of knowledge intensive maintenance.

Keywords

Knowledge management, knowledge sharing, industrial maintenance, physical asset management, knowledge sharing barriers.

1. Introduction

The dynamics of competition within various industries and the origins of competitive advantages have transitioned towards resources rooted in knowledge (Watson and Hewett, 2006) and have created competitive environments based on consolidation of existing knowledge assets as pathways to creating value (Iheukwumere-Esotu and Yunusa

Kaltungo, 2020; Refaiy and Labib, 2009). This is especially evident in knowledge intensive sectors, where a company's competitive edge is intricately linked to its capacity to create and utilize novel knowledge-based solutions (Watson and Hewett, 2006). Knowledge has been classified and characterized from several points of view to individual, social, causal, conditional, general, specific, relational, tacit, explicit (Alavi and Leidner, 2001) embodied, encoded, and procedural (Venzin et al., 1998). An important classification of knowledge views it as tacit or explicit (Polanyi and Sen, 2009). Explicit knowledge is knowledge that has been expressed into words and can be shared formally and systematically in the form of data, specifications, manuals, drawings, audio and video, computer programs, patents, and so on (Becerra-Fernandez and Sabherwal, 2014). In contrast, tacit knowledge covers impressions, intuitions, and hunches, and is difficult to express and formalize, and therefore difficult to share (Khoshsima et al., 2004). Tacit knowledge is more personal and based on personal experiences and activities. Tacit knowledge may also include expertise that is so specific that it may be too expensive to make explicit; therefore, the organization chooses to let it reside with the expert.

The knowledge-based economy is emerging, and KM is being rapidly disseminated in academic circles, as well as in the business world (Chen and Chen, 2006). KM is viewed as an increasingly important discipline that promotes the creation, sharing, and leveraging of the corporation's knowledge (Becerra-Fernandez and Sabherwal, 2014). KM success contributes to, or can even drive, an organization's success (Holsapple et al., 2016), thus learning how to manage organizational knowledge has many benefits such as leveraging core business competencies, accelerating innovation and time-to-market, empowering employees, innovating and delivering high-quality products, improving cycle times and decision-making, strengthening organizational commitment, and building sustainable competitive advantage (Davenport and Prusak, 1998).

A few KM processes have been introduced by researchers in the past decades. These processes involve various activities that relate with tacit and explicit knowledge such as: acquisition and retrieval, internalization, creation and generation, application and utilization, codification, storing, transferring and sharing (Wong et al., 2015). Among processes of KM, KS has been identified as the most vital one (Asrar-ul-Haq and Anwar, 2016). KS has been identified as the most important process for facilitating organizational learning and innovation and is critical to organizations that wish to use their knowledge as an asset to achieve competitive advantage. The major focus of KS is on the individual who can explicate, encode, and communicate knowledge to other individuals, groups, and organizations (King, 2011). Effective KS practices foster collaboration, build trust, and create a culture of continuous learning, promoting innovation and enabling organizations to remain competitive in the rapidly changing business environment. While other KM processes, such as knowledge creation and acquisition, are also essential, KS is the linchpin that connects all KM processes, allowing organizations to realize the full potential of their knowledge assets.

The importance of KM is not equal at all industries and departments and at knowledge intensive companies and departments, KM plays a vital role. "Knowledge-intensive companies and departments" refer to organizations that rely heavily on knowledge and expertise to operate, innovate, and compete in their respective markets. These organizations are characterized by a significant focus on knowledge creation, acquisition, transfer, and application to support their business objectives and gain a competitive advantage. The phrase 'knowledge-intensive' can be used in at least three contexts: knowledge intensive work, knowledge workers and knowledge-intensive firms (Wiig, 2012). Knowledge intensity of work is a function of several factors. Increased knowledge intensity is a function of how much knowledge and understanding a person must possess and apply when required to perform competent work and to be prepared to deal with uncertainties and surprises (Wiig, 2012). Managing knowledge in knowledge intensive companies and departments is critical for success. This involves creating a supportive culture that encourages KS and collaboration, implementing KM systems and processes, and developing strategies to ensure that knowledge is effectively leveraged across the organization. Some of the challenges facing knowledge intensive companies and departments include managing the volume of knowledge generated, ensuring that knowledge is effectively shared and applied, and retaining critical knowledge when employees leave the organization. However, with the right KM strategies and tools in place, organizations can effectively harness their knowledge resources to drive innovation, growth, and competitive advantage.

