زانكۆی پۆلیتەكنیكی هەولێر

ERBIL POLYTECHNIC UNIVERSITY

THE ROLE OF KNOWLEDGE MANAGEMENT PROCESSES IN ENHANCING EXCELLENCE MANUFACTURING PERFORMANCE

AN ANALYTICAL STUDY OF THE INSIGHTS OF ADMINISTRATIVE LEADERS IN RECYCLING SECTOR IN THE KURDISTAN REGION OF IRAQ

A thesis

Submitted to the Council of Technical Administrative College at Erbil Polytechnic University in partial fulfillment of the requirements for the degree of master in business managements technique

Prepared By

Tayib Kazho Ali

B.Sc. Mechanical engineering

MBA Master of business administration

Supervised By

Assist. Prof. Dr. Rizgar Saed Hussein

December , 2024

Supervisor certificate

I hereby acknowledge that I have supervised Tayib Kazho Ali, to complete his thesis entitled: **THE ROLE OF KNOWLEDGE MANAGEMENT PROCESSES IN ENHANCING EXCELLENCE MANUFACTURING PERFORMANCE: AN ANALYTICAL STUDY OF THE INSIGHTS OF ADMINISTRATIVE LEADERS IN RECYCLING SECTOR IN THE KURDISTAN REGION OF IRAQ.**
Require to obtain master degree in Business Management at the College of Technical Administration at Erbil Polytechnic University.

Signature:

Full Name: Assist. Prof. **Dr. Rizgar Saed Hussein**

Date: / / 2024

I confirm that all requirements have been fulfilled .

Signature :

Name :

Head of the department of

Date : / / 2024

I confirm that all requirements have been fulfilled .

Postgraduate Office

Signature :

Name :

Date : / / 2024

Declaration

I hereby confirm that all data in the Thesis was acquired and presented in accordance with academic norms and ethical guidelines. I further affirm that, in accordance with these guidelines and standards of conduct, I have appropriately referenced and cited all data and conclusions that are not original to my work.

Signature :

Student Name : **Tayib Kazho Ali**

Date :

Acknowledgment of a Linguistic Reviewer

I hereby acknowledge that I have linguistically reviewed this master thesis entitled**: THE ROLE OF KNOWLEDGE MANAGEMENT PROCESSES IN ENHANCING EXCELLENCE MANUFACTURING PERFORMANCE:**
AN ANALYTICAL STUDY OF THE INSIGHTS OF ADMINISTRATIVE LEADERS IN RECYCLING SECTOR IN THE KURDISTAN REGION OF IRAQ. I have corrected all linguistic and stylistic errors. Thus, the thesis is ready for VIVA Examination.

Signature:

Full name:

Date: / / 2024

Decision of the Viva Committee

We witness that we are members of the viva committee of master student Tayib Kazho Ali on his thesis entitled - **THE ROLE OF KNOWLEDGE MANAGEMENT PROCESSES IN ENHANCING EXCELLENCE MANUFACTURING PERFORMANCE:**
AN ANALYTICAL STUDY OF THE INSIGHTS OF ADMINISTRATIVE LEADERS IN RECYCLING SECTOR IN THE KURDISTAN REGION OF IRAQ.
We have reviewed the thesis and discussed the student in its contents and its relation to it on (19 / 12 / 2024) , and we witness that its worthy to obtain the degree of master in business management.

Signature :

Assist. Professor
Dr.Sherzad Majed Mahdi
Member
Date : / / 2024

Signature :

Assist. Professor
Dr.Bestun Abdulmajed uthman
Member
Date : / / 2024

Signature :

Assisst. Professor
Dr. Rzgar Saeed Hussen
Supervisor
Date : / / 2024

Signature :

Assist. Professor
Dr.Darun Faraydun Abdulla
Chairman
Date : / / 2024

Signature
Assisst. Professor Dr. Botan Majed Asinger
The Vice President for scientific Affairs and Higher Education
Date : / / 2024

Acknowledgements

First and foremost, I am profoundly grateful to Allah for granting me the strength, knowledge, and perseverance to complete this research. His guidance and blessings have been my source of inspiration throughout this journey.

I would like to extend my heartfelt thanks to my parents, whose unwavering support, encouragement, and love have been my foundation. Their sacrifices and belief in me have been invaluable.

To my family, thank you for your patience, understanding, and constant encouragement. Your support has been crucial in helping me stay focused and motivated.

I am deeply grateful to my supervisor, [Prof. DR. Rizgar S. Hussein], for his invaluable guidance, insightful feedback, and continuous support. His expertise and encouragement have been instrumental in shaping this research.

Lastly, I would like to thank my friends for their support and understanding throughout this journey.

ABSTRACT

Current study aims to examine the role of knowledge management processes in enhancing excellence manufacturing performance in the recycling sector of Kurdistan Region of Iraq. Depending on quantitative approach ,100 questionnaires were distributed among administrative leaders of 50 factories in recycling industry sector , by using SPSS program and a binary logistic regression model. Results of the study indicate a positive influence of knowledge management processes on operational excellence. Results also reveal that Organizations will be able to optimize their operations and improve productivity if they can leverage and apply the cumulative knowledge of their employees. Consequently, the overall model is statistically is significant,as Indicated by a -2 Log likelihood of 38.66 anda Chi-square value of 10.724(p=0.02),with a Nagelkerke R2 of 0.48,meaning that knowledge management processes in the model explain 48% of the variance in manufacturing performance . Indeed, this study identified that employee-to-employee knowledge-sharing and collaboration develop a sort of synergy, which exaggerates the benefits of Knowledge Management initiatives. From these insights, this study develops actionable recommendations for practitioners on investment priorities in Knowledge Management systems and in engaging leadership in Knowledge Management processes. An environment of shared knowledge and continuous learning is very liable to provide sustainable performances through improvements. Aligning Knowledge Management initiatives with broader organizational goals and environmental sustainability objectives can further enhance the impact of these practices. Ultimately, this research offers a roadmap for capitalizing on Knowledge Management as a strategic asset in the pursuit of operational efficiency and sustainability within the recycling sector.

Key words: Knowledge management, Manufacturing performance, Binary Logistic Regression, Kurdistan Region. Recycling sector.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

KRG: Kurdistan Region Government

KM: Knowledge Management

KPIs: Key Performance Indicators

OR: Odds Ratio

DMS: Document Management system

MES: Manufacturing execution system

SMEs: Small and Medium - sized Enterprise

IOT: internet Of Things

1. Chapter 1

1.1. Introduction

Due to the drastic changes and advancements like globalization and free trade of the twenty first century, organizations are required to strive to guarantee their growth and sustainability and even enter into new markets (Azeez, 2012). Nowadays, organizations are in a highly competitive working environment; hence they need to adopt new methods of creating and using knowledge and how to use knowledge management processes to improve and enhance their manufacturing performance.

It is evident that a robust economy is characterized by a developed industrial sector (wall Rostow, 1960) encompassing both extractive and manufacturing industries. Another significant sector utilizes recycled materials as inputs to create new products for reuse. This industry not only contributes to the economy by generating jobs and fostering social development but also plays a crucial role in environmental conservation.

In the Kurdistan region of Iraq, a palpable commitment to environmental sustainability permeates across the corridors of power, evident through the diligent efforts of relevant ministries within the Kurdistan Regional Government (The work plan of ninth cabinet of KRG). This commitment finds tangible expression in the region's vibrant recycling sector, which boasts over fifty factories dedicated to the noble task of transforming waste into valuable resources (by researcher). The recycling fields vary from processing scrap iron to repurposing plastic materials, motor grease, and used cardboard (Investment law in Kurdistan region number 4 in 2006 & Annual plan of Board of investment), these facilities serve as beacons of economic vitality, job creation, and local product proliferation. Yet, their significance extends beyond mere economic metrics, as they stand as guardians of environmental purity, actively contributing to the cleansing and preservation of Kurdistan's natural heritage (Board of protecting environment in Kurdistan). To fortify resilience and efficacy of recycling sector, a strategy focuses on knowledge management processes is imperative (By researcher). Elevating institutional performance across dimensions such as creativity, quality, flexibility, productivity, and safety not only ensures the sector's growth but also underscores Kurdistan's unwavering commitment to sustainable development and environmental stewardship.

A problem with linking organizational forms to economic performance is that it is difficult to develop valid and reliable indicators, both for organizational forms and for economic performance. One way to overcome this problem is to link innovation, learning, and knowledge creation with each other (Lundvall & Nilsen, 2007)

1.2. The Problem of Research and Research Questions

The recycling industry sector starts to grow since 2004 in Kurdistan region ,so there is a dire need to study the effect of knowledge management processes in strengthening the performance of manufacturing in such a sector, which would be very helpful in strategic decision-making for better outcomes in overall industrial performance.

While most scholars have acknowledged the importance of knowledge management processes in promoting excellence in various industries, few studies have elaborated on such processes within the recycling sector to a significant effect. This situation creates an adverse impact on fully realizing growth potential and innovation from the sector. Therefore, filling this important knowledge gap by properly ascertaining the role played by knowledge management processes becomes necessary for an improvement in the manufacturing performance of the industry sector of recycling. This research is vital for identifying essential strategies to enhance the sector's competitiveness and sustainability in the Kurdistan Region of Iraq. Consequently, the research raises the following key questions:

1. What are the key knowledge management processes utilized in the recycling industry sector in the Kurdistan Region of Iraq?
2. How do knowledge management processes contribute to enhancing manufacturing performance in the recycling industry sector?
3. What are the challenges and barriers faced in implementing knowledge management processes in the recycling industry sector?
4. How do contextual factors such as organizational culture and leadership influence the effectiveness of knowledge management processes in the recycling industry sector?
5. What are the socio-demographic factors that influence employees' engagement with knowledge management processes in the recycling industry sector in the Kurdistan Region of Iraq?

1.3. The Objective of the Research

The objective of a research are important ,because research objectives act as a roadmap, they help researcher to ensuring the clarity, consistency ,and alignment with the over all of the study , these are five objective :

1. To identify and describe the knowledge management processes employed in the recycling industry sector in the Kurdistan Region of Iraq.

2. To assess the impact of knowledge management processes on manufacturing performance within the recycling industry sector.
3. To analyze the challenges and barriers encountered in implementing knowledge management processes in the recycling industry sector.
4. To examine the contextual factors affecting the effectiveness of knowledge management processes, including organizational culture and leadership, within the recycling industry sector.
5. To explore the impact of socio-demographic variables such as age, gender, education level, Job Position and years of experience on employees' engagement with knowledge management processes in the recycling industry sector in the Kurdistan Region of Iraq.

1.4. The Significance of the Research

The significance of the research is providing useful insights into the driving forces behind manufacturing excellence in the recycling industry sector in the Kurdistan Region of Iraq. In fact, this study may highlight how knowledge management processes can help enhance performance and thus provide practical recommendations for industry stakeholders to further develop their operations and contribute toward sustainable growth. because the recycling industry is integrally part of environmentally positive development and economic growth in general, a deep appreciation for knowledge management processes that would enhance or foster such an industry has the possible benefit of wide ramifications, whether at the local or more general level. This result can be a further important contribution to innovation, efficiency improvements, and best practices adoption within the industry of waste recycling, enhancing its industrial performance for increased competitiveness in its sustainable development toward regional socioeconomic outcomes.

1.5. The Hypotheses of the Research

The First Main Hypothesis:

H1: “The ordinal importance of the study variables and their dimensions differ according to the nature of dependence on them by the Recycling Industry”, the following sub-hypotheses are branched from the first main hypothesis:

1. “The ordinal importance of the knowledge management variable and its dimension differ according to the nature of dependence on it by the surveyed Recycling Industry”.

2. “The ordinal importance of the Excellence Manufacturing Performance variable and its dimension differ according to the nature of dependence on it by the Recycling Industry”.

The Second Main Hypothesis:

H2: “There is a statistically significant relationship between knowledge management and Manufacturing Performance in Recycling Industry Sector in the Kurdistan region of Iraq at a significance level of (0.05)”, and the following sub-hypotheses emerge from it:

1. “There is a statistically significant relationship between knowledge acquisition dimension and manufacturing performance at a significance level of (0.05)”.
2. “There is a statistically significant relationship between knowledge creation dimension and manufacturing performance at a significance level of (0.05)”.
3. “There is a statistically significant relationship between knowledge transfer dimension and manufacturing performance at a significance level of (0.05)”.
4. “There is a statistically significant relationship between knowledge storage dimension and manufacturing performance at a significance level of (0.05)”.
5. “There is a statistically significant relationship between knowledge application dimension and manufacturing performance at a significance level of (0.05)”.

The Third Main Hypothesis:

H3: “There is a statistically positive and significant impact of knowledge management on the Manufacturing Performance in Recycling Industry Sector in the Kurdistan region of Iraq at a significance level of (0.05)”, and the following sub-hypotheses emerge from it:

1. “There is a statistically positive and significant impact of knowledge acquisition dimension on the manufacturing performance at a significance level of (0.05)”.
2. “There is a statistically positive and significant impact of knowledge creation dimension on the manufacturing performance at a significance level of (0.05)”.
3. “There is a statistically positive and significant impact of knowledge transfer dimension on the manufacturing performance at a significance level of (0.05)”.
4. “There is a statistically positive and significant impact of knowledge storage dimension on the manufacturing performance at a significance level of (0.05)”.
5. “There is a statistically positive and significant impact of knowledge application dimension on the manufacturing performance at a significance level of (0.05)”.

The Fourth Main Hypothesis:

H4: "there are Statistically significant differences among the surveyed recycling industries regarding the study variables due to the difference in all personal characteristics of the respondents at a significance level of (0.05)", and its sub-hypotheses are as follows:

1. "There is a statistically significant difference among the respondents from the recycling industries towards the variables adopted in the current study due to gender of the respondents at a significance level of (0.05)".
2. "There is a statistically significant difference among the respondents from the recycling industries the variables adopted in the current study due to age of the respondents at a significance level of (0.05)"
3. "There is a statistically significant difference among the respondents from the recycling industries towards the variables adopted in the current study due to the educational level of the respondents at a significance level of (0.05)".
4. "There is a statistically significant difference among the respondents from the recycling industries towards the variables adopted in the current study due to years of experience of the respondents at a significance level of (0.05)".
5. "There is a statistically significant difference among the respondents from the recycling industries towards the variables adopted in the current study due to Job Position of the respondents at a significance level of (0.05)".

The Fifth Main Hypothesis:

H5: "The Recycling Industries in Kurdistan region vary in achieving the manufacturing performance according to the different levels of their focus on knowledge management at a significance level of (0.05)".

1.6. Conceptual model of research

Using previous research and relevant literature, the research model aims to explore and assess the connection and impact of the factors examined in the current study. A conceptual framework was created and depicted in Figure (1) to effectively address the study problem and achieve the established objectives. This framework provides a systematic approach to understanding the nature of regression and correlation among research variables. By serving as a roadmap for the study and facilitating the exploration of the relationship and potential significance of the selected variables, the model offers valuable insights into the field of study.

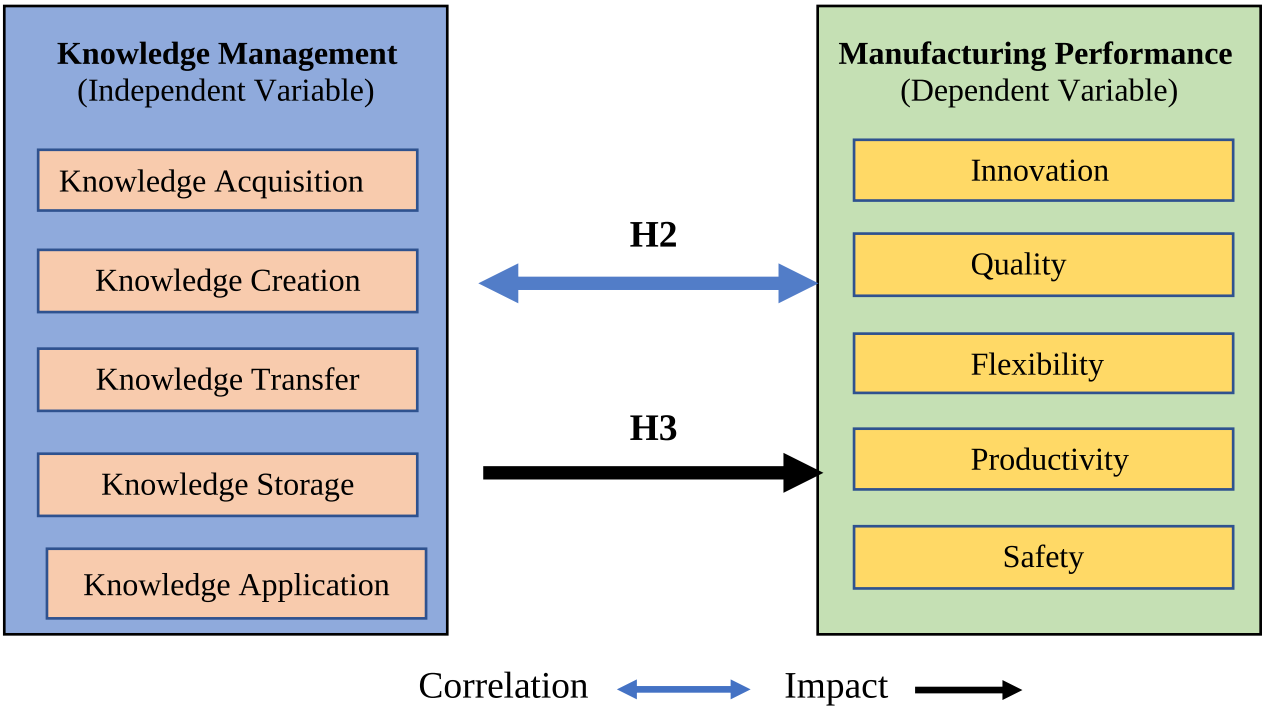

Figure 1.1. Proposed Research Model by Researcher

1.7. Structure of the research

This research is structured into several chapters, each focusing on different aspects of the study.

The following chapters will be covered:

- Chapter one: Introduction
- Chapter Two: Literature review
- Chapter Three: Methodology
- Chapter Four: Results and discussion
- Chapter Five: Conclusion, implications, and recommendations

1.8. Operation Definitions

To ensure clarity and understanding throughout the research, we have provided definitions for key terms used in this study. These definitions will help readers grasp the concepts and terminology used in the context of knowledge management and manufacturing performance.

1.9. Delimitation of the study

It is important to note the scope and limitations of this research. The study focuses specifically on the recycling industry sector in the Kurdistan Region of Iraq. The findings and recommendations may not be directly applicable to other industries or regions. Additionally, the research is limited to the examination of knowledge management processes and their impact on manufacturing performance dimensions, namely innovation, quality, flexibility, productivity, and safety.

2. Literature Review

2.1. Introduction to Knowledge Management:

About the definition of the Knowledge, we can say it is a fundamental resource that enables individuals and societies to innovate, solve problems, and make informed decisions. It evolves through inquiry, learning, and the transfer of information across generations.

It can be categorized in to explicit, tacit, practical, and theoretical knowledge.

Knowledge management (KM)is a topic that has gained increasing attention since the mid-1990s.knowledge about customers, products , processes ,past successes ,and failures are assets that may produce long -term sustainable competitive advantage for organizations(Huber,2001;Leonard &Sensiper,1998;Stewart,2001)

Knowledge Management has garnered considerable attention in recent decades as firms acknowledge the significance of efficiently managing their knowledge assets (Seriki, 2023). Knowledge management is a process that involves the generation, storage, retrieval, and sharing of knowledge and expertise inside an organization to enhance its business performance(Farooq, 2019). The notion of knowledge management is essential for the effective utilization of information, augmenting a firm's capacity to acquire and maintain competitive advantage (Rehman et al., 2022).

Effective knowledge management necessitates a significant transformation in organizational culture and a commitment from all tiers of the company to ensure its success. Effective knowledge management typically necessitates a correct integration of organizational, societal, and managerial strategies, alongside the utilization of suitable technology. Knowledge management aims to utilize and repurpose existing organizational knowledge resources, encouraging individuals to pursue best practices instead of duplicating efforts (Faeq, 2022; Marques et al., 2019).

From these steps of KM evolution in organizational contexts, some fairly distinct generations have clearly demarcated the shifting focuses-from within the organization to knowledge nurturing and value creation through human network integration, social capital, and technology (Rezgui et al., 2010). Nowadays, the area also encompasses inter-organizational contexts, and themes like innovation, networks, and especially human and social issues relating to KM are gaining interest (Agostini et al., 2020). Major driving forces for development regarding KM include advancement in information and communication technology, changing concept and nature of knowledge, as well as tools and techniques being developed and made available (Masic et al., 2017). With the evolution of KM, it came to be understood more as a set of processes rather than simple manipulation of information. Social networking and web applications were considered significant in connecting the practitioners and building social capital (McInerney & Koenig, 2011).

2.2. Importance of KM in Manufacturing

Knowledge management has become a crucial factor that affects the competitiveness and efficiency improvement of manufacturing organizations. Firms operating in the fast-growing manufacturing sector have to be capable of managing their knowledge assets for achieving innovation, quality improvement, operational flexibility, productivity enhancement, and even safety management (Mageswari et al., 2015).

The manufacturing industry is a complex process that requires continuous improvement and adaptation. KM practices enable the organization to capture, share, and leverage knowledge for effective process improvement. Knowledge sharing in manufacturing firms has been seen to positively influence innovation and overall firm performance, according to Wang & Wang (2012). Their study showed that sharing expertise and insights among employees leads to the development of new ideas and improvements in products and processes.

Similarly, Law et al. (2021) investigated the relationship between KM and innovation in high-tech manufacturing SMEs. It can be observed that knowledge acquisition and dissemination significantly influence innovative performance. The study of Law et al. has thus suggested that through an environment that actively creates, develops, and uses knowledge, manufacturing SMEs may achieve innovation capabilities that, in turn, will offer competitive advantages in the marketplace.

Apart from innovation, quality and operational efficiency are also well taken care of by KM. S. D. U. Mageswari et al. (2017) analyzed the effect of applying various types of knowledge management strategies in relation to organizational performance in manufacturing set-ups. The conclusion was drawn that the approach of complementarity in KM, where the organization is taking care of explicit as well as tacit knowledge, would improve the quality and processes for better outcomes. Critical knowledge retention in a company reduces errors and enhances the quality of products through effective knowledge management practices.

Furthermore, KM makes for operational flexibility by enabling firms to respond promptly to changes in markets and customers. On their part, (Liu et al., 2021) indicated that transformational leadership in combination with knowledge management practices enables the enhancement of performance of organizations in the manufacturing industry. According to this research, when leaders enhance the sharing of knowledge and learning, it enhances the adaptability of the organization and flexibility of its operations.

Knowledge acquisition is the most critical process in KM, which refers to the identification, absorption, and internalization of valuable information and expertise from internal and external sources. Effective knowledge acquisition in the manufacturing sector will facilitate innovation, improvement of processes, and gaining a competitive advantage. This section reviews some basic theories and models on knowledge acquisition and explores approaches to knowledge acquisition in the manufacturing environment.

2.3. Knowledge Management Processes

Knowledge management (KM) processes* refer to the systematic approach organizations use to create, acquisition, storage , transfer, and apply and manage knowledge to enhance efficiency and innovation of organizations.

2.3.1. Knowledge Acquisition

The gathering of new knowledge from internal or external sources, acquiring knowledge from external partnerships, competitors, or industry standards.

2.3.1.1. Theories and Models of Knowledge Acquisition

A number of theories and models have been developed that describe how organizations acquire knowledge and the factors that influence the process. Key among these are the concepts of absorptive capacity, the knowledge-based view of the firm, and the SECI model.

