LAPPEENRANTA-LAHTI UNIVERSITY OF TECHNOLOGY LUT
School of Engineering Science
Software Engineering
Master's Programme in Software Engineering and Digital Transformation (SEDT)

Azheganova Ekaterina

DEVELOPMENT OF A KNOWLEDGE MANAGEMENT SYSTEM IN OIL REFINING COMPANY

Examiners: Associate Professor Sami Hyrynsalmi
Assistant Professor Cand Sc. (Economic) Anastasia Levina

ABSTRACT

Lappeenranta-Lahti University of Technology
School of Engineering Science
Software Engineering
Master's Programme in Software Engineering and Digital Transformation (SEDT)

Azheganova Ekaterina

Development of a knowledge management system in oil refining company
Master's Thesis 2021

64 pages, 17 figures, 6 tables,
Examiners: Associate Professor Sami Hyrynsalmi
Assistant Professor Cand Sc. (Economic) Anastasia Levina
Keywords: enterprise knowledge management, digital enterprise,
knowledge management system, knowledge communities

The main question of the research is how to build a knowledge management system that would meet the needs of the oil refinery in question and allow optimizing its business processes that have unique specifics. In the course of this thesis, many literature sources were analyzed, as well as leading approaches and models of knowledge management were investigated. Further, based on the existing methods and analysis of the current situation of knowledge management in the oil enterprise, the concept of knowledge management system was graphically modeled. As a result, a knowledge management system was built, taking into account the specifics of the oil refinery and the conditions of digital transformation, and the prospects for further improvement and refinement of the built system were considered.

ACKNOWLEDGEMENTS

For the timely and constructive feedback during the entire period of work on the master's thesis, I would like to express my gratitude to the examiners: Associate Professor from Lappeenranta-Lahti University of Technology (LUT University) Sami Hyrynsalmi and Assistant Professor, Candidate of Sciences in Economics from Peter the Great St. Petersburg Polytechnic University (SPbPU) Anastasia Levina.

TABLE OF CONTENTS

1 INTRODUCTION 3

1.1 KNOWLEDGE TYPES 4

1.2 KNOWLEDGE MANAGEMENT PROCESS 6

1.3 APPROACHES TO KNOWLEDGE MANAGEMENT 10

1.4 KNOWLEDGE MANAGEMENT MODELS 20

2 KNOWLEDGE MANAGEMENT IN OIL REFINING COMPANY 47

2.1 BRIEF DESCRIPTION OF THE COMPANY AND ITS CURRENT KM STATUS 47

2.2 SHORTCOMINGS OF THE CURRENT KM STATUS. BUSINESS NEEDS 48

3 DEVELOPMENT OF A CORPORATE KNOWLEDGE MANAGEMENT SYSTEM IN OIL REFINING COMPANY 51

3.1 KNOWLEDGE MANAGEMENT SYSTEM CONCEPT 51

4 DISCUSSION AND CONCLUSIONS 56

5 SUMMARY 57

REFERENCES 59

LIST OF SYMBOLS AND ABBREVIATIONS

KM	Knowledge Management
KMS	Knowledge Management System

1 INTRODUCTION

Knowledge management helps companies in making prompt and effective decisions. In the era of digitalization and high competitiveness, progressive organizations strive to have a single knowledge base that consists of employees' current and previous experience and developments. When all employees are provided with access to this single database, the company gets at its disposal the strongest weapon – more intelligent and qualified workforce who, based on the knowledge available to them, are able to act quickly and reasonably, bringing significant benefits.

Furthermore, knowledge management makes the company more flexible and allows it to respond faster to changes and innovations that arise in the digital world. The accumulated knowledge base facilitates the process of implementing new technologies, provides an opportunity to anticipate possible problems in advance and extract the maximum benefit from new information.

The necessity to streamline the knowledge management process in the company may arise for various reasons. For example, after the retirement of «star» employees, there is a need to retain their knowledge and keep it inside the company. When recruiting new staff, knowledge management can also help in training newcomers. Also, during a company takeover or merger, there is often an urge to retain existing knowledge and encourage teams to share experiences.

With the development of digital technologies, the problem of transferring the knowledge of employees and teams within the company is becoming more and more relevant. In the digital age, the speed of response and decision-making is more important than ever, it actually determines the success of a company in the market and its ability to survive and adapt. That is why the «bites» of company's accumulated knowledge are associated with great risk.

These bites of knowledge are collected by the company in the process of work. It can be, for example, information about customers and markets, algorithms and ways to solve certain tasks and problems, as well as various methods for managing projects and employees. The combination of this accumulated knowledge and experience determines the success of the company, how fast it will be able to resolve the difficulties.

For the company in the era of digitalization, the question becomes relevant: how to create a single base that will store, accumulate and update knowledge, and ensure the success of our company in the long term?

1.1 Knowledge types

In order to create such a unified knowledge base, the company needs to understand what forms of knowledge can be and how to distinguish these forms from each other. The success of the company's future knowledge management strategy depends on the extent to which the company has a complete understanding of the various knowledge types it has. For example, the information that is stored in the files and documents must be managed differently compared to the professional knowledge and experience gathered by employees during their work in the company.

In theory, there are two types of accumulated knowledge: explicit and tacit. Explicit knowledge is formalized and codified. It is stored in documentation, records, databases, etc. Tacit knowledge is intuitive and usually non-regulated. This knowledge is based on personal experience and observations, specifically, individual skills, new ideas, personal opinions and attitudes to something, etc. (fig. 1.) [1,2].

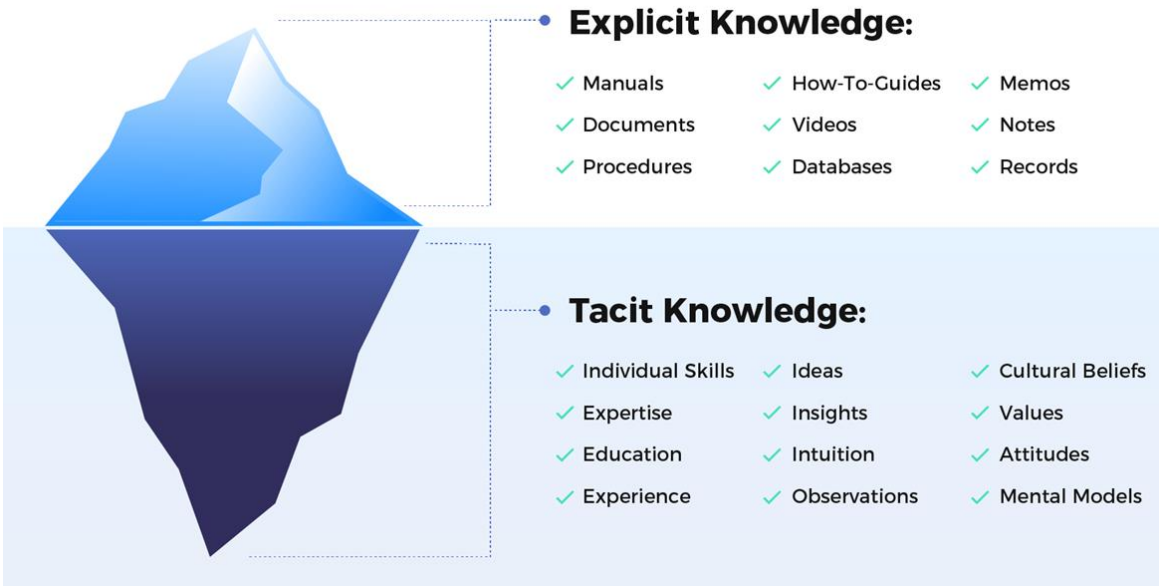

Figure 1. Knowledge types

The concept of knowledge management, which originated in the early 90s, is based on the interaction of these two types [2] The sphere of interaction between explicit and tacit knowledge is quite wide. In practice, knowledge combines explicit and tacit elements, so they should be considered together, not separately [1]. But to understand how knowledge is formed, a company needs to have a theoretical understanding of these two opposite types.

In some sources, embedded knowledge is also included in a separate category as part of tacit knowledge. Embedded knowledge is embodied in the company's processes, corporate

culture and everyday life [3]. This additional category is important in terms of the requirements for managing such knowledge, which may differ from the first two types outlined above.

In the digital world, the process of managing each of the three types of knowledge has its own difficulties. Regarding explicit knowledge, due to its structure and formalization, it is easy enough to define, extract or just accumulate it [4]. The challenges in managing explicit knowledge for a company are to:

- Ensure the safe keeping of important knowledge;
- provide employees with timely access to the necessary information;
- keep the knowledge base updated regularly, review existing and remove irrelevant data.

Some researchers, e.g. Cook and Brown, are of the opinion that it is easier to manage explicit knowledge, because it's more simple in nature. For this knowledge, it will be enough to have special information support and software [5-7]. Some companies, when implementing knowledge management initiatives, often focus only on explicit knowledge by mistake, because it is more tangible. Explicit knowledge does not contain the know-how and personal experience that create a competitive advantage, therefore companies should shift their focus and pay more attention to comprehensive management with a bias towards tacit, unique knowledge.

Tacit knowledge is closely related to context and personal characteristics, so it is not easy to transfer [1]. Tacit knowledge is of the great value, because it has a lot of hidden potential, and with the proper ability to accumulate and manage it, the company can most likely make a breakthrough [8]. A company's low interest in tacit knowledge reduces its potential for development and innovation, as well as its competitiveness [9,10]. The difficulty of managing tacit knowledge for the company is that existing management systems are not able to transmit the intuitive understanding and experience of the employee. Due to the intangible nature of this knowledge, it is almost impossible to formalize it in any way and transfer to the documentation for sharing. The tacit knowledge of employees is a valuable asset. To successfully manage it, the company should «manually» operate the tacit domain, using IT as auxiliary tool.

Embedded knowledge, as a part of tacit knowledge, also has its own management nuances. The sources of such knowledge may be explicit – the rules prescribed in the corporate charter, but the knowledge itself is not explicit, i.e. at first sight it's not obvious why compliance with these rules will benefit the company. Embedded knowledge is embodied in culture, products, processes, and can be collected in both formalized and free form. For example, by management initiative of the company, a specific process can be formalized, but the nature of the internal process mechanisms might be informal [9,10]. The obstacle in managing embedded knowledge lies in the choice of management approach. Depending on how this knowledge is accumulated, the principles of its management differ. The company's culture and internal processes can be difficult to understand and change. Yet, it's much easier to cope with any formal operations integrated into products and procedures. For instance, IT may be used to define company knowledge areas and support corporate culture and processes. Information technology can also help in getting hidden embedded knowledge from the product, decomposing it into data components. Since not everyone can effectively manage the embedded knowledge, then those companies that successfully pull off this task will gain another significant competitive advantage.

1.2 Knowledge management process

Key KM components. Once the company has identified what types of knowledge it has, it can start developing a comprehensive knowledge management framework. This framework connects company's internal elements and provides a free exchange of knowledge within it. Regardless of the company size and requirements, industry, or knowledge, the key KM framework elements are content, process, people, technology, and strategy, which brings together all the previous ones. To develop an effective framework, the company needs to fully understand each element in order to build their interaction in the best possible way and «free» the knowledge [11,12] (fig. 2).

Content. This is the knowledge that the company is planning to use in its daily life, or in the future. Content can be anything from video instructions and official documentation to various unstructured information and experiences that employees share with each other. Content is very important in the context of knowledge management. If the company is smart in creating content and knows where to use it, this makes internal processes and collaboration much easier for both individual employees and departments. Unless the company does not pay due attention to content management, "self-management" occurs.

Employees make and use content, but, for example, do not open access to it, or recreate existing documents and reuse irrelevant information and wrong data.

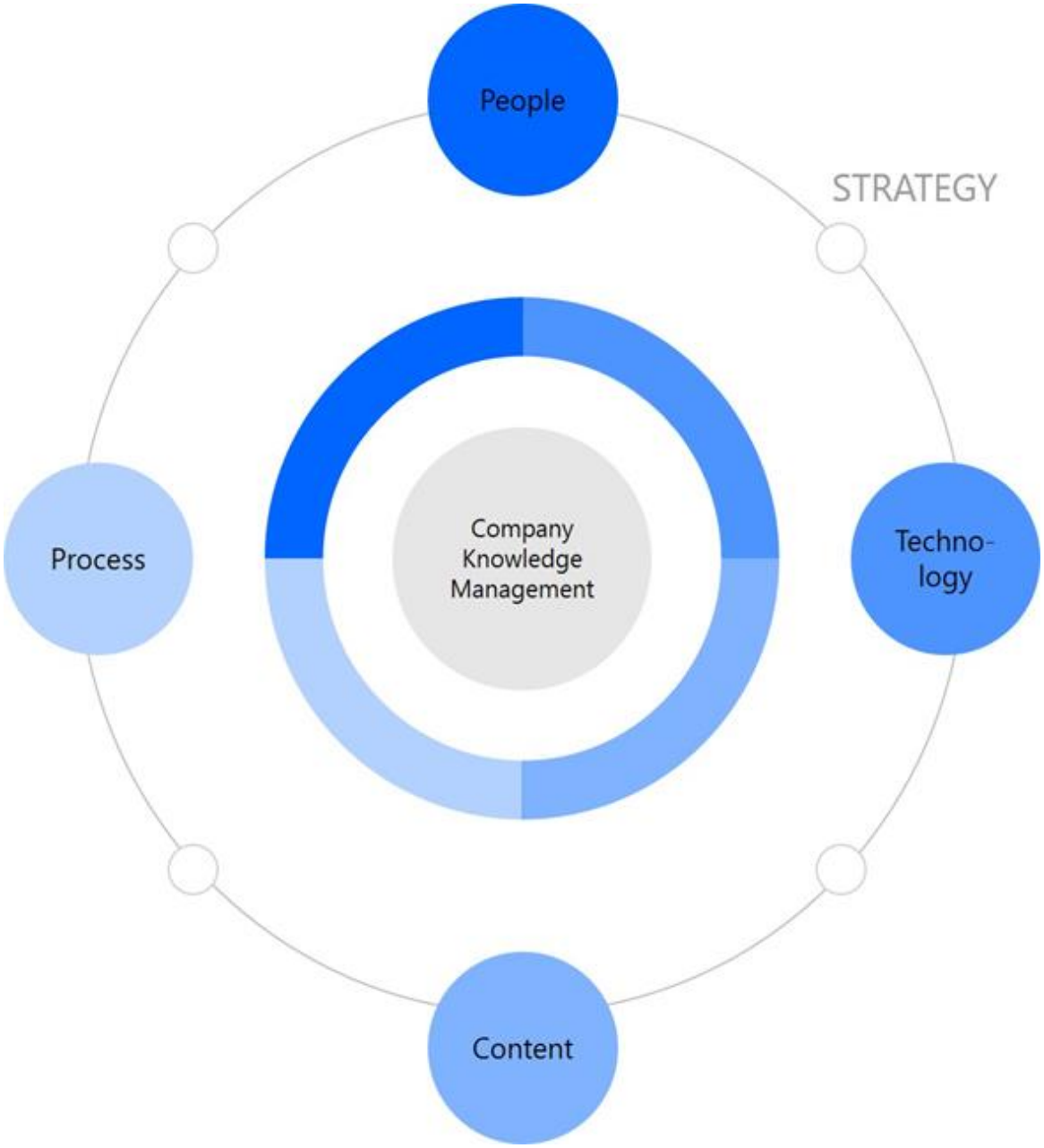

Figure 2. Knowledge management framework

Processes. Knowledge flows in every company and is embedded in its business processes. However, knowledge management is also a separate group of processes that a company must integrate into the business to achieve success. In essence, knowledge management processes are those actions that help a company cope with the flow of knowledge at various development stages. KM consists of 7 key processes that help knowledge flow freely in the company [7] (fig. 3):

1. Create. New knowledge is constantly being created in any company every day.
2. Identify. The company should identify the key knowledge to develop its strategy and business.
3. Collect. In order to share valuable information in the future, as well as to pass on current developments to employees, the company needs to collect knowledge.
4. Review. For successful management, the company has to regularly review current knowledge and evaluate how relevant and applicable it is. This helps to avoid a situation where employees continue using already irrelevant data or outdated practices.
5. Share. To ensure that knowledge is regularly updated and supplemented, employees must openly share it with each other through the intranet, while attending corporate events, as well as using documentation.
6. Access. The company can provide access to knowledge in different ways, for example, through notifications and different data access levels, or employees can search for the necessary information on the intranet or other sources.
7. Use. The company should be able to intelligently apply its existing knowledge in order to make more balanced, well-thought-out decisions and quickly deal with emerging problems.