2. Literature Review

While KM is relevant to all organizational units, its importance varies. In production, KM is relatively straightforward due to the adherence to pre-approved instructions and repetitive tasks. In contrast, maintenance, R&D and engineering departments consider KM highly critical. Maintenance is defined as "the combination of all of technical,

administrative and managerial actions performed during life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function (Márquez, 2007). Industrial maintenance is a complex and knowledge intensive field (Aromaa et al., 2015). KM is difficult in maintenance due to many factors, such as the way in which their technicians are used to working based on their experience and not upon sharing and explaining their knowledge of operating (Cárcel-Carrasco et al., 2020).

Maintenance knowledge representation can capitalize on both conventional knowledge and maintenance data (Pistofidis et al., 2016). Typical maintenance work encounters a highly diverse and non-routine tasks associated with electronic, hydraulic, software, hardware and electromechanical systems, requiring different sets of skills and competencies to diagnose and solve a problem (Chirumalla et al., 2015). Maintenance departments within companies operate with technicians with high knowledge based on their professional experiences, with a high component of tacit knowledge and, traditionally, with null KM policies (Cárcel-Carrasco et al., 2020). It is important to interact with and to share experiences among individuals within an organization, in order to formulate new knowledge (Shehab et al., 2018). Maintenance effectiveness depends in part on the quality, timeliness, accuracy and completeness of information related to machine degradation state, based on which decisions are made (Bjorling et al., 2013). Maintenance effectiveness, to a large extent, also depends on the quality of the knowledge of the managers and maintenance operators and the effectiveness of the internal and external collaborative environments (Bjorling et al., 2013). The following four categories of maintenance data are needed in data management (Raouf et al., 2006): failures/replacement data (failure mode/suspension, date and time of failure), inspection data (covariates, data and time of inspection), maintenance action data (maintenance action, start and finish date and time of maintenance action), and installation data (date and time of installation).

It has been acknowledged that the main way of developing competence of maintenance workforce is using the accumulated knowledge and experience available in the company (Alsyouf, 2007). Maintenance workforce, such as service engineers, maintenance technicians, and repairmen, acquire firm-specific knowledge from their experience of working with the equipment over the years (Refaiy & Labib, 2009). Moreover, many large companies have been using some kind of computerized maintenance management system (CMMS) to accumulate, store and visualize maintenance-related data and learning from experiences (Márquez, 2007). Production and maintenance workforce are feeding in different types of formal information as well as individual insights and experiences after each maintenance intervention (e.g., type of failure, cause, actions performed). While the formal data acquired is often only used for traceability purpose (Ruiz et al., 2014) reusing experiences reported by maintenance workers' are still limited in practice. In the problem-solving phase of the maintenance work, the organizations often rely on maintenance workers' and production operators' descriptions and reports (Mannonen and Hölttä, 2013). Thus, it is important to capture and store experiences in such a way that those can be reused in the future for performing the right maintenance action at the right time.

Maintenance managers must strongly consider how to transfer expertise and knowledge from experts who have it to novices who need to know (Hinds et al., 2001). Sharing knowledge is not a common activity in most organizations, especially in maintenance. It has been shown that individuals are rewarded mostly for what they know, and not for what they share. The competitive environment that encourages individual instead of collective productivity has stimulated employees to consider their knowledge as their own property, and that to deepen and defend their knowledge is the main way to keep their jobs. An important effect of maintenance KS is that it will transfer maintenance expertise between experts and novices. This will lead to much faster handling of machine failures, training of new staff and to reduce the dependence on external maintenance companies. Even more importantly, it will reduce the number of accidents related to maintenance activities. Industrial maintenance is a crucial function for ensuring the smooth and efficient operation of manufacturing facilities and other industrial settings. KM and KS are increasingly recognized as critical components of industrial maintenance as they help ensure the continuous improvement of maintenance practices, which can result in improved equipment reliability, reduced downtime, and increased profitability.

There are numerous examples where KS practices have not accomplished their objectives to manage companies' knowledge assets and skills, which is mainly due to the large diversity of potential sharing barriers (Riege, 2005). Some factors affect the KS and identified ones have been classified in five categories: ''individual'', ''technological'', ''organizational'', ''cultural'' and ''geographical'' (Anwar et al., 2019).

2.1. General barriers

Organizations often face a multitude of barriers when it comes to KM and KS. Some of the most prominent individual barriers include a general lack of time for KS, fear of job insecurity, low awareness of knowledge's value, and dominance of explicit knowledge over tacit knowledge (Riege, 2005). Team-level barriers encompass issues like a lack of team cohesiveness, limited communication, resistance to change, lack of trust, inadequate leadership, and a lack of team diversity. At the organizational level, barriers can arise from the absence of integrated KM strategies, leadership direction, spaces for sharing and reflecting, transparent rewards systems, supportive corporate culture, knowledge retention strategies, and infrastructure for sharing (Riege, 2005). Technological barriers include challenges related to IT systems integration, technical support, maintenance, KS tools, central knowledge repositories, technological knowledge gaps, compatibility issues, reluctance to use IT systems, and a lack of training. Cultural barriers revolve around trust, resistance to change, hierarchy and power distance, competitive cultures, and a lack of recognition for KS efforts. Overcoming these barriers requires a shift in organizational values and practices, emphasizing trust, collaboration, recognition, and a culture of continuous learning and improvement.