Absorptive capacity, initially developed by Cohen & Levinthal (1990) and later revised by Zahra and George (2002), simply defines the capability of a firm to identify the value of new knowledge coming from an external environment, absorb it internally, and convert it to a commercial function. Zahra & George (2002) later redefined absorptive capacity into two dimensions: Potential absorptive capacity (Knowledge Acquisition and Knowledge Assimilation) and realized absorptive capacity (Knowledge Transformation and Knowledge Exploitation). This model brings out the fact that knowledge acquisition is not only a matter of access to information, but rather the ability of the organization to process and put the knowledge to work.

The KBV posits that knowledge is the most strategically significant resource of a firm (Grant, 1996). Under this view, the firm's ability to acquire, integrate, and apply knowledge is central to achieving and sustaining competitive advantage. This perspective underscores the importance of knowledge acquisition as a strategic capability, especially in dynamic and complex environments like manufacturing.

Nonaka & Takeuchi (1995) SECI model describes knowledge creation and acquisition through four modes: Socialization, Externalization, Combination, and Internalization. Although originally focused on knowledge creation, the model also provides insights into how organizations acquire tacit and explicit knowledge. Socialization (tacit to tacit) involves sharing experiences, while Combination (explicit to explicit) pertains to integrating different sets of explicit knowledge, both of which are pertinent to knowledge acquisition.

Todorova & Durisin (2007) introduced the concept of dynamic capabilities, which are the firm's processes to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments. Knowledge acquisition is a key dynamic capability that enables firms to adapt and innovate in response to market changes (Easterby-Smith, Lyles, & Peteraf, 2009).

2.3.1.2. Methods of Acquiring Knowledge in Manufacturing Settings

Knowledge acquisition in manufacturing environments takes various forms and technologies. Speech recognition together with the Web Ontology Language gives automated, tacit knowledge acquisition from workers, which are validated with methods of

Euclidean-distance (Patalas-Maliszewska et al., 2017). Acquisition of data from production systems is the basis for effective management, closing the gap between business and manufacturing layers. Methods range from simple, using sensors and actuators, PLCs, and the use of automatic identification such as barcodes and radio-frequency identification systems (Ćwikła, 2014). This led to the development of models and frameworks for the acquisition of tacit knowledge for research and development departments by manufacturing companies in Poland and Germany. Manufacturing organizations develop different ways of acquiring knowledge both through external and internal means. These methods contribute effectively to innovation, process improvements, and the ability of the manufacturing companies to remain relevant in an increasingly global competitive market (Patalas-Maliszewska et al., 2017).

2.3.1.2.1. External Knowledge Acquisition

Meanwhile, collaborations with suppliers, customers, research institutions, and even competitors often act as avenues for the reception of knowledge from external sources, also defined as "open innovation". Bigliardi et al. (2020) find a positive effect of openness, defined as "open innovation, on a firm's innovative performance; thus, manufacturing firms realize joint ventures, strategic alliances, and partnerships in acquiring new technologies and market issues.

Customer and supplier integration into the development process enables firms to gather valuable knowledge. Freije et al. (2021) proved that supplier integration increases product innovation by offering suppliers with exclusive knowledge and capabilities. Likewise, customer feedback and participation are also contributing to the fine-tuning of products and services.

Advanced technology can be input by a firm through the purchase of patents, licenses, and technological solutions. This also agrees with the idea of Ramayah et al. (2020) where one of the critical parts in developing innovation and competitive advantage in absorptive capacity is through the acquisition of technology from outside sources.

2.3.1.2.2. Internal Knowledge Acquisition

By investing in employee education, an organization increases its knowledge base. Training programs, workshops, and continuous professional development enable the working staff to acquire new knowledge and abilities for production processes (Michalakoudis et al., 2018).

Intranets, databases, and knowledge management systems allow the capture and sharing of knowledge within the company. These platforms provide access to best practices, lessons learned, and expert insights that enhance collective knowledge acquisition (Barão et al., 2017).

It encourages coordination and collaboration between other sections so that people can share diversified knowledge and ideas. A community of practice helps put together people with common interests where various experiences can be shared and skills developed to create and strengthen ways of gaining knowledge, not only individually but at an organizational level also (Zhang & Tang, 2017).

Industry 4.0 technologies have revolutionized knowledge acquisition in manufacturing activities through the use of big data analytics, the Internet of Things, and artificial intelligence. The technologies will go a long way in revolutionizing real-time data collection and analytics to garner insights into operational efficiencies, predictive maintenance, and process optimization of manufacturing companies. Knowledge can be acquired about machine data, production metrics, and supply chain information of great value to a manufacturer (Bettiol et al., 2023).

2.3.1.2.3. Challenges and Best Practices

While knowledge acquisition is essential, manufacturers face challenges such as information overload, knowledge silos, and resistance to sharing. To overcome these challenges, best practices include:

Organizational culture plays a crucial role in fostering knowledge sharing and learning within organizations. A knowledge-friendly culture encourages employees to contribute to knowledge acquisition efforts (Caruso, 2016). Leaders can promote such a culture by setting clear goals, adapting leadership styles, leading by example, and recognizing knowledge-sharing behaviors (Yi, 2019). Key elements of a knowledge-friendly culture include valuing individual development, embracing change, promoting cooperation and communication, and engaging with the environment (Janićijević, 2015). To leverage organizational knowledge effectively, it is essential to create an environment that supports informal workplace learning and provides performance support (Caruso, 2016). In educational settings, a knowledge-friendly culture is particularly important for transforming institutions into knowledge organizations (Stylianou & Savva, 2016). By fostering a culture that values learning and knowledge sharing, organizations can enhance their ability to capture, share, and manage valuable employee knowledge, ultimately improving organizational performance.

Implementing structured processes for knowledge management is crucial for effectively capturing, validating, and integrating valuable information. Knowledge engineering techniques can systematically capture and store structured knowledge, preserving rich relationships. Validation, a critical quality-control step, ensures that only accurate, relevant, and useful knowledge enters the system. These include management review, peer review, and external expert review, among many others (Janus, 2017). Data mining, information extraction, and validation integrated with collaborative knowledge management will enhance data acquisition processes (Ali et al., 2018). Decision tables are structured knowledge representation and validation; thus, they offer extensive verification and assist in the process of knowledge acquisition (Azad et al., 2020).

The role of leadership, in particular, is rather crucial when it comes to the development of knowledge acquisition and management capabilities within a firm. Leaders can promote an enabling culture for knowledge with good behavior, building trust, and encouraging knowledge workers (Pellegrini et al., 2020). The support from leadership has positive relations to continuous intention of the employees to seek knowledge. Leadership support promotes the use of KMS for knowledge seeking (Veeravalli & Vijayalakshmi, 2022). While not a prerequisite, transformational leadership dimensions can enable knowledge acquisition by followers for self-managing teams. The human-relationship-oriented approach, in addition to participative decision-making, is related positively with essential skills and traits in knowledge management, according to Jiang & Chen (2018). Effective leaders set the expectations, provide resources, and recognize contributions to be able to create an environment that is conducive to knowledge acquisition and sharing, thus adding to organizational performance and competitive advantage (Abubakar et al., 2017).

2.3.2. Knowledge Creation

Generally speaking, knowledge creation is probably the most fundamental process to define as KM. The process helps in the development of an organization's new ideas and solutions and in innovation capability. Knowledge creation is paramount in driving innovation, driving improvement in processes and enhancing products, and maintaining significant competitive advantage in the context of the manufacturing sector of any economy. This segment discusses some innovation theories attached to knowledge creation and determines the processes through which a modern organization develops new knowledge (Rehman et al., 2021).

2.3.2.1. Innovation Theories Related to Knowledge Creation

Innovation theories explain how new ideas and technologies emerge and are put into place within organizations. Theories abound on the relationship between knowledge creation and innovation.

One of the most influential theories on knowledge creation is the SECI model of Nonaka et al. (2000). This model describes a dynamic process of interaction between tacit and explicit knowledge in creating new knowledge through four modes:

1. **1. Socialization (Tacit to Tacit):** It is the process of sharing experiences to create the tacit knowledge, such as skills and mental models.
2. **2. Externalization - Tacit to Explicit:** Articulating the knowledge which is tacit usually by way of metaphors, analogies or models.
3. **3. Combination (Explicit to Explicit):** Systematic integration of varied bodies of explicit knowledge.
4. **4. Internalization - Explicit to Tacit:** To embed the explicit knowledge into the tacit knowledge base through learning and possibly practice.

The spiral model underlines that knowledge creation is one continuous and iterative process to be followed in innovation.

Stei et al. (2023) elaborated the concept of dynamic capabilities as an organization's ability to integrate, build, and reconfigure its internal and external competencies in response to rapidly changing environments. The ability of a firm to create knowledge is one such dynamic capability that enables a firm to innovate and make changes. According to this theory, the organizations keep creating new knowledge to sustain the continuous technological development and market shift.

Hutton et al. (2021) identified open innovation as an organization's use of external ideas and paths to market in addition to internal ideas and paths to market. This allows acceleration of internal innovation and the ability to expand markets through the inflow and outflow of knowledge. In this regard, knowledge creation is created in collaboration with external partners, customers, and even competitors.

Auqui-Caceres & Furlan (2023) argue that it is through single-loop and double-loop learning that the organizations learn and build knowledge. Single-loop learning will focus on only optimization of already existing processes whereas in double-loop learning these underlying assumptions and norms are questioned and thus changed accordingly. Knowledge creation results in reflective practices, learning from experience leads to innovation-its transformative kind.

As discussed in the previous section, absorptive capacity, Khraishi et al. (2022) also relates to knowledge creation. It is not just about the acquisition of external knowledge; rather, it is an issue of transformation and exploitation in creating new knowledge and innovations.

2.3.2.2. Processes of Developing New Knowledge Within Organizations

Various processes are used by organizations to develop knowledge at both individual creativity and collective efforts. Identifying such processes is particularly significant in manufacturing industries for product development, process enhancement, and technological advancement.

Cross-functional teams are a group of people with diversified functional background and expertise that work as a team to accomplish a common project objective. Such diversity in knowledge and perception can also trigger creativity and the generation of new ideas. (Li & Long, 2022). Widmann et al. (2016) have found that the collaboration of teams is going to enhance learning and the potential for innovation because tacit knowledge from different spheres combines.

This will provide a clear indication that generating new knowledge and innovations is very much possible through investing in R & D. R&D Department focuses on the discovery of technologies, materials, and procedures. (Gómez et al., 2020). Leung & Sharma (2021) showed that R&D intensity influences the performance of innovation positively and attached great importance to this area since it is related to dedicated efforts in knowledge creation.

Hutasuhut et al. (2021) explained that a learning organization has a concept of continuous learning and adaptation, integrated into operations. The culture of continuous knowledge creation is embedded with the encouragement of TQM or lean manufacturing to employees of every level for suggesting improvement points.

The point by Miao et al. (2023) is that knowledge-sharing environmental development among employees creates opportunities for generating new ideas. Organizational social networks foster information flow and problem-solving collaboration. Social capital fosters creation and development in intellectual capital at an organization.

Advanced technologies, such as computer-aided design and simulation software, support creation by opening opportunities for experimentation and coming up with innovations. Big data analytics and artificial intelligence can therefore help an organization generate insight leading to new knowledge from a pile of data (Kakatkar et al., 2018).

This will empower the initiative and decision-making powers among employees, developing a sense of ownership and hence creativity in them. Grošelj et al. (2020) identified that psychological empowerment strengthens innovative behavior for creating knowledge among employees.

Engaging with external stakeholders in the form of universities, research institutions, and industry consortia expands the organization's knowledge base. In this regard, Rybnicek & Königsgruber (2019) indicated that university-industry linkages are significant sources of new knowledge and technological advancements.

A culture that interprets failures as a means to learn would lead to more experimentation and taking of risks. Kim & Lee (2020) learning from failure is important to innovation since it results in much deeper comprehension and the establishment of new knowledge.

Accordingly, leadership may play a strategic role in providing an environment that will be ripe for knowledge creation. The so-called transformational leaders use energy and enthusiasm to encourage subordinates and instigate one to pursue innovation and exchange knowledge. Knowledge creation processes are supported by the corporate culture of learning, openness, and creativity (Pellegrini et al., 2020).

2.3.3. Knowledge Transfer

Knowledge transfer is one of the important aspects of KM, representing the process of knowledge flow from one part of an organization to another or even between organizations. Effective knowledge transfer ensures that valuable insights, skills, and information are transferred to where they are needed, enabling innovation, efficiency, and competitive advantage. This section considers the mechanisms for transferring knowledge internally and externally within manufacturing settings and explores the challenges associated with effective knowledge transfer.

2.3.3.1. Mechanisms for Transferring Knowledge Internally and Externally

Knowledge transfer mechanisms can be categorized into internal and external processes, each playing a vital role in enhancing organizational capabilities in the manufacturing sector.

2.3.3.1.1. Internal Knowledge Transfer Mechanisms

Structured training programs are a primary method for transferring knowledge within an organization. These programs can include workshops, seminars, mentoring, and coaching sessions that aim to disseminate technical skills and organizational practices (Noe, Clarke, & Klein, 2014). In manufacturing, training on new machinery, processes, or safety protocols ensures that employees are up-to-date with current practices.

CoPs are made up of people connected by a mutual concern or passion for some aspect of their work, interacting regularly to learn how to improve their knowledge and expertise. The CoP in manufacturing organizations thus enables the sharing of best practices, problem-solving techniques, and ideas of innovation among the employees across different departments or locations.

Knowledge repositories allow for the process of storing and retrieving explicit knowledge, such as documents, manuals, and standard operating procedures. Thus, these systems enable access and the sharing of information by employees with ease and efficiency (Alavi & Leidner, 2001). Large manufacturing firms use ERP systems and intranets to enable internal knowledge transfer.

Rotating staff through various positions or departments exposes them to the multiple functions and processes of the organization. This practice enhances their knowledge of the organization as a whole and promotes the transference of tacit knowledge (Edwards, Sanchez, & Sessions, 2017).

Informal relationships of the employees through casual conversations, social gatherings, and various projects being carried out in groups help considerably in knowledge dissemination. Such informal interactions often have results in terms of extracting tacit knowledge that gets lost in formal mechanisms alone (Cross, Borgatti, & Parker, 2001).

2.3.3.1.2. External Knowledge Transfer Mechanisms

Firms access external knowledge through collaborations with other organizations, suppliers, customers, and research institutions. Collaborative projects, joint ventures, and strategic alliances are all means of accessing the skills and technologies of other organizations (Inkpen & Tsang, 2005). For example, manufacturing companies might collaborate on research projects with universities to develop new materials or processes.

Hiring external consultants or experts brings specialized knowledge into the organization. These professionals can provide insights into best practices, industry trends, and innovative solutions that the firm may not possess internally (Werr & Styhre, 2003).

Attending industry conferences, workshops, and networking events enables organizations to stay abreast of the latest developments and share knowledge with peers (Tallman & Chacar, 2011). These platforms offer opportunities to learn from the experiences of other firms and adopt new practices.

Licensing agreements, patents, and technology purchases are formal mechanisms for acquiring and transferring technology-based knowledge from external sources (Lichtenthaler & Lichtenthaler, 2010). Manufacturing companies may acquire rights to use proprietary technologies to enhance their production capabilities.

Benchmarking involves comparing organizational processes and performance metrics to industry bests or competitors to identify areas for improvement (Anand & Kodali, 2008). Competitive intelligence gathers information about competitors' activities, enabling firms to adapt and innovate accordingly.

2.3.3.2. Challenges in Effective Knowledge Transfer

Despite the importance of knowledge transfer, organizations often face significant challenges in implementing effective knowledge transfer mechanisms. These challenges can impede the flow of knowledge, leading to inefficiencies and lost opportunities.

Organizational culture greatly influences knowledge transfer. A culture that does not support sharing or values individual knowledge hoarding can hinder the dissemination of information (De Long & Fahey, 2000). In manufacturing firms with hierarchical structures, employees may be reluctant to share knowledge upward or across departments.

Trust among employees and between organizations is essential for knowledge transfer. Without trust, individuals may fear that sharing knowledge could diminish their value or be used against them (Levin & Cross, 2004). This barrier is particularly relevant in external collaborations where intellectual property concerns exist.

Differences in language, terminology, and communication styles can impede knowledge transfer. In manufacturing settings, technical jargon or complex processes may not be easily understood by all employees, leading to misunderstandings (Szulanski, 1996).

An organization's ability to recognize, assimilate, and apply new knowledge—its absorptive capacity—affects knowledge transfer effectiveness (Cohen & Levinthal, 1990).

Limited absorptive capacity can result from a lack of relevant skills, experience, or resources to process and utilize new knowledge.

For organizations operating across multiple locations or time zones, geographical and temporal separation can hinder knowledge transfer. Physical distance reduces opportunities for face-to-face interactions, which are crucial for sharing tacit knowledge (Ambos & Ambos, 2009).

Inadequate technological infrastructure can impede the transfer of knowledge, especially explicit knowledge that relies on information systems. Outdated or incompatible systems may prevent efficient knowledge sharing (Gupta & Govindarajan, 2000).

Developing an organizational culture that encourages knowledge sharing involves promoting values such as openness, collaboration, and mutual respect. Leadership plays a crucial role in modeling and reinforcing these behaviors (Wang & Noe, 2010).

Establishing trust requires consistent and transparent communication, reliability, and demonstrating respect for individuals' contributions. Trust-building initiatives can include team-building activities and recognition programs (Dirks & Ferrin, 2001).

Providing communication training, standardizing terminology, and using clear and accessible language can reduce misunderstandings. Utilizing multiple communication channels—face-to-face meetings, emails, video conferencing—accommodates different preferences and situations (Maznevski & Chudoba, 2000).

Investing in employee training and development enhances the organization's ability to absorb new knowledge. Encouraging continuous learning and hiring individuals with diverse skills and experiences contribute to building absorptive capacity (Volberda, Foss, & Lyles, 2010).

Implementing advanced information and communication technologies facilitates knowledge transfer across distances. Collaborative platforms, knowledge management systems, and social media tools enable real-time sharing and collaboration (Alavi & Leidner, 2001).

Formalizing knowledge transfer processes ensures that knowledge sharing is integrated into daily operations. Incentive structures that reward knowledge sharing behaviors motivate employees to participate actively (Husted & Michailova, 2002).

Siemens, a global manufacturing company, implemented a comprehensive knowledge management system called "ShareNet" to facilitate knowledge transfer among its employees worldwide. The platform allows employees to share best practices, solutions to common problems, and innovative ideas. As a result, Siemens enhanced collaboration across its global operations, leading to improved efficiency and innovation (Voelpel & Han, 2005).

P&G adopted an open innovation approach called "Connect + Develop" to access external knowledge and technologies. By collaborating with external partners, suppliers, and even competitors, P&G accelerated its innovation processes and brought new products to market more quickly. This strategy exemplifies effective external knowledge transfer contributing to competitive advantage (Huston & Sakkab, 2006).

2.3.4. Knowledge Storage

Knowledge storage is one of the most critical elements in knowledge management, which encompasses the processes involved in retaining, organizing, and retrieving knowledge within an organization. Effective knowledge storage in manufacturing ensures that useful information, expertise, and experiences are retained for future use to inform better decision-making, innovation, and operational efficiency. The section covers technologies and systems for knowledge storage and investigates best practices in maintaining knowledge repositories.

2.3.4.1. Technologies and Systems for Knowledge Storage

The advancement in information technology has actually changed how knowledge is managed and stored in organizations. Different technologies and systems can help capture explicit and implicit knowledge, making knowledge accessible with ease to all levels and functions in an organization.

Enterprise Content Management Systems are integrated platforms that enable organizations to create, store, share, and manage documents, records, web content, and digital assets. In regard to explicit knowledge, ECMS supports storage, retrieval, and sharing through central repositories available to the accredited users (Smith & McKeen, 2003). For example, manufacturing may use ECMS for storing technical documents, design specifications, process guidelines, and compliance records to assure repetition and adherence to the standard.

These knowledge bases could be databases or content management systems that might handle structured and unstructured knowledge, like best practices, lessons learned, project documentation, and expert opinions. According to Alavi and Leidner (2001), Knowledge repositories strengthen the memory of the organization; because much of the valuable knowledge will otherwise be lost if personnel are transferred or retired, and for various reasons, individuals lack enough time to write down knowledge in accessible formats. In manufacturing companies, for example, repositories are widely used in storing histories of product development, records concerning routine maintenance, and related data relating to quality control.

Collaborative platforms, such as intranets, wikis, and social networking tools, enable employees to create, share, and update knowledge collaboratively. These platforms support real-time communication and knowledge sharing, breaking down silos and fostering a culture of collaboration (Wang & Noe, 2010). For istance, an internal wiki can serve as a living knowledge base where employees contribute insights on manufacturing processes, troubleshooting techniques, and innovation ideas.

Document Management Systems provide tools for storing, tracking, and managing electronic documents and images of paper-based information. DMS ensure version control, access rights management, and compliance with regulatory requirements (Munkvold et al., 2006). In manufacturing, DMS are essential for managing technical manuals, engineering drawings, and standard operating procedures.

The cloud storage solution provides a scalable, flexible platform for large volumetric data and knowledge asset storage. Cloud computing allows all types of organizations to start accessing knowledge resources remotely; this thereby enhances collaboration among teams operating across different geographical locations Marston et al. (2011). In case manufacturing firms use big data developed from the IoT devices, sensors, and production systems based on the cloud service provider.

AI and machine learning are going to bring more development in knowledge storage through these processes of organization and retrieval on their own. Intelligent systems can classify the documents and extract relevant information by responding to the queries made (Gandomi & Haider, 2015). In a manufacturing environment, for example, the AI-powered knowledge system can analyze production data for finding patterns, predictive maintenance, and recommending process improvement methods.

2.3.4.2. Best Practices in Maintaining Knowledge Repositories

Effective knowledge storage does not stop at the implementation of technological systems but involves strategic management and adherence to best practices that will keep the knowledge repositories valuable and relevant.

Knowledge repositories rely on up-to-date and accurate knowledge. The organization should, therefore, set up a system for periodic review and updating of content with the involvement of subject matter experts to validate information (Dalkir, 2017). Outdated or incorrect knowledge leads to poor decision-making and operational inefficiencies.

Applying standardized formats, taxonomies, and metadata enhances the organization and retrieval of knowledge. Consistency in how knowledge is categorized and labeled enables users to find information efficiently (Zhou & Fink, 2003). In manufacturing, standardization is particularly important for technical documents and process guidelines.

Protecting sensitive knowledge and intellectual property is essential. Implementing access controls ensures that only authorized personnel can access certain knowledge assets, thereby safeguarding proprietary information (Alavi & Leidner, 2001). Security measures also prevent unauthorized alterations or deletions of critical knowledge.

Knowledge repositories should be designed with user experience in mind. Intuitive interfaces and robust search capabilities encourage user adoption and facilitate efficient knowledge retrieval (Maier, 2007). Features such as keyword search, filters, and advanced queries enable users to locate specific information quickly.

Integrating knowledge storage systems with existing business processes and workflows enhances their effectiveness. When knowledge repositories are embedded within the tools and systems that employees use daily, knowledge sharing becomes a seamless part of operations (King, 2009). For instance, integrating knowledge systems with manufacturing execution systems (MES) allows real-time access to production data and insights.

Knowledge repositories thrive when users actively contribute content and engage with the system. Organizations should foster a culture that encourages knowledge sharing and recognizes contributions (Suppiah & Sandhu, 2011). Incentives, training, and support can motivate employees to document their knowledge and share it with others.

Establishing clear policies and guidelines for knowledge storage ensures consistency and compliance with organizational standards. Governance structures define roles and responsibilities for managing knowledge assets, including content creation, review, and archiving processes (Weber et al., 2009). Effective governance prevents knowledge duplication, redundancy, and decay.

Monitoring the usage and performance of knowledge repositories provides insights into their effectiveness. Analytics can track user interactions, popular content, and search queries, informing continuous improvement efforts (Lehner & Haas, 2010). Soliciting user feedback helps identify gaps in the knowledge base and areas for enhancement.