Figure 3. Knowledge management processes

If a company properly develops KM framework and activities, it can easily review its knowledge management processes, identify and fix bottlenecks, while continuing to maintain the knowledge flow. KM processes help to build and establish communication between employees and departments, as well as increase the efficiency of decision-making.

People. In fact, the entire success of knowledge management in a company depends on the extent to which employees are willing to share their knowledge and experience [13]. Therefore, the level of trust in the company also plays a big role. If employees do not trust initiatives, then all KM efforts will be a waste of time. Large companies need to do more for adapting knowledge management initiatives, as the larger the organization, the weaker the communication and trust between employees, because they are much less likely to contact each other [6]. A company that wants to succeed in KM has to win the trust of employees and, as much as possible, make it easier for them to share knowledge.

Technology. It is a tool that helps a company manage its knowledge. Technologies support context and facilitate access to information, as well as speed up the process of data extraction and exchange, and ensure reliable data storage. Previously, companies could successfully manage knowledge without IT involvement [14:15]. However, now, in the digital age, it's not possible. Technologies allow to capture knowledge more quickly and efficiently. They are especially important in international companies while managing knowledge at the global level, when branches are located in different countries [13;15].

Strategy. An element that binds all the components together. Strategy is a key element, because it sets the direction, the course, where the company will move in the context of knowledge management. The strategy ensures that knowledge management is aligned with business needs, targeted at the right objectives, and consistent with other changes in the company. As part of the company KM strategy, it is necessary to clearly formulate the goal, determine what business problems are based on knowledge, view what knowledge resources the company has, analyze the situation and understand what can be done with knowledge and its artifacts in this case, and how to manage it [16].

The next step after the company has understood the main components and mechanisms of the knowledge flow is to choose a management approach. To decide how the company will manage, it needs to consider the existing approaches and choose the most appropriate one for itself.

1.3 Approaches to Knowledge Management

At the moment, there are two main approaches to knowledge management: process and practical. Practice approach is people-intensive, while process method relies more heavily on technology.

The *process* approach focuses on the explicit knowledge that is embedded in business processes. Companies that use this approach to a greater extent tend to have clear, formalized policies for data management and processing. The main tools for working with knowledge in the process approach are information technologies and systems that companies apply to optimize their management. These technologies include, for example, corporate networks, intranet, knowledge repositories, data warehouses, decision support systems, group software etc.

The process approach is best suited to those companies whose products or services are mass-produced and not unique. Usually all the processes built around such regular products are already organized and transparent, as is the nature of knowledge embedded in these processes. In order to manage such knowledge, the company does not need a complex internal ecosystem, technology does the job well.

The *practical* KM approach centers on company's tacit knowledge, which cannot be transferred by any formal ways. Since the nature of tacit knowledge is much more complex, this approach is about building an ecosystem, creating various communities that promote free knowledge sharing. It's the main difference between practical and process approach. The practical approach is commonly used by companies that provide custom solutions for their clients. The unique knowledge they generate is difficult to capture and consolidate. In such companies, the most intensive knowledge exchange takes place by personal contacts. In order for the practical approach to develop successfully, companies that use it invest large sums in creating their own internal communication space – knowledge ecosystem. The space for sharing knowledge can be both real and virtual. Virtual ecosystems created via information technologies enable employees to exchange knowledge in a virtual space. The main characteristics of both approaches are presented in table 1:

Table 1. Comparing Process and Practice KM Approaches

	Process Approach	**Practice Approach**
Type of knowledge supported	Explicit knowledge – formalized and contained in business processes	Tacit knowledge – difficult to capture and systemize
Way of transferring	Formal procedures with a strong focus on IT for knowledge transfer	Informal communities and social groups where knowledge is transferred by personal or virtual communication
Benefits	Structured use of ideas and knowledge makes it easy to consolidate and reuse them	A space for sharing ideas and valuable tacit knowledge increases company's flexibility in a changing environment
Disadvantages	Ignores tacit knowledge, limits innovations, and encourages patterned actions	May be inefficient: many ideas, but no execution structure and no support
Role of information technology	Link separate formal knowledge with each other	Used as a collaboration tool to ease transfer of tacit knowledge

It should be noted that process and practical approaches do not contradict each other, and to achieve success in the field of knowledge management, the company should harmoniously combine elements of both approaches. There is a continuous tension and balancing act between the need for IT and the need to focus on people [17].

Most «self-made» KM approaches fall into one or more of four categories: self - service, lessons learned, communities of practice, and the facilitated transfer of best practices (figure 4) [17]. The categories of approaches vary by how much they focus on explicit and tacit knowledge and how much human interaction or facilitation is involved [18;19]:

1. *Self - service.* Help employees of the organization with access to the necessary knowledge. Thus, they can search and view various information directly during the discussion. The main purpose of self-service is to facilitate the interaction of employees in the workplace with the sources of knowledge that they need for further successful work. Using various self-service tools: corporate portals, search tools, intranet, etc. – employees themselves extract and master the necessary knowledge. This item should be included in any knowledge management initiative.

2. *Lessons learned.* This approach gives the company's employees the opportunity to better assimilate and record the knowledge they have already acquired, as well as to re-apply it if necessary and pass it on to their colleagues. The approach provides space to effectively reuse the lessons that employees have learned from their previous work experience. The specifics of its application in the organization is that employees analyze their actions and the results of important events that occur to them. In the process of analysis, they learn from their own experience, find out the main reasons for their successes and failures, take measures to avoid repeating their mistakes in the future, study best practices and gain experience from leading experts or organizations. The company also needs to encourage employees to pass on the knowledge, skills, and lessons learned to their colleagues, who in turn will apply this information to their situation. The lessons learned approach is suitable for use in almost any organization, except those working in high-risk industries where mistakes have to be paid for, for example, in the defense industry, in the aerospace and oil and gas industries, in high-risk and emergency areas, etc.
3. *Communities of practice.* Communities of practice, sometimes referred to as networks, include active and proactive employees of the organization who come together to solve various problems and share useful knowledge, skills and experiences. Communities of practice can be both physical (clubs) and virtual (video conferences). They are mostly formalized and focus on the professional development of their members. This approach is used most often in organizations and is also one of the key elements of any knowledge management program.
4. *Transfer of best practices.* This approach is to find and disseminate successful practices between the departments of the organization. This allows you to align all organizational units and keep their productivity at a high level. The stability and reliability of the knowledge transfer process is ensured by training and mentoring in a structured methodology, as well as formal assistance. Of all the above, this approach is the most profitable, because it is sharpened for the application and use of proven practices. The most successful transfer of best practices will be in organizations that produce mass-produced standard products, whose divisions work similarly (most often companies from the industry or retail trade) or in those where all operating divisions operate in accordance with a single global process (finance, construction, engineering, etc.).

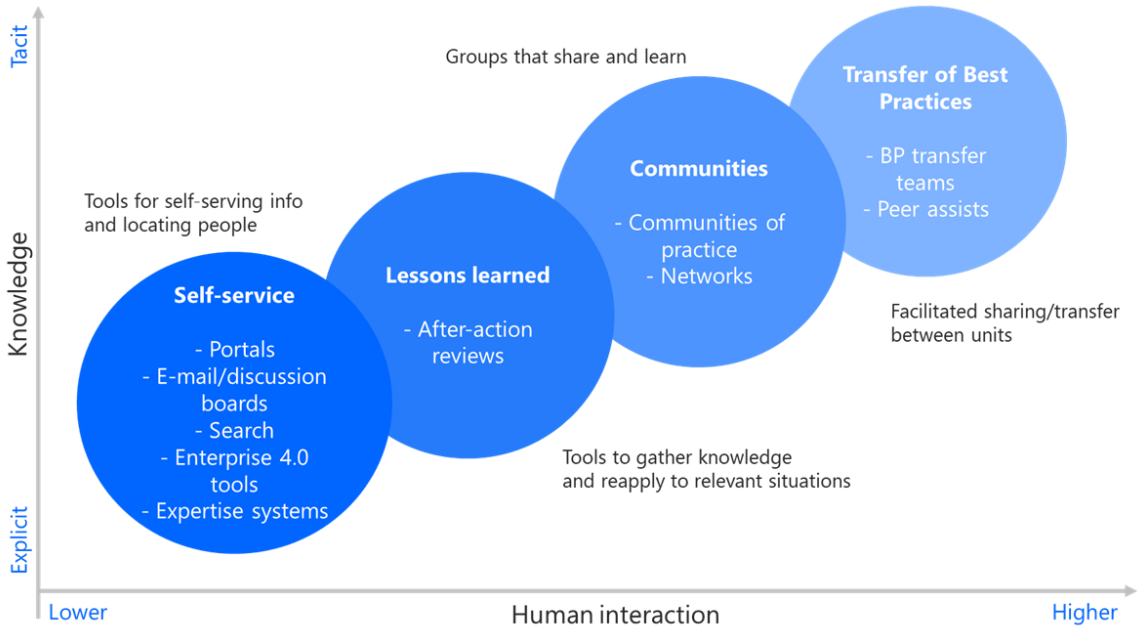

Figure 4. Categories of KM approaches

Many approaches to knowledge management, such as communities of practice, have been used for a long time and are well established. Other tools, such as intra-corporate social networks, are still gaining momentum and have great potential for development.

The answers to the questions below will help the organization determine which approaches are best suited for its knowledge management, as well as what key knowledge assets and capabilities it has [20]:

1. Is the key knowledge tacit or explicit?
2. What type of knowledge transformation is required?

– Tacit-to-explicit
– Tacit-to-tacit
– Explicit-to-tacit
– Explicit-to-explicit

3. What is the main activity?

– Production
– Designing
– Scientific and technical, for example, engineering or research activities
– Customer focus, for example, sales
– Problem solving, for example, help desks

4. How do employees interact with each other? Are there working communities or networks that can be used?
5. What are the qualities of employees and working conditions that influence the structure of knowledge sharing?

– Experience working together
– Cultural, regional, and language differences

6. Is it possible to apply existing tools? How well-developed is the IT infrastructure? What tools do employees currently use?
7. Are there any resources available to develop and maintain knowledge management approaches?

– Centralized resources
– Involving departments

8. What is the reason for using knowledge management approaches, is the organization in a crisis situation, or is it just working for a long-term perspective?
9. What results does the organization want to achieve? In what time frame? What does the organization think the successful implementation of knowledge management approaches will mean? Does the organization have any business measures that will be improved as a result of the approaches?

The first two questions will help the organization determine the nature of its knowledge and how it will be transformed. The answers to the following questions will give you an idea of how extensive and ambitious knowledge management initiatives can be in a particular organization. The above algorithm of questions should be passed each time when considering a new approach to knowledge management for a better understanding of how the implementation process will take place. Together, the answers to these questions will provide a complete picture of the nature of knowledge, the availability of the necessary resources, and the people interested in implementing knowledge management approaches.

Classic knowledge management approaches. Classical approaches are those that have already proven themselves over a fairly long time of the existence of knowledge management as a discipline. Using proven classical approaches, the organization takes fewer risks and gets results faster. To successfully develop the concept of knowledge management, along with the classical approaches of the organization, it is necessary to use the lessons learned by earlier followers, as well as best practices-based application guidelines, and incorporate them into its business case. The classic approaches to knowledge management,

such as lessons learned, best practices transfer, and communities of practice, will be discussed in more detail later, as they have proven over time that their use brings measurable and sustainable benefits to the organization [21].

Communities of Practice. The community of practitioners has many different functions for working with knowledge, including searching, collecting, storing and transmitting the necessary information. Communities allow employees to connect to the right sources at the right time, capture and deliver the right content during an interaction, and store it for later use. [21, 22]. Below is a list of what communities of practice as an approach can bring to an organization:

- Help to create a global knowledge base in the organization by combining and translating individual local practices into a common concept.
- Support and strengthen internal communication, exchange of ideas, and collaboration between individual employees and departments.
- Erases time, geographical, cultural, and process boundaries.
- Provides an innovative advantage and reaction speed for market leadership.
- Integrates into the structure of business processes and value chains, strengthening the management cycle.
- Coordinates successfully with formal management structures.

At the group level, communities of practice help employees build effective communication and increase their interest in organizational knowledge management initiatives. Community members learn from each other, learn from each other, and learn about various topics that are relevant to them and to the organization. Belonging to communities plays an important role in both the professional and personal development of employees, especially in large companies with a large number of divisions, both local and international.

It should be emphasized that communities of practice are also the driving force and generator of best practices, as community members constantly offer and explore fresh ideas. Thus, community members identify and voice promising ideas that can potentially solve a problem or optimize organizational processes. Based on the proposed ideas, representatives of the organization's expert groups can then approve and adopt the best of them. (fig. 5).

In organizations that actively use best practices and benchmarking, communities of practice are also necessarily present and are an important tool for achieving business goals, solving common problems, creating an innovative environment, and preventing failures. Such

organizations have well-established management processes and resources to support their communities of employees in different regions and countries. Also, sub-levels or various local communities with special interests can be created within large communities. Communities are clearly aligned with the organization's global strategy and business objectives, and their effectiveness is measured by a specific set of indicators that help better demonstrate the value of using communities to the company's top management.