2.2. Specific barriers

In the realm of maintenance activities, organizations encounter not only the general KM and KS barriers mentioned earlier but also a set of specific challenges that are unique to this domain and given the cultural resistance to change, KM might not be an easy concept to implement. The biggest challenge for many organizations today is how to encourage their staff to share knowledge (Al-Hawamdeh, 2003). Exploring the researches shows that beside above mentioned general KM and KS barriers in maintenance, the following specific barriers (Table 1) have been identified at maintenance activities:

Table 1. Specific KS barriers in maintenance domain. Source: (Chirumalla et al., 2015).

KS barriers	
1	The absence of standard language to report the breakdowns.
2	Difficulty to search the similar problem history from different times.
3	The lack of contextual information in after action reports or descriptions.
4	Difficulty in codifying experiences or tacit knowledge.
5	The lack of motivation to spread experiences through documentation.
6	Difficulty in educating and training novices.
7	Different work styles and mindsets.

The existing literature on KM and KS is generally very broad and does not address the specificities posed by departments and units. This means that extant KM and KS theories and models might have a limited application to specific situations and contexts.

This study is underpinned by the recognition that effective KM and KS are pivotal for the success of maintenance departments in knowledge intensive industries. As illustrated by the comprehensive list of potential barriers and specific challenges within the maintenance domain, the complexities and nuances of managing and sharing knowledge are particularly pronounced in this context. While many organizations struggle to foster a culture of KS, maintenance activities add a layer of intricacy due to their specialized nature. Addressing these unique barriers, enablers, and recommendations is imperative, as they hold the key to enhancing KM and KS within the maintenance domain. The potential benefits are substantial, including improved performance, minimized downtime, and more efficient problem-solving processes. By shedding light on these specific challenges and offering practical recommendations, this study not only contributes to the KM field but also provides valuable insights for organizations in high-tech industries, ultimately facilitating their quest to optimize KM and sharing practices in maintenance departments.

Indeed, it is worth noting that research in this specific area is relatively limited, and there exists a scarcity of comprehensive studies that delve deep into the specific barriers and enablers of KM and KS within maintenance domains. Despite the pivotal role maintenance plays in high-tech industries, the literature falls short in offering a holistic understanding of the intricacies involved. This study bridges that gap by providing a detailed examination of the challenges and opportunities unique to this context. Therefore, the findings and recommendations presented in this research offer a significant contribution to a field that is in need of more in-depth exploration. By doing so, this study

sets the stage for further investigations and encourages future research endeavors to build upon this foundation, ultimately advancing our comprehension of KM and Knowledge Sharing in maintenance departments.

3. Methods

This research adopts a qualitative multi case study design, concentrating on the maintenance departments of three knowledge intensive industries. The case study approach was chosen for its suitability in examining the multifaceted issues surrounding KM and KS within maintenance departments. The primary objective of this research is to comprehensively explore the barriers and enablers of KM and KS within the maintenance departments of a knowledge intensive organization, as well as to gather valuable suggestions for improving these crucial processes. Specifically, the research aims to achieve the following goals: to pinpoint the primary barriers perceived by maintenance knowledge users (MKUs) in effective KM and KS within maintenance departments and qualitatively assess the perspectives of KMEs regarding identified barriers and enablers for KM and KS. Additionally, the study explores practical suggestions and recommendations for enhancing KM and KS as offered by both MKUs and knowledge management experts (KMEs). This research is designed to align with the broader context of knowledge-intensive industries and address the unique challenges faced by maintenance departments in these organizations.

The study is guided by the following research questions:
a. What are the primary barriers to effective KM and KS within the maintenance departments, as perceived by MKUs?
b. How do KMEs within the organization view these barriers and the enablers for KM and KS?
c. What practical suggestions and recommendations for enhancing KM and KS are offered by both knowledge MKUs and KMEs?