The accumulation of vast amounts of data can lead to information overload, making it difficult for users to find relevant knowledge. Implementing effective categorization and search tools mitigates this issue (Bawden & Robinson, 2009).

Rapid technological advancements and changing business environments can render stored knowledge obsolete. Regular content reviews and updates are necessary to maintain the relevance of knowledge repositories (Dalkir, 2017).

Employees may resist using knowledge storage systems due to perceived complexity, lack of time, or skepticism about their benefits. Addressing user concerns through training, communication, and demonstrating value encourages adoption (Jones, 2005).

2.3.5. Knowledge Application

Knowledge application is the process of utilizing accumulated knowledge effectively to make decisions, solve problems, improve processes, and drive innovation within an organization. In the manufacturing sector, applying knowledge is crucial for enhancing operational efficiency, product quality, and overall organizational performance. This section explores strategies for applying knowledge to improve manufacturing processes and examines the impact of knowledge application on organizational performance, with a focus on recent literature.

2.3.5.1. Strategies for Applying Knowledge to Improve Processes

Application of knowledge successfully is a matter of deliberately deploying strategies that can make organizations turn their knowledge into action both practically and effectively. Application of knowledge in manufacturing settings may be facilitated by various strategies identified from the literature.

Embedding knowledge into the business process means that employees can apply relevant information and expertise when performing their duties. Integration involves embedding knowledge resources within workflow systems, standard operating procedures, and decision-making processes (Kianto et al., 2016). For instance, MES may embed real-time data and knowledge inputs to optimize production schedules and resource allocation.

The implementation of continuous improvement methodologies, such as Lean Manufacturing and Six Sigma, provides structured approaches to knowing there is an application or enhancement of processes (Anand et al., 2009). Both these programs support employees in applying data-driven analytic and problem-solving techniques to find inefficiencies, decrease the causes of waste, and focus attention on the improvement of quality. Further, the cyclical basis behind these methodologies, or a series of PDCA-plan-do-check-act-promotes ongoing knowledge application and learning.

Interdepartmental collaboration and functions enable various knowledge and insights to be shared and put into practice. Complex issues can be solved with cross-functional teams through the integration of expert knowledge in engineering, production, quality assurance, among others (Luca & Atuahene-Gima, 2007). This helps enforce innovation and process improvement by a collective application of expertise.

Empowerment of employees to decide and initiate enhances a culture where knowledge is actively applied at all levels of the organization. Employees who are empowered to act on their knowledge and ideas will be more likely to contribute to process improvements and innovation (Baird et al., 2019). Empowerment strategies include decentralized decision-making structures and supportive leadership practices.

Knowledge-sharing platforms, such as collaborative software and social media tools, enable employees to more easily access and apply knowledge. The platform supports best practice sharing, lessons learned, and expert advice on how to apply knowledge in daily operations (Razmerita et al., 2016). For instance, employees can ask for responses to specific problems on discussion forums or online communities and directly apply the shared knowledge.

Providing regular training and opportunities for skill enhancement helps equip employees with the knowledge and competencies they need to apply effectively. Training that focuses on critical thinking, problem-solving, and technical capabilities can greatly help in transforming knowledge into action among workers (Jehanzeb & Bashir, 2013). For manufacturing, training on new technologies, new equipment, or new process methodologies may be considered.

Performance metrics aligned with knowledge application initiatives ensure that efforts at the application of knowledge contribute or lead to organizational goals. Well-set objectives and KPIs on knowledge application allow organizations to follow up on progress and nurture behaviors that help achieve their strategic objectives (Wang et al., 2014). A good example is measuring the reduction in production downtime or improvement in product quality based on knowledge application initiatives.

2.3.5.2. Impact of Knowledge Application on Organizational Performance

Efficiency, innovation, quality, flexibility, productivity, and safety are dimensions within which knowledge application might influence organizational performance in manufacturing.

This also leads to greater operational efficiencies with regards to processes and reduces unnecessary wastage while trying to derive optimal returns from available resources. In that case, Iqbal et al. (2019 note that a knowledge application positively influences a firm's operational performance since it increases the efficiency to make or solve various operational problems for manufacturing firms. Productivity grows when workers implement their understanding to facilitate and smooth workflow to minimize bottlenecks.

Application of knowledge, in turn, enhances the quality of products and processes by improving the use of best practices, standards, and continuous improvement. According to Xu et al. (2010), application of knowledge improves the performance level of quality through early identification and elimination of any form of quality issues at earlier stages. Such a preclusive approach leads to less defective works, rework, or customer complaints.

Knowledge application encourages innovation by translating ideas and insights into new products, services, or processes. According to Donate and de Pablo (2015), knowledge application enhances technological innovation in firms, which eventually upgrades competitive advantages. Thus, it is possible for manufacturing firms that apply knowledge to generate innovative solutions and thereby succeed in distinguishing themselves within the marketplace.

Applying knowledge enables organizations to respond swiftly to changes in the market, technology, or customer preferences. Knowledge application supports organizational flexibility by facilitating rapid adaptation of processes and strategies (Gold et al., 2001). In manufacturing, this agility allows firms to customize products, adjust production volumes, and introduce new offerings efficiently.

The application of knowledge related to safety protocols, hazard identification, and risk mitigation enhances workplace safety. When employees apply safety knowledge consistently, the incidence of accidents and injuries decreases (Kim et al., 2016). Safe behaviors assure regulatory compliance and creation of safety culture. Knowledge Application This improves financial performance through not only the improvement of revenues or even the reduction of costs, improving profitability. Tseng and Lee (2014) based on the results of their manufacturing industry investigation, indicated that KA together with

FPIs significantly show a positive relationship, insinuating that the adoption and implementation of knowledge application facilitates corporations in improving their financial efficiency. Optimizing operations using more effective work methods and driving innovation leads to better knowledge application, thus improved finances.

2.4. Manufacturing Performance

Manufacturing performance is a multidimensional concept comprising several dimensions, and the simultaneous definition of these dimensions represents efficiency, effectiveness, and competitiveness of the manufacturing organizations. The road to manufacturing excellence requires an organization to effectively grasp these dimensions. This section identifies some of the key dimensions like innovation, quality, flexibility, productivity, and safety, and also explores how they contribute to excellence in manufacturing. Each of these will be critically assessed in light of their contribution to manufacturing and the contribution of KM processes in improvement.

2.4.1. Innovation

Innovation is a key driver of competitive advantage and one of the cornerstones of manufacturing excellence. It is characterized by the introduction of new products, processes, or services, and the enhancement of existing ones in response to evolving market needs and technological developments.

2.4.1.1. Role of Innovation in Manufacturing Excellence

Innovation in manufacturing covers: product innovation, process innovation, and organizational innovation. Product innovation refers to a new or significantly improved product; process innovation entails improved methods of production enhancing efficiency or quality (Damanpour & Aravind, 2012). Organizational innovations include new managerial practices and business models that enhance performance.

Manufacturing excellence in this regard is achieved when an organization innovates continuously to stay ahead with superior products and services, optimizes processes, and adapts to changing market conditions. Innovation helps manufacturers to be different from their competitors, respond quickly to the needs of customers, and exploit new market opportunities that open up (Yam et al., 2011). It is the firms that direct much attention to innovation issues that are better positioned to ensure continuity of growth, profitability, and market leadership.

In the fast-moving global economy, Industry 4.0, automation, and digitalization have changed manufacturing landscapes. In order for them to hold their own in competition, manufacturers need to welcome such novelties (Liao et al., 2017). For example, additive manufacturing, better known as 3D printing, enables rapid prototyping and personalization, while advanced robotics improves production efficiency.

2.4.1.2. Impact of Knowledge Management on Fostering Innovation

It deals with the fact that the important role of knowledge management lies in encouraging innovation in manufacturing organizations. Creating, sharing, and application-every process related to knowledge is vital in the development and execution of new ideas or innovations.

Innovation is the direct result of the knowledge creation process, which may come in the form of new insights, technologies, and methodologies. The SECI model of Nonaka and Toyama's (2015) emphasized the need for socialization, externalization, combination, and internalization of knowledge in creating innovation. In manufacturing, such collaboration and interaction among employees create an avenue for the exchange of tacit knowledge, which may trigger creative thinking and idea generation (Ferraresi et al., 2012).

Mechanisms of effective knowledge sharing allow the employees to access various knowledge sources, hence creating a culture of innovation. The communities of practice and collaborative platforms enable knowledge sharing across boundaries to cross-pollinate the ideas that bloom (Scuotto et al., 2017). The sharing of best practices, lessons learned, and technical expertise by the employees are hence helping each other in innovating problems and processes.

In contrast, innovation ideas require an effective translation of knowledge into application. The processes of KM ensure that the right knowledge becomes available and is integrated in decision-making and project execution processes (Du Plessis, 2007). In those organizations where KM is involved in the innovation strategy, it would be seen that they are capable of better application of new technologies and processes; thereby reducing time to market, along with enhancing product quality.

Indeed, several studies have evidenced the positive relationship between KM practices and innovation performance in manufacturing firms. For instance, Kiessling et al. (2009) found that KM positively influences organizational culture and innovation, leading to improved performance. In this line, Andreeva and Kianto (2011) also found that effective KM practices enhance innovation outcomes by facilitating knowledge sharing and learning.

In the context of Small and Medium-sized Enterprises, which are predominant in the manufacturing sector, KM is all the more important in view of resource limitations to be overcome and achieve innovation.

Durst and Edvardsson (2012) noted that innovation capability and competitiveness increase for SMEs implementing KM practices.

While KM significantly contributes to innovation, organizations may experience knowledge silos, cultural barriers, and insufficient KM infrastructure. These pitfalls can be mitigated through developing a knowledge-sharing culture, investment in KM systems, and linking KM initiatives with innovation goals (Lee et al., 2013).

2.4.2. Quality

Quality is one of the cornerstones of manufacturing excellence and has a direct link with customer satisfaction, operational efficiency, and competitive advantage. The manufacturing industry needs high-quality products and services to meet customers' expectations and regulatory standards for long-term success. The next section discusses the importance of quality in manufacturing and inspects how Knowledge Management processes support quality improvement.

2.4.2.1. Importance of Quality in Manufacturing Excellence

Quality in manufacturing is the level at which a product or service meets specified requirements and satisfies customer needs. High-quality products increase customer loyalty, reduce costs related to rework and waste, and reinforce a company's market position (Oakland, 2014).

Key Aspects of Quality in Manufacturing:

Customer Satisfaction and Loyalty: Quality products increase customer satisfaction, which engenders repeat business and positive word-of-mouth referrals (Parasuraman et al., 2002).

Operational Efficiency: Implementing quality management practices reduces defects and inefficiencies, leading to cost savings and improved productivity (Zu et al., 2008).

Regulatory Compliance: Adherence to quality standards ensures compliance with industry regulations and certifications, which is critical for market access and reputation management (Hoyle, 2009).

Competitive Advantage: Companies known for superior quality can differentiate themselves in the marketplace, allowing them to command premium pricing and increase market share (Prajogo, 2016).

Quality management methodologies such as Total Quality Management (TQM), Six Sigma, and Lean Manufacturing have been widely adopted to enhance quality and operational performance. These methodologies emphasize continuous improvement, employee involvement, and a customer-centric approach (Dale et al., 2016).

2.4.2.2. Relationship Between Knowledge Management and Quality Improvement

Knowledge Management plays a pivotal role in enhancing quality within manufacturing organizations. KM processes facilitate the sharing, retention, and application of critical knowledge related to quality standards, best practices, and problem-solving techniques.

Sharing knowledge about quality procedures and standards ensures that all employees are informed and equipped to maintain high-quality outputs. According to Hung et al. (2011), effective knowledge sharing leads to better understanding and implementation of quality practices, resulting in reduced errors and defects.

Communities of Practice: Establishing groups focused on quality improvement allows employees to share experiences and solutions, fostering a culture of continuous learning (Wang & Wang, 2012).

Training and Development: Regular training programs update employees on the latest quality standards and methodologies, enhancing their skills and competencies (Kaynak, 2003).

Capturing and storing knowledge related to quality issues, solutions, and innovations helps organizations prevent the recurrence of past mistakes. Knowledge repositories and databases enable easy access to this information (Choo et al., 2007).

Lessons Learned Databases: Documenting insights from quality improvement projects aids in institutionalizing knowledge and promoting best practices (Zhang et al., 2015).

Appropriate utilization of accumulated knowledge results in enhanced quality outcomes. By making use of organizational knowledge, employees can identify root causes of quality issues and make effective solutions (Linderman et al., 2010).

Problem-Solving Techniques: everal tools like Root Cause Analysis and FMEA are based on common knowledge to solve quality problems in a systematic manner of the highest priority (Antoni et al., 2005).

Standardization: Standardized procedures are developed from collective knowledge, ensuring the quality consistency within the organization (Ibrahim et al., 2007).

The positive relationship between KM practices and quality performance has already been established by many empirical studies:

Enhanced Process Quality: Through KM practices, organizations dramatically reduce the number of defects and increase process reliability (Choi et al., 2008).

Improved Product Quality: Effective KM ensures better design of products, innovativeness of products to meet customer expectations (Jiménez-Jiménez & Sanz-Valle, 2011).

Most potential barriers toward the institutionalization of KM for quality improvement include resistance to change, knowledge hoarding, and technology infrastructure deficiencies. Overcoming them will entail:

Cultivating a Knowledge-Sharing Culture: Encouraging openness and collaboration among employees (Lee & Choi, 2003).

Leveraging Technology: In capture and dissemination of knowledge facilitated by the KM systems (Alavi & Leidner, 2001).

Leadership Support: The management should champion the KM initiatives and integrate them into the organization's quality strategy (Jain & Moreno, 2015).

2.4.3. Flexibility

Flexibility in manufacturing alludes to the ability of an organization in effecting rapid and effective responsive adjustments to changes in the markets, technologies, and customers, along with their demands. Thereby, it is to change the production process, and operational strategy based on the changing needs. Yet another critical dimension of manufacturability is flexibility or an organization's ability in continuing to be competitive in relevantly dynamic environments. This section discusses flexibility in manufacturing operations and further reviews how KM processes are supporting this enhancement of flexibility.

2.4.3.1. Importance of Flexibility in Manufacturing Operations

The rapid change in technology, globalization, and fluctuating customer preferences drive the modern manufacturing landscape. Flexibility, in this regard, is a strategic imperative that enables organizations to achieve manufacturing excellence. Flexibility thus enables the manufacturer to:

Respond to Market Changes: Organizations can adjust production volumes, introduce new products, or modify existing ones to meet changing market demands (Sánchez & Pérez, 2005).

Customize Products: Flexibility gives firms the potential for mass customization by allowing firms to sell tailored products without losing economies (Blecker & Abdelkafi, 2006).

Integrate New Technologies: The ability to adapt and adjust to technological innovations improves production and keeps companies up-to-date with advanced technology (Chung & Swink, 2009).

Reduce Lead Times: With flexible operations, production cycles are shortened to improve time to market and customer satisfaction (Inman et al., 2011).

Manage Supply Chain Disruptions: Flexibility in sourcing and logistics can help an organization deal with supply chain uncertainties (Stevenson & Spring, 2007).

Types of Manufacturing Flexibility:

Volume Flexibility: It enables the firms to function with efficiency between different levels of output (Slack, 2005).

Mix Flexibility: The ability to manufacture different products in the same facility (Upton, 1995).

New Product Flexibility: he ability to quickly introduce new products (Gerwin, 1993).

Routing Flexibility: Capability to use multiple paths or processes to produce a product (Koste & Malhotra, 1999).

Flexibility contributes to strategic objectives by enhancing organizational agility, enabling firms to capitalize on emerging opportunities and mitigate risks associated with volatility (Teece et al., 2016). Manufacturers with high flexibility are better positioned to deliver value to customers and maintain a competitive edge.

2.4.3.2. Enhancing Flexibility Through Effective Knowledge Management

Knowledge Management processes contribute to a great degree in enhancing flexibility in manufacturing operations. By providing the ability to create, share, and apply knowledge, KM helps organizations to act promptly against changes and innovate effectively.

Knowledge Sharing and Organizational Learning:

Facilitating Adaptation: This includes knowledge shared regarding the trends in the market, customers' feedback, and developments in technology on which, after due deliberation within the organization, changes are implemented (Yang, 2010).

Cross-Functional Communication: The basis of KM is that this integration will allow multiple types of knowledge and ideas into one department from various ones, allowing for coordinated flexibility in response (van den Hooff & de Ridder, 2004).

Continuous Learning: organizations that make learning part of their cultures have the capability to build and acquire new skills and knowledge necessary for flexibility. (Bhatt, 2000).

Knowledge Creation and Innovation:

Developing New Capabilities: Knowledge creation processes allow organizations to develop altogether new solutions and processes, adding to their capability of offering new products or variants (Nonaka & von Krogh, 2009).

Employee Empowerment: The idea contribution and problem-solving involvement of employees have increased significantly the capacity of the organization to respond to changes (Zhang & Sharifi, 2007).

Knowledge Application in Flexible Operations:

Process Optimization: Knowledge application to optimize processes enables the quick re-configuration of operations, which enables volume and mix flexibility to be supported.

Technological Integration: Knowledge on new technologies facilitates adoption and integration into the manufacturing systems. (Hallgren & Olhager, 2009).

Technological Integration: Technological knowledge about new technologies ensures their adoption and integration into a manufacturing system (Kumar et al., 2017).

Role of KM Systems and Technologies:

Knowledge accessibility: KM systems offer access to critical information in real-time, hence making much quicker decisions possible (Davenport & Prusak, 1998).

Collaboration Tools: Virtual collaboration technologies support the coordination of flexible responses across teams that are geographically dispersed (Pan & Scarbrough, 1998).

Empirical Evidence of KM Enhancing Flexibility:

Positive Correlation: There is a positive relationship, as indicated by most studies, between KM practices and manufacturing flexibility. For instance, Reyes et al. (2010) establish how KM improves flexibility through facilitation of information flow and the resultant responsiveness of the organization.

Case Studies: any organizations reported increased flexibility in accommodating customer requirements and changes in the market in general as a result of adopting KM initiatives (Alegre et al., 2013).

Challenges and Solutions:

Overcoming Rigid Structures: Organizational hierarchies and inflexible processes also form a barrier for achieving flexibility. KM espouses decentralization and empowerment of knowledge as the ways through which these challenges may be approached (Chen & Huang, 2009).

Managing Knowledge Overload: oo much information can impede decision-making. Good KM includes sifting and prioritizing information that is relevant for flexibility as stated (Eppler & Mengis, 2004).

2.4.4. Productivity

Productivity is one of the basic dimensions of manufacturing performance and is defined as the effectiveness of the transformation processes of inputs into output. Productivity has a direct impact on an organization in terms of profitability, competitiveness, and satisfaction of customers. The next section is devoted to analyzing measures of productivity in manufacturing, as well as discussing the impact of the Knowledge Management process on the level of productivity.

2.4.4.1. Measures of Productivity in Manufacturing

Productivity in manufacturing refers to the ratio of outputs, or goods produced, to the inputs, or labor, materials, energy, etc., used in the production process. High productivity implies that resources are utilized efficiently, hence assuring cost savings, higher output, and increased profitability (Griffin, 2006).

Key Aspects of Productivity in Manufacturing:

Operational Efficiency: Productivity leads to a reduction in production costs through minimization of waste and optimization of resource utilization (Malik et al., 2007).

Competitive Advantage: An organization with higher productivity can offer competitive prices, improve market share, and eventually enhance customer satisfaction (Syverson, 2011).

Capacity Utilization: It is expected that efficient use of capacity utilization by firms can allow them to meet fluctuations in demand without substantial extra investment (Coelli et al., 2005).

Economic Growth: At a macro level, productivity improvements contribute to economic development and industry growth (OECD, 2001).

Measures of Productivity:

Labor Productivity: The output in relation to a unit of labor input, usually in terms of units produced per employee or per labor hour (Bartelsman & Doms, 2000).

Capital Productivity: This refers to the output per unit of capital input or the effective utilization of capital investment (Bernolak, 1997).

Total Factor Productivity (TFP): A comprehensive measure that considers all inputs, reflecting technological advancements and efficiency improvements (Comin, 2006).

Factors Influencing Productivity:

Technology Adoption: Advanced technologies implemented improve production processes and efficiency (Brynjolfsson & Hitt, 2003).

Process Optimization: Streamlining workflows and eliminating bottlenecks improve productivity (Womack & Jones, 2003).

Workforce Skills: The skilled employees increase the productivity by better performance and innovation (Black & Lynch, 2001).

Management Practices: Effective management strategies and organizational structures support productivity improvements (Bloom & Van Reenen, 2010).

2.4.4.2. Influence of Knowledge Management Processes on Productivity Levels

Knowledge Management processes are considered very important in improving productivity in manufacturing organizations. It helps in acquiring, sharing, and applying knowledge to attain operational efficiency and effectiveness.

Knowledge Sharing and Employee Performance

Enhancing Skills and Competencies: Knowledge sharing among the employees develops the skills, hence they are able to perform their work in a much more efficient way (Wang & Noe, 2010).

Reducing Rework and Errors: haring of best practices and lessons learned will reduce errors and reworks, increasing productivity (Cantner et al., 2011).

Promoting Collaboration: KM supports collaborative work environments that encourage problem-solving and innovation, hence positive productivity (Hansen, 2002).

Knowledge Application and Process Improvement

Implementing Best Practices: Applying knowledge of effective methods and techniques optimizes processes and resource utilization (Gold et al., 2001).

Adapting to Technological Changes: Knowledge about new technologies enables organizations to adopt and integrate them efficiently, enhancing productivity (Zack et al., 2009).

Continuous Improvement: KM institutes a culture of continuous improvement whereby employees are proactive in seeking ways to improve productivity continuously (Linderman et al., 2004).

Knowledge Retention and Organizational Memory

Preventing Knowledge Loss: Capturing and retaining critical knowledge prevents productivity decline due to employee turnover or retirement (Martins & Meyer, 2012).

Access to Information: KM systems make access easy to information that is required for decision-making and accomplishment of tasks, hence minimizing delays and inefficiency (Alavi & Leidner, 2001).

Empirical Evidence of KM's Impact on Productivity

Positive Correlation: This is where there is a positive relationship between the levels of KM practices and productivity. For instance, the capability in KM, in regard to Mills and Smith (2011), significantly affects organizational performance related to productivity.

SMEs and KM: Most SMEs applying KM practices are said to raise productivity by exploiting collective knowledge (Hutchinson & Quintas, 2008).

Challenges and Solutions

Overcoming Resistance: People resist knowledge sharing due to mistrust or the fear of losing job security. In such cases, building a supportive culture will promote and encourage knowledge sharing with incentives attached to it (Davenport et al., 1998).

Ensuring Relevance: Knowledge, to have a positive impact on productivity, has to be relevant and current. For this, regular reviews and updates of the knowledge repositories are required (Maier, 2007).

2.4.5. Safety

The safety dimension of manufacturing performance is one of the most critical in the organizational context, whereby the organization must take due care to ensure the employees, machinery, and environmental setting of its business process do not get hurt or meet with accidents. Safety standards associated with a high level of relevance in a manufacturing environment guarantee organizational efficiency, employees' morale, or corporate brand image. Instead, ethical and legal consideration assumes prime importance. The next section dwells on the importance of safety within manufacturing operations of organizations and their respective Knowledge Management initiatives to ensure workplace safety.

2.4.5.1. Safety Standards and Regulations in Manufacturing

Manufacturing environments are full of complex machinery, hazards of materials, and processes; therefore, strict adherence to safety standards and regulations minimizes risks and provides a safe environment to employees for work.

Key Aspects of Safety in Manufacturing:

Occupational Health and Safety (OHS): OHS involves preventing workplace injury and illness by identifying hazards, assessing the associated risks, and the implementation of control measures (Kelloway et al., 2010).

Legal Compliance: The process of manufacturing should be at par with the national and international safety regulations, such as the standards of OSHA in the United States or any other equivalent laws in other countries (Hale et al., 2010).