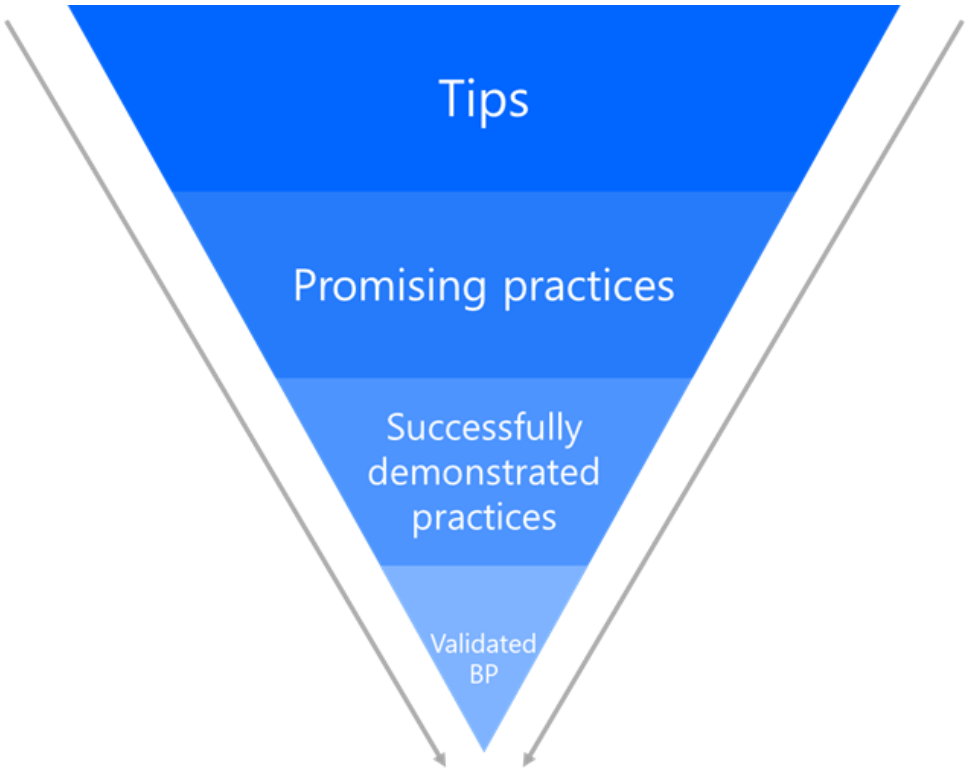

Figure 5. Continuum of Knowledge Shared in Communities of Practice

Lessons Learned. As mentioned above, the concept of lessons learned helps to preserve the collective achievements, as well as previous organizational experience and practice. This approach provides an opportunity to collect knowledge on the results of projects by analyzing their stages, as well as on other events or activities, so that this knowledge can then be applied in similar cases and avoid new mistakes. The lessons-learned approach usually requires the organization to answer the following questions:

1. What should have been the result of the event/project?
2. What result did the organization actually get?
3. What caused the difference between the plan and the fact?
4. Who else might need this information?

This approach solves the two main problems of any approach to knowledge management, which are the involvement of employees in the process, as well as the reluctance of employees to reuse the knowledge already acquired. When employees focus on specific processes or projects, they are already automatically interested in a well-coordinated team work. And the study of these processes or projects gives the project team a context for interaction, a built-in experience base, and a goal for repeated application of the lessons learned in the organization. Lessons - learned method helps organization to:

- Move away from information redundancy and repetition.
- Produce products or services of higher quality with less manufacturing time and fewer failures and errors.
- Create standards based on your own best practices and optimize your operations, increasing productivity and reducing costs.
- Improve the skills of employees, reduce the average time allotted for training, and integrate training initiatives into the life cycle.
- Make the process of knowledge sharing a part of the corporate culture.

Yet, for all their popularity, lessons - learned approaches regularly fail to deliver the intended results. Lessons may be captured, but they are often not absorbed or applied even within the same project, much less elsewhere in an organization.

Not every organization will have this advantage, but a process management orientation drives and enhances a lessons -learned approach. A standardized process management approach also increases the likelihood that an improvement resulting from a lesson will transfer easily to other parts of your organization. Less translation has to take place for the lesson to f t into other areas or situations.

However, despite the fact that this approach is also widely used, it does not produce the desired results on a regular basis. This is due to the fact that although employees learn certain lessons, in order to re-use them, if not within the entire organization, then at least one project, it requires the interest of employees. The human factor plays a big role in this approach, and with all motivational measures, it is still very difficult to control it. Not every organization can do this, but there are some aspects that can strengthen this approach, including a focus on process management. Process management increases the possibility that the knowledge learned from the lessons will be transferred by employees to other departments and areas. Another aspect is the integration of the process of lessons learned into the business

environment of the organization, in particular in operational processes and projects. In this case, repeatedly referring to the lessons will be an important part of the workflow, so employees will naturally do this by using the lessons as a guide. At the same time, employees will come to understand that changes in strategy and project management occur as a result of analyzing organizational lessons.

Transfer of Best Practices. An important competitive advantage for an organization is the ability to quickly discover and apply best practices. No matter in which area the company operates, the application of best practices has a number of important advantages, such as increasing customer satisfaction, reducing the time to produce products or services, increasing the speed and quality of decision-making, reducing costs, lower risks, etc. When employees share best practices in different departments and parts of the organization, they accumulate theoretical knowledge, personal experience, and receive confirmation of certain assumptions and actions. Applying the internal corporate theory in practice, other employees of the organization get the opportunity to learn more effectively. However, the transfer of best practices within the company is quite a time-consuming process, which involves the development of an organized strategy and its strict compliance, as well as the availability of a significant amount of necessary resources and the removal of obstacles in the transfer process. The conditions for the successful transfer of best practices in the organization are as follows [21,22]:

- There is an explicit and standard transfer process in place.
- The transfer approach is available for use throughout the organization.
- A central group facilitates the transfer approach.
- Designated roles and significant resources are devoted to the transfer approach.
- Transfer or replication is integrated with other improvement initiatives.

Three situations in which a transfer approach is appropriate: when the business model entails leveraging a fixed set of resources through cost minimization; when the business model requires a standardized approach in multiple markets; and when cost reduction, quality enhancement, or consistency of customer (or employee) experience is an important driver. When the business model meets one or more of the aforementioned situations, the decision to invest in systematic transfer programs hinges on the potential return on investment.

Once the business case is clear, it is important to develop a transfer process appropriate to organization. A systematic and robust transfer process usually includes steps to:

1. Identify best practices
2. Capture or document tacit and explicit knowledge
3. Review, evaluate, or validate the practices
4. Communicate and share the practices, possibly including enabling a dialogue or exchange between a potential recipient and the source of the practice
5. Provide support to help a recipient adapt or adopt the practices

An examination of critical success factors is especially important for this method because knowledge and best practices exist in every organization, yet employees rarely share them. And even when they do share them, practices are not necessarily implemented. The challenges might involve time, process ambiguity, a lack of incentive, culture, ego, skepticism, or even a lack of awareness of the practices. To address these challenges, some critical success factors follow:

1. Consider more than just direct site-to-site transfer between a single source and recipients. You can mediate site-to-site transfer using a core team, experts, or standing communities that identify, validate, and disseminate practices.
2. Adapt the approach to organization. Transfer models vary by how you define, identify, or create best practices; the role of validation through which you deem a practice best; whether adoption of the practice is mandatory or voluntary; and the extent of support you provide for adoption.
3. Look for opportunities to include best practices transfer within any organization - wide process improvement efforts. In some organizations, there is a convergence of KM tools and principles with rigorous process improvement methodologies, including Six Sigma and process reengineering techniques. The improvement methodology plays a role in defining and codifying the practice, as well as supporting its implementation.
4. Secure strong involvement and encouragement from senior leadership, robust change management strategies (especially for mandatory adoption), and extensive resources and staffing to support the transfer itself.
5. Prepare for mandatory adoption to require more facilitation and rigor. The costs will be higher than for models allowing voluntary adoption. Mandatory adoption is a characteristic of a process standardization approach.
6. You need a defined organizational unit to support the transfer of best practices and enable clearly designated roles and accountability.

7. Use outcome measures more often than other KM approaches.

Surrounding these proven classic KM approaches is the infrastructure necessary to support them. Also KM is not static and what keeps it exciting and fresh is the way KM implementers respond to the cultural forces swirling around. Approaches emerging out of social computing hold great promise to provide new ways of achieving KM long-held objectives.

1.4 Knowledge management models

It would seem that after the company has studied KM process and basic approaches to knowledge management, it can safely get down to business and develop its own strategy. However, this is not the case. For a company's knowledge management initiative to be successful, it requires a solid theoretical foundation. In order to build their own KM processes, described in the previous chapter, the company needs a conceptual framework. Otherwise, its knowledge management processes will not be properly coordinated and the company won't receive the expected benefits [27].

Among plenty of theoretical KM models only 6 have become generally accepted and are widely applied in practice. All of these models, which will be discussed further, reflect different perspectives on how the main elements of KM framework interact. Knowledge management models help to understand how knowledge is formed and flows in a particular company. [24;27]

SECI (Spiral) model by Nonaka and Takeuchi (fig. 6). The first model that has received widespread scientific recognition and practical application is SECI. SECI model was originally created by Ikujiro Nonaka in the 90s, and later modified by Takeuchi. The professors created this model based on the experience of Japanese companies, which they studied for a long time for the emergence of innovations and creative ideas.

In their observations, Nonaka and Takeuchi concluded that Japanese corporate culture, as well as the internal beliefs of Japanese employees, encourage the exchange of tacit knowledge. In a Japanese company, knowledge is shared, easily transformed, transferred, and distributed [23]

Nonaka and Takeuchi (1995) studied the success of Japanese companies in achieving creativity and innovation. They quickly found that it was far from a mechanistic processing of objective knowledge. Instead, they discovered that organizational innovation often stemmed from highly subjective insights that can best be described in the form of metaphors,

slogans, or symbols. The Nonaka and Takeuchi model of KM has its roots in a holistic model of knowledge creation and the management of "serendipity." The tacit/explicit spectrum of knowledge forms (the epistemological dimension) and the individual/group/organizational or three-tier model of knowledge sharing and diffusion (the ontological dimension) are both needed in order to create knowledge and produce innovation.

Nonaka and Takeuchi argue that a key factor behind the Japanese enterprises' successful track record in innovation stems from the more tacit-driven approach to knowledge management. They maintain that Western culture considers knower and known as separate entities (harkening back to the cognitivist approach, which places greater importance on communicating and storing explicit knowledge). In contrast, the Japanese, through the structural characteristics of their language and through influences such as Zen Buddhism, believe in the oneness of humanity and nature, body and mind, self and other [23]. Accordingly, it may be easier for Japanese managers to engage in the process of "indwelling," a term used by Polanyi to define the individual's involvement with objects through self-involvement and commitment, in order to create knowledge. In such a cultural environment, knowledge is principally "group knowledge," easily converted and mobilized (from tacit to explicit, along the epistemological dimension) and easily transferred and shared (along the individual to the group to the organization, in the ontological dimension).

Nonaka and Takeuchi underline the necessity of integrating the two approaches, from the cultural, epistemological, and organizational points of view, in order to acquire new cultural and operational tools for better knowledge-creating organizations. Their construct of the hypertext organization formalizes the need for integrating the traditionally opposed concepts of Western and Japanese schools of thought.

The Knowledge Creation Process Knowledge creation always begins with the individual. A brilliant researcher, for example, has an insight that ultimately leads to a patent. Or a middle manager has an intuition about market trends that becomes the catalyst for an important new product concept. Similarly, a shop floor worker draws upon years of experience to come up with a process innovation that saves the company millions of dollars. In each of these scenarios, an individual's personal, private knowledge (predominately tacit in nature) is translated into valuable, public organizational knowledge. Making personal knowledge available to others in the company is at the core of this KM model. This type of knowledge creation process takes place continuously and occurs at all levels of the organization. In many cases, the creation of knowledge happens in an unexpected or unplanned way.

According to Nonaka and Takeuchi, there are four modes of knowledge conversion that: constitute the “engine” of the entire knowledge-creation process. These modes are what the individual experiences. They are also the mechanisms by which individual knowledge gets articulated and “amplified” into and throughout the organization). Organizational knowledge creation, therefore, should be understood as a process that organizationally amplifies the knowledge created by individuals and crystallizes it as a part of the knowledge network of the organization. Knowledge creation consists of a social process between individuals in which knowledge transformation is not simply a unidirectional process but it is interactive and spiral.

Knowledge Conversion. The SECI model focuses on creation and spread of knowledge. It describes how explicit and tacit knowledge can be transformed within a company. SECI shows the dynamic interaction of two dimensions: ontological and epistemological. Epistemological dimension contains four main processes of knowledge transformation. Ontological describes the knowledge levels in the context of employee interaction. When knowledge goes through all 4 exchange forms, it expands and moves to higher ontological levels in a spiral. Initially, the idea may arise from one employee, then it’s promoted by the team, after that it reaches various departments and units, and may even go beyond being transferred to another company (NonakagTakeuchi 1995, Dalkir Wilde). There are four modes of knowledge conversion, as illustrated in figure 6 [24]

1. Tacit-to-tacit: the process of socialization.
2. Tacit-to-explicit: externalization.
3. Explicit-to-explicit: combination.
4. Explicit-to-tacit: internalization.

Socialization (tacit to tacit) – the exchange of implicit knowledge and experience through observation, imitation, and trial-and-error. For example, this can be a mentor-junior employee interaction, client communication, brainstorming with colleagues, or working together with another department or work group [28].

Socialization is among the easiest forms of exchanging knowledge because it is what we do instinctively when we gather at the coffee machine or engage in impromptu corridor meetings.