The study involved a total of 33 participants, including 25 MKU and 8 KME from three knowledge intensive companies. The diverse participant pool ensures a comprehensive perspective on KM and KS within maintenance departments. Data was primarily collected through semi-structured, in-deep interviews with participants. These interviews were designed to uncover the specific barriers and enablers of KM and KS as experienced and perceived by both MKUs and KMEs. Interviews were conducted one-on-one in a familiar setting at the participants' workplace. They were encouraged to share their experiences, insights, and suggestions regarding KM and KS. The interviews were recorded with participants' consent and transcribed for analysis. Ethical considerations were diligently observed. Informed consent was obtained from all participants, and their identities were protected through the use of pseudonyms. Data confidentiality and security were maintained throughout the research process. Thematic analysis was employed to examine the interview data, focusing on identifying barriers and enablers of KM and KS. Suggestions and recommendations from MKUs and KMEs were also systematically coded for further analysis. To ensure the validity and reliability of the findings, a second researcher independently reviewed and coded a subset of the data. Member checking was conducted by sharing preliminary findings with participants, allowing them to validate and provide feedback on the interpretations. Triangulation was utilized by combining insights from both MKU and KME to validate and strengthen the findings related to KM and KS barriers, enablers, and improvement suggestions.

In conclusion, this research methodology was designed to thoroughly investigate the complex landscape of KM and KS within the maintenance departments of knowledge intensive organizations. The study gathers insights from MKUs and KMEs, addressing barriers, enablers, and practical suggestions for improvement. The methodology ensures rigor and trustworthiness in the findings and aims to contribute significantly to the field of KM and KS, offering actionable insights for organizations seeking to optimize their maintenance department's KM and KS practices.

4. Results and Discussion

This section presents the key findings derived from an in-depth exploration of KM and KS practices within the maintenance departments of three knowledge intensive manufacturing companies. The insights collected through interviews with MKU and KME offer a comprehensive understanding of the barriers, enablers, and recommendations that shape the landscape of KM in this context.

The findings are categorized into several dimensions, each shedding light on the intricacies of KM and KS. From individual-level barriers and enablers to interpersonal, organizational, cultural, and infrastructure-related factors, this study unveils the intricate dynamics at play in maintenance departments. These insights stem from the perspectives of

both those actively engaged in the day-to-day operations of maintenance and those with expertise in KM within the organization.

The key findings encompass a range of challenges, facilitators, and strategic recommendations. Notable among these are the challenges posed by the absence of a common standard language for recording experiences, the fear of sharing unsuccessful experiences, and the reluctance among technical personnel to document reports. On the flip side, the benefits of reducing the time gap between experience acquisition and recording, promoting face-to-face KS, and fostering informal communication among individuals are clear enablers to effective KM and KS.

Furthermore, this section discusses the organizational and cultural aspects that influence KM within the knowledge intensive maintenance context. The role of management support, environmental pressure, and the power dynamics of knowledge ownership within the organization are explored. Recommendations are offered to address these challenges, such as the incorporation of KM into organizational strategies and the allocation of adequate time for recording events. In addition, the study highlights the need for creating a culture of knowledge exchange, supported by the sharing of failure experiences by organizational leaders. The infrastructure-related challenges, including the lack of a suitable environment for knowledge recording and the limitations of knowledge recording systems, are also addressed with recommendations that seek to enhance the recording and utilization of knowledge. The following section present a comprehensive analysis of these findings, providing valuable insights for organizations looking to improve their KM and KS practices in knowledge-intensive maintenance departments. The tables below summarize the barriers, enablers, and recommendations presented by both MKU and KME in each of these dimensions, offering a deeper understanding of the intricate landscape of KM and KS within maintenance environments. This study's investigation is organized into five tables, each presenting unique perspectives. Table 2 examines individual viewpoints, Table 3 delves into interpersonal insights, and Table 4 explores the organizational perspective. Table 5 offers insights from a cultural standpoint, while Table 6 underscores the influence of infrastructure on our understanding of these critical elements. In tables, the "∗" denotes that the idea has been emphasized by MKUs, KMEs, or both. Its presence indicates agreement or relevance as highlighted by these perspectives in barriers, enablers, and recommendations.

Table 2. Insight from individual perspective.

Individual perspective		Insight of MKU	Insight of KME
Barriers	Lack of a common standard language for recording and reporting experiences and acquired knowledge.	∗	∗
	Fear of reporting unsuccessful experiences and failures.		∗
	Technical personnel do not have a strong inclination towards writing and documenting reports.	∗	∗
	Inadequate detail in reports, making them ineffective.	∗	∗
Enablers	Reducing the time gap between gaining experience and its recording (utilizing Ebbinghaus's Forgetting Curve).		∗
	Face-to-face KS can be more effective.		∗
	Informal communication among individuals facilitates KS.	∗	∗
	Building mutual trust among individuals facilitates KS.	∗	∗
	KS should be a two-way process where all participants engage.		∗
Recommendations	Events should be recorded and reported immediately after their completion.		∗
	Encourage individuals to refer to documented materials.		∗

Table 3. Insight from interpersonal (team) perspective**.**

Interpersonal perspective		Insight of MKU	Insight of KME
Barriers	Generation gap among employees hinders KS.	∗	
	Neglecting the use of previously recorded reports.	∗	∗