Safety Management Systems: Organized methods for safety management include OHSAS 18001 or ISO 45001; such systems are put in place to help any organization incorporate safety into the general management system (Zeng et al., 2008).

Employee Training and Awareness: The employees through frequent training programs would be aware of the procedures relating to safety, emergency protocols, and proper usage of equipment (Haslam et al., 2005).

Safety Culture: The safety culture is a development of a work environment that prioritizes safety, which thus encourages people to be more proactive with safety and feel responsible as a whole (Cooper, 2000).

Impact of Safety on Manufacturing Performance:

Reduction in Accidents and Injuries: Efficient safety practices reduce the number of workplace accidents, thus reducing downtime and other costs associated with such incidents (Fernández-Muñiz et al., 2009).

Enhanced Employee Morale and Retention: Such a safe working environment means great satisfaction for the employees and that they are valued and protected (Mearns et al., 2003).

Operational Efficiency: Accidents reduce productivity and continuity of operations by minimizing disruptions (Masi & Cagno, 2015).

Reputation Management: It shows the commitment of a company to safety, hence organizational reputation is perceived among all stakeholders like customers, investors, and regulatory bodies (Wu et al., 2008).

2.4.5.2. Knowledge Management's Role in Promoting Workplace Safety

Safety is a significant concern in manufacturing that is greatly enhanced through the process of Knowledge Management, as it allows sharing, retention, and application of safety-related knowledge.

Knowledge Sharing and Safety Practices:

Dissemination of Safety Information: KM systems enable the distribution of safety manuals, procedures, and guidelines to all employees so that a proper understanding of the same concept of safety is instilled among them (Guldenmund et al., 2006).

Learning from Incidents: Organizations are allowed to learn from past incidents and avoid recurrence by sharing information related to accidents, near-misses, and hazard reporting (Weick & Sutcliffe, 2011).

Best Practices Exchange: The practice allows employees to share effective safety practices and innovations, thus creating a culture of continuous improvement in safety (Lingard & Rowlinson, 2005).

Knowledge Retention and Organizational Memory:

Capturing Tacit Knowledge: The experienced employees possess lots of valuable tacit knowledge on safety practices. The KM processes help in capturing and codifying this knowledge before it is lost due to turnover (Martins & Meyer, 2012).

Safety Knowledge Repositories: The establishment of databases storing safety procedures, incident reports, and risk assessments allows for easy access to critical safety information (Jørgensen et al., 2009).

Knowledge Application in Safety Management:

Risk Assessment and Mitigation: Application of lessons learnt from previous experience, coupled with hazard analysis, generally provides an increased effectiveness to the processes of risk assessment (Hopkins, 2009).

Training and Competence Development: KM, therefore, helps in working out a training program based on its knowledge inventory in the concern for employee competence in safety practices (Robson et al., 2007).

Decision-Making: Comprehensive safety knowledge allows managers to make informed decisions about safety investments and interventions (Reason, 2000).

Empirical Evidence of KM Enhancing Safety:

Positive Correlation: There exists a determination that organizations with superior KM practices perform well on safety. For example, Aksorn and Hadikusumo (2008) have identified that knowledge sharing and communication are one of the critical success factors in safety program performance.

Learning Organizations and Safety: Those organizations that facilitate the continuous process of learning and sharing of knowledge demonstrate greater awareness regarding safety and have fewer accidents (Antonsen, 2009).

Challenges and Solutions:

Overcoming Communication Barriers: Language differences, literacy levels, and cultural factors can impede safety knowledge sharing. Such barriers will require particularized communication strategies to enhance their effectiveness (Mattila et al., 1994).

Encouraging Reporting: Employees do not report incidents because they are afraid to be blamed. A good nonpunitive reporting culture helps build openness and, hence learning (Probst & Estrada, 2010).

2.5. The Relationship Between Knowledge Management Processes and Manufacturing Performance

The integration of the KM process with the dimension of manufacturing performance becomes extremely important to those organizations striving to achieve excellence and sustain competitive advantage. This section discusses how each process of KM, such as the acquisition of knowledge, its creation, transfer, storage, and application, integrates with important manufacturing performance dimensions including innovation, quality, flexibility, productivity, and safety. The empirical evidence will be drawn from previous studies that have targeted the recycling industry within the Kurdistan Region of Iraq to reveal the synergistic effects of KM on manufacturing outcomes.

2.5.1. The Relationship Between Knowledge Acquisition And Innovation

Knowledge acquisition refers to the process through which valuable information is obtained from external and internal sources. It is one of the prime facilitators of innovation capability in manufacturing. With the acquisition of new knowledge, organizations can develop new products and adopt new technologies or processes.

Empirical Evidence:

Lichtenthaler and Lichtenthaler (2009) pointed out that a firm's absorptive capacity, in other words, its capability to acquire and use external knowledge, is a vital role in open innovation. They observed that a firm with stronger capability in knowledge acquisition is in a better position for innovating and responding to technological changes.

Chen and Huang (2009) showed that human resource practices, which facilitate the acquisition of knowledge, have a strategic effect on innovation performance; their study indicated that encouraging workers to acquire and share knowledge will spur the innovation in the firm - this was shown in their study in Taiwanese manufacturing firms.

2.5.1.1. The Relationship Between Knowledge Acquisition and Quality Improvement

It helps organizations understand the best practices, quality standards, and customer feedback for enhancing the quality of the products or processes.

Empirical Evidence:

Ahmed and Hameed (2019) have studied the firms in Iraq recycling industry, which include the Kurdistan Region of Iraq. Their results have indicated that knowledge acquisition significantly influences quality improvement. In such firms, improvement in product quality has taken place once these firms gained the necessary knowledge related to the advanced technique for recycling and the international standard concerning the quality.

Liu et al. (2018) showed that knowledge acquired from customers and suppliers resulted in improved quality control and product design for the manufacturing firms. Access to external expertise lets the organizations align their quality practices with industry benchmarks.

2.5.2. Knowledge Creation's Impact on Flexibility and Productivity

2.5.2.1. The Relationship Between Knowledge Creation and Flexibility

Knowledge creation increases organizational flexibility because new ideas and solutions are generated that help the firm adapt to changed circumstances.

Empirical Evidence:

Gharakhani and Mousakhani (2012) found that knowledge creation processes enhance flexibility in manufacturing SMEs. Their study showed that organizations which are more active in creating knowledge are more agile and responsive to market fluctuations.

Sanz-Valle and Jiménez-Jiménez (2018) proved that the innovative work behavior emerging due to knowledge creation leads to the enhancement of operational flexibility. Employees who engage in creative problem-solving contribute to an organization's ability to adapt processes and products.

2.5.2.2. Knowledge Creation and Productivity Enhancement

New knowledge acts as a trigger to process innovation and efficiency enhancement in productivity.

Empirical Evidence:

Nonaka and Toyama (2015) claimed that the creation of knowledge lies at the very core of the development of productivity in the improvement of methodologies and technologies of manufacturing.

Iqbal et al. (2019) proved that knowledge creation has a positive influence on productivity since continuous improvement is enabled, and resources can be optimized.

2.5.3. Effectiveness of Knowledge Transfer on Safety Practices

2.5.3.1. Knowledge Transfer and Safety Improvement

Effective knowledge transfer ensures that any information related to safety would spread within the organization in order to have safer working conditions.

Fang et al. (2015) identified that the knowledge transfer from supervisors has a significant influence on the safety behavior of workers on construction projects. The same will apply to the manufacturing setting where supervisors are one of the key channels of disseminating the practice of safety.

Bahn (2013) supported hazard identification and knowledge management. Knowledge on safety measures will be well communicated to reduce the rate of accidents during industrial operation.

2.5.3.2. Challenges in Knowledge Transfer for Safety

The transfer of safety knowledge might be influenced by barriers, including communication gaps and cultural differences.

According to Szulanski (1996), in knowledge transfer, there exists a "stickiness" when natural friction forces reduce the flow of critical information, which includes safety practices.

Michailova and Mustaffa (2012) discussed challenges in multinational corporations, underlining that language and cultural norms differences influence safety knowledge transfer.

2.5.4. Role of Knowledge Storage in Sustaining Performance Improvements

2.5.4.1. Knowledge Storage and Continuous Improvement

Organizational knowledge is conserved through storage, whereby such valuable information is documented for later use that supports sustained performances.

According to Perez-Soltero et al. (2019) knowledge storage leads to sustainability in maintaining the best practices and lessons learned of manufacturing processes for continuous improvement.

Wang and Wang (2012) established that knowledge storage systems that are effective nurture innovation and performance by providing avenues for employees to access the collective knowledge of the organization.

2.5.4.2. Knowledge Storage and Organizational Memory

Building organizational memory through knowledge storage prevents critical information from being lost by employee turnover.

Martins and Meyer (2012) argue that knowledge retention strategies are relevant to help manufacturing organizations sustain their present levels of productivity and quality.

Durst and Wilhelm (2013) identified some knowledge risks in SMEs; for example, poor knowledge storage may result in operational inefficiencies and lower performance.

2.5.5. Application of Knowledge for Continuous Improvement

2.5.5.1. Knowledge Application and Operational Excellence

Knowledge effectively applied has been continuously improving and assuring operational excellence in manufacturing.

Abualoush et al. (2018) confirmed the influence of applying knowledge processes on organizational performance through increasing innovation and efficiency.

Anand and Ward (2004) demonstrated that it is the application of knowledge that allows firms to realize fit and flexibility, thus coping with dynamic environments.

2.5.5.2. Knowledge Application and Competitive Advantage

Organizations that are the best at applying knowledge have the edge in improved processes and products.

It was discussed by Shujahat et al. (2019) that strategic management models that involve knowledge application have better decision-making and performance outcomes.

López-Nicolás and Meroño-Cerdán (2011) indicated that the application of strategic knowledge in manufacturing firms significantly improves innovation and competitiveness.

2.6. Recent Studies on Knowledge Management and Manufacturing Performance

2.6.1. Overview of Recent Research (2020–2023)

The inter-relationships involving the linkage of Knowledge Management to performance have, therefore, remained crucial in the last couple of years and captured the increasing interest of scholars and practitioners. With the rapid advancement of technologies regarding Industry 4.0, AI, and IoT, which transformed manufacturing landscapes, effective knowledge management has become more critical than ever. This section presents a comprehensive overview of key findings from studies conducted during the period 2020 to 2023, reflecting diverse influences on the dimensions of manufacturing performance.

Digital Transformation and KM Integration

Rajapathirana and Hui (2021) investigated the role of KM in improving innovation performance within manufacturing firms while undergoing digital transformation. In this study, it has been revealed that integrating KM practices with digital technologies increases the innovation capabilities of the firms: in other words, developing new products or processes more efficiently.

Li et al. (2020) examined how KM affects operational efficiency within smart manufacturing environments. They found that integrating KM processes with IoT and data analytics improves decision-making speed and accuracy, thus driving productivity and flexibility.

KM and Sustainable Manufacturing

Dubey et al. (2021) examined the impact of the dimensions of KM practices on sustainable manufacturing performance. They realized that "effective KM leads to a significant improvement in various environmental sustainability dimensions, including resource efficiency, waste reduction, and the diffusion of green technologies.

Gupta and Singh (2020) studied the role of knowledge management in developing circular economy practices at the manufacturing sector. The results of the study have shown that knowledge sharing and collaboration are key in deploying sustainable practices such as recycling and remanufacturing.

Impact on Quality and Customer Satisfaction

Zhang et al. (2021) studied the influence of KM on quality management and customer satisfaction within the manufacturing firm. From this study, it was found that the organization with strong KM systems would be in a better position to meet the standards required to satisfy the customers for increased loyalty and market share.

Singh and Gupta (2022) studied the impact of knowledge sharing on product quality in manufacturing SMEs. The findings showed that the transfer of internal knowledge improves the quality control processes through the reduction of defects and rework.

KM in the Context of Industry 4.0

Kagermann et al. (2021) discuss how KM practices are integrated into Industry 4.0 frameworks. In that respect, they have pointed out that it is relevant to leverage KM for advanced manufacturing technologies; hence, an organization is able to adapt quickly to the change in technology and sustain the competitive advantages.

Santos et al. (2022) investigated how KM embraces the introduction of smart factories. The results indicated that an appropriate acquisition and application of relevant knowledge are necessary for the optimization of these automated processes toward better, enhanced operational efficiency.

Role of KM in Enhancing Safety

Chen et al. (2020) investigated the impact of KM performance on safety performance within high-hazard manufacturing settings. Results indicated that the sharing and storing of knowledge about safety would significantly diminish workplace accidents and boost compliance to safety regulations.

Wang and Wu (2021) conducted an analysis of how KM affects the development of the culture in their papers on safety. The results suggest that organizations which encourage knowledge-sharing or, more so, continuous learning have larger-sized and safety cultures with stronger concomitant safety outcomes.

Sharma et al. (2021) investigated the role of KM in improving the agility of manufacturing firms. It has been established in the research that processes for creating and transferring knowledge make an organization capable of quickly responding to changes in the markets, which enhances flexibility and resilience.

2.6.2. Gaps Identified in Recent Literature

Although the number of research works on KM and manufacturing performance is increasing, several gaps still persist that require further investigation.

Limited Focus on Specific Industries

Although many studies have investigated KM in general contexts of manufacturing, few studies have focused on specific industries, such as recycling, especially in developing regions. Unique challenges and opportunities that exist within the industry of recycling, particularly from areas like the Kurdistan Region of Iraq, are not addressed.

Ali and Anwar (2021) called for more empirical studies on the recycling industry's KM practices in the Kurdistan Region. Their study thus proposed to explore context-specific knowledge management applications and performance variations through localized studies.

Integration of KM with Emerging Technologies

Although the awareness of Industry 4.0 as a factor in KM's importance is documented, further research is required to understand the integration of the KM processes with emerging technologies such as AI, machine learning, and big data analytics in the manufacturing setup.

Li et al. (2020) suggested that future studies should look at how KM and advanced technologies interact with each other to impact various dimensions of manufacturing performance, including innovation and productivity.

Measuring the Impact of KM on Sustainability

Even though this linkage has been qualitatively investigated, there is a need to quantify how KM practices will directly affect sustainability outcomes in manufacturing.

Dubey et al. (2021) have recommended that future research develop metrics and models to represent the contribution of KM in enabling sustainable manufacturing practices, such as waste reduction or energy efficiency.

Cross-Cultural and Regional Studies

While most existing research is concentrated in developed countries, there are fewer studies which have examined the practices of KM across different cultural and regional contexts.

Hassan and Rashid (2020) emphasized how research in regions like the Middle East was needed that explored cultural factors influencing the implementation of KM and the resultant manufacturing performance.

Longitudinal Studies on KM Implementation

Most of the existing studies do not focus on the development of KM practices over time or their long-term influence on manufacturing performance.

Santos et al. (2022) have called for research designs that capture the dynamic nature of KM processes and their evolving impact on organizational outcomes.

Comprehensive Models Linking KM and Performance

Most of the existing literature focuses on either individual KM processes or single performance dimensions; overall models that integrate all the KM processes and examine their impact collectively on different performance dimensions are lacking.

Sharma et al. (2021) recommend that integrated frameworks be developed for explaining the complicated relationships among KM practices and different facets of manufacturing performance.

2.6.3. Successful KM Implementation Examples

2.6.3.1. Siemens AG: Enhancing Innovation Through Knowledge Sharing

Siemens AG, a worldwide leader in electronics and electrical engineering, felt the urge to exploit its vast knowledge assets spread across its global operations. Siemens implemented a full-fledged KM system called ShareNet with the objective of fostering innovation and competitiveness.

KM Implementation

ShareNet Platform: Introduced during the late 1990s, ShareNet is the knowledge-sharing platform for Siemens employees. The platform is designed as a group of databases, discussion forums, and best practice repositories (Voelpel & Han, 2005).

Focus on Customer Solutions: The platform puts much emphasis on the sharing of customer solutions and experiences, and thus, facilitates employees in accessing and contributing valuable insights.

Incentive Structures: Siemens introduced mechanisms of reward for sharing knowledge, including recognition programs and performance appraisals related to KM involvement.

Impact on Performance

Enhanced Innovation: ShareNet allowed ideas and solutions to flow really fast, thereby accelerating innovation processes. Employees could obtain previously created knowledge, without having duplication of efforts (Barrett et al., 2004).

Improved Efficiency: Centralized knowledge base access improved problem-solving efficiency, therefore reducing costs and time-to-market for new products.

Global Collaboration: Geographical and organizational boundaries are pulled together through this platform for collective learning and a sense of collaboration.

Key Success Factors

Leadership Support: The top management showed their commitment, which means that KM is crucial for the success of organizations.

User-Friendly Technology: Easy to use, the platform was implemented over the vision of maximum usage by the employees.

Cultural Alignment: Cultural alignment was supported in the strategy through knowledge sharing that Siemens had facilitated using communication and training, including embedding KM in the organizational culture.

2.6.3.2. Toyota Motor Corporation: Continuous Improvement Through KM

Toyota is famous not only for the TPS (Toyota Production System) but also for the philosophy of Kaizen, or continuous improvement. In many ways, KM forms an integral part of the operational excellence at Toyota, which supports the creation and sharing of knowledge to improve quality and efficiency.

KM Implementation

A3 Reports: These are structured problem-solving and communication tool used at Toyota, putting all information on one piece of paper (Shook, 2008). This practice promotes clarity and knowledge sharing.

Knowledge Sharing Routines: Regular meetings, such as daily stand-ups and discussions across functional teams, allow knowledge sharing.

Employee Empowerment: All employees, regardless of level, are encouraged to identify problems and suggest improvements, thus building a culture of continuous learning.

Impact on Performance

Quality Enhancement: KM practices have brought drastic improvement in product quality and defect reductions (Dyer & Nobeoka, 2000).

Operational Efficiency: Continuous improvement initiatives supported by KM have optimized production processes and reduced waste.

Innovation: Knowledge creation and sharing allowed Toyota to innovate in manufacturing techniques and product development.

Key Success Factors

Cultural Integration: In Toyota, the concept of KM is sunk deep into its culture-a shared value reflecting collective accountability for learning and improvement.

Systematic Processes: The structured methodologies, such as the A3 process, will ensure that knowledge is captured and disseminated effectively.

Long-Term Commitment: The fact that Toyota has focused on KM over several decades shows the importance of consistency and dedication.

2.6.3.3. Procter & Gamble (P&G): Open Innovation Through Connect + Develop

Faced with the need to accelerate the pace of innovation, Procter and Gamble had to change from an exclusively R&D approach to a model of open innovation called Connect + Develop. A strategy that includes collaboration with external partners in order to access and leverage external knowledge.

KM Implementation

External Collaboration: The current efforts of P&G's open innovation involve active seeking of ideas and technologies from universities, suppliers, competitors and customers

(Huston & Sakkab, 2006).

Knowledge Integration: Integrating external knowledge into internal capabilities in product development-novelty and incremental enhancement.

Knowledge Brokers: P&G has sourced people and teams that would find external sources of knowledge and manage them.

Impact on Performance

Increased Innovation Output: Since the implementation of Connect + Develop, the productivity of innovation at P&G has increased significantly: more than 50 percent of product initiatives involve outside collaborators (Dodgson et al., 2006).

Market Success: These products developed in this open approach have contributed to revenue growth and market expansion.

Cost Efficiency: Tapping external knowledge has helped reduce R&D costs and shorten product development cycles.

Key Success Factors

Strategic Alignment Strategy for the KM approach based on P&G's business for growth through innovation.

Collaborative Culture: Openness and internal, external collaboration led to an efficient dissemination of knowledge.

Robust Processes: established procedures for identifying, acquiring, and integrating external knowledge-make implementation routine.

2.6.4. Lessons Learned from KM Failures

While successful KM implementations offer valuable insights, examining failures is equally important to understand common pitfalls and how to avoid them.

2.6.4.1. Case Study: Ford Motor Company's Best Practice Replication Effort

In the late 1990s, Ford Motor Company attempted to replicate best practices across its global operations to improve efficiency and competitiveness. The initiative involved identifying successful practices in one location and implementing them elsewhere.

Failure Factors

Lack of Contextual Adaptation: Ford faced challenges because practices that worked in one plant did not necessarily translate effectively to others due to differences in culture, infrastructure, and workforce skills (Szulanski & Winter, 2002).

Insufficient Engagement: Employees in receiving plants were not adequately involved in the knowledge transfer process, leading to resistance and lack of ownership.

Inadequate Communication: There was a failure to communicate the rationale and benefits of the new practices, resulting in misunderstandings and skepticism.

Lessons Learned

Customize Knowledge Transfer: Effective KM requires adapting practices to the local context rather than applying a one-size-fits-all approach.

Engage Stakeholders: Involving employees in the process fosters acceptance and facilitates smoother implementation.

Communicate Clearly: Transparent communication about objectives, benefits, and expectations is crucial to gain buy-in.

2.6.4.2. Case Study: British Petroleum (BP) and the "Virtual Teamwork" Initiative

BP initiated a KM project to enhance collaboration among its global teams through virtual platforms. The goal was to improve knowledge sharing and operational efficiency.

Failure Factors

Technology Overemphasis: The project focused heavily on implementing new technologies without adequately addressing the human and cultural aspects of KM (Storey & Barnett, 2000).

Lack of Training: Employees were not sufficiently trained to use the new tools effectively, leading to low adoption rates.

Cultural Resistance: There was resistance to changing established work practices, and the importance of interpersonal relationships in knowledge sharing was underestimated.

Lessons Learned

Balance Technology and People: KM initiatives should consider both technological solutions and the human factors that influence knowledge sharing.

Provide Adequate Support: Training and support are essential to help employees adopt new systems and practices.

Address Cultural Factors: Understanding and addressing cultural barriers can enhance acceptance and effectiveness.

3. METHODOLOGY

3.1. Research Design

In the process of data collection, the quantitative approach has been adopted to investigate the role of knowledge management processes in improving manufacturing performance in the recycling sector of the Kurdistan Region of Iraq. A structured questionnaire was designed to obtain data on the perceptions and experiences of administrative leaders of various recycling organizations. The sample population consisted of administrative leaders, that is managers, departmental heads, and decision-makers in a selection of recycling companies within the regional area. A simple random sampling technique aimed at ensuring that representatives from various company categories were included in the study population. In this regard, 100 participants were selected randomly in the study.

3.2. Data Collection Methods

Therefore, quantitative and qualitative data in respect of knowledge management processes and their impact on excellence in manufacturing performance in the recycling sector shall be gathered through a structured questionnaire. Hence, this will be forwarded to 100 administrative leaders from different companies in the Kurdistan Region, Iraq. It consists of various sections, starting with a demographic profile to gather data on the age, gender, education, years of experience in the waste recycling sector, and organizational position held by the respondents. The next section covers knowledge management processes, through which the perception of the participants is gauged about the current practices followed within their respective organizations. In addition, this section takes a closer look at knowledge management strategies employed, such as knowledge sharing, training programs, and documentation processes; it also gauges the perceived effectiveness of such strategies in encouraging knowledge flow and innovation. Afterwards, the section on manufacturing performance excellence will review the perceived impact of knowledge management on the performances concerning KPIs in terms of productivity, efficiency, quality control, and customer satisfaction. It concludes by examining the correlation of knowledge management processes with the overall organizational performance. The open-ended questions will enable the participants to share experiences about the challenges faced in implementing knowledge management practices and give suggestions for improvement.

3.3. Distribution and Data Collection Process

The questionnaires has been mailed through electronic mail and survey sites for easy access by the respondents. Follow-up reminders will also be employed to encourage participation and ensure a maximum response rate. The questionnaire will be tested with a few administrative leaders ahead of time to ensure this is clear and relevant.