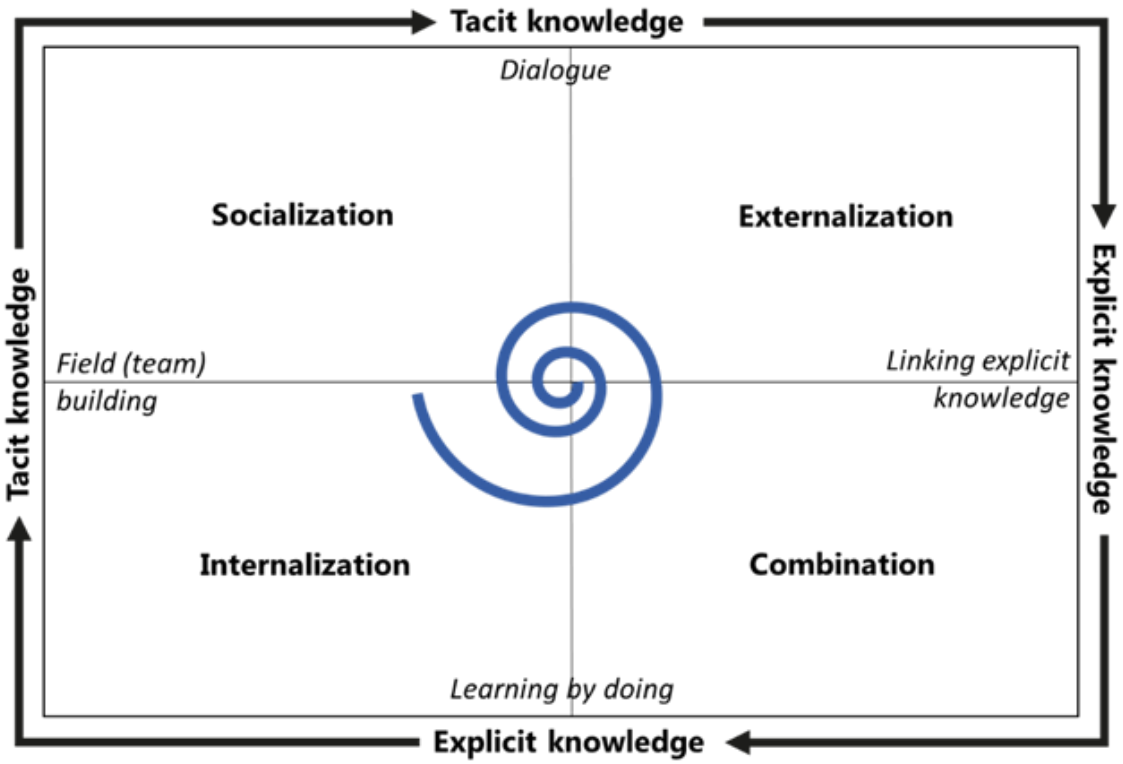

Figure 6. SECI model by Nonaka and Takeuchi

The greatest advantage of socialization is also its greatest drawback: because knowledge remains tacit, it is rarely captured, noted, or written down anywhere. It remains in the minds of the original participants. Although socialization is a very effective means of knowledge creation and sharing, it is one of the more limited means. It is also very difficult and time consuming to disseminate all knowledge using only this mode.

Externalization (tacit to explicit) – publishing and documenting the transfer of tacit knowledge. It can be defined as "a quintessential knowledge creation process in that tacit knowledge becomes explicit, taking the shapes of metaphors, analogies, concepts, hypotheses, or models" [25;28]. For example, various graphics, documents, and images support tacit knowledge. When tacit knowledge is transformed into explicit, it's much easier to transfer and share it with colleagues, and it also becomes the basis for creating new knowledge. Externalization is the most important transformation, because it's the only one that makes it possible to further promote knowledge and make it available to the entire company.

In this mode, individuals are able to articulate the knowledge and know-how and, in some cases, the know-why and the care-why. Previously tacit knowledge can be written down, taped, drawn, or made tangible or concrete in some manner. An intermediary is often needed

at this stage; it is always more difficult when we transform one type of knowledge into another. A knowledge journalist is someone who can interview knowledgeable individuals in order to extract, model, and synthesize in a different way (format, length, level of detail, etc.) and thereby increase its scope (a wider audience can understand and apply this content now).

Once externalized, knowledge is tangible and permanent. It can be shared more easily with others and leveraged throughout the organization. Good principles of content management will need to be brought into play in order to make future decisions about archiving, updating, and retiring externalized knowledge content. It is particularly important not to lose attribution and authorship information when tacit knowledge is made explicit. This involves codifying metadata or information about the content along with the actual content

Combination (explicit to explicit) – combining explicit knowledge with each other to create new ones. The company can collect its internal and external explicit knowledge, then it is combined, adjusted or processed, and new knowledge is formed and distributed throughout the company. This form of knowledge exchange is supported by communication networks, documentation and large-scale databases, etc. Some examples would be a synthesis in the form of a review report, a trend analysis, a brief executive summary, or a new database to organize content. No new knowledge is created per se; it is a new combination or representation of existing or already explicit knowledge. In other words, combination occurs when concepts are sorted and systematized in a knowledge system. Some examples would be populating a database when we teach, when we categorize and combine concepts, or when we convert explicit knowledge into a new medium such as a computer-based tutorial.

For example, in developing a training course or curriculum for a university course, existing, explicit knowledge would be recombined into a form that better lends itself to teaching and to transferring this content

Internalization (explicit to tacit) – the process of training an employee in practice, as a result of which he forms his own knowledge. In this case, employee's explicit knowledge that he has received and will apply in the future, becomes an asset of the company. Internalization converts or integrates shared and/or individual experiences and knowledge into individual mental models. Once internalized, new knowledge is then used by employees who broaden it, extend it, and reframe it within their own existing tacit knowledge bases.

They understand, learn, and buy into the new knowledge, and this is manifested as an observable change; that is, they now do their jobs and tasks differently.

The advantages and disadvantages of the spiral model are presented in table 3 [29]:

Table 3. Advantages and disadvantages of SECI model

Advantages	Disadvantages
Reflects the dynamics of knowledge formation and nature	Model is not universal and is based on the experience of Japanese companies, which prefer tacit knowledge, because usually employees can work in the company all their lives.
Provides a framework for managing relevant processes	Linear concept. The model does not answer the question of whether the spiral can spin counterclockwise and whether it is possible to skip any stages of the spiral, depending on the specifics of the company. In some cases, the transformation of knowledge can begin with a combination or socialization, depending on what is the source of the new knowledge.
	The model does not show how new knowledge and ideas are created in practice

The SECI model has proven itself well in the field of knowledge management due to its simplicity and reliability. However, despite this, the model does not cover all knowledge management stages and has white spots. It focuses on knowledge types transformation, but does not address the broader topic as how the decisions are made with these types of knowledge. One of its greatest strengths is its simplicity—both in terms of understanding the basic tenets of the model and in terms of being able to quickly internalize and apply the KM model. One of its major shortcomings is that, through valid, it does not appear to be sufficient to explain all of the stages involved in managing knowledge. The Nonaka and Takeuchi model focuses on the knowledge transformations between tacit and explicit knowledge, but the model does not address larger issues of how decision making takes place by leveraging both forms of knowledge.

The Choo Sense-making KM Model. Choo has described a model of knowledge management that stresses sense making, knowledge creation and decision making. The Choo KM model focuses on how information elements are selected and subsequently fed into organizational actions. Organizational action results from the concentration and absorption of information from the external environment into each successive cycle, as illustrated in figure 7. Each phase, sense making, knowledge creation, and decision making, has an outside stimulus or trigger [24, 26, 31].

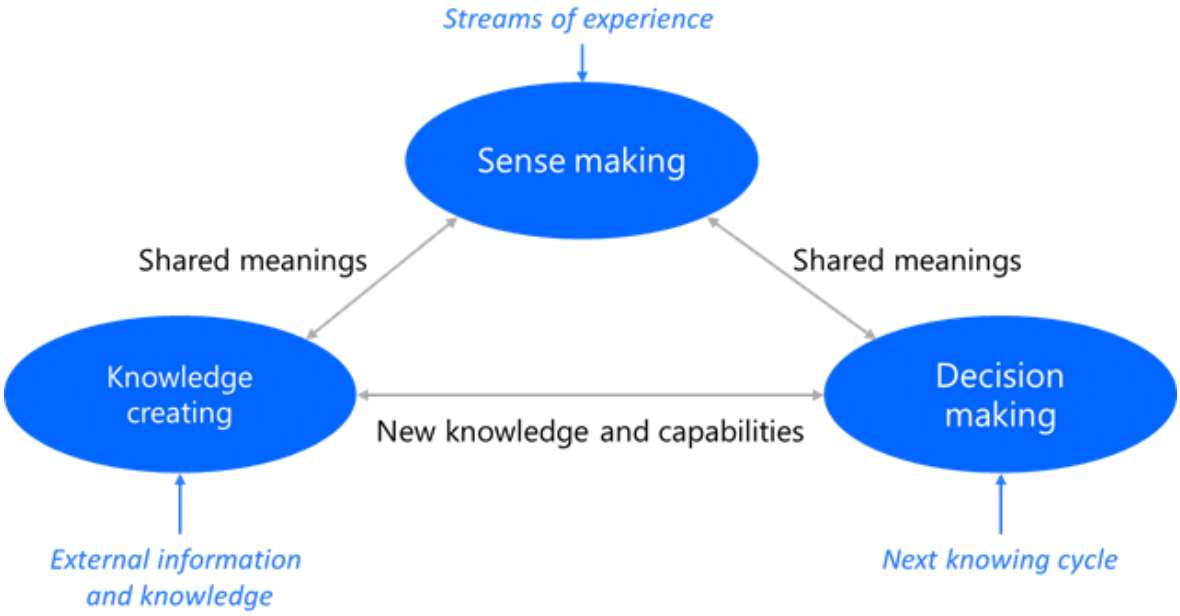

Figure 7. Choo Sense-making model

In the sense-making stage, one attempts to make sense of the information streaming in from the external environment. Priorities are identified and used to filter the information. Individuals construct common interpretations from the exchange and negotiate information fragments combined with their previous experiences. Weick [30] proposed a theory of sense making to describe how chaos is transformed into sensible and orderly processes in an organization through the shared interpretation of individuals. Loosely coupled system is a term used to describe systems that can be taken apart or revised without damaging the entire system. A human being is "tightly coupled," whereas the human genome is "loosely coupled." Loose coupling permits adaptation, evolution, and extension. Sense making can be thought of as a loosely coupled system whereby individuals construct their own representation of reality by comparing current with past events.

Weick proposes that sense making in organizations consists of four integrated processes [30, 33, 35]:

1. Ecological change
2. Enactment
3. Selection
4. Retention

Ecological change is a change in the environment that is external to the organization – one that disturbs the flow of information to participants – and triggers an ecological change in the organization. Organizational actors enact their environment by attempting to closely examine elements of the environment.

In the enactment phase, people try to construct, rearrange, single out, or demolish specific elements of content. Many of the objective features of their environment are made less random and more orderly through the creation of their own constraints or rules. Enactment clarifies the content and issues to be used for the subsequent selection process.

Selection and retention are the phases in which individuals attempt to interpret the rationale for the observed and enacted changes by making selections. The retention process in turn furnishes the organization with an organizational memory of successful sense-making experiences. This memory can be reused in the future to interpret new changes and to stabilize individual interpretations into a coherent organizational view of events and actions. These phases also serve to reduce any uncertainty and ambiguity associated with unclear, poorly defined information.

Knowledge creating may be viewed as the transformation of personal knowledge between individuals through dialogue, discourse, sharing, and storytelling. This phase is directed by a knowledge vision of “as is” (current situation) and “to be” (future, desired state). Knowledge creation widens the spectrum of potential choices in decision making by providing new knowledge and new competencies. The result feeds the decision-making process with innovative strategies that extend the organization’s capability to make informed, rational decisions. Choo draws upon the Nonaka and Takeuchi model for a theoretical basis of knowledge creation [1, 26, 32].

Decision making is situated in rational decision-making models that are used to identify and evaluate alternatives by processing the information and knowledge collected to date.

The model may have weaknesses, but the individual will try to behave rationally within the constraints or boundaries of that model. Individuals can be bound in a decisional process by a number of factors such as:

- Limits in knowledge, skills, habits, and responsiveness.
- Availability of personal information and knowledge.
- Values and norms held by the individual, which may differ from those of the organization.

This theory has long been accepted in organizational and management sciences. Bounded rationality is characterized by individual use of limited information analysis, evaluation and processing, shortcuts and rules of thumb (sometimes called heuristics), and "satisficing" behavior, which means it may not be fully optimized but it is good enough.

One strength of the Choo KM model is the holistic treatment of key KM cycle processes extending to organizational decision making, which is often lacking in other theoretical KM approaches. This makes the Choo model one of the more "realistic" or feasible models of KM, for the model represents organizational actions with "high fidelity." The Choo KM model is particularly well suited to simulations and hypothesis- or scenario-testing applications.

The Wiig Model for Building and Using Knowledge. Wiig approached his KM model with the following principle: in order for knowledge to be useful and valuable, it must be organized. Knowledge should be organized differently depending on what use will be made of the knowledge. For example, in our own mental models, we tend to store our knowledge and know-how in the form of semantic networks. We can then choose the appropriate perspective based on the cognitive task at hand [19].

Knowledge organized within a semantic network can be accessed and retrieved using multiple-entry paths that map onto different knowledge tasks to be completed. Some useful dimensions to consider in Wiig's KM model include: (1) completeness, (2) connectedness, (3) congruency, and (4) perspective and purpose.

Completeness addresses the question of how much relevant knowledge is available from a given source. Sources may be human minds or knowledge bases (i.e., tacit or explicit knowledge). We first need to know that the knowledge is out there. The knowledge may be complete in the sense that all that is available about the subject is there, but if no one knows of its existence and/or availability, they cannot make use of this knowledge.

Connectedness refers to the well-understood and defined relations between the different knowledge objects. Very few knowledge objects are totally disconnected from the others. The more connected a knowledge base is (i.e., the greater the number of interconnections in the semantic network), then the more coherent the content and the greater its value.

A knowledge base is said to possess congruence when all the facts, concepts, perspectives, values, judgments, and associative and relational links between the knowledge objects are consistent. There should be no logical inconsistencies, no internal conflicts, and no misunderstandings. Most knowledge content will not meet such ideals where congruency is concerned. However, concept definitions should be consistent, and the knowledge base as a whole needs to be constantly "fine-tuned" to maintain congruency.

Perspective and purpose refer to the phenomenon through which we "know something" but often from a particular point of view or for a specific purpose. We organize much of our knowledge using the dual dimensions of perspective and purpose (e.g., just-in-time knowledge retrieval or just enough "ondemand" knowledge). Semantic networks are useful ways of representing different perspectives on the same knowledge content [19, 22].

Wiig's KM model goes on to define different levels of internalization of knowledge. Wiig's approach can be seen as a further refinement of Nonaka and Takeuchi's fourth quadrant, internalization. Table 4 briefly defines each of these levels:

Table 4. Wiig model: degrees of internalization

Level	Type	Description
1	Novice	Does not know, or knows very little, how to apply knowledge.
2	Beginner	Has an idea of what knowledge is and where to get it, but can't apply it.
3	Competent	Can successfully apply knowledge from external sources (people and documentation).
4	Expert	Freely applies knowledge and extracts it from various sources without outside help.
5	Master	Qualitatively assimilates knowledge, has a deep understanding of the value and consequences of the application of knowledge.

In general, there is a continuum of internalization, starting with the lowest level, the novice, who "does not know he does not know" – who does not have even an awareness that the knowledge exists – and extending to the mastery level where there is a deep understanding not just of the knowwhat, but the know-how, the know-why, and the care-why (i.e., values, judgments, and motivations for using the knowledge).

Wiig also defines three forms of knowledge: public knowledge, shared expertise, and personal knowledge (fig. 8). Public knowledge is explicit, taught, and routinely shared knowledge that is generally available in the public domain. An example would be a published book or information on a public website.

Knowledge form	Knowledge type			
	Factual	Conceptual	Expectational	Methodological
Public	Measurement reading	Stability balance	Supply exceeds demand price drop	Look for temperatures outside the norm
Shared	Forecast analysis	Market is hot	A little water in the mix is okay	Check for past failures
Personal	Right color texture	Company has good track record	Hunch that analyst has it wrong	What is the recent trend?