	Possessing knowledge leads to increased workload and additional tasks.	*	*
	If KS is mandatory and against individuals' will, they won't transfer all their knowledge.		*
	Monopolized knowledge gives power to individuals.	*	*
	Individuals do not refer to documented records.	*	*
	Lack of competition for learning among individuals.	*	
	Individuals do not consider knowledge transfer as their responsibility.		*
Enablers	Informal communication among individuals outside the organization.	*	
	Motivation for KS should exist.	*	*
	Individuals of similar age find it easier to share their knowledge.		
	Keeping and not sharing knowledge creates a sense of job security.	*	*
Recommendations	New employees should have mentors.		*

Table 4. Insight from organizational perspective.

Organizational perspective		Insight of MKU	Insight of KME
Barriers	Insufficient support from management.	*	*
	Insufficient environmental pressure for knowledge sharing.		*
	Poor quality of recorded reports due to insufficient rigor and oversight.	*	*
	Knowledge is power within the organization.	*	*
	Power lies in possessing knowledge, not in sharing it.	*	*
	Lack of standardized data recording.	*	*
Enablers	Having a robust organizational KM structure.		*
	Referring to previously recorded information should be part of the process.		*
	Experienced individuals who share their knowledge should be identified, introduced, and tagged in the organization.		*
	Reports are concise, rendering them unusable	*	
	Job rotation can lead to increased knowledge among individuals.		*
	Non-monetary incentives should be provided for KS.		*
Recommendations	KS and discussion sessions should be held alongside equipment breakdowns.		*
	KM should be incorporated into organizational strategies.		*
	Adequate time should be allocated for recording events for individuals.	*	*
	Career advancement should be linked to participation in KS.	*	*
	The extent of KS should be measured and evaluated.		*

Table 5. Insight from cultural perspective.

Cultural perspective		Insight of MKU	Insight of KME
Barriers	Lack of a culture of knowledge exchange.	*	*
Enablers	Support and approval from superiors have a significant impact on fostering a culture of KS.	*	

	The organization should be a pioneer in recording and reporting its failures and its managers should share their failure experiences.		*
Recommendations	Establish a culture of KS within the organization.	*	*

Table 6. Insight from infrastructural perspective.

Infrastructure point of view		Insight of MKU	Insight of KME
Barriers	Lack of a suitable and tranquil environment for recording and reporting experiences.	*	*
	Insufficient hardware infrastructure for knowledge recording, such as computers.	*	
	Knowledge on the Maintenance is inherently complex.	*	*
	The knowledge recording system is not user-friendly.	*	
	Registering information in the enterprise resource planning (ERP) system is difficult.	*	
	Inadequate tagging and search capabilities for reports.	*	*
Enablers	Adequate and sufficient hardware and software infrastructure for recording and reporting event.	*	*
Recommendations	Recorded knowledge should be validated.		*
	Utilizing augmented reality (AR) and virtual reality (VR) for recording experiences.		*

The tables in this section reveal key findings from an in-depth exploration of KM and KS practices within maintenance departments of knowledge-intensive manufacturing companies. Insights from MKUs and KMEs provide a nuanced understanding of barriers, enablers, and recommendations shaping the KM landscape in this context. Categorized across individual, interpersonal, organizational, cultural, and infrastructural dimensions, the results highlight challenges like the absence of a common standard language and technical personnel's reluctance to document reports, alongside enablers such as reducing the time gap for recording experiences and fostering face-to-face KS.

5. Conclusion

Effective KM and KS are pivotal components of any knowledge intensive maintenance department's success. In this study, we delved into the practical challenges faced by knowledge users within three knowledge intensive manufacturing companies, as well as their insights into the enablers and barriers surrounding KM and KS. The results revealed a comprehensive landscape of factors that influence the efficient management and sharing of knowledge within this dynamic and technologically advanced environment.

5.1. Barriers

The list of barriers uncovered through interviews offers valuable insights into the unique challenges faced by knowledge users in the maintenance department. These barriers include the absence of a standard language for knowledge recording, the fear of sharing unsuccessful experiences, a lack of enthusiasm for documenting reports among technical personnel, and issues related to generational gaps and job rotation. In particular, the fear of recording unsuccessful experiences is a notable psychological barrier that affects individuals' willingness to contribute to the knowledge pool. Additionally, the lack of enthusiasm for documenting reports, especially among technical personnel, highlights a disconnection between the daily routines of employees and the documentation processes required for effective KM and KS.

Furthermore, the absence of a common language for recording knowledge suggests a critical need for standardization in documenting and sharing experiences within the maintenance department. This barrier aligns with the need for a comprehensive, user-friendly knowledge recording system that would encourage employees to actively contribute their insights and experiences. The generation gap among employees, coupled with job rotation, exemplifies the

unique dynamics of the high-tech industry. These structural and cultural barriers pose significant challenges to KM and KS within the department.