- **Population of the Research**

Recycling of Scrap steel

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	5	2,000,000	3,000	Reinforced Steel
Sulaymaniyah	6	2,100,000	2,220	Reinforced Steel
Duhok	0	0	0	0
Total	9	4,100,000	5,220	

Recycling of used Engine oil

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	4	100,000	70	Engine oil
Sulaymaniyah	6	215,000	105	Engine oil
Duhok	3	30,000	35	Engine oil
Total	14	345,000	210	Engine oil

Recycling of used (Copper + Aluminum + Lead)

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	5	40,000	150	
Sulaymaniyah	1	3000	10	
Duhok	3	10,000	50	
Total	8	50,000	200	

Recycling of used carboard (Carton)

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	4	30,000	100	
Sulaymaniyah	-	-	-	
Duhok	-	-	-	
Total	4	30,000	100	

Recycling of used Plastic

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	8	50,000	250	
Sulaymaniyah	8	5,500	70	
Duhok	5	2,000	25	
Total	17	57,500	312	

3.4. Data Analysis

Binary logistic regression is a statistical analysis technique considering the relationship between one or more independent variables and a binary dependent variable with two possible outcomes, normally coded as 0 and 1. This is especially helpful when one needs to forecast the likelihood of a certain event occurring given various predictors.

Key Features of Binary Logistic Regression

1. Binary Outcome: The dependent variable in nature is dichotomous, that is, it contains one of the two possible outcomes; for instance, it ranges between the occurrence or non-occurrence of an event such as success/failure, yes/no, or presence/absence.
2. Independent Variables: Following kinds of independent variables can be included in a binary logistic regression :
   - Continuous variables (e.g., age, income)
   - Categorical variables (e.g., gender, education level)
3. Logistic Function: The model uses the logit function to link the probability of the dependent variable being 1 to the independent variables:

$$logit(p) = \ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k \ldots\ldots 3.1$$

Here, p is the probability of the dependent variable equaling 1, β_0 is the intercept, and β_1, β_2,…, β_k are the coefficients for the independent variables.

4. Interpretation of Coefficients: The coefficients obtained from binary logistic regression can be interpreted in terms of odds ratios. Specifically, the odds ratio for a predictor indicates how the odds of the dependent event occurring change with a one-unit increase in that predictor, holding all other variables constant.
5. Model Evaluation: The goodness-of-fit of a binary logistic regression model can be assessed using various metrics, such as:
   - Likelihood Ratio Test: Tests the significance of the overall model.
   - Hosmer-Lemeshow Test: Assesses how well the model fits the data.
   - Receiver Operating Characteristic (ROC) Curve: Evaluates the model's ability to discriminate between the two outcome categories.
6. Goodness of Fit:
   - Several metrics can assess model fit, such as the -2 Log Likelihood, chi-square statistic, and pseudo-R^2 values (like Nagelkerke R^2).
   - These statistics help evaluate how well the model explains the data.
7. Assumptions: While binary logistic regression does not assume a normal distribution of

the predictors, it assumes:

- Independence of observations.
- Linearity between the logit of the outcome and the continuous predictors.
- Absence of multicollinearity among predictors.

Odds ratio (OR)

The odds ratio (OR) is a statistic that quantifies the strength of association between two events, typically used in the context of binary outcomes. It represents the odds of an event occurring in one group compared to the odds of it occurring in another group.

$$odds = \frac{p}{1-p} \dots\dots\dots\dots (3.2)$$

Where:

Odds of an event is defined as the probability of the event occurring divided by the probability of it not occurring. Mathematically, it can be expressed as:

4. Results and Discussion

4.1. Results

Here are the results of three variables of the research Socio-demographic characteristics, knowledge management processes (), and manufacture performance (dependent variable).

4.1.1. Socio-demographic characteristics

Out of 100 respondents, 83 are male (83) and 17 are female (17), indicating a significant gender imbalance that likely reflects broader trends in male leadership within the sector. This may affect the findings because most of them are male respondents, and their understanding and experiences about the knowledge management process may differ from their female counterparts. Since knowledge management involves the creation, distribution, and use of knowledge that may be valuable in manufacturing performance improvement, such a skewed distribution may not be representative enough to ensure variability in the perspectives presented and may affect the comprehensiveness of the analysis. Understanding the reasons for such a gender imbalance is important for future research and policy recommendations. Moreover, the adaptation of knowledge management processes to support inclusiveness and the exploitation of diversity in perspectives may boost overall performance in the recycling industry. Eventually, this will also be useful in the development of broader insights into and the improvement of knowledge management strategies in the industry.

The demographic variables were analyzed to understand the responses regarding the investigation of the role of knowledge management processes in enhancing manufacturing performance within the recycling sector in KRG, Iraq. These variables will help in identifying various aspects of the outlook of administrative leaders and possible influences on KM practices. Regarding the age of respondents, the structure looks like this: 46% fall in the category between 21 and 30 years of age, while another 28% fall between the brackets of 31-40 years of age. The other participants were: 14% were in the age brackets of 41-50, and finally, the people who were over 50 formed a category with a percentage contribution of 12%. In that perspective, a rather young composition may have direct positive implications on attitudes to implementing novel KM practices. Younger leaders might be more adaptable and receptive to new technologies and methodologies, potentially driving improvements in manufacturing performance.

The educational background of the respondents is significantly skewed towards higher education, with 90% holding a bachelor’s degree, only 2% with a higher diploma, and 4% possessing either a master's or a PhD. This strong representation of bachelor’s degree holders suggests a well-educated leadership, which is vital for implementing effective KM processes. A knowledgeable workforce is typically more equipped to engage in knowledge creation, sharing, and application, thereby enhancing operational efficiency and fostering innovation within the recycling sector.

Regarding experience, 50% of respondents have five years or less of service, while 16% each have between six to ten years and eleven to fifteen years. Only 4% have 16 to 20 years of service, and 14% have more than 20 years. The high percentage of relatively new leaders indicates a potential for fresh perspectives and innovative ideas in KM practices. However, this also suggests a possible lack of experience in navigating complex challenges, which may affect the implementation of KM processes unless supported by mentorship and training.

In terms of job positions, 44% of respondents are managers, 42% are supervisors, and 14% hold the title of CEO. The predominance of managerial and supervisory roles highlights that the study captures insights from those directly involved in operational decision-making and day-to-day management. Given their proximity to the workforce and operational challenges, these leaders are likely to provide valuable opinions on the practical application of KM processes in enhancing manufacturing performance.

Finally, the geographical distribution shows that 78% of respondents are based in Erbil, with only 22% for Duhok and Sulymanyeh. This might reflect the economic and industrial activities centered in Erbil, which may affect the availability of resources and infrastructures for implementing KM practices. This geographic aspect has to be considered when interpreting the results, as knowledge management dynamics can vary significantly across different cities in the KRG.

Table 4.1. Socio-demographic characteristics

Demography	Characters	Frequency	Percentage
Gender	Male	83	0.83
	Female	17	0.17
Total		**100**	**100.0**
Age group	21 - 30	46	46
	31 - 40	28	28
	41 - 50	14	14
	Over 50	12	12
Total		**100**	**100**

Demography	Characters	Frequency	Percentage
Education	Higher Diploma	2	2
	Bachelor	90	90
	Master	4	4
	PhD	4	4
Total		**100**	**100.0**
Years of Service	5 years and less	50	50
	6 - 10	16	16
	11 - 15	16	16
	16 - 20	4	4
	More than 20	14	14
Total		**100**	**100**
Job Position	CEO	14	14
	Manager	44	44
	Supervisor	42	42
Total		**100**	**100**
City group	Duhok	10	4
	Erbil	78	92
	Sulaymaniyah	12	4
Total		**100**	**100**

4.1.2. Excellence Manufacturing Performance

4.1.2.1. Descriptive statistics of innovation

In the responses to the survey regarding knowledge management processes' integration for manufacturing performance improvement in the recycling industry, the general outlook from respondents is positive. The overall response from 55% of the participants who either strongly agree or agree that new technologies and innovative practices in the recycling process are always incorporated at the facility, henceforth express strong commitment towards innovation. Furthermore, 55% believe that a large portion of the facility's budget is devoted to research and development in order to enhance the processes of recycling, which further shows this commitment. Also, 63% of the respondents said that recent innovations have considerably improved recycling operations, which in turn is a proof of the effectiveness of the changes. The culture for innovation appears to be very supportive at the facility, as 57% of the participants agreed that innovative ideas by employees are encouraged and supported. Moreover, 59% confirm that the facility invests in research and development, reinforcing the importance placed on continuous improvement in recycling practices.

Table 4.2. Descriptive statistics of innovation

Item		**Frequency**	**Percentage**
Our recycling facility regularly integrates new technologies and innovative practices into the recycling process.	Strongly agree	25	25
	Agree	30	30
	Neutral	20	20
	Disagree	15	15
	Strongly disagree	10	10
	Total	100	100
A significant percentage of our facility's budget is allocated towards research and development for improving recycling processes.	Strongly agree	22	22
	Agree	33	33
	Neutral	18	18
	Disagree	17	17
	Strongly disagree	10	10
	Total	100	100
Recent innovations have significantly improved our recycling operations.	Strongly agree	28	28
	Agree	35	35
	Neutral	14	14
	Disagree	13	13
	Strongly disagree	10	10
	Total	100	100
Our facility encourages and supports innovative ideas from employees	Strongly agree	27	27
	Agree	30	30
	Neutral	20	20
	Disagree	15	15
	Strongly disagree	8	8
	Total	100	100
Our facility invests in research and development (R&D)	Strongly agree	30	30
	Agree	29	29
	Neutral	19	19
	Disagree	12	12
	Strongly disagree	10	10
	Total	100	100

4.1.2.2. Descriptive statistics of Flexibility

The response rate about the adaptability and responsiveness of the recycling facility has been quite useful in understanding various operational features.

Among respondents, 58% strongly agree or agree that this facility is capable of adjusting well when there are changes in volume and materials to be recycled. Therefore, it simply shows there is a general belief in the flexibility of the plant regarding responding to market demand. But then again, 22 percent said neutral or disagree, thus area for improvement is indicated specially by an implication on communication or training relative to adaptability.

This has to do with how the facility is working to handle fluctuations in incoming materials of recyclables without affecting the level of efficiency. The results show a big divide, whereby 42% strongly agree, 2% agree, a large percentage of 28% being indifferent, and 28% of the respondents disagreeing show a lot of operational challenges the facility might not be in control of. This is where discrepancies may point toward possible inefficiencies or murkiness of processes that might be needed to be addressed.

The frequency at which the facility could change its processes to handle new kinds of recyclable materials is strongly agreed upon by 42%, agree by only 2%, while 28% respond neutrally. Conversely, 28% express disagreement, again showing confidence in adaptability, but also considerable uncertainty concerning responsiveness of the facility to new materials. This might mean the need for greater training or resources so that the staff would be more competent to handle various recyclable materials.

About responding to requests from clients for customization, an overwhelming 58% strongly agree 52%, agree 6% that the facility is effective in that regard. That strong affirmation might imply the facility does quite a bit well in customer service and perhaps has it right by knowing what the client wants. Another 32% either disagree or show neutrality, and this suggests there is partial breakdown in communication or execution with regards to the fulfilling of the client request.

Finally, the facility's effectiveness in managing production schedules to handle unexpected disruptions presents a more challenging picture. Only 54% of respondents express confidence, with just 4% strongly agreeing and 50% agreeing. Alarmingly, 40% either disagree (10%) or strongly disagree (30%), indicating significant concerns about the facility’s resilience in the face of disruptions. This suggests that there may be critical vulnerabilities in the operational framework that need to be addressed to enhance overall efficiency and reliability.

Table 4.3. Descriptive statistics of Flexibility

Item		Frequency	Percentage
Our recycling facility can quickly adapt to changes in the types or volumes of materials being recycled.	Strongly agree	26	26
	Agree	32	32
	Neutral	20	20
	Disagree	12	12
	Strongly disagree	10	10
Our recycling operations can handle fluctuations in incoming recyclable materials without compromising efficiency.	Strongly agree	42	42
	Agree	2	2
	Neutral	28	28
	Disagree	24	24
	Strongly disagree	4	4
Our facility frequently adjusts its processes to accommodate new types of recyclable materials.	Strongly agree	42	42
	Agree	2	2
	Neutral	28	28
	Disagree	24	24
	Strongly disagree	4	4
Our facility responds to customization requests from clients effectively.	Strongly agree	52	52
	Agree	6	6
	Neutral	10	10
	Disagree	28	28
	Strongly disagree	4	4
Our facility highly effective in managing production schedules to handle Unexpected disruptions.	Strongly agree	4	4
	Agree	50	50
	Neutral	4	4
	Disagree	10	10
	Strongly disagree	30	30

4.1.2.3. Descriptive statistics of quality

The survey results related to the quality of recycled materials and associated quality management practices within the facility offer important insights into operational effectiveness and stakeholder satisfaction.

Starting with the statement regarding the defect rate of processed materials, only 4% of respondents strongly agree that the defect rate is consistently low and meets recycling quality standards, while 42% agree. However, a significant 48% of participants either disagree (20%) or strongly disagree (28%), indicating substantial concerns about the quality of processed materials. This suggests that a considerable portion of the workforce perceives quality issues that may need to be addressed to ensure compliance with industry standards.

Regarding the effectiveness of measures in place to ensure that recycled materials meet quality standards, the results show that 50% agree, while only 4% strongly agree. However, 32% of respondents either disagree (30%) or strongly disagree (2%), revealing skepticism about the adequacy of the facility's quality assurance measures. Such a divide emphasizes the need for a more robust quality management system to enhance confidence among employees regarding the facility's operational standards.

When considering stakeholder satisfaction with the quality of recycled materials, 56% of respondents express a favorable view, with 22% strongly agreeing and 34% agreeing. Despite this positive sentiment, 24% remain neutral or express dissatisfaction (14% disagree and 10% strongly disagree), indicating that while many stakeholders are satisfied, there are still significant concerns that could impact relationships with clients and partners.

The facility's commitment to training programs focused on quality improvement is represented positively, with 58% of respondents either strongly agreeing (28%) or agreeing (30%) that such programs are conducted. However, 20% remain neutral, and 20% express disagreement (10% disagree and 10% strongly disagree), suggesting that while training is prioritized, there may be room for improvement in both the frequency and effectiveness of these initiatives.

Finally, concerning the handling of customer complaints and feedback about product quality, 59% of respondents either strongly agree (29%) or agree (30%) that the facility is responsive to such concerns. However, 22% remain neutral or express disagreement (12% disagree and 10% strongly disagree), indicating that while there is a generally positive view of the facility's responsiveness, there are still gaps that need to be addressed to ensure all customer feedback is effectively managed.

Table 4.4. Descriptive statistics of quality

Variables		Frequency	Percentage
The defect rate of processed materials in our facility is consistently low and meets recycling quality standards.	Strongly agree	4	4
	Agree	42	42
	Neutral	6	6
	Disagree	20	20
	Strongly disagree	28	28
Our facility has effective measures in place to ensure that recycled materials consistently meet the required quality standards.	Strongly agree	4	4
	Agree	50	50
	Neutral	14	14
	Disagree	30	30
	Strongly disagree	2	2
Our stakeholder are highly satisfied with the quality of recycled materials produced by our facility.	Strongly agree	22	22
	Agree	34	34
	Neutral	20	20
	Disagree	14	14
	Strongly disagree	10	10
Our facility conducts training programs focused on quality improvement	Strongly agree	28	28
	Agree	30	30
	Neutral	22	22
	Disagree	10	10
	Strongly disagree	10	10
Our facility handles customer complaints and feedback regarding our product quality.	Strongly agree	29	29
	Agree	30	30
	Neutral	19	19
	Disagree	12	12
	Strongly disagree	10	10

4.1.2.4. Descriptive statistics of Productivity

The survey results concerning the productivity and throughput of the recycling facility provide valuable insights into operational efficiency and effectiveness.

Starting with the statement about processing a high average throughput of materials per day, a combined total of 58% of respondents either strongly agree (27%) or agree (31%). This indicates a positive perception of the facility's capacity to handle materials efficiently.

However, 23% of respondents are neutral or disagree (13% disagree and 10% strongly disagree), suggesting that there may be inconsistencies in throughput perceptions that could warrant further investigation.

Regarding the productivity of recycling operations, 59% of participants either strongly agree (25%) or agree (34%) that productivity has significantly improved over the past year. This is a promising indication that recent efforts to enhance operational efficiency may be yielding positive results. However, 23% remain neutral or express disagreement (13% disagree and 10% strongly disagree), which suggests that not all employees perceive the improvements equally, highlighting a potential communication gap regarding productivity initiatives.

When assessing the effectiveness of strategies in place to improve productivity, 61% of respondents either strongly agree (28%) or agree (33%). This suggests a strong belief in the facility’s strategic direction and commitment to increasing productivity. Nonetheless, 29% are neutral or disagree (12% disagree and 10% strongly disagree), indicating that some employees may not fully understand or believe in the implemented strategies, which could affect overall engagement and effectiveness.

In terms of time management for timely completion of manufacturing tasks, 58% of respondents either strongly agree (26%) or agree (32%). This reflects confidence in the facility’s ability to manage time effectively. However, 22% remain neutral or disagree (12% disagree and 10% strongly disagree), which implies that there might be areas where time management practices could be optimized or more clearly communicated to all employees.

Finally, when evaluating the company's ability to set and achieve productivity targets, 59% of respondents either strongly agree (29%) or agree (30%). This indicates a strong belief in the facility’s goal-setting and achievement processes. However, similar to other variables, 22% remain neutral or disagree (12% disagree and 10% strongly disagree), suggesting that some employees may feel disconnected from the target-setting process or its outcomes.

Table 4.5. Descriptive statistics of Productivity

Variables		Frequency	Percentage
Our facility processes a high average throughput of materials per day.	Strongly agree	27	27
	Agree	31	31
	Neutral	19	19
	Disagree	13	13
	Strongly disagree	10	10
The productivity of our recycling operations has significantly improved in the past year.	Strongly agree	25	25
	Agree	34	34
	Neutral	18	18
	Disagree	13	13
	Strongly disagree	10	10
We have effective strategies in place to improve the productivity of our recycling facility.	Strongly agree	28	28
	Agree	33	33
	Neutral	17	17
	Disagree	12	12
	Strongly disagree	10	10
Our facility manages time to ensure timely completion of manufacturing tasks effectively.	Strongly agree	26	26
	Agree	32	32
	Neutral	20	20
	Disagree	12	12
	Strongly disagree	10	10
Our company sets and achieves productivity targets effectively.	Strongly agree	29	29
	Agree	30	30
	Neutral	19	19
	Disagree	12	12
	Strongly disagree	10	10

4.1.2.5. Descriptive statistics of Safety

The survey results regarding safety procedures and the overall safety culture within the recycling facility provide important insights into employee perceptions of safety practices and their effectiveness.

Starting with the statement about the frequency of safety procedures, a combined total of 58% of respondents either strongly agree (30%) or agree (28%) that safety procedures occur frequently in the facility. This indicates a positive view of the commitment to safety practices. However, 24% of respondents are neutral or disagree (14% disagree and 10% strongly disagree), suggesting that there may be areas where safety procedures could be communicated more clearly or implemented more consistently.

Regarding the effectiveness of measures in place to ensure worker safety, 62% of participants either strongly agree (33%) or agree (29%), reflecting confidence in the facility's safety protocols. However, 21% of respondents remain neutral or express disagreement (12% disagree and 9% strongly disagree), indicating that some employees may perceive gaps in safety measures or may not be aware of the full extent of the safety initiatives in place.

In the entire facility, 59% either strongly agree at 27% or agree at 32% that the safety culture is excellent, thus indicating a fairly good perception about the safety atmosphere. However, 21% remained neutral or expressed disagreement, with 11% expressing disagreement and 10% strongly disagreeing. What this means is that, while many employees may feel relatively good about safety culture, it also means there are ample concerns that need to be addressed in order to ensure it is universally perceived as positive.

Sixty percent would either strongly agree (29%) or agree that the organization revises policies and procedures necessary to meet approved standards with regard to the review and updating safety policies and procedures. True, this could suggest an endeavor toward having effective and working safety policies; however, 22% are relatively neutral or disagreeing- moreover, they may respond that employees might not be effectively aware of the process of effected policy updates, or alternatively, think improvements ought to happen.

Finally, regarding the effectiveness of safety measures in preventing workplace accidents, 60% of respondents either strongly agree (26%) or agree (34%), indicating a strong belief in the effectiveness of these measures. However, 22% remain neutral or express disagreement (12% disagree and 10% strongly disagree), which points to a potential need for better communication about the measures in place and their impacts on workplace safety.

Table 4.6. Descriptive statistics of Safety

Variables		Frequency	Percentage
Safety procedures occur frequently in our recycling facility.	Strongly agree	30	30
	Agree	28	28
	Neutral	18	18
	Disagree	14	14
	Strongly disagree	10	10
Our facility has effective measures in place to ensure the safety of workers.	Strongly agree	33	33
	Agree	29	29
	Neutral	17	17
	Disagree	12	12
	Strongly disagree	9	9
The overall safety culture within our recycling facility is excellent.	Strongly agree	27	27
	Agree	32	32
	Neutral	20	20
	Disagree	11	11
	Strongly disagree	10	10
Our organization review and update its safety policies and procedures according to approved standards.	Strongly agree	29	29
	Agree	31	31
	Neutral	18	18
	Disagree	12	12
	Strongly disagree	10	10
Our facility safety measures are highly effective in preventing workplace accidents.	Strongly agree	26	26
	Agree	34	34
	Neutral	18	18
	Disagree	12	12
	Strongly disagree	10	10

4.1.3. Knowledge Management Processes

4.1.3.1. Factors affecting Knowledge Acquisition

The survey results regarding knowledge acquisition and its impact on recycling processes within the facility reveal several key insights. A total of 62% of respondents view the facility's methods for acquiring new knowledge as effective, demonstrating a strong positive perception. However, nearly 20% remain neutral or disagree, indicating that some employees may not recognize the effectiveness of these methods, suggesting a need for improved communication about available resources or training on how to leverage them effectively.

When it comes to engagement with external experts, 55% of respondents believe the facility frequently seeks knowledge from outside sources. While this reflects a proactive approach to learning, the 25% who are neutral or disagree suggest potential gaps in outreach or collaboration opportunities that are not fully utilized or communicated within the organization. Regarding the impact of new knowledge affecting manufacturing performance, 59% describe how this has significantly embedded good performance through learning and adaptation. On the other hand, 22% are neutral or hold a contrary opinion, which corroborates that not all employees can precisely observe direct benefits, reinforcing the need to make links perceived between the acquisition of new knowledge and direct outcomes within the organization.

As for the use of marketplace research and competitive analysis, through which manufacturing strategies are reportedly informed, 59% profess a strong understanding of the competition. At the same time, 21% either show a neutral view or disagree, because it is not transparent how that marketplace insight has been further used in decision-making. Finally, the fact that 58% of respondents indicate that customer and supplier feedback is actively gathered and used reflects a commitment to stakeholder engagement. However, with 22% either being neutral or disagreeing, this shows inconsistencies in how feedback is collected and applied, emphasizing the need for more systematic approaches in incorporating insights from stakeholders into operations.

Table 4.7. Factors affecting Knowledge Acquisition

Variables		Frequency	Percentage
Our facility's methods for acquiring new knowledge and information relevant to recycling processes are highly effective.	Strongly agree	28	28
	Agree	34	34
	Neutral	18	18
	Disagree	12	12
	Strongly disagree	8	8
Our facility frequently engages with external experts or sources to acquire new knowledge about recycling technologies and practices.	Strongly agree	25	25
	Agree	30	30
	Neutral	20	20
	Disagree	15	15
	Strongly disagree	10	10
The acquisition of new knowledge has significantly improved the overall manufacturing performance of our recycling facility.	Strongly agree	27	27
	Agree	32	32
	Neutral	19	19
	Disagree	12	12
	Strongly disagree	10	10
Our facility use market research and competitive analysis to inform its manufacturing strategies	Strongly agree	29	29
	Agree	30	30
	Neutral	20	20
	Disagree	12	12
	Strongly disagree	9	9
Our facility gather and utilize feedback from customers and suppliers to improve recycling operations	Strongly agree	30	30
	Agree	28	28
	Neutral	20	20
	Disagree	12	12
	Strongly disagree	10	10

4.1.3.2. Factors affecting Knowledge Creation

The responses to the question of encouraging new knowledge creation and innovation within the recycling facility reveal several important insights on the commitment of the organization to research and development. To this end, 62% strongly agree/agree that the facility encourages new knowledge creation through R&D activities, which reflects a good organizational culture embracing innovation. However, the 28% who are neutral or disagree suggest that some employees may not fully perceive this encouragement, indicating a need for better communication about ongoing initiatives and the importance of innovation in the workplace.