Figure 8. Wiig knowledge management matrix

Shared expertise is proprietary knowledge assets that are exclusively held by knowledge workers and shared in their work or embedded in technology. This form of knowledge is usually communicated via specialized languages and representations. Although he does not use the term, this knowledge form would be common in communities of practice and among informal networks of likeminded professionals who typically interact and share knowledge in order to improve the practice of their profession. Finally, personal knowledge is the least accessible but most complete form of knowledge. It is typically more tacit than explicit and is used nonconsciously in work, play, and daily life.

In addition to the three major forms of knowledge (personal, public, and shared), Wiig defines four types of knowledge: factual, conceptual, expectational, and methodological [19, 31]. Factual knowledge deals with data and causal chains, measurements, and readings—typically, directly observable and verifiable content. Conceptual knowledge involves systems, concepts, and perspectives (e.g., concept of a track record, a bullish market).

Expectational knowledge concerns judgments, hypotheses, and expectations held by knowers. Examples are intuition, hunches, preferences, and heuristics that we make use of in our decision making. Finally, methodological knowledge deals with reasoning, strategies, decision-making methods, and other techniques. Examples would be learning from past mistakes or forecasting based on analyses of trends.

Together, the three forms of knowledge and the four types of knowledge combine to yield a KM matrix that forms the basis of the Wiig KM model.To summarize, Wiig proposes a hierarchy of knowledge that consists of public, shared, and personal knowledge forms. His hierarchy of knowledge forms is shown in figure 9. The major strength of the Wiig model is that, despite having been formulated in 1993, the organized approach to categorizing the type of knowledge to be managed remains a powerful theoretical model of KM.

The Wiig KM model is perhaps the most pragmatic of the models in existence today and can easily be integrated into any of the other approaches. This model enables practitioners to adopt a more detailed or refined approach to managing knowledge based on the type of knowledge but goes beyond the simple tacit/explicit dichotomy. Its major shortcoming is the paucity of research and/or practical experience involving the implementation of this model [19, 22, 34].

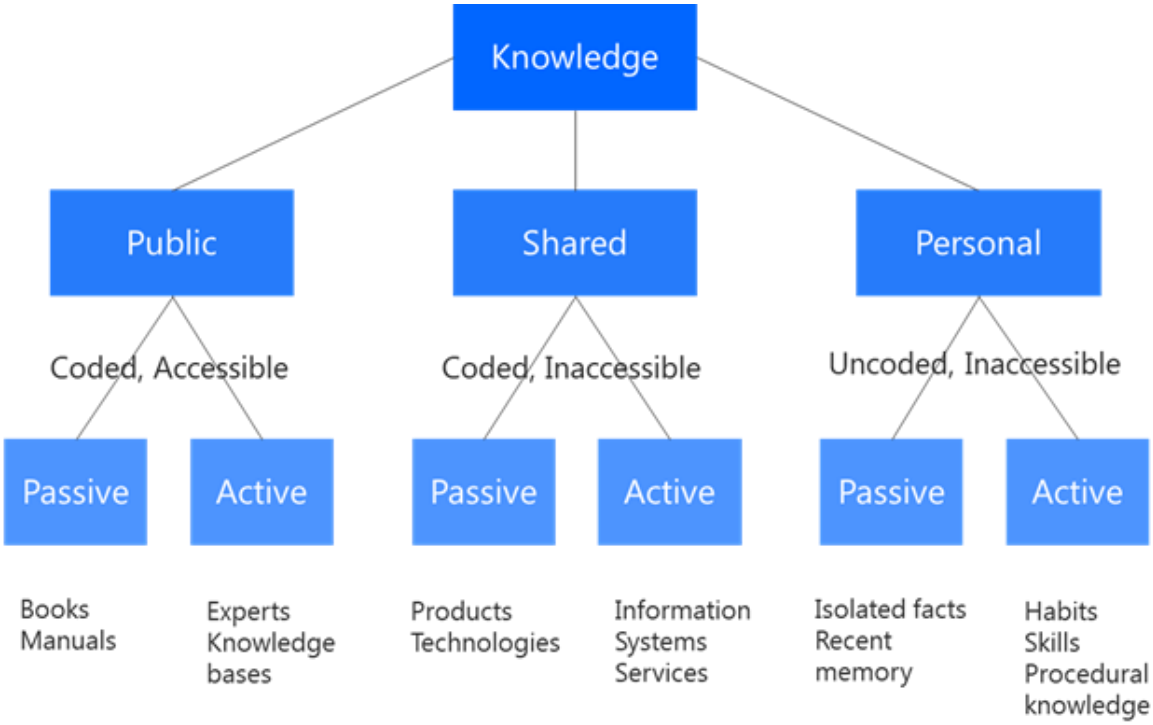

Figure 9. Wiig hierarchy of knowledge forms

The Boisot I-Space KM Model. The Boisot KM model is based on the key concept of an "information good" that differs from a physical asset. Boisot distinguishes information from data by emphasizing that information is what an observer will extract from data as a function of his or her expectations or prior knowledge. The effective movement of information goods is largely dependent on senders and receivers sharing the same coding scheme or language. A knowledge good is one that also possesses a context within which it can be interpreted. Effective knowledge sharing requires that senders and receivers share the context as well as the coding scheme. Boisot proposes the following two key points [7, 19, 35]:

- The more easily data can be structured and converted into information, the more diffusible it becomes.
- The less data that has been so structured requires a shared context for its diffusion, the more diffusible it becomes.

Together, they underpin a simple conceptual framework, the Information Space or I-Space KM model. Data is structured and understood through the processes of codification and abstraction. Codification refers to the creation of content categories—the fewer the number of categories, the more abstract the codification scheme. It is assumed that the well-codified abstract content is much easier to understand and apply than the highly contextual content. Boisot's KM model addresses the tacit form of knowledge by noting that in many situations, the loss of context due to codification may result in the loss of valuable content. This content needs a shared context for its interpretation and implies face-to-face interaction and spatial proximity—which is analogous to socialization in the Nonaka and Takeuchi model.The I-Space model can be visualized as a three-dimensional cube with the following dimensions (fig. 10) [7]:

1. Codified – uncodified
2. Abstract – concrete
3. Diffused – undiffused

The activities of codification, abstraction, diffusion, absorption, impacting, and scanning all contribute to learning. Where they take place in sequence— and to some extent they must—together they make up the six phases of a social learning cycle (SLC). The Boisot model incorporates a theoretical foundation of social learning and serves to link together content, information, and knowledge management in a very effective way.

In an approximate sense, the codification dimension is linked to categorization and classification; the abstraction dimension is linked to knowledge creation through analysis and understanding; and the third diffusion dimension is linked to information access and transfer [7, 19, 21, 35].

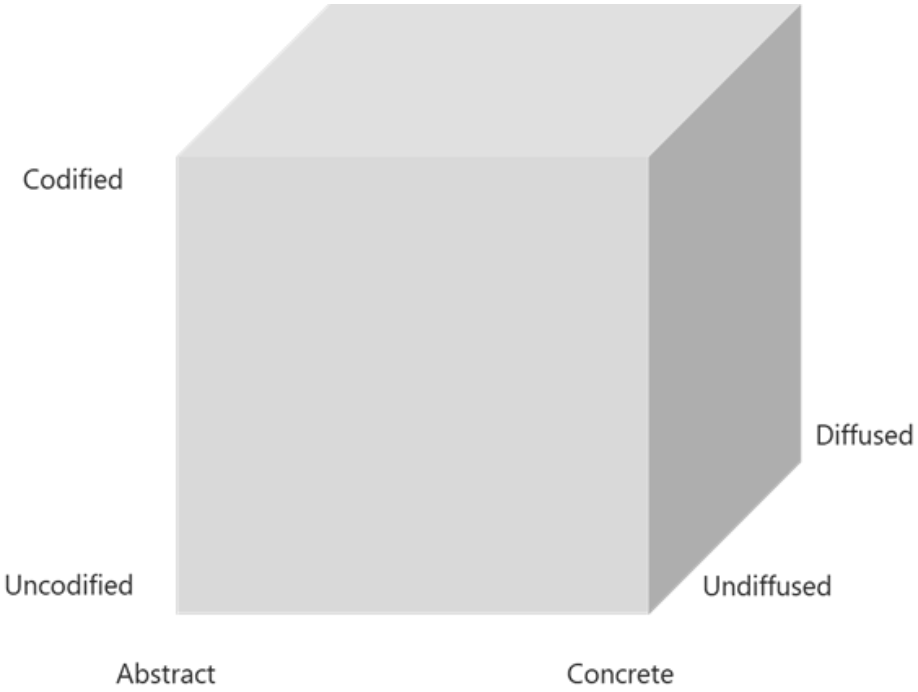

Figure 10. Boisot I-Space KM model

There is a strong potential to make use of the Boisot I-Space KM model as to map and manage an organization's knowledge assets as the social learning cycle – something that the other KM models do not directly address.

However, the Boisot model appears to be somewhat less well known and less accessible, and as a result has not had widespread implementation. More extensive field-testing of this model would provide feedback regarding its applicability as well as more guidelines on the best way to implement the I-Space approach.

ZACK KM Model. This model focuses on the engineering of information products. In knowledge management, lessons learned from the information product lifecycle can also be actively used and incorporated into the program. Information products represent the knowledge that is sold to customers both internally and externally. Such products include, for example, profiles, information in databases, news, etc. Meyer and Zack suggest that the knowledge of creating such information products has the potential to deepen in the field of

intelligence and can well be used as a foundation in the organizational cycle of knowledge management [5, 19, 21].

The Zack model provides an idea of the architecture of the information products platform-knowledge repository - and processes-knowledge processing, and also includes the added value that is required by the organization to work with knowledge. The essence of the knowledge management cycle is to build a knowledge product, the added value of which will increase with each new stage of knowledge processing. For example, a company puts a certain amount of knowledge in a database. Further, when extracting the trend from this data, their value may increase. The source data takes a different form, suitable for trend analysis, which can later form the basis of the organizational decision-making procedure. Also, a process can be directly launched when competitive intelligence can be collected to change the type of data, making it instead of raw verified and interpreted in the right way so that this information is of value to end users. Another example is a news service that filters and interprets different information by personalizing and profiling value-adding processes to meet the needs of different groups or individuals.

Meyer and Zack also highlighted the importance of life cycle management and improving the architecture of a corporative product through knowledge to gain a significant competitive advantage. Depending on the chosen strategy for building this architecture and integrating knowledge, the company ultimately has the appropriate functionality, quality and efficiency of the product. Conducting research in the field of information product development is a tool for developing the organizational cycle of knowledge management. In Zack's model, the interfaces are built seamlessly during the transition to each subsequent stage. Creating seamless and standardized interfaces involves preliminary analysis of internal and external user interfaces.

The knowledge management cycle in the Zack model consists of production and technological processes for creating products and services. The authors of the model are of the opinion that information products should be represented as a vessel that contains knowledge structured in a certain way. The knowledge contained in the information products is the data of the repository-the content on the basis of which the subsequent parts of the final information products are built. The content for each organization and business sector is different, for example, if it is a banking sector, the content will mainly include personalized customer information, such as account numbers of individuals and legal entities; in the insurance sector, it will be information about insurance policies and various customer

requests; if the organization is pharmaceutical, it usually accumulates a lot of different professional, research and marketing information in relation to products being created or already sold [5, 21, 32].

In addition to the content, an important aspect that also needs to be taken into account is the overall architecture and approach to managing this content, namely, how it is collected, processed, stored and retrieved. In this case, the unit of knowledge is represented as an atom of information, which is supposed to be controlled. The concept of a unit of knowledge is important for the further successful functioning of the organizational concept of knowledge. Focusing on a specific unit of knowledge is one of the main differences between knowledge management and document management. The document management system manages documents as a whole, and the knowledge management system manages a set of elements/units of knowledge that are contained in a single document. At the same time, the units of knowledge that are being studied have completely different structures and sizes. This leads to the idea that in knowledge management, the central place is not the huge amount of content, but its quality, because during the life cycle of knowledge management, the captured knowledge is changed and interpreted. This interpretation operation is usually performed by content management systems.

Depending on its specifics, the organization can use different units of knowledge, for example, in the financial reporting database, the units of knowledge can be links recorded in the information management system of this report. So, an employee has the opportunity to review and analyze a specific financial report that he needs using key attributes in the form of links. In a system that contains different expert data of an organization, different categories of this data can act as units of knowledge, for example, financial expert category analytics. Knowledge units are also used to facilitate the process of finding and selecting specific experts or people related to knowledge within an organization. The model repository also consists of various indexing, linking, labeling, and cross-referencing procedures for knowledge units that form the content of the knowledge management program.

Although the Zack model was originally intended for information products, its focus later shifted to knowledge management, where it became most commonly used. The properties of knowledge in each organization are unique, but this does not mean that previously recommended approaches to content management need to be re-developed.

Table 5. Social learning cycle in Boisot's I-space KM model

Phase	Name	Description
1	Scanning	– Search for opportunities and threats in mixed content. – Scan templates, unique ideas that then pass into the possession of small groups. – If the data is abstract and structured, the scanning process is fast, but if the data depends on the context and does not have a clear structure, the scanning can be quite slow.
2	Problem solving	– Codification and structuring of knowledge. – Knowledge is shaped, and much of the uncertainty is eliminated. – If the problem-solving process starts in an uncodified area, it entails conflicts and risks.
3	Abstraction	– Using structured ideas for a wider range of cases. – Conceptualization and reduction of knowledge to significant features. – A combination of abstraction and problem solving.
4	Diffusion	– Transfer new ideas to other employees. – From a technological point of view, the transfer of structured and abstract information to a large number of employees is not as problematic as the transfer of unstructured data. – The only way to increase the speed of unstructured data transmission is for the sender and receiver to share the context. – The probability of a shared context is inversely proportional to the number of employees.
5	Absorption	– Using new ideas in other cases as learning by doing. – The combination of structured and unstructured knowledge helps to regulate their use in specific cases.
6	Impacting	– Integration of abstract knowledge into organizational practices. – Integration can be carried out in corporate practices or in technical and organizational rules. – The combined effect of absorption and exposure.

It is quite sufficient to rely on current approaches, especially when working with formal codified knowledge, the processes of which are managed in much the same way as the processes of the life cycle of information products. When working with implicit knowledge, approaches to content management need to be slightly modified and adjusted, but the current proven practices of content management should still be taken as a basis.

The repository serves as the basis for creating information products in the organization, and the higher the scale, depth, and complexity of the design, the more diverse they are and the greater the flexibility of their output. In most cases, the repository is the core of corporate memory.

The authors examined the key stages of the knowledge repository development: capturing, confirming, storing and retrieving, distributing and using knowledge, and correlated them with the knowledge management lifecycle. The authors of the model themselves call this cycle a «refinery». Figures 11 and 12 summarize the main stages of the Zack cycle [5,6].

The sources of raw materials (volume, reliability, relevance, etc.) are determined by obtaining the source data. At the same time, it is important to note that the initial quality of the source data should be high enough if the organization wants to get the same high result at the output. In the opposite case, the knowledge products produced in subsequent stages based on low-grade data will be much worse and may not meet the company's strategical objectives.