5.2. Enablers

Conversely, the enablers identified in the study shed light on strategies and initiatives that can enhance KM and KS in high-tech maintenance departments. Notably, the recommendation that knowledge sharing should be a two-way process emphasizes the importance of active participation from all individuals involved. Face-to-face interactions are encouraged, emphasizing the interpersonal dimension of knowledge sharing. Trust among colleagues, facilitated by informal communication, emerges as a key enabler. The study highlights the significance of fostering a culture of knowledge exchange within the organization, a culture where both failures and successes are openly shared.

The insights reveal the potential for utilizing AR and VR technologies in knowledge sharing, presenting an exciting opportunity to incorporate emerging technology into KM and KS practices. Similarly, the prospect of incorporating non-monetary incentives to encourage knowledge sharing offers a practical way to motivate employees. Furthermore, measuring and evaluating the extent of knowledge sharing and linking career advancement to participation in KM and KS provide valuable strategies for organizations seeking to strengthen their KM efforts.

5.3. Limitations

This study is not without limitations. The research focused on three knowledge intensive manufacturing companies, and the findings may not be fully transferable to other organizational contexts. Additionally, the study primarily relied on self-reported data from knowledge users and experts, which can introduce potential biases. Future research should aim to encompass a broader range of knowledge intensive industries and utilize mixed methods to enhance the robustness of the findings.

5.4. Future Research Directions:

The insights gained from this study open avenues for future research in the realm of KM and KS. To address the limitations of this study, further investigations should aim to explore KM practices across various knowledge intensive industries, considering the nuances and specific challenges within each sector. Additionally, future research could delve deeper into the role of emerging technologies, such as AR and VR, in facilitating KM and KS. Furthermore, the dynamics of knowledge transfer between different generations within the workforce merit additional attention. Investigating the impact of generational gaps on KS, as well as strategies to bridge these gaps, could provide valuable insights for organizations aiming to harness the collective wisdom of their workforce. In conclusion, this research not only contributes to the body of knowledge in the field of KM but also offers actionable recommendations for enhancing KS practices within knowledge intensive maintenance departments. The insights from knowledge users are instrumental in addressing the unique challenges posed by the knowledge intensive industries, and the strategies and recommendations provided can be adapted by organizations to facilitate efficient KM and KS for sustained success. This study can acts as a catalyst for further research and innovation in the realm of KM within knowledge intensive industries.

In summary, this study sheds light on the intricate landscape of KM and KS within knowledge intensive maintenance departments. The identified barriers underscore the need for a standardized knowledge recording system, bridging generational gaps, and fostering a culture that encourages active participation. On the flip side, the enablers offer actionable strategies, from promoting face-to-face interactions to leveraging AR and VR technologies, to enhance KS. The key takeaway is the urgent requirement for organizations to implement user-friendly knowledge recording systems, foster a culture of open communication, and leverage emerging technologies to overcome the identified barriers. This study not only contributes to the academic understanding of KM and KS but also offers practical recommendations for immediate implementation in knowledge-intensive maintenance departments.

References

Al-Hawamdeh, S., *Knowledge management: cultivating knowledge professionals*. Elsevier, 2003.

Alavi, M., and Leidner, D. E., Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, pp. 107-136, 2001.

Alsyouf, I., The role of maintenance in improving companies' productivity and profitability. *International Journal of production economics*, Vol. 105, no. 1, pp. 70-78, 2007.

Anwar, R., Rehman, M., Wang, K. S., and Hashmani, M. A., Systematic literature review of knowledge sharing barriers and facilitators in global software development organizations using concept maps. *IEEE Access*, vol. 7, pp. 24231-24247, 2019.

Aromaa, S., Väätänen, A., Aaltonen, I., and Heimonen, T., A model for gathering and sharing knowledge in maintenance work. *Proceedings of the European Conference on Cognitive Ergonomics*, pp. 1-8, 2015.

Asrar-ul-Haq, M., and Anwar, S. A systematic review of knowledge management and knowledge sharing: Trends, issues, and challenges. *Cogent Business & Management*, vol. 3, no. 1, 1127744, 2016.

Becerra-Fernandez, I., and Sabherwal, R., *Knowledge management: Systems and processes*. Routledge, 2014.

Bjorling, S.-E., Baglee, D., Galar, D., and Singh, S., Maintenance knowledge management with fusion of CMMS and CM, 2013.

Cárcel-Carrasco, J., Cárcel-Carrasco, J.-A., and Peñalvo-López, E., Factors in the relationship between maintenance engineering and knowledge management. *Applied Sciences*, vol. 10, no. 8, 2810, 2020.