In terms of effectiveness, 63% of respondents believe the facility is highly effective in developing innovative solutions to improve recycling processes and manufacturing performance, demonstrating confidence in the facility's capability to innovate. Nonetheless, the 28% who are neutral or disagree highlight variability in experiences or awareness of innovative practices among employees. Regarding the impact of new knowledge on efficiency, 60% affirm that its creation has significantly improved operational efficiency, suggesting that knowledge creation is seen as beneficial. However, the 22% who are neutral or disagree indicate that some employees may not directly associate new knowledge with efficiency gains, pointing to an opportunity for clearer communication about how new initiatives translate into improved performance.

On the support for collaborative projects in the application of new recycling technologies, support is given by 57% who feel that all facilities actively encourage such kinds of efforts. This puts a very positive attitude there toward working in teams on innovation. Yet, the somewhat neutral view and disagreement by 31% is indicative that some employees tend to be either unaware and/or not engaged in such aspects, which indicates the future need for better integration internally of team projects within the body's innovation strategy. About internal training programs for creating new knowledge, 60% affirm that these are well-conducted, reflecting the commitment of an organization toward employee development and continuous learning. On the other hand, 30% showing neutrality or disagreement could reflect a situation of lack of awareness or inconsistency in training provided, and greater emphasis on training opportunities may have to be made in such cases for engaging employees toward knowledge creation.

Table 4.8. Factors affecting Knowledge Creation

Variables		Frequency	Percentage
Our facility frequently encourages the creation of new knowledge through research and development activities.	Strongly agree	30	30
	Agree	32	32
	Neutral	18	18
	Disagree	10	10
	Strongly disagree	10	10
Our facility is highly effective in creating innovative solutions to improve recycling processes and manufacturing performance.	Strongly agree	28	28
	Agree	35	35
	Neutral	16	16
	Disagree	12	12
	Strongly disagree	9	9
The creation of new knowledge has significantly improved efficiency in our recycling operations.	Strongly agree	29	29
	Agree	31	31
	Neutral	18	18
	Disagree	12	12
	Strongly disagree	10	10
Our facility support collaborative projects aimed at developing new recycling technologies or processes	Strongly agree	27	27
	Agree	30	30
	Neutral	20	20
	Disagree	12	12
	Strongly disagree	11	11
Our facility conduct internal training programs to foster the creation of new knowledge among employees	Strongly agree	31	31
	Agree	29	29
	Neutral	19	19
	Disagree	10	10
	Strongly disagree	11	11

4.1.3.3. Factors affecting Knowledge Sharing

The survey results regarding the encouragement of new knowledge creation and innovation within the recycling facility reveal several important insights into the organization's commitment to research and development (R and D). A total of 62% of respondents either strongly agree or agree that the facility frequently encourages the creation of new knowledge through R and D activities, reflecting a positive organizational culture that values innovation. However, the 28% who are neutral or disagree suggest that some employees may not fully perceive this encouragement, indicating a need for better communication about ongoing initiatives and the importance of innovation in the workplace.

In terms of effectiveness, 63% of respondents believe the facility is highly effective in developing innovative solutions to improve recycling processes and manufacturing performance, demonstrating confidence in the facility's capability to innovate. Nonetheless, the 28% who are neutral or disagree highlight variability in experiences or awareness of innovative practices among employees. Regarding the impact of new knowledge on efficiency, 60% affirm that its creation has significantly improved operational efficiency, suggesting that knowledge creation is seen as beneficial. However, the 22% who are neutral or disagree indicate that some employees may not directly associate new knowledge with efficiency gains, pointing to an opportunity for clearer communication about how new initiatives translate into improved performance.

57% believe that the facility encourages such efforts, whereas 31% are neutral or disagree with such a statement. This suggests that positive attitudes are present toward working in teams during innovation, yet some employees might not be actively aware of or involved in collaborative efforts concerning new recycling technologies, and integration of team projects within the strategy of the facility is required. Lastly, about the internal training programs that would enhance new knowledge creation, 60% agree that these programs are well conducted, reflecting commitment to employee development and continuous learning. However, the 30% who take a neutral or disagreeing view may reflect a lack of awareness or inconsistency in the availability of training, and this would suggest that further emphasis on training opportunities could go some way toward improving employee engagement and knowledge creation.

Table 4.9. Factors affecting Knowledge Sharing

Variables		**Frequency**	**Percentage**
The mechanisms for knowledge sharing among employees in our facility are highly effective.	Strongly agree	30	30
	Agree	32	32
	Neutral	15	15
	Disagree	13	13
	Strongly disagree	10	10
Knowledge-sharing sessions or meetings are held frequently to disseminate important information about recycling processes.	Strongly agree	28	28
	Agree	35	35
	Neutral	17	17
	Disagree	12	12

Variables		Frequency	Percentage
	Strongly disagree	8	8
Knowledge sharing has significantly contributed to improving manufacturing performance in our recycling facility.	Strongly agree	27	27
	Agree	31	31
	Neutral	20	20
	Disagree	11	11
	Strongly disagree	11	11
The mechanism of our facility's processes for documenting and transferring tacit knowledge (unwritten-based knowledge) is highly effective	Strongly agree	29	29
	Agree	30	30
	Neutral	18	18
	Disagree	10	10
	Strongly disagree	13	13
Our facility utilize digital platforms (e.g., internet, knowledge portals) to share information and knowledge effectively	Strongly agree	31	31
	Agree	28	28
	Neutral	20	20
	Disagree	10	10
	Strongly disagree	11	11

4.1.3.4. Factors affecting Knowledge Storage

The results regarding the effectiveness of knowledge storage and organization in the recycling facility are presented to depict some useful insights into managing information concerning the processes for recycling. Accordingly, 63% of the respondents believe that the facility has been highly effective in knowledge storage and organization and that the positive perception of knowledge management practices was very strong at the facility. On the other hand, however, the 22% neutral and disagreeing reflect possible inconsistencies or at least grey areas as to how knowledge is organized and presented. The remaining portion concerns accessibility: 61% of respondents consider knowledge in storage to be readily available for all employees' needs; this is where there is seemingly positive regard for information-sharing practices within the facility.

Nevertheless, the percentage of those who were neutral or disagreed stands at 29%, hence showing that some employees access information hardly, and this indicates a probable need to improve the current systems or strategies in place. Moving to the impact that effective knowledge storing has on manufacturing processes, 59% indicated that effective knowledge storage dramatically improved the speed and accurateness with which core operations are done-a sign that advantages of a well-managed information environment are realized. However, the neutral 31% or those not in agreement indicate that more clarity should be ensured on how knowledge storage directly correlates with performance. On keeping stored knowledge secure and its integrity, respondents are confident that the facility could safeguard information, at 59%.

While this is a good indication, the 31% who were neutral or disagreed indicated that some employees might still have issues either with data security or a lack of awareness of what measures exist to secure information. Lastly, 59% believe that the facility is effective in archiving processes to preserve valuable historical data related to manufacturing performance; thus, showing an understanding of how important maintaining historical records really is. However, the 22% who were neutral or disagreed showed potential gaps in either archiving practices or the communication of the relevance of historical data.

Table 4.10. Factors affecting Knowledge Storage

Variables		**Frequency**	**Percentage**
Our facility is highly effective in storing and organizing knowledge and information related to recycling processes.	Strongly agree	29	29
	Agree	34	34
	Neutral	15	15
	Disagree	12	12
	Strongly disagree	10	10
Stored knowledge and information are easily accessible to employees who need it to perform their tasks.	Strongly agree	31	31
	Agree	30	30
	Neutral	18	18
	Disagree	10	10
	Strongly disagree	11	11
Effective knowledge storage has significantly improved the speed and accuracy of our manufacturing processes.	Strongly agree	27	27
	Agree	32	32
	Neutral	20	20
	Disagree	11	11
	Strongly disagree	10	10
Our facility ensures the	Strongly agree	30	30

Variables		Frequency	Percentage
security and integrity of stored knowledge and information effectively	Agree	29	29
	Neutral	20	20
	Disagree	10	10
	Strongly disagree	11	11
Our facility is highly effective in archiving processes in preserving valuable historical data related to manufacturing performance	Strongly agree	28	28
	Agree	31	31
	Neutral	19	19
	Disagree	12	12
	Strongly disagree	10	10

4.1.3.5. Factors affecting Knowledge Application

The results of the survey on how well knowledge is applied to improve the processes of recycling and manufacturing performance give insight into how effective the facility is at applying acquired and created knowledge. Overall, 62% of respondents feel that the facility effectively applies this knowledge to enhance operations, reflecting a strong positive perception of its ability to leverage information. However, the 20% neutral or disagreeing indicate that some may not fully recognize or experience the impact of knowledge application, which gives room for improvement in communication or execution. On the application of new knowledge and best practices, 62% feel these are integrated into the facility's operations regularly, indicating a proactive approach toward continuous improvement.

However, the 28% that are neutral or disagree point to potential inconsistencies in how new practices are adopted, which could be improved through better training or awareness programs. To the question regarding the impact of new knowledge on manufacturing performance metrics, such as efficiency, quality, and cost, 60% believe its application has led to measurable improvements. This would mean a strong belief in the tangible impact of applying knowledge, while 20% being neutral/disagree indicates a need for clearer metrics to show, and to communicate better, impacts. 58% of respondents agree that insights and new knowledge are put in place to review and refine the processes, which shows a commitment to continual improvement. However, the 31% who take a neutral view, or disagree, would seem to suggest that there could be gaps in how effectively such a process is carried out, or communicated. Finally, 60% of respondents believe the facility is highly successful in implementing knowledge-based strategies to achieve better manufacturing outcomes, indicating confidence in its strategic direction. Nonetheless, the 20% who are neutral or disagree highlight an opportunity for enhanced communication and engagement regarding these strategies.

Table 4.11. Factors affecting Knowledge Application

Variables		**Frequency**	**Percentage**
Our facility effectively applies acquired and created knowledge to improve recycling processes and manufacturing performance.	Strongly agree	32	32
	Agree	30	30
	Neutral	18	18
	Disagree	10	10
	Strongly disagree	10	10
New knowledge and best practices are frequently implemented in our facility's operations.	Strongly agree	30	30
	Agree	32	32
	Neutral	17	17
	Disagree	12	12
	Strongly disagree	9	9
The application of new knowledge has led to measurable improvements in manufacturing performance metrics (e.g., efficiency, quality, cost).	Strongly agree	29	29
	Agree	31	31
	Neutral	20	20
	Disagree	11	11
	Strongly disagree	9	9
Our facility reviews and refines its manufacturing processes based on new knowledge and insights effectively	Strongly agree	30	30
	Agree	28	28
	Neutral	19	19
	Disagree	12	12
	Strongly disagree	11	11
Our facility is highly successful in implementing knowledge-based strategies to achieve better manufacturing outcomes in recycling	Strongly agree	31	31
	Agree	29	29
	Neutral	20	20
	Disagree	10	10
	Strongly disagree	10	10

4.1.4. Reliability for excellent manufacturing performance

The provided data presents Cronbach’s alpha values for various dimensions associated with excellent manufacturing performance, measuring the internal consistency and reliability of each dimension. Cronbach's alpha ranges from 0 to 1, with higher values indicating greater reliability. Generally, an alpha value of 0.70 or above is considered acceptable, while values exceeding 0.80 are regarded as good, and those above 0.90 as excellent.

For the innovation dimension, the Cronbach's alpha is 0.84, reflecting a high level of reliability and suggesting that the items measuring innovation in manufacturing performance are consistent and well-defined. Similarly, the flexibility dimension has a reliability score of 0.81, indicating good consistency in how respondents understand and evaluate the facility's adaptability to changes in demand or processes. The quality dimension, with a score of 0.72, is on the lower end of the acceptable range but still indicates reasonable reliability, suggesting some variability in how respondents interpret quality-related items. The alpha for the productivity dimension is 0.76, showing acceptable reliability and that there is a clear understanding of how to assess productivity in manufacturing contexts. The safety dimension internally shows consistency with a score of 0.79, meaning that the respondents reliably capture perceptions of safety practices within the facility.

Table 4.12. Reliability for excellence manufacturing performance

Dimension	Item	**Cronbach's alpha**
Innovation	5	0.84
Flexibility	5	0.81
Quality	5	0.72
Productivity	5	0.76
Safety	5	0.79

4.1.5. Reliability for knowledge management processes

These represent Cronbach's alpha of various dimensions of knowledge management and point toward the internal consistency and, therefore, reliability of each of the various dimensions. The Cronbach's alpha is a reliability measure that, by concept, ranges from 0 to 1. High overall scores indicate that all the underlying constructs are high and combine in a reliable aggregate variable. For a basic assessment of Cronbach's Alpha above 0.7 being considered generally acceptable, a good scoring surpasses 0.80 and excellent at 0.90.

It holds an acceptable internal consistency in the score at 0.75 in the knowledge acquisition dimension. That would mean that there is generally reliable measurement of how the organization gathers information and insight, but there may be a variation within the perception of respondents, which could benefit from further clarification. The knowledge creation dimension has the value of 0.79, revealing good internal consistency, since the items that measure the generation of new knowledge have a similar understanding across respondents; hence, it sets a very good framework for assessing processes related to knowledge creation.

The knowledge sharing dimension is reasonably reliable with a Cronbach's alpha of 0.81, which means the items measuring the effectiveness of knowledge dissemination within the organization are consistent in reflecting a clear understanding of mechanisms that facilitate knowledge sharing among employees. The knowledge storage dimension also had a high reliability score, standing at 0.85, thus showing excellent internal consistency. This suggests that the items assessing how knowledge is organized and stored are very reliable, reflecting a strong capability in managing knowledge resources effectively. Finally, the knowledge application dimension has a reliability score of 0.73, which is acceptable but on the lower end of the scale. This indicates that while the items measuring how acquired knowledge is utilized are generally reliable, there may be some inconsistencies in interpretation, suggesting a need for further refinement.

Table 4.13. Ratability for knowledge management processes

Dimension	Item	**Cronbach's alpha**
Knowledge acquisition	5	0.75
Knowledge creation	5	0.79
Knowledge sharing	5	0.81
Knowledge storage	5	0.85
Knowledge application	5	0.73

4.1.6. Binary logistic regression model socio demographic

The binary logistic regression model results provide insights into how various socio-demographic variables influence the likelihood of a specific outcome. The constant coefficient is 6.822, with a p-value of 0.045, indicating that when all other variables are held constant, the log odds of the outcome occurring is significantly positive, with an odds ratio of 2.447 suggesting a baseline increase in odds. The variable for gender has a positive coefficient of 0.275 and a p-value of 0.066, indicating that being of a certain gender (likely male, if coded as such) increases the odds of the outcome by approximately 31.7%. However, this result is marginally significant, suggesting further investigation may be warranted. The age group variable shows a coefficient of 0.124 and a high p-value of 0.798, indicating that age does not significantly influence the outcome. In contrast, education has a coefficient of 0.646 and a significant p-value of 0.017, suggesting that higher education levels are associated with a 52.4% increase in the odds of the outcome occurring. Similarly, years of service shows a coefficient of 0.275 and a p-value of 0.044, indicating that each additional year of service increases the odds by approximately 76%, highlighting the positive impact of experience. The job position variable, with a coefficient of 0.640 and a p-value of 0.020, suggests that higher job positions increase the odds of the outcome by 52.7%. Conversely, the city group variable has a negative coefficient of -1.709 but a high p-value of 0.707, indicating that individuals from this group have significantly lower odds of the outcome, although this finding is not statistically significant. Overall, the model's -2 Log Likelihood value of 53.99, a Chi-square statistic of 2.479 with a p-value of 0.002, and a Nagelkerke R^2 of 0.18 suggest that the model is statistically significant, explaining approximately 18% of the variance in the outcome. This indicates that while education, years of service, and job position are significant predictors of the outcome, additional factors may also influence it and should be considered for a more comprehensive analysis.

Table 4.14. Binary logistic regression model for socio-demographic on knowledge

Variables	Coefficient	Standard error	P-value	Odd ratio
Constant	5.134	2.567	0.028	3.162
Gender	0.487	0.642	0.054	1.627
Age group	0.321	0.394	0.601	1.378
Education	0.812**	0.365	0.014	2.250
Years of Service	0.489**	0.308	0.038	1.630
Job position	0.758**	0.422	0.012	2.128
City group	-2.134	0.789	0.823	0.118
-2 Log likelihood	53.99			
Chi-square (P-value)	2.479 (0.002)			
Nagelkerke R^2	0.33			

Note: ***, **and* indicate significance levels at 1%, 5% and 10% respectively.

The binary logistic regression model shows that knowledge creation has a significant positive effect on innovation. For each unit increase in knowledge creation, the odds of innovation increase by 2.374 times, with a statistically significant p-value of 0.015. While the constant term is not significant, the overall model is statistically significant (p = 0.042), and it explains 28% of the variation in innovation, as indicated by the Nagelkerke R^2. This suggests that promoting knowledge creation activities can meaningfully enhance innovation within organizations.

Table 4.15. Binary logistic regression model for innovation on knowledge

Variables	Coefficient	Standard error	P-value	Odd ratio
Constant	1.475	1.874	0.382	4.390
Knowledge Creation	0.865**	0.312	0.015	2.374
-2 Log Likelihood	49.25			
Chi-square (P-value)	0.042			
Nagelkerke R^2	0.28			

Note: ***, **and* indicate significance levels at 1%, 5% and 10% respectively.

The binary logistic regression model shows that knowledge storage has a significant positive impact on quality. For each unit increase in knowledge storage, the odds of achieving higher quality increase by 2.509 times, with a statistically significant p-value of 0.009. The overall model is significant (p = 0.021), and it explains 25% of the variation in quality, as indicated by the Nagelkerke R^2. This highlights the importance of effective knowledge storage in improving quality outcomes.

Table 4.16. Binary logistic regression model for quality on knowledge

Variables	Coefficient	Standard error	P-value	Odd ratio
Constant	1.276	1.432	0.412	3.577
Knowledge Storage	0.921**	0.289	0.009	2.509
-2 Log Likelihood	36.98			
Chi-square (P-value)	5.342 (0.021)			
Nagelkerke R^2	0.25			

Note: ***, **and* indicate significance levels at 1%, 5% and 10% respectively

The binary logistic regression model shows that knowledge sharing has a significant positive effect on flexibility. For each unit increase in knowledge sharing, the odds of increased flexibility rise by 2.318 times, with a statistically significant p-value of 0.023. The overall model is significant (p = 0.013), and it explains 31% of the variation in flexibility, as indicated by the Nagelkerke R^2. This underscores the importance of enhancing knowledge sharing to improve flexibility within organizations.

Table 4.17. Binary logistic regression model for Flexibility on knowledge

Variables	Coefficient	Standard error	P-value	Odd ratio
Constant	1.254	1.680	0.481	3.516
Knowledge Sharing	0.842**	0.378	0.023	2.318
-2 Log Likelihood	37.52			
Chi-square (P-value)	6.174 (0.013)			
Nagelkerke R^2	0.31			

Note: ***, **and* indicate significance levels at 1%, 5% and 10% respectively.

The binary logistic regression model indicates that knowledge acquisition has a significant positive impact on productivity. For each unit increase in knowledge acquisition, the odds of enhanced productivity increase by 2.303 times, with a statistically significant p-value of 0.018. The overall model is significant (p = 0.02) and explains 29% of the variation in productivity, as indicated by the Nagelkerke R^2. This highlights the importance of improving knowledge acquisition to boost productivity within organizations.

Table 4.18. Binary logistic regression model for Productivity on knowledge

Variables	Coefficient	Standard error	P-value	Odd ratio
Constant	1.168	1.712	0.495	3.215
Knowledge acquisition	0.834**	0.352	0.018	2.303
-2 Log likelihood	38.66			
Chi-square (P-value)	6.824 (0.02)			
Nagelkerke R^2	0.29			

Note: ***, **and* indicate significance levels at 1%, 5% and 10% respectively

The binary logistic regression model reveals that knowledge application has a significant positive effect on safety. For each unit increase in knowledge application, the odds of enhanced safety increase by 2.490 times, with a statistically significant p-value of 0.009. The overall model is significant (p = 0.024) and explains 28% of the variation in safety, as indicated by the Nagelkerke R^2. This highlights the importance of improving knowledge application to enhance safety within organizations.

Table 4.19. Binary logistic regression model for Safety on knowledge

Variables	Coefficient	Standard error	P-value	Odd ratio
Constant	1.345	1.620	0.458	3.849
Knowledge Application	0.912**	0.289	0.009	2.490
-2 Log Likelihood	37.45			
Chi-square (P-value)	7.412 (0.024)			
Nagelkerke R^2	0.28			

Note: ***, **and* indicate significance levels at 1%, 5% and 10% respectively

4.1.7. Binary logistic regression model for management processes

The binary logistic regression model for knowledge management processes identifies flexibility, quality, productivity, and safety as significant predictors of the outcome. Specifically, increased flexibility is associated with lower odds of the outcome, while higher quality, productivity, and safety are linked to higher odds of the outcome. The model's overall significance is supported by a Chi-square p-value of 0.02, and it explains approximately 48% of the variance in the outcome, as indicated by the Nagelkerke R^2 value. The constant term is not significant, suggesting it does not substantially impact the outcome.

Table 4.20. Binary logistic regression model for manufacturing performance on knowledge

Variables	Coefficient	Standard error	P-value	Odd ratio
Constant	1.168	1.712	0.495	3.215
Knowledge acquisition	0.136**	0.264	0.006	0.873
Knowledge creation	0.584**	0.359	0.010	0.557
Knowledge sharing	0.703**	0.403	0.031	1.495
Knowledge storage	0.344**	0.362	0.034	1.709

Knowledge application	0.834**	0.352	0.018	2.303
-2 Log likelihood	38.66			
Chi-square (P-value)	10.724 (0.02)			
Nagelkerke R^2	0.48			

Note: ***, **and* indicate significance levels at 1%, 5% and 10% respectively.

4.1.8. Binary logistic regression model for excellence manufacturing performance

The binary logistic regression model explores the relationship between various knowledge management processes and the likelihood of achieving excellence in manufacturing performance. The constant in the model has a coefficient of 1.293, suggesting a baseline increase in the odds of manufacturing excellence, but with a p-value of 0.475, it is not statistically significant. Knowledge acquisition has a positive effect, with an odds ratio of 1.060, indicating a slight increase in the likelihood of achieving excellence, although this effect is also not statistically significant (p-value of 0.873).

Significant predictors include knowledge creation, knowledge sharing, and knowledge storage. Knowledge creation has a coefficient of 0.792 and is significant at the 5% level (p-value of 0.031). Interestingly, the odds ratio of 0.451 implies that higher levels of knowledge creation are associated with a decrease in the likelihood of achieving excellence, suggesting that excessive focus on creation without proper application could lead to inefficiencies. Similarly, knowledge sharing, with a coefficient of 0.245 and a p-value of 0.043, is also significant at the 5% level. Its odds ratio of 0.782 indicates that increased knowledge sharing is linked to a 21.8% decrease in the odds of excellence, which may reflect the need for managing communication effectively to avoid negative consequences. On the other hand, knowledge storage, with a coefficient of 0.031 and a p-value of 0.015, has a positive and significant effect on manufacturing excellence, increasing the odds by 3.2%, underscoring the importance of effectively storing and retrieving knowledge.