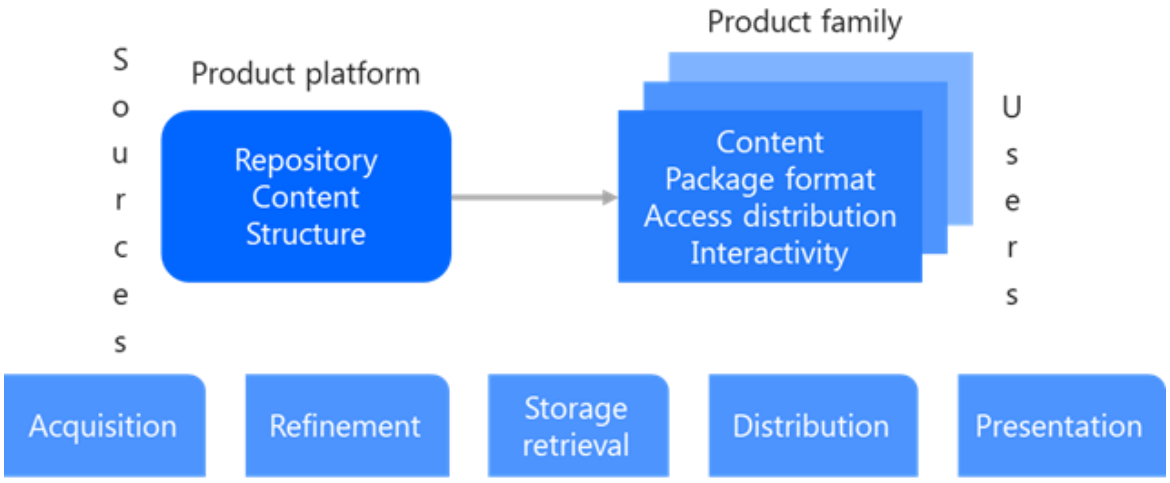

Figure 11. High-level view of the Meyer and Zack KM cycle

Refinement acts as the main tool for adding value. Refinement can be physical-moving knowledge from one place to another, and logical-restructuring, integration, additional labeling, etc. Refinement also includes content cleansing, which can be done to establish the

confidentiality of sources and key stakeholders, and standardization, such as tailoring content to best practices and lessons learned specific to the organization. At the refinement stage, you can analyze content statistics and conduct a meta-analysis, which is a multi-level review of the main categories of knowledge and templates that are contained in the organizational base of knowledge units. This phase of the Zac model adds value by facilitating the use of knowledge units and the flexibility to use content in the long run.

Storage/retrieval is the transition stage between collecting and refining knowledge, which fills the repository, as well as paves the way for other stages of product creation. There are two types of storage: physical - documentation, various files, etc., and digital-special knowledge management systems.

The distribution reflects the process of delivering products to the end user - by e-mail, fax, etc., and also covers other parameters of knowledge delivery, such as deadlines.

The last stage is the presentation of knowledge. The focus here is on the context, and the effectiveness of the previous stages with accumulated added value is also reflected in this phase. This determines whether the organization has the necessary context to be able to use this content. If the required context is not sufficient for an organization, then its knowledge management lifecycle cannot support value for both individual employees and the company as a whole.

To ensure that the lifecycle works properly, an organization needs to accumulate and present frontend knowledge. For this purpose, the rules are defined, according to which the organization receives, clarifies, stores and places knowledge in its own knowledge repository. At the final stage, it may also be necessary to develop rules for the distribution and use of content (define copyright, publication rules, privacy distribution, and others) that will be applied. The joint work of the storage facility and the "refinery" allows for effective knowledge management in the organization. These aspects of the company must be supported by its process and technological capabilities, internal and external knowledge of the business and the external environment.

An important point to mention is that the organizational repository and the refinery should be periodically updated to prevent the use of irrelevant knowledge. The update should be built into the Zack cycle in the form of circular feedback processes, such as restructuring the main content in the repository to make decisions about the need for more innovative products or restoring old developments. The update entails changes in the structure of integration

analysis operations, etc., as well as the need to build a more complex cross-reference structure and more carefully standardize the content.

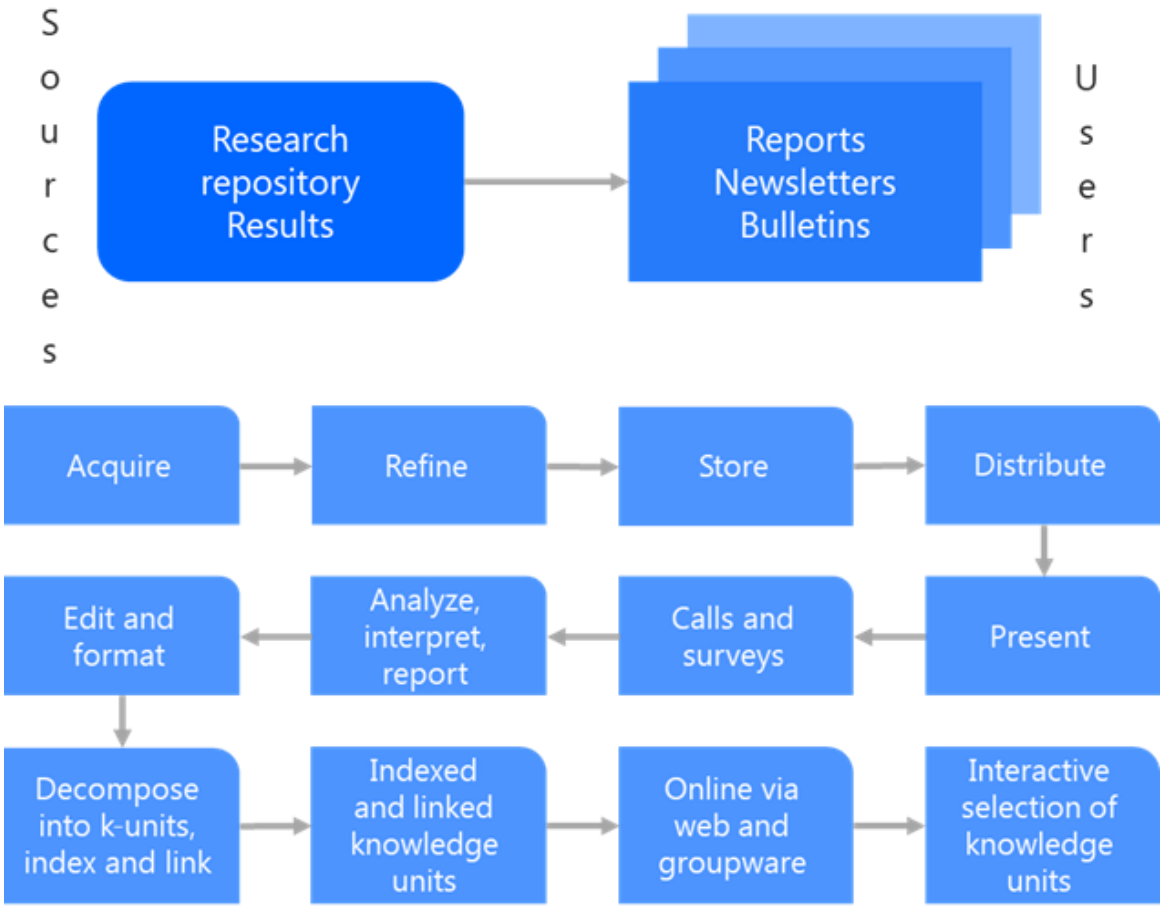

Figure 12. High-level view of the Meyer and Zack KM cycle (continued)

The Zack model most fully demonstrates the main components of knowledge management in an organization. Its strength is the all-encompassing concept of data processing, which can be almost one-on-one imposed on the management of content and knowledge. The model also contains the concept of refinement, which is important for the knowledge management cycle as a whole, which in most cases is ignored and omitted in other models [5, 19].

Complex Adaptive System Models of KM. This model considers the organization as a smart system that can quickly adapt to environmental conditions. Such complex adaptive systems consist of various individual agents that are in local contact with each other. The combined interaction of these agents creates complex adaptive processes by which such systems self-organize and self-clean. The activities of these independent agents are not controlled by

anyone, since there are no control bodies associated with this area of activity. The results of the interaction of the agents is the general pattern of the behavior of the model [8].

The Intelligent Integrated Adaptive System (ICAS) model consists of various subsystems and their combinations that enable organizations to adapt to various technological and social changes. Complex adaptive systems contain many different self-organizing modules, and the main task of each module is to achieve a specific result for itself to the maximum, but the activity of the modules is carried out according to uniform pre-established rules and in accordance with the context of the organization's interaction with the external environment.

In an ICAS, the intelligent components consist of people who are empowered to self-organize but who remain part of the overall corporate hierarchy. The challenge is to take advantage of the strengths of people while getting them to cooperate and collaborate to leverage knowledge and to maintain a sense of unity of purpose. Organizations take from the environment, transform those inputs into higher-value outputs, and provide them to customers and stakeholders. Organizational intelligence becomes a form of competitive intelligence that helps facilitate innovation, learning, adaptation, and quick responses to new unanticipated situations. Organizations solve problems by creating options, and they use internal and external resources to add value above and beyond the value of the initial inputs. They must also do this in an effective and efficient manner.

Knowledge becomes the most valuable of these resources because it is critical in taking effective action in a variety of uncertain situations. This is often used to distinguish information management (predictable reactions to known and anticipated situations) and knowledge management (use of existing or new reactions to unanticipated situations). Knowledge will typically consist of experience, judgment, insight, context, and the “right” information. Understanding and meaning become prerequisites to taking effective action, and they create value by ensuring the survival and growth of the organization.

The key processes in the ICAS KM model can be summarized as [8, 12]:

1. Understanding.
2. Creating new ideas.
3. Solving problems.
4. Making decisions.
5. Taking actions to achieve desired results.

Since only people can make decisions and take actions, this model emphasizes the individual knowledge worker and his or her competency, capacity, learning, and so on. These knowledge assets are leveraged through multiple networks (communities of practice, for example) to make available the knowledge, experience, and insights of others. This type of tacit knowledge is leveraged through dynamic networks and makes a broader "highway" available to connect data, information, and people through virtual communities and knowledge repositories.

To survive and successfully compete, an organization also requires eight emergent characteristics, according to this model [8, 23, 34]:

- Organizational intelligence
- Shared purpose
- Selectivity
- Optimum complexity
- Permeable boundaries
- Knowledge centricity
- Flow
- Multidimensionality

An emergent characteristic is the result of nonlinear interactions, synergistic interactions, and self-organizing systems. The ICAS KM model follows along the lines of the other approaches in that it is connectionist and holistic in nature. The emergent ICAS characteristics are outlined in figure 13. These emergent properties serve to endow the organization with the internal capability to deal with the future unanticipated environments yet to be encountered.

Organizational intelligence refers to the capacity of the firm to innovate, acquire knowledge, and apply that knowledge to relevant situations. In the ICAS model, this property refers to the organization's ability to perceive, interpret, and respond to its environment in such a way as to meet its goals and satisfy its stakeholders. This is very similar to the approach taken in the Choo sense-making model. Unity and a shared purpose represent the organization's ability to integrate and mobilize its resources through a continuous, two-way communication with its large number of relatively independent subsystems, much like the VSM.

Optimum complexity represents the right balance between internal complexity (i.e., number of different relevant organizational states) to deal with the external environment without losing sight of the overall goal and the notion of a firm that despite its size does not lose its common identity. The major difference here with VSM is the notion of relevant states—not all possible states. This selectivity is in keeping with the notion of evaluating content in KM as opposed to a more exhaustive warehousing approach.

The process of selectivity consists of filtering incoming information from the outside world. Good filtering requires broad knowledge of the organization, specific knowledge of the customer, and a strong understanding of the firm's strategic goals.

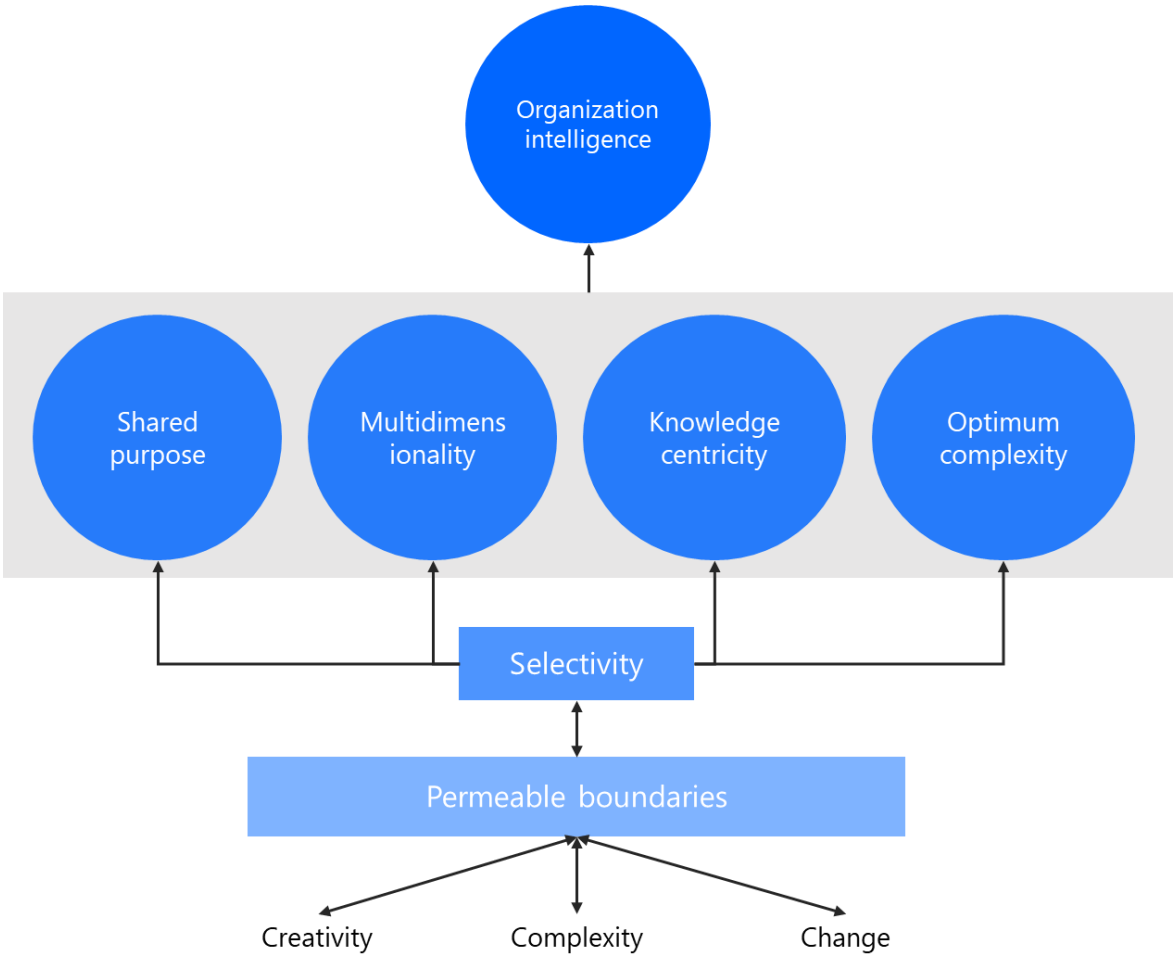

Figure 13. Overview of the ICAS model

Knowledge centricity refers to the aggregation of relevant information from self-organization, collaboration, and strategic alignment. Flow enables knowledge centricity and facilitates the connections and continuity needed to maintain unity and give coherence to organizational intelligence. Permeable boundaries are essential if ideas are to be exchanged and built upon. Finally, multidimensionality represents organizational flexibility that ensures

that knowledge workers have the competencies, perspectives, and cognitive ability to address issues and solve problems. This is sometimes seen as being analogous to developing human instinct [8].