Chen, M.-Y., and Chen, A.-P., Knowledge management performance evaluation: a decade review from 1995 to 2004. *Journal of Information Science*, vol. 32, no. 1, pp. 17-38. 2006.

Chirumalla, K., Bengtsson, M., and Söderlund, C., Experience reuse in production maintenance: Practices and challenges. *22nd European Operation Management Association Conference*, EurOMA, June, 2015.

Davenport, T. H., and Prusak, L., *Working knowledge: How organizations manage what they know*. Harvard Business Press, 1998.

Hinds, P. J., Patterson, M., and Pfeffer, J., Bothered by abstraction: The effect of expertise on knowledge transfer and subsequent novice performance. *Journal of applied psychology*, vol. 86, no. 6, 1232, 2001.

Holsapple, C. W., Hsiao, S.-H., and Oh, J.-Y., Parameters of knowledge management success. In *Successes and failures of knowledge management* (pp. 1-12). Elsevier, 2016.

Iheukwumere-Esotu, L., and Yunusa Kaltungo, A., Assessment of Barriers to Knowledge and Experience Transfer in Major Maintenance Activities. *Energies*, vol. 13, no. 7, 1721, 2020.

Khoshsima, G., Lucas, C., and Mohaghar, A., Assessing knowledge management with fuzzy logic. *International Conference on Practical Aspects of Knowledge Management*, 2004.

King, W. R., Knowledge sharing. In *Encyclopedia of Knowledge Management, Second Edition* (pp. 914-923). IGI Global, 2011.

Mannonen, P., and Hölttä, V., Where the knowledge goes? Information gathering and managing practices in a global technical support center. *Procedia CIRP*, vol. 11, pp. 412-415, 2013.

Márquez, A. C., *The maintenance management framework: models and methods for complex systems maintenance*. Springer Science & Business Media, 2007.

Pistofidis, P., Emmanouilidis, C., Papadopoulos, A., and Botsaris, P. N., Management of linked knowledge in industrial maintenance. *Industrial Management & Data Systems*, 2016.

Polanyi, M., and Sen, A., *The tacit dimension*. University of Chicago press, 2009.

Raouf, A., Duffuaa, S., Ben-Daya, M., Tsang, A. H., Yeung, W., Jardine, A. K., and Leung, B. P., Data management for CBM optimization. *Journal of Quality in Maintenance Engineering*, 2006.

Refaiy, M., and Labib, A., The effect of applying tacit knowledge on maintenance performance: an empirical study of the energy sector in the UK and Arab countries. *Knowledge Management Research & Practice*, vol.7, no.3, pp. 277-288, 2009.

Riege, A., Three-dozen knowledge-sharing barriers managers must consider. *Journal of Knowledge Management*, vol. 9, no. 3, pp. 18-35, 2005.

Ruiz, P. P., Foguem, B. K., and Grabot, B., Generating knowledge in maintenance from Experience Feedback. *Knowledge-Based Systems*, vol. 68, pp. 4-20, 2014.

Shehab, S., Rahim, R. E. A., and Daud, S., A review of individual factors on knowledge sharing: Evidence from the empirical literature. *International Journal of Engineering and Technology (UAE)*, vol.7, no. 4, pp. 186-194, 2018.

Venzin, M., Von Krogh, G., and Roos, J., Future research into knowledge management. *Knowing in firms: Understanding, managing and measuring knowledge*, pp. 26-66, 1998.

Watson, S., and Hewett, K., A multi-theoretical model of knowledge transfer in organizations: Determinants of knowledge contribution and knowledge reuse. *Journal of management studies*, vol. 43, no. 2, pp. 141-173, 2006.

Wiig, K., *People-focused knowledge management*. Routledge, 2012.

Wong, K. Y., Tan, L. P., Lee, C. S., and Wong, W. P., Knowledge management performance measurement: measures, approaches, trends and future directions. *Information Development*, vol. 31, no. 3, pp. 239-257, 2015.

Biographies

Hamid Roham, a dedicated PhD student in management at the University of Lisboa, Portugal, since 2020, brings a wealth of experience to his academic pursuits. With a strong academic foundation that includes a DBA from the same institution in 2020 and an MSc in biomedical engineering from the University of Technology Amir-Kabir, Iran, Hamid has consistently demonstrated a passion for learning and research. In addition to his academic achievements, Hamid boasts an impressive 23 years of hands-on experience in maintenance management and equipment manufacturing at knowledge-intensive companies. This extensive practical experience has significantly enriched his academic journey and provides valuable real-world insights into his research interests, which primarily focus on maintenance management and human resource management. Hamid's multidimensional background, combining academic rigor and extensive industry expertise, uniquely positions him to make substantial contributions to his field and advance the understanding of knowledge-intensive processes and practices.