Knowledge application, however, shows no significant effect, with a p-value of 0.971, suggesting it does not have a measurable impact on manufacturing excellence in this model. The model's overall fit is reasonably good, with a -2 Log likelihood of 52.14, and the chi-square test result (p-value of 0.058) indicates that the model is marginally significant. Additionally, the Nagelkerke R^2 value of 0.41 shows that about 41% of the variation in manufacturing excellence can be explained by the knowledge management variables, indicating a moderately strong relationship. In conclusion, while some knowledge management processes positively contribute to manufacturing excellence, others, such as knowledge creation and sharing, may require careful management to avoid inefficiencies.

4.2. Discussion

These findings highlight the fact that effective knowledge management works as a strategic asset to enhance operational excellence in the recycling sector. Knowledge management processes ensure that all kinds of knowledge are systematically collected, shared, and used regarding the operations to render them efficient. By tapping into the knowledge and experience of administrative leaders, organizations can help streamline processes, reduce waste, and boost productivity-all quite important in a dynamic recycling environment where flexibility and efficiency have to be ensured. Knowledge management also enhances continuous learning and innovation, ensuring cooperation among stakeholders and employees. This, in turn, encourages innovation: not only in contributing toward manufacturing excellence but also in supporting goals related to environmental sustainability. On the other hand, administrative leadership could give big inputs toward shaping organizational strategy, and the insight they would gain into KM processes would certainly enhance the decision-making capabilities by providing access to relevant information and expertise in a timely manner. Good KM systems ensure data-driven decision-making, and therefore, leaders can take decisions which are in tune with the organizational goals. In a highly competitive industry like recycling, it is knowledge utilization that provides the competitive advantage so that organizations can explore market trends and customers' preferences and operational best practices. Also, it is important to interpret these findings in the light of their contextual relevance to the conditions of the Kurdistan Region, Iraq, given that socioeconomic conditions and cultural dynamics keep reshuffling challenges and opportunities within the context of recycling. The emphasis on administrative leaders underlines the commitment of leadership to the implementation of KM processes and provides valuable insights into barriers and enablers within organizations. These findings emphasize that knowledge management should be viewed as an integrated process; hence, a holistic KM strategy must cover the acquisition, creation, sharing, storage, and application of knowledge. This would ensure that there is easy flow of knowledge within the organization and thus an effective understanding of how it affects manufacturing performance. This study thus provides insights to practitioners in the recycling industry regarding how investment in a KM system, training programs, and collaborative platforms could result in sustained gains in manufacturing performance and overall success. The study, in conclusion, focuses on the most important knowledge management processes involved in developing manufacturing excellence within the recycling industry and stresses a strategic approach in knowledge management toward pursuit of operational excellence.

Results obtained highlight how knowledge management processes act like a catalyst for innovation, which is necessary in the recycling sector to keep companies competitive and up to date with technological changes. In fact, KM enables the individual and collective knowledge of employees and stakeholders to drive continuous improvement and experimentation as a cultural trait in optimizing resources and reducing waste. Besides, KM supports decision-making through evidence-based information, ensuring that administrative management is in time to have access to relevant information. In the industry featured by rapid market conditions, accurate data enables the organization to be agile and appropriate to sustainability purposes (Shahzad et al, 2020).

Moreover, it boosts organizations' resilience in retaining valuable knowledge amidst challenges in either manpower or socio-economic spheres-Issues that have been quite predominant in the Kurdistan Region of Iraq. It is with regards to this that leadership commitment to KM serves as an important catalyst to bring about change in knowledge culture and influence the basis of resource allocation by minimizing organizational silos. The active involvement of leaders in KM initiatives also helps overcome resistance to change and encourages collaboration. In addition, through KM, organizations can respond to local and global challenges by amalgamating regional competencies with international best practices. This ensures the adaptability of organizations to local constraints while keeping them responsive to global trends in recycling technologies and regulations (Zhang et al, 2021).

This is also regarding the fact that sustainability and KM are connected since effective knowledge-sharing processes allow the reduction of waste and ecological practices. Embedding KM into the fabric of an organization enables recycling companies to turn into learning organizations, which are continuously able to adapt and improve processes. This is necessary in light of continuous learning within the Kurdistan Region's socio-economic dynamics, which requires organizations to keep competitive. Other actionable recommendations for practitioners include investments in KM platforms, conducting training programs, fostering cross-functional collaboration, and the capture of tacit knowledge from senior employees. This will help manufacturers improve manufacturing excellence while attaining sustainability and long-term success in the recycling business (Balasubramanian et al, 2020).

5. Conclusion and Recommendation

5.1. Conclusion

This study highlights the contributions of knowledge management processes toward better achievement of manufacturing excellence for the recycling sector in the Kurdistan Region, Iraq. In fact, it shows that proper KM practices-meaning collection, sharing, and application-will contribute so much to the better operational efficiency, fostering innovation, and environmentally sustainable performance. Administrative leaders therefore have a very important role in championing KM initiatives, shaping organizational strategy, and ensuring a culture of continuous learning and collaboration. It is through KM that an organization is able to make informed decisions based on facts, improve productivity, and hold its own against the constantly changing industry.

Moreover, the study insists that a holistic KM strategy will integrate all aspects of knowledge acquisition, sharing, and application in a seamless flow of knowledge within the organization. This holistic approach supports not only manufacturing excellence but also prepares organizations to respond to both local and global challenges while contributing to sustainability objectives. These insights from this research would, therefore, present priority indications that KM investments, leadership involvement, and the development of collaborative platforms will provide opportunities for recycling organizations to realize sustained performance improvements and long-term success. Finally, KM is not only an operational tool in search of efficiency but also a strategic asset shaping organizational resilience, innovation, and excellence within the dynamic and competitive recycling industry. The study articulates further that an integrated and strategic approach to knowledge management might help address several specific challenges facing the Kurdistan Region of Iraq, such as socio-economic factors and constraints in infrastructure. It would thus be easier to adapt to such local conditions and make informed decisions that not only consider regional constraints but also global industry trends by cultivating a culture of knowledge within an organization. That flexibility is important in the recycling industry, where efficiency, innovation, and sustainability are connected to competitiveness on the market.

The research also highlights the need for leadership commitment as a driving force behind successful KM implementation. Administrative leaders must not only advocate for KM systems but also actively participate in creating an environment that values knowledge sharing and continuous improvement. Their role in breaking down silos and encouraging cross-functional collaboration is essential for unlocking the full potential of KM in enhancing manufacturing excellence. The binary logistic regression analysis reveals significant relationships between various knowledge management (KM) processes and manufacturing performance. Knowledge acquisition is shown to have a positive impact, with a p-value of 0.006 and an odds ratio of 0.873, indicating that enhancing knowledge acquisition increases the likelihood of improving manufacturing performance by approximately 87.3%, though the less-than-one odds ratio suggests diminishing returns with further improvements. Similarly, knowledge creation positively affects performance (p = 0.010, odds ratio = 0.557), highlighting its importance in fostering innovation and operational adaptability. Knowledge sharing also plays a crucial role (p = 0.031, odds ratio = 1.495), with organizations benefiting from a culture of collaboration and open dissemination of information, increasing the chances of operational excellence by nearly 50%.

Knowledge storage, with a p-value of 0.034 and an odds ratio of 1.709, demonstrates that retaining and making knowledge accessible significantly contributes to enhanced performance and organizational resilience. The strongest influence comes from knowledge application (p = 0.018, odds ratio = 2.303), which more than doubles the likelihood of improved performance. This finding emphasizes that effectively utilizing knowledge is crucial for achieving manufacturing success. The overall model is statistically significant, as indicated by a -2 Log likelihood of 38.66 and a Chi-square value of 10.724 (p = 0.02), with a Nagelkerke R2 of 0.48, meaning that the KM processes in the model explain 48% of the variance in manufacturing performance. These results underscore the critical role of KM processes, suggesting that focusing on knowledge acquisition, creation, sharing, storage, and application can significantly enhance manufacturing performance, especially in dynamic sectors like recycling. The findings point to the fact that KM is a foundational element in the pursuit of operational excellence. By investing in knowledge management systems, training programs, and collaborative practices, organizations in the recycling sector can significantly improve their performance and resilience. The study provides a blueprint for practitioners seeking to leverage KM to meet the demands of a competitive and evolving industry, ensuring that knowledge becomes a sustainable resource that drives both environmental and organizational success.

5.2. Recommendations

Based on the study's conclusions, here are seven recommendations for industrial organization leaders, CEO, and directors and who are working in the decision positions of the recycling sector

1. Invest in KM systems:

The leaders should develop and implement KM systems to facilitate the collection, storage, sharing, and application of knowledge. Investment in technology platforms, training, and collaborative tools will lead to better decision-making, operational efficiency, and a culture of innovation.

2. Encourage Knowledge-Based Culture:

Foster a culture where sharing of knowledge and continuous learning are at the heart of the organization's values. Leaders should enable collaboration cross-functionally in an attempt to break down silos that block the flow of knowledge across departments. This is also crucial for enhancing operational resilience and adaptability in response to local and global challenges.

3. Champion KM Initiatives:

Administrative leaders must take ownership of KM initiatives by embedding them into organizational strategies. They must establish some goals related to knowledge acquisition, storage, and application, and engage teams in the process and contribute effectively. Leaders should model the continuous learning and open communication behaviors.

4. Alignment of KM with Sustainability Goals:

Since the recycling industry is closely linked to environmental sustainability, organizations should ensure that their KM efforts are aligned and contribute to sustainable objectives. Working through KM, they will be able to innovate in waste reduction, process efficiencies, and greening of technologies-driving both environmental and economic performances.

5. Data-Driven Decision Making:

Moreover, leaders are in a position to drive data-driven decisions by making informed choices using the insights availed by the KM systems. Regular analysis of knowledge stored within an organization shall enable better forecasting, strategic planning, and improvement of processes.

6. Adapt KM to the Local Challenges:

It will also enable the leaders to design strategies of KM for organizations in the

Kurdistan Region of Iraq or similar regions, keeping in view the socio-economic challenges and limitations in infrastructure. This, in turn, will help an organization get through socio-economic and infrastructural constraints more efficiently by creating a culture for knowledge sharing that would better align with and adapt to the conditions in the region.

7. Establish Leadership Commitment:

Leadership should not only advocate for KM but lead by example in the active development of a knowledge-sharing environment. This means leading from the front in setting the tone through KM initiatives, participating in learning sessions, and modeling the behavior that reflects knowledge as a strategic asset.

5.3. Proposed Future Studies

1. KM and Sustainability Performance:

In fact, this series of analyses of KM processes may lead to direct impacts on the sustainability performances of recycling companies and their leading to the emergence of green technology, innovation, efficient waste management, energy utilization, and environmental improvements owing to such effort at the next tier.

2. KM in Other Regions:

Comparative studies may also focus on the differences in the practice of KM across different regions and industries, with explanations of unique challenges and opportunities facing KM in each socio-economic and infrastructure environment. This would be particularly handy, for instance, in regions whose infrastructures are not as well developed, such as the Kurdistan Region of Iraq.

3. Longitudinal Impact of KM Investments:

On the other hand, an ethnographic or longitudinal study on how investments in KM systems can prove whether long-term gains exist across organizations in operational efficiency, innovative capacity, and resilience over an extended period would be of value. Such would delineate the sustainability of benefits that could point out, or highlight, the critical contributing variables to success.

4. Cross-Industry Comparison of KM in Recycling:

The study would ensure a comparative analysis in various sectors involved in the recycling industry about their practices with respect to KM. This will indicate how KM processes would be different between organizations with various foci on types of recyclable wastes, such as plastic, metal, and electronic waste.

5. Role of Leadership in KM Adoption:

Investigate the specific leadership styles and strategies that most effectively drive KM adoption and success. This study could focus on understanding the relationship between leadership behavior, organizational culture, and the effectiveness of KM practices in different types of organizations.

6. KM and Innovation Correlation:

Further research could explore how KM practices influence innovation rates within the recycling sector. Understanding the relationship between knowledge creation and technological advancements can provide deeper insights into how KM fosters a culture of continuous improvement and innovation.

These recommendations and proposed studies aim to build on the findings of the current research, providing practical guidance for leaders and decision makers while identifying areas for further exploration to advance the role of KM in manufacturing excellence, especially within the recycling sector.

References

1. The impact of strategic leadership and entrepreneurial in achieving organizational performance By reasecher (khanda khwarahm Azeez)Adminstration and Economics business administration April 2021.
2. Walt Rostow -Rostow ,in the stages of economic growth : A non -communist manifesto (1960), outlined a model where the “take- off” phase of economic development is driven by industrialization .
3. (The work plan of ninth cabinet of KRG IN 2019, Article No.)
4. (Investment law in Kurdistan region number 4 in 2006&Annual plan of Board of investment)
5. Board of protecting environment in Kurdistan.
6. Lundvall, Bengt-Åke and Nilsen, Peter (2007), "Knowledge management and innovation performance", International Journal of Manpower, Vol.28, No.3/4, pp.207-223..
7. Abubakar, A. M., Elrehail, H., Alatailat, M. A., & Elçi, A. (2017). Knowledge management, decision-making style and organizational performance. *Journal of Innovation & Knowledge*, *4*(2), 104–114. https://doi.org/10.1016/J.JIK.2017.07.003
8. Agostini, L., Nosella, A., Sarala, R., Spender, J. C., & Wegner, D. (2020). Tracing the evolution of the literature on knowledge management in inter-organizational contexts: a bibliometric analysis. *Journal of Knowledge Management*, *24*(2), 463–490. https://doi.org/10.1108/JKM-07-2019-0382
9. Ali, M., Ali, R., Khan, W. A., Han, S. C., Bang, J., Hur, T., Kim, D., Lee, S., & Kang, B. H. (2018). A Data-Driven Knowledge Acquisition System: An End-to-End Knowledge Engineering Process for Generating Production Rules. *IEEE Access*, *6*, 15587–15607. https://doi.org/10.1109/ACCESS.2018.2817022
10. Auqui-Caceres, M. V., & Furlan, A. (2023). Revitalizing double-loop learning in organizational contexts: A systematic review and research agenda. *European Management Review*, *20*(4), 741–761. https://doi.org/10.1111/EMRE.12615
11. Azad, M., Chikalov, I., & Moshkov, M. (2020). Representation of Knowledge by Decision Trees for Decision Tables with Multiple Decisions. *International Conference on Knowledge-Based Intelligent Information & Engineering Systems*, *176*, 653–659. https://doi.org/10.1016/J.PROCS.2020.09.037
12. Barão, A., de Vasconcelos, J. B., Rocha, Á., & Pereira, R. (2017). A knowledge

management approach to capture organizational learning networks. *International Journal of Information Management*, *37*(6), 735–740. https://doi.org/10.1016/J.IJINFOMGT.2017.07.013

13. Bettiol, M., Capestro, M., Di Maria, E., & Grandinetti, R. (2023). Leveraging on intra- and inter-organizational collaboration in Industry 4.0 adoption for knowledge creation and innovation. *European Journal of Innovation Management*, *26*(7), 328–352. https://doi.org/10.1108/EJIM-10-2022-0593
14. Bigliardi, B., Ferraro, G., Filippelli, S., & Galati, F. (2020). The influence of open innovation on firm performance. *International Journal of Engineering Business Management, 12*. https://doi.org/10.1177/1847979020969545
15. Caruso, S. J. (2016). A Foundation For Understanding Knowledge Sharing: Organizational Culture, Informal Workplace Learning, Performance Support, And Knowledge Management. *Contemporary Issues in Education Research*, *10*(1), 45–52. https://doi.org/10.19030/CIER.V10I1.9879
16. Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, *35*(1), 128. https://doi.org/10.2307/2393553
17. Ćwikła, G. (2014). Methods of manufacturing data acquisition for production management - A review. *Advanced Materials Research*, *837*, 618–623. https://doi.org/10.4028/WWW.SCIENTIFIC.NET/AMR.837.618
18. Faeq, D. K. (2022). A Mediated Model of Employee commitment: The Impact of Knowledge Management Practices on Organizational Outcomes. *International Journal of Advanced Engineering Management and Science*, *8*(9), 44–58. https://doi.org/10.22161/IJAEMS.89.6
19. Farooq, R. (2019). Developing a conceptual framework of knowledge management. *International Journal of Innovation Science*, *11*(1), 139–160. https://doi.org/10.1108/IJIS-07-2018-0068/FULL/XML
20. Freije, I., de la Calle, A., & Ugarte, J. V. (2021). Role of supply chain integration in the product innovation capability of servitized manufacturing companies. *Technovation*, *118*. https://doi.org/10.1016/J.TECHNOVATION.2020.102216
21. Gómez, J., Salazar, I., & Vargas, P. (2020). The Role Of Extramural R&D And Scientific Knowledge In Creating High Novelty Innovations: An Examination Of Manufacturing And Service Firms In Spain. *Research Policy*, *49*(8). https://doi.org/10.1016/J.RESPOL.2020.104030
22. Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic*

Management Journal, *17*(SUPPL. WINTER), 109–122. https://doi.org/10.1002/SMJ.4250171110

23. Grošelj, M., Černe, M., Penger, S., & Grah, B. (2020). Authentic and transformational leadership and innovative work behaviour: the moderating role of psychological empowerment. *European Journal of Innovation Management*, *24*(3), 677–706. https://doi.org/10.1108/EJIM-10-2019-0294
24. Hutasuhut, I., Ahmad Zaidi Adruce, S., & Jonathan, V. (2021). How a learning organization cultivates self-directed learning. *Journal of Workplace Learning*, *33*(5), 334–347. https://doi.org/10.1108/JWL-05-2020-0074
25. Hutton, S., Demir, R., & Eldridge, S. (2021). How does open innovation contribute to the firm's dynamic capabilities? *Technovation, 106*. https://doi.org/10.1016/J.TECHNOVATION.2021.102288
26. Janićijević, N. (2015). *Impact of Organizational Culture on Organizational Learning and Knowledge Management*.
27. Janus, S. S. (2017). Step 3: Validation. *Capturing Solutions for Learning and Scaling Up: Documenting Operational Experiences for Organizational Learning and Knowledge Sharing*, 37–44. https://doi.org/10.1596/978-1-4648-1114-2_STEP3
28. Jiang, Y., & Chen, C. C. (2018). Integrating Knowledge Activities for Team Innovation: Effects of Transformational Leadership. *Journal of Management*, *44*(5), 1819–1847. https://doi.org/10.1177/0149206316628641
29. Kakatkar, C., Bilgram, V., & Füller, J. (2018). Innovation Analytics: Leveraging Artificial Intelligence in the Innovation Process. *Business Horizons*. https://doi.org/10.2139/SSRN.3293533
30. Khraishi, A., Paulraj, A., Huq, F., & Seepana, C. (2022). Knowledge management in offshoring innovation by SMEs: role of internal knowledge creation capability, absorptive capacity and formal knowledge-sharing routines. *Supply Chain Management*, *28*(2), 405–422. https://doi.org/10.1108/SCM-05-2021-0256
31. Kim, N., & Lee, J. (2020). Who is leaping through failure? The influence of innovation characteristics on learning from failure. *Industry and Innovation, 27*(9), 1014–1039. https://doi.org/10.1080/13662716.2020.1751088
32. Law, K. M. Y., Lau, A. K. W., & Ip, A. W. H. (2021). The Impacts of Knowledge Management Practices on Innovation Activities in High- and Low-Tech Firms. *Journal of Global Information Management, 29*(6). https://doi.org/10.4018/JGIM.20211101.OA41

33. Leung, T. Y., & Sharma, P. (2021). Differences in the impact of R&D intensity and R&D internationalization on firm performance – Mediating role of innovation performance. *Journal of Business Research*, *131*, 81–91. https://doi.org/10.1016/J.JBUSRES.2021.03.060
34. Li, F., & Long, J. (2022). Strategies to promote cross-functional team creativity in SMEs: the cooperative effect of organizational fit and cognitive interaction. *SHS Web of Conferences*, *145*, 01011. https://doi.org/10.1051/SHSCONF/202214501011
35. Liu, G., Tsui, E., & Kianto, A. (2021). Revealing deeper relationships between knowledge management leadership and organisational performance: a meta-analytic study. *Knowledge Management Research & Practice*, *20*(2), 251–265. https://doi.org/10.1080/14778238.2021.1970492
36. Mageswari, S. D. U., Sivasubramanian, R. C., & Dath, T. N. S. (2017). A comprehensive analysis of knowledge management in Indian manufacturing companies. *Journal of Manufacturing Technology Management*, *28*(4), 506–530. https://doi.org/10.1108/JMTM-08-2016-0107
37. Mageswari, S., Sivasubramanian, C., & Dath, T. (2015). *Knowledge Management Enablers, Processes and Innovation in Small Manufacturing Firms: A Structural Equation Modeling Approach*.
38. Marques, J. M. R., La Falce, J. L., Marques, F. M. F. R., De Muylder, C. F., & Silva, J. T. M. (2019). The relationship between organizational commitment, knowledge transfer and knowledge management maturity. *Journal of Knowledge Management*, *23*(3), 489–507. https://doi.org/10.1108/JKM-03-2018-0199
39. Masic, B., Nesic, S., Nikolic, D., & Dzeletovic, M. (2017). Evolution of knowledge management. *Industrija*, *45*(2), 127–147. https://doi.org/10.5937/INDUSTRIJA45-13201
40. McInerney, C. R., & Koenig, M. E. D. (2011). Knowledge Management (KM) Processes in Organizations: Theoretical Foundations and Practice. *Synthesis Lectures on Information Concepts, Retrieval, and Services*, *3*(1), 1–96. https://doi.org/10.2200/S00323ED1V01Y201012ICR018
41. Miao, B., Liang, Y., & Suo, Y. (2023). The Influence of Organizational Social Network on Enterprise Collaborative Innovation—Mediating Role of Knowledge Sharing and Moderating Effect of Digital Construction. *IEEE Access*, *11*, 5110–5122. https://doi.org/10.1109/ACCESS.2023.3236398
42. Michalakoudis, I., Aurisicchio, M., Childs, P., Koutlidis, A., & Harding, J.