Each of these characteristics must emerge from the nature of the organization. They cannot be designed by managerial decree; they can only be nurtured, guided, and helped along. In summary, there are four major ways in which the ICAS model describes organizational knowledge management:

1. Creativity
2. Problem solving
3. Decision making
4. Implementation

Creativity is the generation of new ideas, perspectives, understanding, concepts, and methods to help solve problems, build products, offer services, and so on. Individuals, teams, networks, or virtual communities are useful in problem solving, and they take the outputs of the creative processes as their inputs. Decision making is the selection of one or more alternatives generated during the problem-solving process, and implementation is the carrying out of the selected alternative(s) in order to obtain the desired results.

Complex KM models based on adaptive system theory show both an evolution and a return to systems thinking roots in the KM world. All of the models presented in this chapter are relevant, and each offers valuable theoretical foundations in understanding knowledge management in today's organizations. What they all share is a connectionist and holistic approach to better understand the nature of knowledge as a complex adaptive system that includes knowers, the organizational environment, and the "bloodstream" of organizations – the knowledge-sharing networks [23].

Comparative analysis of km models. The structure of the knowledge creation module of the Choo model is similar to SECI, since this model is based on the model of Nonako and Takeuchi and also reflects the process of knowledge transformation within the company. However, unlike SECI, which turned out to be quite narrow-profile due to the fact that it was built on the Eastern corporate culture, the Choo model is the closest to universal, since it somehow affects all the processes of the knowledge management cycle, regardless of the specifics of the company's culture (table 6).

Table 6. Comparison of frequently used KM models

Model	**Purpose**	**Advantages**	**Disadvantages**	**Limitations in digital environment**
SECI	Creating knowledge	-Reflects the dynamics of the formation and the very nature of knowledge -Provides a structure for managing meaningful processes	-The model is not universal. -Linear concept. The model does not answer the question of whether the spiral can spin counterclockwise and whether it is possible to skip any stages of the spiral, depending on the specifics of the company. -The model does not show how new knowledge and ideas are created in practice	-Restrictions on virtual knowledge transfer between organizations. -Internalization does not take into account virtual interaction.
Choo	Decision-making	-The model reflects the key processes of the knowledge management cycle with an emphasis on decision-making. -One of the most realistic and feasible models in practice, because it describes the actions of the company very accurately. -The model can be used to test hypotheses and various scenarios.		
Wiig	Constructing knowledge	-Can be easily integrated into any other approach. -Allows practitioners to develop a more detailed KM approach	Insufficient research and practical experience in implementing this model	

As for the potential of application in the digital enterprise, here the Choo and Wiig models have no significant limitations, can be freely adapted and used for various scenarios. It may take a little longer for the company to adapt the Wiig, since this model is more theoretical and has not been used so often in practice. The SECI model for digital capacity has some gaps, in particular in the process of knowledge transfer between organizations, in the issues of remote communication and online training of employees. In this regard, to successfully adapt this model, the digital enterprise will have to independently modify SECI to meet its needs.

In general, all three models have proven themselves quite well and can be applied to a greater or lesser extent in the digital enterprise in various areas of knowledge management. These models were chosen for comparison for a number of reasons:

- They represent a holistic approach to knowledge management and take into account all its elements.
- These models were among the first to appear, have been reviewed many times, criticized and widely discussed by scientists and experts in the field of knowledge management.
- The considered models have also been implemented in practice, have been tested and are reliable.

Strategic implications of KM models. Knowledge management models allow organizations to take their knowledge representation to a higher level. Models as a method are a new phenomenon in the practice of knowledge management, as well as a breakthrough aspect that moves the entire field of knowledge management forward. A knowledge management process model, all elements of which interact in a coherent manner, is essential for an organization's knowledge management initiatives to truly contribute to its strategic business objectives. However, this does not mean that knowledge management models and this area as a whole are a panacea and a solution to all organizational problems. The scope of the company's intellectual capital, where knowledge management processes are integrated, requires a solid theoretical foundation and an understanding of the main processes of the knowledge management lifecycle. This helps the organization correctly interpret the information received, establish cause-and-effect relationships, and successfully implement knowledge management solutions.

Practical implications of KM models. Despite the fact that the field of knowledge management is not new, research on this subject is quite small, and therefore organizations that implement knowledge management initiatives often do it intuitively. Thanks to their case studies and rather extensive experience in the knowledge management practice pool, many valuable lessons and advanced solutions were collected, mainly on an empirical basis. But in addition to the practical component, knowledge management also requires more solid theoretical support. The main purpose of knowledge management models is to maintain the level of completeness of management practices, i.e. they act as a tool for taking into account critical factors. Another advantage of knowledge management models is their descriptive component, which helps to visually present the necessary information and also on their basis to develop recommendations for the implementation of business tasks. Knowledge management models help the organization gain an understanding of what is happening with knowledge at the moment and provide a plan and roadmap for achieving knowledge management efforts.

2 KNOWLEDGE MANAGEMENT IN OIL REFINING COMPANY

2.1 Brief description of the company and its current KM status

The main activities of the considered oil refining company are oil fields exploration and development, as well as petroleum products sale and production. The company is top three Russian oil companies in terms of oil production and refining and is one of the leaders of Russian oil industry. It includes more than 50 oil-producing, refining and marketing enterprises both in Russia and in the countries of the near and far abroad.

The company promotes regional development and sets ambitious strategic goals for the production, processing and marketing of petroleum products. The scope of its activities is expanding every year, and this company has a huge intellectual potential, without the effective use of which it is impossible to implement the ambitious initiatives and strategies. However, the scale of the company and the scope of its operation is also an obstacle to high-quality knowledge exchange and is slowing down the process of training employees.

At the moment, knowledge management in the oil refining company is organized as follows (fig. 14): knowledge management initiatives that arise in various departments, network groups and competence centers are implemented separately. These initiatives include methodological support and their own technological solutions, such as corporate portals. Thus, the company implements the ideas for managing research in a separate way, without any single methodology and strategy.

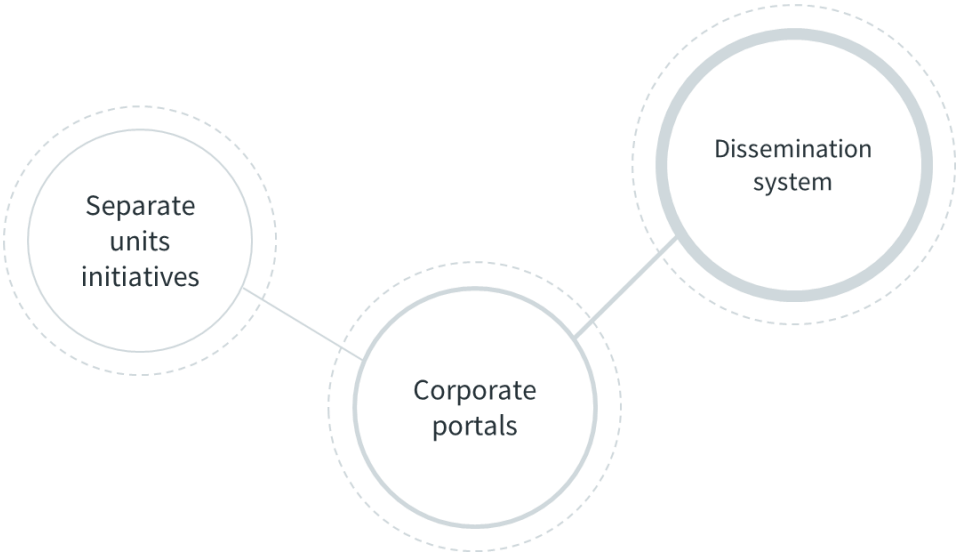

Figure 14. Existing KM components

An example of such initiatives is the knowledge dissemination system, which was created by one of the company's research development centers. The system coordinates the processes of knowledge management in the field of oil exploration and production, which significantly accelerates the process of making production and technological decisions by employees. The system also allows to customize the processes of collecting, processing and distributing knowledge in order to get the maximum benefit from the practices and technologies implemented in the organization. It has several modules that contain all the necessary information on various aspects of work at the oil field. Any employee can offer material for publication to the system or ask a question to an expert who answers questions and forms a library of knowledge on various subject areas. All employees have access to the library.

2.2 Shortcomings of the current KM status. Business needs

The considered oil refining company has a large scale of activity, faces new operational challenges every day, and is rapidly developing and implementing innovations. The company is also gradually accomplishing digital transformation process, and it is very important for it to continue increasing its competitive advantage. To optimize the operations, organization conducted internal research and found that it has certain management problems caused by the current knowledge infrastructure, which do not allow it to reach the forefront (fig. 15).

Top management of the company makes key decisions, for example, on modernization or introduction of innovative methods of oil products extraction, in cooperation with an expert group, whose members have access to separate technological databases and data repositories. Since the company currently does not have a single knowledge repository, all information is stored in different repositories by branches and divisions. If desired, decision makers can easily access the necessary information in each repository, but the main challenge here is that those who request access should know exactly what data and in which specific department they want to request. If some abstract or general information needed, for example, for internal statistical research, difficulties arise.

Also, due to the lack of a single repository, there are often situations when different units are solving the same problem, because they do not know that any of their colleagues have already found a solution. For the same reason, there is an issue of transferring and updating knowledge within the company, when employees can not find and contact experts, who can help with the solution, as well as when an expert with valuable knowledge leaves the

company, takes with him the necessary information and organization essentially loses some of the knowledge.

The lack of centralized knowledge management also slows down the process of innovation in the company and negatively affects the formation of project portfolios. Therefore the organisation loses the speed of reaction, because it can not include new developments in the portfolio in a timely manner, since it takes a lot of time and effort to acquire information.

In general, the lack of a unified knowledge management system negatively affects both the organization's strategy and its business processes, and creates five main problems, listed below:

1. *Duplicate tasks.* Communication between departments and subsidiaries is quite low, so there are often situations when different departments are engaged in solving the same task, not knowing that one of their colleagues has already coped with it and is ready to share their experience.
2. *Irrelevant information.* Due to the lack of a single space for knowledge exchange, the data on the portals of various departments may differ, and in this case, several units may work on already outdated information.
3. *Loss of valuable knowledge.* Many of unique knowledge and experience of the company's employees is lost after their dismissal or retirement. A lot of useful data from the external environment may also be not recorded and lost, or not fully recorded.
4. *Difficulty of finding information.* Often, if the employees have any questions, they do not know who to contact and have challenges in finding the necessary data on projects and current activities.
5. *Less space for innovation.* The lack of a unified knowledge space and instant feedback slows down the process of consolidating best practices and implementing innovations.

Thus, in connection with the current problems the company has established the following business needs:

- Improving communication between departments;
- solving problem with a quick search of relevant information;
- regular saving of key knowledge and expertise;
- saving and reuse of valuable experience;

– implementing of innovations and practices of exchanging experience;
– process optimization;
– minimizing errors;
– support and real-time feedback to keep the best practices and accelerate innovation.

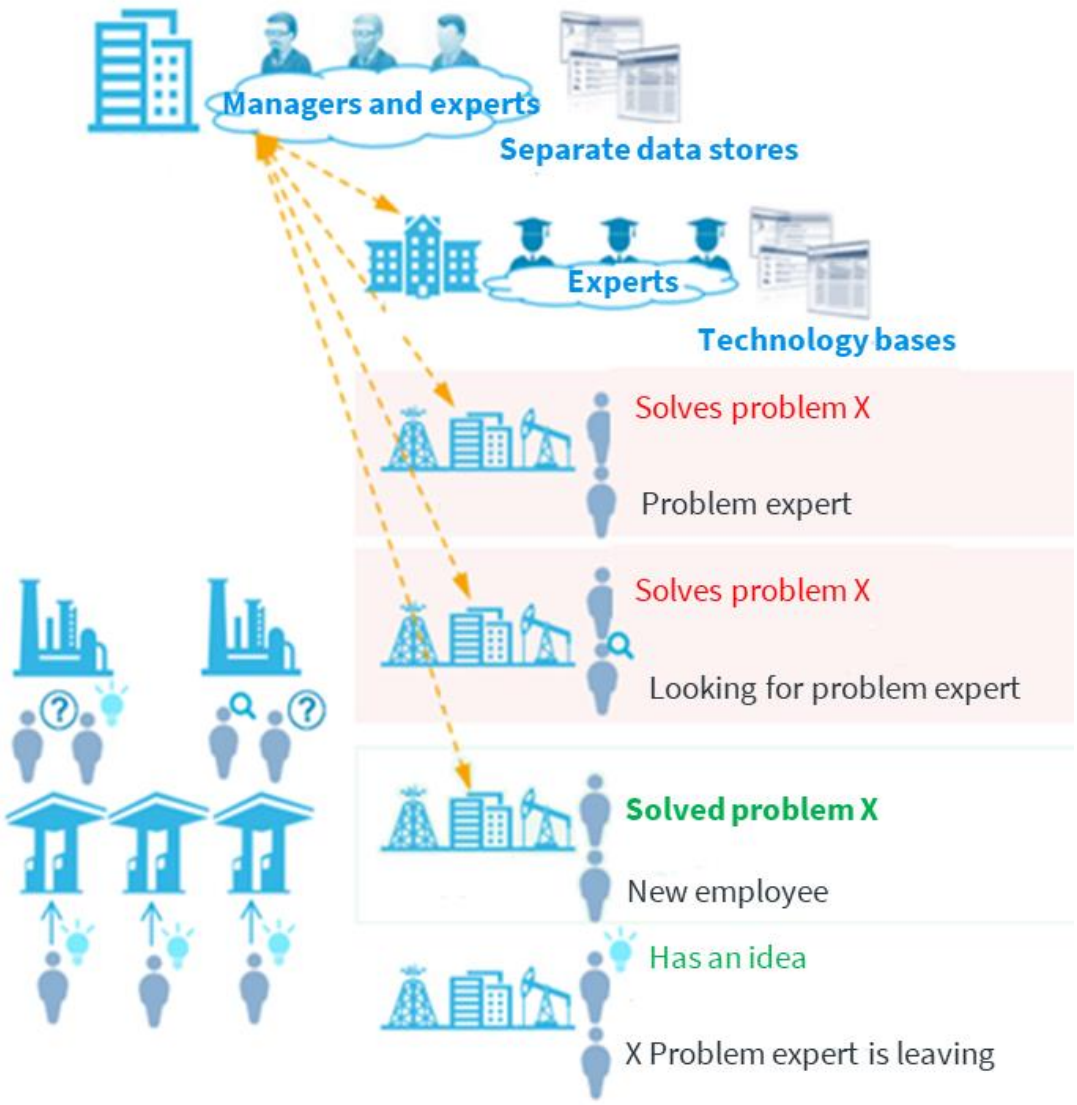

Figure 15. Company's KM problems

According to the main business needs, the top management, together with HR department decided on the need to create a unified corporate knowledge management system that will create, combine and multiply knowledge in the company at all levels. It is expected that in the short term, the system is designed to accelerate the development of employee competencies, as well as expand the internal base by retaining the best practices and cutting-edge ideas. In the long term, the new system will allow to reach a higher level, accelerating the process of innovation and maintaining the leader position in Russian oil market.