Jorge F.S. Gomes is Full Professor in Organizational Behavior and Human Resource Management at the Lisbon School of Economics and Management, University of Lisbon, and researcher at Advance/CSG. Dr. Gomes's research interests cover the HRM process view, alternative perspectives on leadership, and organizational purpose. He has published in Technovation, International Journal of HRM, Human Resource Management, British Journal of Political Science, European Management Review, and Journal of Organizational Change Management. He holds a PhD degree from the Alliance Manchester Business School (2001); an MSc in Statistics and Information Systems Management, from the Higher Institute of Statistics and Information Systems Management, Lisbon Nova University, Portugal (1995); and a BSc in Social and Organizational Psychology, from the Higher Institute of Applied Psychology, Portugal (1992).

Amir Reza Safdar Tourehei, an accomplished professional, combines an educational background in Industrial Engineering (Bahonar University of Kerman) and Social Communication Sciences (Azad University) with valuable skills. As a certified Project Management Professional (PMP) specializing in Project Management Information System (PMIS) and Procurement/Supply Chain, he serves as the Supply Chain Manager at Mapna Group. Amir's skills extend to teaching, photography, graphic design, and database management. He holds an MBA in Information Technology Management, various certifications including PMP and Six Sigma – Black Belt, and actively participates in social impact projects.

Elham Kamouri Yousefabad, a highly skilled professional with a background in Materials Engineering from Sharif University of Technology, serves as an Analysis and Lifetime Estimation Specialist. She contributes her expertise to the Manufacture and Assembly of Gas Turbine Blades at MAPNA Turbine Engineering and Manufacturing. Experienced in the field of Failure Analysis and Research & Development, Elham has authored articles in renowned journals like the Engineering Failure Analysis Journal. She holds a comprehensive understanding of additive manufacturing, heat treatment, alloy design, and a range of metallurgical processes.

Sepideh Aghajani holds a strong educational background with a Master of Science (M.Sc.) in Industrial Engineering from K. N. Toosi University of Technology, awarded in 2009. She also obtained a Bachelor of Science (BSc) in Industrial Engineering from Iran University of Science and Technology in 2004. With her educational foundation, Sepideh has acquired valuable skills in SAP and Python programming, making her a proficient professional in her field. She has accumulated significant work experience over the years. Currently, Sepideh serves as a Planner at MAPNA Group, a role she has held since 2016. Her dedication and contributions have amounted to 7 years of service within the organization. Previously, she worked as an HR Specialist at IRANOL Oil Co. from 2015 to 2016. Her role involved expertise in systems and production planning. Sepideh's educational qualifications, combined with her diverse skill set and extensive professional experience, make her a highly capable and accomplished individual in the field of industrial engineering and planning.

Ali Behnam holds a Bachelor's degree in Mechanical Engineering with a specialization in Solid Design from Alborz University of Science and Industry. He also possesses a Master's degree in MBA with a focus on Finance from Kharazmi University. Behnam has an extensive career history, starting as a Tool-making Specialist at Iran Khodro Machine Tools. He later joined Mapna Company, where he served as both a Tool-making Specialist and eventually became the Head of Tool-making. Currently, he works at Mapna Company as a Strategy Specialist and Manager of Innovation Camps, advising the Deputy for Human Resources in Innovation Affairs. He has completed an Advanced Strategic Management Course from the Industrial Management Organization.

Mohammad Ali Avestam holds a Master's degree in Information Technology Management with a specialization in Electronic Business from Tehran University of Science and Technology. He also has a Bachelor's degree in Business Management from Islamic Azad University, Tehran North Branch, and an Associate degree in Information and Communication Technology from Karaj Applied Scientific University. Avestam's work experience includes roles as an IT Specialist at Mapna Turbine Engineering & Manufacturing - Parto, hardware employee at Farineh Fanavari, and maintenance planning employee at Iran Pipe and Machinery Manufacturing. He's also co-founder and a board member of Danaye Sabz World Informatics. Avestam has published articles in the field of technology. He is an official member of the International Institute of Business Analysis (IIBA).

Arash Malekmohammadi, a dedicated professional with a Bachelor's degree in Electrical Engineering, boasts over 15 years of valuable experience in Maintenance Engineering. His expertise extends beyond electrical engineering, encompassing both software and hardware engineering, making him a well-rounded specialist in electronics. Arash's passion for innovation led him to become an expert in Design Thinking, enabling him to approach problem-solving and product development with a creative and user-centric perspective. His versatile skill set and wealth of experience have positioned him as a valuable asset in the fields of engineering and design, making him a true innovator at the intersection of technology and human-centered solutions.