(2018). Empowering manufacturing personnel through functional understanding. *Production Planning & Control*, *29*(8), 688–703. https://doi.org/10.1080/09537287.2018.1455995

43. Nonaka, I., & Takeuchi, H. (1995). *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press.
44. Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and Leadership: A Unified Model of Dynamic Knowledge Creation. *Long Range Planning*, *33*(1), 5–34. https://doi.org/10.1016/S0024-6301(99)00115-6
45. Patalas-Maliszewska, J., Krebs, I., & Dudek, A. (2017). An approach to automated tacit-knowledge acquisition and transformation in manufacturing companies. *International Conference on Methods & Models in Automation & Robotics,* 356–360. https://doi.org/10.1109/MMAR.2017.8046853
46. Pellegrini, M. M., Ciampi, F., Marzi, G., & Orlando, B. (2020). The relationship between knowledge management and leadership: mapping the field and providing future research avenues. *Journal of Knowledge Management*, *24*(6), 1445–1492. https://doi.org/10.1108/JKM-01-2020-0034
47. Ramayah, T., Soto-Acosta, P., Kheng, K. K., & Mahmud, I. (2020). Developing process and product innovation through internal and external knowledge sources in manufacturing Malaysian firms: the role of absorptive capacity. *Business Process Management Journal*, *26*(5), 1021–1039. https://doi.org/10.1108/BPMJ-11-2019-0453
48. Rehman, S. U., Bresciani, S., Ashfaq, K., & Alam, G. M. (2021). Intellectual capital, knowledge management and competitive advantage: a resource orchestration perspective. *Journal of Knowledge Management*, *26*(7), 1705–1731. https://doi.org/10.1108/JKM-06-2021-0453
49. Rehman, S. U., Bresciani, S., Ashfaq, K., & Alam, G. M. (2022). Intellectual capital, knowledge management and competitive advantage: a resource orchestration perspective. *Journal of Knowledge Management*, *26*(7), 1705–1731. https://doi.org/10.1108/JKM-06-2021-0453/FULL/XML
50. Rezgui, Y., Hopfe, C. J., & Vorakulpipat, C. (2010). Generations of knowledge management in the architecture, engineering and construction industry: An evolutionary perspective. *Advanced Engineering Informatics*, *24*(2), 219–228. https://doi.org/10.1016/J.AEI.2009.12.001
51. Rybnicek, R., & Königsgruber, R. (2019). What makes industry–university collaboration succeed? A systematic review of the literature. *Journal of*

Business Economics, *89*(2), 221–250. https://doi.org/10.1007/S11573-018-0916-6

52. Seriki, O. (2023). Knowledge Management. *Encyclopedia of Sustainable Management*, 2171–2175. https://doi.org/10.1007/978-3-031-25984-5_472
53. Stei, G., Rossmann, A., & Szász, L. (2023). How Knowledge-intensive Organizations Thrive Under Dynamic Conditions: An Organizational Capability Perspective. *European Conference on Knowledge Management, 24*(2), 1607–1614. https://doi.org/10.34190/ECKM.24.2.1479
54. Stylianou, V., & Savva, A. (2016). Investigating the Knowledge Management Culture. *Universal Journal of Educational Research*, *4*(7), 1515–1521. https://doi.org/10.13189/UJER.2016.040703
55. Todorova, G., & Durisin, B. (2007). Absorptive capacity: Valuing a reconceptualization. *Academy of Management Review*, *32*(3), 774–786. https://doi.org/10.5465/AMR.2007.25275513
56. Veeravalli, S., & Vijayalakshmi, V. (2022). Revisiting Knowledge Management System Use: Unravelling Interventions that Nurture Knowledge Seeking. *International Journal of Knowledge Management*, *18*(1), 1–25. https://doi.org/10.4018/IJKM.291707
57. Wang, Z., & Wang, N. (2012). Knowledge sharing, innovation and firm performance. *Expert Systems with Applications*, *39*(10), 8899–8908. https://doi.org/10.1016/J.ESWA.2012.02.017
58. Widmann, A., Messmann, G., & Mulder, R. H. (2016). The Impact of Team Learning Behaviors on Team Innovative Work Behavior. *Human Resource Development Review*, *15*(4), 429–458. https://doi.org/10.1177/1534484316673713
59. Yi, Z. (2019). A leader's approaches to fostering a culture of knowledge sharing in an information organization. *Library Management*, *40*(8–9), 593–600. https://doi.org/10.1108/LM-11-2018-0083
60. Zahra, S. A., & George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension. *The Academy of Management Review*, *27*(2), 185. https://doi.org/10.2307/4134351
61. Zhang, G., & Tang, C. (2017). How could firm's internal R&D collaboration bring more innovation? *Technological Forecasting and Social Change, 125,* 299–308. https://doi.org/10.1016/J.TECHFORE.2017.07.007
62. Alavi, M., & Leidner, D. E. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues.

MIS Quarterly, 25(1), 107-136.
63. Ambos, T. C., & Ambos, B. (2009). The impact of distance on knowledge transfer effectiveness in multinational corporations. Journal of International Management, 15(1), 1-14.
64. Anand, G., & Kodali, R. (2008). Benchmarking the benchmarking models. Benchmarking: An International Journal, 15(3), 257-291.
65. Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. Administrative Science Quarterly, 35(1), 128-152.
66. Cross, R., Borgatti, S. P., & Parker, A. (2001). Beyond answers: Dimensions of the advice network. Social Networks, 23(3), 215-235.
67. De Long, D. W., & Fahey, L. (2000). Diagnosing cultural barriers to knowledge management. Academy of Management Executive, 14(4), 113-127.
68. Dirks, K. T., & Ferrin, D. L. (2001). The role of trust in organizational settings. Organization Science, 12(4), 450-467.
69. Edwards, M. G., Sanchez, R., & Sessions, H. (2017). Toward a learning orientation: Training, development, and organizational culture. Human Resource Management, 56(1), 35-52.
70. Gupta, A. K., & Govindarajan, V. (2000). Knowledge flows within multinational corporations. Strategic Management Journal, 21(4), 473-496.
71. Huston, L., & Sakkab, N. (2006). Connect and develop: Inside Procter & Gamble's new model for innovation. Harvard Business Review, 84(3), 58-66.
72. Husted, K., & Michailova, S. (2002). Diagnosing and fighting knowledge-sharing hostility. Organizational Dynamics, 31(1), 60-73.
73. Inkpen, A. C., & Tsang, E. W. (2005). Social capital, networks, and knowledge transfer. Academy of Management Review, 30(1), 146-165.
74. Levin, D. Z., & Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. Management Science, 50(11), 1477-1490.
75. Lichtenthaler, U., & Lichtenthaler, E. (2010). Technology transfer across organizational boundaries: Absorptive capacity and desorptive capacity. California Management Review, 53(1), 154-170.
76. Maznevski, M. L., & Chudoba, K. M. (2000). Bridging space over time: Global virtual team dynamics and effectiveness. Organization Science, 11(5), 473-492.
77. Noe, R. A., Clarke, A. D. M., & Klein, H. J. (2014). Learning in the twenty-first-century workplace. Annual Review of Organizational Psychology and

Organizational Behavior, 1(1), 245-275.
78. Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. Strategic Management Journal, 17(S2), 27-43.
79. Tallman, S., & Chacar, A. S. (2011). Communities, alliances, networks and knowledge in multinational firms: A micro-analytic framework. Journal of International Management, 17(3), 201-210.
80. Volberda, H. W., Foss, N. J., & Lyles, M. A. (2010). Absorbing the concept of absorptive capacity: How to realize its potential in the organization field. Organization Science, 21(4), 931-951.
81. Voelpel, S. C., & Han, Z. (2005). Managing knowledge sharing in China: The case of Siemens ShareNet. Journal of Knowledge Management, 9(3), 51-63.
82. Wang, S., & Noe, R. A. (2010). Knowledge sharing: A review and directions for future research. Human Resource Management Review, 20(2), 115-131.
83. Werr, A., & Styhre, A. (2003). Management consultants as agents of organizational change: The importance of knowledge sharing. Leadership & Organization Development Journal, 24(2), 149-161.
84. Wenger, E. (2000). Communities of practice and social learning systems. Organization, 7(2), 225-246.
85. Dalkir, K. (2017). Knowledge Management in Theory and Practice (3rd ed.). MIT Press.
86. Davenport, T. H., & Prusak, L. (1998). Working Knowledge: How Organizations Manage What They Know. Harvard Business School Press.
87. Zhang, B., Comite, U., Yucel, A.G., Liu, X., Khan, M.A., Husain, S., Sial, M.S., Popp, J. and Oláh, J., 2021. Unleashing the importance of TQM and knowledge management for organizational sustainability in the age of circular economy. Sustainability, 13(20), p.11514.
88. Shahzad, M., Qu, Y., Zafar, A.U., Rehman, S.U. and Islam, T., 2020. Exploring the influence of knowledge management process on corporate sustainable performance through green innovation. Journal of knowledge management, 24(9), pp.2079-2106.
89. Balasubramanian, S., Al-Ahbabi, S. and Sreejith, S., 2020. Knowledge management processes and performance: The impact of ownership of public sector organizations. International Journal of Public Sector Management, 33(1), pp.1-21.

Appendix (1)

Recycling of Scrap steel

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	5	2,000,000	3,000	Reinforced Steel
Sulaymaniyah	6	2,100,000	2,220	Reinforced Steel
Duhok	0	0	0	0
Total	9	4,100,000	5,220	

Recycling of used (Engine oil)

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	4	100,000	70	Engine oil
Sulaymaniyah	6	215,000	105	Engine oil
Duhok	3	30,000	35	Engine oil
Total	14	345,000	210	

Recycling of used (Copper + Aluminum + Lead)

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	5	40,000	150	
Sulaymaniyah	1	3000	10	
Duhok	3	10,000	50	
Total	8	50,000	200	

Recycling of used carboard (Carton)

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	4	30,000	100	
Sulaymaniyah	-	-	-	
Duhok	-	-	-	
Total	4	30,000	100	

Recycling of used (Plastic)

Name of city	No. of factories	Total capacity/ Ton	No. of job opportunity	New product
Erbil	8	50,000	250	
Sulaymaniyah	8	5,500	70	
Duhok	5	2,000	25	
Total	17	57,500	312	

Appendix (2)

Erbil Polytechnic university

College of Technical Administration

Department of Technical Administration

Dear Respondent,

You are invited to participate in a research study as part of a master's dissertation titled **"The Role of Knowledge Management Processes in Enhancing Excellence Manufacturing Performance: An analytical study of the opinions of administrative leaders in Recycling Sector in the Kurdistan Region of Iraq"**. This study aims to gather insights that will be used solely for academic purposes. Your participation is entirely anonymous, and no personal information will be linked to individual responses. Completing this questionnaire will take approximately 10 minutes of your time.

Your cooperation and support are greatly valued, and all the information provided will be kept strictly confidential.

Thank you for your valuable contribution.

Notes:

1. Please do not leave any statement unanswered because it means that it is not valid for analysis.
2. Please put a tick (✓) in front of the statement that represents your point of view.

Master Student: Tayib Kazho Ali. ……………… **Supervisor(s):**

Phone No.: 0750 445 1339 Assoc. Prof. Dr. Rizgar S. Hussein

Email Address: engineertayib@yahoo.com…………………………………

First: Identifying information related to respondents

1. Gender: Male ☐ Female ☐

2. Age: 21 - 30 years ☐ 31– 40 years ☐ 41 – 50 years ☐ Over 50 years ☐

3. Education Level: Technical Diploma ☐ Bachelor ☐ Higher Diploma ☐ Master ☐ PhD ☐

4. Years of Service: 5 years and less ☐ 6 – 10 years ☐ 11 – 15 years ☐ 16 – 20 years ☐ More than 20 years ☐

5. Job Position: CEO ☐ Manager ☐ Supervisor ☐

7. City: ……………………………

Second: Research Variables

First Variable: excellence Manufacturing Performance:

1. Innovation:

No.	Statements	Strongly Agree	agree	Neutral	Disagree	Strongly Disagree Strongly Agree Disagree
1	Our recycling facility regularly integrates new technologies or innovative practices into the recycling process.					
2	A significant percentage of our facility's budget is allocated towards research and development for improving recycling processes.					
3	Recent innovations have significantly improved our recycling operations.					
4	Our facility encourages and supports innovative ideas from employees					
5	Our facility invests in research and development (R&D)					

2. Flexibility:

No.	Statements	Strongly Agree	agree	Neutral	Disagree	Strongly Disagree Strongly Agree Disagree
6	Our recycling facility can quickly adapt to changes in the types or volumes of materials being recycled.					
7	Our recycling operations can handle fluctuations in incoming recyclable materials without compromising efficiency.					
8	Our facility frequently adjusts its processes to accommodate new types of recyclable materials.					
9	Our facility responds to customization requests from clients effectively					
10	Our facility highly effective in managing production schedules to handle Unexpected disruptions.					

3. Quality:

No.	Statements	Strongly Agree	agree	Neutral	Disagree	Strongly Disagree Strongly Agree Disagree
11	The defect rate of processed materials in our facility is consistently low and meets recycling quality standards.					
12	Our facility has effective measures in place to ensure that recycled materials consistently meet the required quality standards.					

13	Our stakeholder are highly satisfied with the quality of recycled materials produced by our facility.					
14	Our facility conducts training programs focused on quality improvement					
15	Our facility handles customer complaints and feedback regarding our product quality.					
4. Productivity:						
No.	**Statements**	**Strongly Agree**	**agree**	**Neutral**	**Disagree**	**Strongly Disagree Strongly Agree Disagree**
16	Our facility processes a high average throughput of materials per day.					
17	The productivity of our recycling operations has significantly improved in the past year.					
18	We have effective strategies in place to improve the productivity of our recycling facility.					
19	Our facility manages time to ensure timely completion of manufacturing tasks effectively .					
20	Our company sets and achieves productivity targets effectively.					
5. Safety:						
No.	**Statements**	**Strongly Agree**	**agree**	**Neutral**	**Disagree**	**Strongly Disagree Strongly Agree Disagree**
21	Safety procedures occur frequently in our recycling facility.					
22	Our facility has effective measures in place to ensure the safety of workers.					
23	The overall safety culture within our recycling facility is excellent.					
24	Our organization review and update its safety policies and procedures according to approved standards.					
25	Our facility safety measures are highly effective in preventing workplace accidents.					

Second Variable: Knowledge Management Processes

1. Knowledge Acquisition:

No.	Statements	Strongly Agree	agree	Neutral	Disagree	Strongly Disagree Strongly Agree Disagree
1	Our facility's methods for acquiring new knowledge and information relevant to recycling processes are highly effective.					
2	Our facility frequently engages with external experts or sources to acquire new knowledge about recycling technologies and practices.					
3	The acquisition of new knowledge has significantly improved the overall manufacturing performance of our recycling facility.					
4	Our facility use market research and competitive analysis to inform its manufacturing strategies					
5	Our facility gather and utilize feedback from customers and suppliers to improve recycling operations					

2. Knowledge Creation:

No.	Statements	Strongly Agree	agree	Neutral	Disagree	Strongly Disagree Strongly Agree Disagree
6	Our facility frequently encourages the creation of new knowledge through research and development activities.					
7	Our facility is highly effective in creating innovative solutions to improve recycling processes and manufacturing performance.					
8	The creation of new knowledge has significantly improved efficiency in our recycling operations.					
9	Our facility support collaborative projects aimed at developing new recycling technologies or processes					
10	Our facility conduct internal training programs to foster the creation of new knowledge among employees					

3. Knowledge Sharing:

No.	Statements	Strongly Agree	agree	Neutral	agree	Strongly Disagree Strongly Agree Disagree
11	The mechanisms for knowledge sharing among employees in our facility are highly effective.					

12	Knowledge-sharing sessions or meetings are held frequently to disseminate important information about recycling processes.					
13	Knowledge sharing has significantly contributed to improving manufacturing performance in our recycling facility.					
14	The mechanism of our facility's processes for documenting and transferring tacit knowledge (unwritten-based knowledge) is highly effective					
15	Our facility utilize digital platforms (e.g., internet, knowledge portals) to share information and knowledge effectively					

4. Knowledge Storage:

No.	Statements	Strongly Agree	agree	Neutral	agree	Strongly Disagree Strongly Agree Disagree
16	Our facility is highly effective in storing and organizing knowledge and information related to recycling processes.					
17	Stored knowledge and information are easily accessible to employees who need it to perform their tasks.					
18	Effective knowledge storage has significantly improved the speed and accuracy of our manufacturing processes.					
19	Our facility ensures the security and integrity of stored knowledge and information effectively					
20	Our facility is highly effective in archiving processes in preserving valuable historical data related to manufacturing performance					

5. Knowledge Application:

No.	Statements	Strongly Agree	Disagree	Neutral	agree	Strongly Disagree Strongly Agree Disagree
21	Our facility effectively applies acquired and created knowledge to improve recycling processes and manufacturing performance.					
22	New knowledge and best practices are frequently implemented in our facility's operations.					
23	The application of new knowledge has led to measurable improvements in manufacturing performance metrics (e.g., efficiency, quality, cost).					
24	Our facility reviews and refines its manufacturing processes based on new knowledge and insights effectively					
25	Our facility is highly successful in implementing knowledge-based strategies to achieve better manufacturing outcomes in recycling					

Appendix (3)

CV

- Name: Tayib Kazho Ali
- Certification: bachelor degree in mechanical engineering
-Birth date: 11-1-1974
- Position: director of Erbil industrial development in the ministry of trade and industry in KRG .
- phone number: 07504451339
-Email address: engineertayib@yahoo.com
- Home address: Erbil -Baharka sub-district.

*** Languages:**

- Kurdish, Arabic, English, Turkish and Persian.

*** Work Experiences:**

- working as a director of Erbil industrial development since 2007 till now
- (2003 -2007) i have worked as head of mechanical department in ministry of housing and construction.
- (2000-2002) i have worked as a supervisor of deep well drilling team in ministry of reconstruction and development by coordinating with UNICEF organization .
- (1999-2000) i have worked in road and water projects in the ministry of reconstruction and development .

*** Training Course in other Countries :**

1- Project management course-south Korea 2005 2-protecting environment course -Germany 2009 3-local economic development course -Jordan 2011

4- Developing industrial zones course -Ankara turkey 2012 .

5- Local economic development course -Istanbul turkey with ILO organization.

6- Building and supervising and managing organized industrial zones 2013-bursa turkey .

7- Water treatment projects 2014 -Latvia

8- Wind turbine energy course 2017 -chena -India

9- Economic and industrial relations workshop 2017 -Hanover Germany .

10- Safety and security of dual used materials course 2023 -Amman Jordan .

11- Participating in many local economic and industrial activities such as workshops and seminars .

خلاصة

تهدف هذا البحث الى دراسة دور عمليات إدارة المعرفة في تعزيز أداء التصنيع المتميز في قطاع إعادة التدوير في إقليم كردستان العراق. واعتمادا على النهج الكمي، تم توزيع ١٠٠ استبيان بين القادة الإداريين لـــــ ٥٠ مصنعا في قطاع صناعة إعادة التدوير، باستخدام برنامج SPSS ونموذج الانحدار اللوجستي الثنائي Binary logistic Regression . تشير نتائج الدراسة إلى وجود تأثير إيجابي لعمليات إدارة المعرفة على التميز التشغيلي. كما تكشف النتائج أن المنظمات ستكون قادرة على تحسين عملياتها وتحسين الإنتاجية إذا تمكنت من الاستفادة من المعرفة التراكمية لموظفيها وتطبيقها. وبالتالي، فإن النموذج الإجمالي ذو دلالة إحصائية، كما هو موضح باحتمالية -2 Log likelihood of 38.66 anda Chi-square value of Nagelkerke R2 10.724(p=0.02)، مما يعني أن عمليات إدارة المعرفة في النموذج تفسر ٤٨٪ من التباين في أداء التصنيع. في الواقع، حددت هذه الدراسة أن تبادل المعرفة والتعاون بين الموظفين يطور نوعا من التآزر، مما يبالغ في فوائد مبادرات إدارة المعرفة. ومن خلال هذه الرؤى، تطور هذه الدراسة توصيات قابلة للتنفيذ للممارسين بشأن أولويات الاستثمار في أنظمة إدارة المعرفة وفي إشراك القيادة في عمليات إدارة المعرفة. إن بيئة المعرفة المشتركة والتعلم المستمر من المرجح جدا أن توفر أداء مستداما من خلال التحسينات. إن مواءمة مبادرات إدارة المعرفة مع الأهداف التنظيمية الأوسع وأهداف الاستدامة البيئية يمكن أن يعزز تأثير هذه الممارسات. في النهاية، يقدم هذا البحث خارطة طريق للاستفادة من إدارة المعرفة كأصل استراتيجي في السعي لتحقيق الكفاءة التشغيلية والاستدامة داخل قطاع إعادة التدوير.

الكلمات الرئيسية: إدارة المعرفة، أداء التصنيع، الانحدار اللوجستي الثنائي Binary logistic Regression ، إقليم كردستان. قطاع إعادة التدوير.

پوختە

ئامانجی ئەم نامەیە بریتییە لە لێکۆڵینەوە لە ڕۆڵی پرۆسەکانی بەڕێوەبردنی زانیاری لە بەرزکردنەوەی ئەدای بەرهەمهێنانی نایاب لە کەرتی ڕیسایکلین لە هەرێمی کوردستانی عێراق. بەپێی ڕێبازی چەندایەتی، ١٠٠ پرسیارنامە لە نێوان سەرکردە کارگێڕییەکانی ٥٠ کارگە لە کەرتی پیشەسازی ڕیسایکلکردندا دابەشکرا، بە بەکارهێنانی بەرنامەی SPSS و مۆدێلی پاشەکشەی لۆجستیکی دووانەیی Binary logistic Regression . ئەنجامەکانی توێژینەوەکە ئاماژە بە کاریگەری ئەرێنی پرۆسەکانی بەڕێوەبردنی زانیاری لەسەر باشی کارکردن دەکەن. هەروەها ئەنجامەکان ئاشکرای دەکەن کە ڕێکخراوەکان دەتوانن کارەکانیان و بەرهەمەکانیان باشتر بکەن ئەگەر بتوانن زانیاری کەڵەکەبووی کارمەندەکانیان بەکاربهێنن، لە ئەنجامدا، مۆدێلی گشتی لە ڕووی ئامارییەوە گرنگە، وەک بە ئەگەری -2 Log likelihood of 38.66 anda Chi-square value of 10.724(p=0.02), ٤٨٪ی Nagelkerke R2ی، واتە پرۆسەکانی بەڕێوەبردنی زانیاری لە مۆدێلەکەدا جیاوازی لە ئەدای بەرهەمهێناندا ڕوون دەکەنەوە. لەڕاستیدا، ئەم توێژینەوەیە دیاریکرد کە هاوبەشکردنی زانیاری و هاوکاری فەرمانبەر بۆ هاوپیشەکەی جۆرێک لە هاوکاری پەرەپێدەدات، کە زیادەڕەوی لە سوودەکانی دەستپێشخەرییەکانی بەڕێوەبردنی زانیاری دەکات. لەم تێگەیشتنانە، ئەم توێژینەوەیە پێشنیاری کردارییە بۆ سەرکردە کارگێڕییەکان لە ریسایکلین سەبارەت بە ئەولەویەتەکانی وەبەرهێنان لە سیستەمەکانی بەڕێوەبردنی زانین و لە بەشداریکردنی سەرکردایەتی لە پرۆسەکانی بەڕێوەبردنی زانین پەرەپێدەدات. ژینگەیەکی زانیاری هاوبەش و فێربوونی بەردەوام زۆر پێویست و کاریگەرە لە پێشکەشکردنی ئەدای بەردەوام لە ڕێگەی باشترکردنەوە. هاوتەریبکردنی دەستپێشخەرییەکانی بەڕێوەبردنی زانین لەگەڵ ئامانجە ڕێکخراوەییەکانی فراوانتر و ئامانجەکانی بەردەوامیی ژینگەیی دەتوانێت کاریگەرییەکانی ئەم پراکتیزانە زیاتر بەرز بکاتەوە. لە کۆتاییدا، ئەم توێژینەوەیە نەخشەڕێگایەک پێشکەش دەکات بۆ سەرمایەگوزاریکردن لە بەڕێوەبردنی زانیاری وەک سەرمایەیەکی ستراتیژی لە بەدواداچوونی کارایی و بەردەوامیی کارکردن لەناو کەرتی ڕیسایکلکردندا.

وشە سەرەکییەکان: بەڕێوەبردنی زانیاری، ئەدای بەرهەمهێنان، پاشەکشەی لۆجستیکی دووانەیی Binary logistic Regression ، هەرێمی کوردستان. کەرتی ڕیسایکلکردن.

ڕۆلی پرۆسەکانی بەڕێوەبردنی زانیاری
لە بەرزکردنەوەی ئەدای بەرهەمهێنان
لە پڕۆژە پیشەسازییەکانی ریسایکلین

لێکۆڵینەوەیەکی شیکارییە لە تێڕوانینی سەرکردە کارگێڕییەکان لە کەرتی ڕیسایکلکردن لە هەرێمی کوردستان – عێراق

نامەیەکە

پێشکەشی ئەنجوومەنی کۆلێژی تەکنیکی کارگێڕی هەولێر کراوە لە زانکۆی پۆلیتەکنیکی هەولێر وەکو بەشێک لە پێداویستییەکانی بەدەستهێنانی پلەی ماستەر لە تەکنیکی بەڕێوەبردنی کار

لە لایەن

طیب کەژۆ علی

بەکالۆریۆس لە ئەندازیاری میکانیک

ماستەر لە کارگێڕی کار

بەسەرپەرشتی

پرۆفیسۆری یاریدەدەر

د. رزگار سعید حسین

أربیل - کوردستان