3 DEVELOPMENT OF A CORPORATE KNOWLEDGE MANAGEMENT SYSTEM IN OIL REFINING COMPANY

3.1 Knowledge management system concept

Since building a system from scratch on the basis of a single IT platform is quite a long and expensive process, in this case, the knowledge management system will be developed on the basis of several existing technological solutions for knowledge management in the company, which will be finalized, integrated and combined into a single system. It is assumed that the corporate knowledge management system of the oil refining company will combine 4 main components:

1. Existing technological solutions of knowledge management departments: a knowledge distribution system that contains the corporate database-a structured repository of formalized information-and other solutions.
2. A single corporate portal where employees register their profile, and from where they get access to the community of practitioners and experts within the company, as well as to various training programs.
3. A bank of ideas that contains all the necessary tools for collecting and implementing initiatives and best practices both within the company and in the external environment, thus increasing the innovative potential of the company.
4. Other technological components and systems that are integrated with the knowledge management system (databases, document management systems, enterprise resource management systems, etc.).

Building the concept of a knowledge management system was based on the following principles:

- The system is built according to the clearly defined business needs;
- the system is designed to manage critical knowledge of companies;
- the core of the system is a community of practitioners and a bank of ideas;
- the system is aimed at the development of social learning and the exchange of knowledge between employees;
- the knowledge management cycle embedded in the system is integrated into the company's business processes;
- when building the system, the existing IT infrastructure of the company is used

The concept of a knowledge management system for an oil refining company is presented in fig. 16. The proposed system aims to develop and support the three main aspects of the company: people, technology, and processes. The development and further operation of this system should be carried out strictly in line with the company's strategic goals and business processes. The efficiency of the system will be measured using performance indicators, that will allow top-management to get up-to-date usage statistics, as well as all the necessary information about the sources and flows of knowledge within the organization.

A single platform that integrates all the elements of knowledge management will allow the company to maintain a competitive advantage in the face of digital transformation. The main tasks of the developed system are the creation, storage, dissemination and application of knowledge.

The community of practice is responsible for all three of them. The company's employees, who are members of the community of practitioners, demonstrate their best practices, share their experience, work together to solve complex professional problems and evaluate technological innovations.

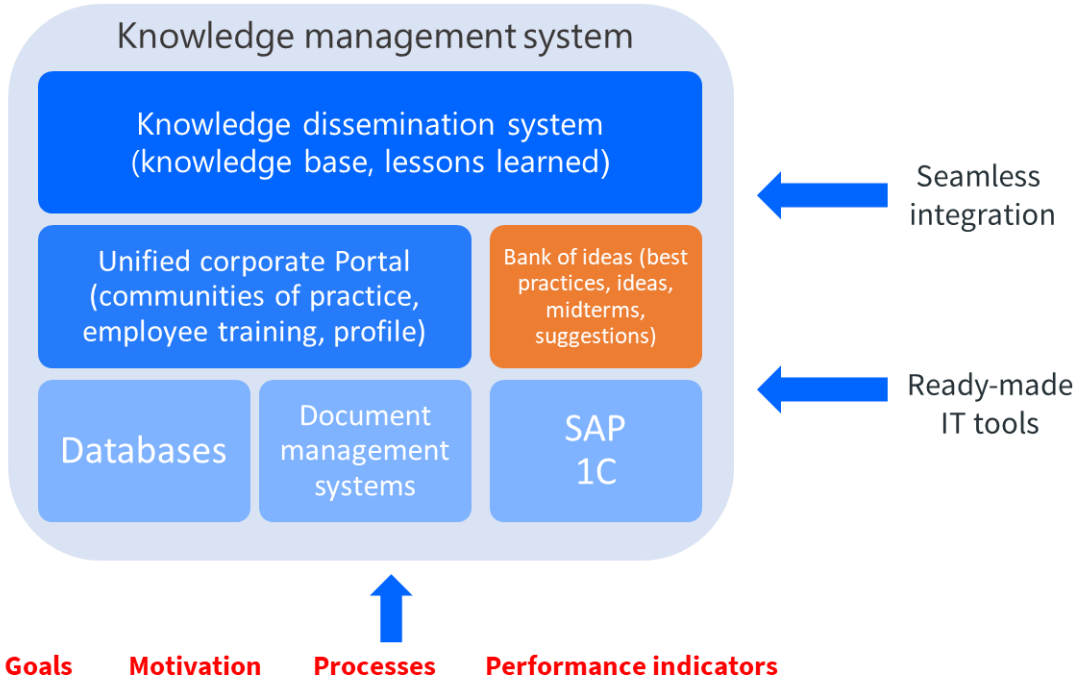

Figure 16. Knowledge management system concept

The information shared by the community members is recorded in the knowledge base, where it is formalized and classified. The presence of a single internal knowledge base will help the company not to miss valuable developments, as well as to identify and store only

the most important, critical knowledge. The knowledge base also facilitates the process of finding up-to-date information, which will now be available to all employees, regardless of the department. Also, the knowledge from the repository is always at hand and can be applied at any time, which increases the speed of the organization's response to changes.

The preservation and dissemination of knowledge also occurs naturally through employee training. The company in question has a fairly extensive program of internal training and training of specialists, which allows you to effectively transfer knowledge to newcomers, retain and replenish them within the organization. Training in the company is also aimed not only at newly arrived employees, but also at improving the professional skills of existing employees, which allows them to bring their knowledge to a new level in a spiral.

It is assumed that the work of employees in the corporate system will be carried out by registering in the profile, where all the basic information about this employee will be collected. It will also indicate which courses he has attended and which professional communities he is a member of. All the latest ideas and suggestions of employees, as well as the best practices of both external and internal successful cases of the company, will be recorded and stored in the bank of ideas. Thus, when a company needs to go back to previous developments or solve a non-trivial case, it will already have its own "treasury", from where it can get the right solution at any time. With access to the system, seamless integration is implemented for all employees. The system is integrated with databases, document management systems, as well as with various modules of enterprise resource management systems.

The new corporate system will enable the company to regularly conduct internal and external benchmarking at all stages of the life cycle, as knowledge management processes are integrated with key business processes. All the best practices, fresh ideas and suggestions of employees will be recorded and sent to the bank of ideas, from where in the future the company will be able to get these developments and use them whenever possible.

At the same time, no matter how perfect the corporate system is, knowledge management in an organization cannot be successfully implemented without the full involvement of people. To support the effective operation of the system, a project team will be formed and employees will be involved at all levels of the oil refining company, from individual departments to top management. In order to ensure the effective collection and preservation of best practices, communities of practice will be created, which will allow the exchange of

new knowledge and ideas not only within the company, between departments, but also with other companies from this field or related areas of business.

The distribution of responsibilities in the system will be carried out as follows (fig. 17):

- The company's employees working in different projects and involved in different processes will be the main driving force, they will offer new ideas and promising developments, as well as actively use the existing knowledge of the organization.
- Moderators will provide support and coordination on key issues, as well as help employees contact the right experts if necessary. They will also monitor the quality of the connection during the training process and ensure the effective functioning of the technical component for employees in the process of sharing knowledge and experience.
- Community development and expertise responsibilities will be handled directly by the owners of the practice communities. Community owners can also select the best and most promising developments from the idea bank, propose and discuss these initiatives with top management for further implementation.
- The development of the knowledge management strategy, the management itself, the motivational component and the evaluation of the effectiveness are carried out by the project team. The project team also ensures that the creation of the system is carried out according to the vision and strategic goals of the company.

Figure 17. Key roles in knowledge management system

Active employee engagement, motivation, and seamless integration provide opportunities for internal benchmarking in an oil refining company at all stages of its life cycle. Due to these factors, the system also provides fast and timely feedback at any stage. This allows to optimize the company's business processes and achieve the growth of its economic efficiency by accelerating the introduction of innovations.

Feedback allows the company to plan in the long term and act ahead of the curve, which is a useful option in the competitive struggle in the context of digital transformation. It allows you to quickly develop, test and implement new technologies and create a project reserve that can be used at any time as a replacement for a failed project or included in the portfolio after the end of the previous one.

When building and further using the system, elements of both a practical and a process approach will be applied, which will make it easier for the company to manage not only formalized knowledge, but also implicit knowledge, which is contained in the valuable experience and qualifications of its employees.

Conceptually, the system is based on a hybrid knowledge management model that combines the features of the perviously mentioned in chapter 1 SECI and Choo models with the focus on knowledge creation and effective decision-making. Such a construction will allow the system to combine a clear structure for managing the company's key processes, which covers both explicit and tacit knowledge, and an updated decision-making model that allows testing various scenarios. Testing scenarios will help the company to expand the space for innovation and experiment with different developments. In this way, the organization will be able to estimate which of them will be most effective if they are included in the portfolio, or which ideas/projects/technologies will be particularly useful in the long term.

4 DISCUSSION AND CONCLUSIONS

For the successful and long-term functioning of the corporate knowledge management system described above, the company should not forget about some aspects related to its specifics. As a rule, on average, 10-100 thousand users can log in to the system at the same time (taking into account the regional distribution). The amount of data that the system works with is also quite large, especially if it is processed in real time.

To ensure the smooth operation of the system, the company needs to accurately calculate the maximum load level, i.e. determine how many users the system can withstand during uptime, as well as pay attention to data storage, allocate and prepare storage, and check the correctness of the format. The accuracy of the search and output of information in the system depends on how well the data is stored in the future.

However, when implementing knowledge management initiatives in the company, it is necessary to remember that the technological component is not everything, and the creation of a knowledge management culture in the company is possible only in the process of creating a certain system of employee relationships. Technologies provide convenience and speed of communication, but the main carriers and users of knowledge in the company are its employees. Information technology helps to accumulate and disseminate useful information, and the transfer of valuable knowledge is carried out by people.

The most important factors that determine the further successful development of the knowledge management system in the organization are:

- Support for the initiative by the company's management, which involves understanding the main processes, securing funding and understanding the main goals and objectives of the project.
- The presence of a professional leader who has the appropriate competencies and experience in the field of knowledge management.
- Employee engagement, which is determined both by the production necessity itself and by a specially developed system of motivation for knowledge exchange. The interest of employees is often determined by the degree of their involvement and active participation in the knowledge management project at all its stages.

Taking into account the above-mentioned aspects will help the organization not only to successfully implement the corporate knowledge management system, but also to continue a successful policy in this direction, to store, develop and accumulate its own valuable knowledge.

5 SUMMARY

This master's thesis examined the existing approaches and models of knowledge management, the possibilities of their application in the context of digital transformation, as well as the current structure of knowledge management at the oil refinery. Based on existing methods and models, the concept of a knowledge management system has been developed that solves existing problems and meets the current needs of the organization.

The system was developed using a combination of two knowledge management models, the SECI and Choo. Despite the fact that these knowledge management models were developed in the early 90s, they still do not lose their relevance and either unchanged or with minor changes can be applied in any modern organization. The use of these models in the creation of the system will allow the oil refining company to increase the efficiency of decision-making and provide space for the use of innovations.

The developed concept of knowledge management in the company involves a combination of a practical and process approach with the support of IT and the full involvement of employees at all levels of the organization. This allows to create a single ecosystem within the company and facilitate the management of not only formalized, but also implicit knowledge, which is contained in the personal experience and qualifications of employees.

The created management system focuses not on technologies that act as an intermediary to increase the dynamics of the organization, but on employees whose initiative is a key factor in the successful functioning of this system. The system integrates organizational processes, information solutions, customers, employees, and communities of practice. In the future, it can be scaled, modified and refined depending on the goals of the oil refining company.

In the course of the work, the factors of further successful development of the knowledge management system in the oil refining company were also identified:

- Support for the initiative by the company's management, which includes understanding the main processes, securing funding and understanding the main goals and objectives of the project, as well as communicating to employees the importance of the knowledge management initiative for the development of the organization and maintaining the developed concept throughout the entire period of operation.

- A competent and qualified project team, as well as the presence of a leader with the appropriate professional skills and experience in the field of knowledge management for the successful and painless implementation of the implementation project.
- Employee engagement, which is determined both by the production necessity itself and by a specially developed system of motivation for knowledge exchange. The interest of employees is often determined by the degree of their involvement and active participation in the knowledge management project at all its stages. For the system to function successfully, employee engagement must be maximized.

From the point of view of architecture, the system is a single platform that integrates all the elements of knowledge management, which will allow the company to maintain a competitive advantage in the face of digital transformation. The main tasks of the developed system are the creation, storage, dissemination and application of knowledge.

The new corporate system will allow the company to regularly conduct internal and external benchmarking at all stages of the life cycle, as knowledge management processes are integrated with key business processes. All the best practices, fresh ideas and suggestions of employees will be recorded and sent to the bank of ideas, from where in the future the company will be able to get these developments and use them as far as possible. Moderators will provide support and coordination on key issues. Community development and expertise responsibilities will be handled directly by the community owners. Strategy development, management, motivational component and performance evaluation are carried out by the project team.

From the business point of view, when using this corporate system, the organization receives such benefits as creating and consolidating competitive advantages, becoming a self-organizing system, reducing personnel costs and maximizing the professional and personal capabilities of employees. The concept of the created system for an oil refining company can later be used as a best practice and adapted by other organizations with similar specifics or corporate structure.

REFERENCES

1. Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization science*, *5*(1), 14-37.
2. Botha, A., Kourie, D., & Snyman, R. (2014). *Coping with continuous change in the business environment: Knowledge management and knowledge management technology*. Elsevier.
3. Horvath, J. A. (2000). *Working with tacit knowledge* (pp. 65-69). Butterworth-Heinemann, Wobum, CA, USA.
4. Wellman, J. (2009). *Organizational learning: How companies and institutions manage and apply knowledge*. Springer.
5. Cook, S. D. N., & Brown, J. S. (2012). Bridging Epistemologies: The Generative Dance between Organizational Knowledge and Organizational Knowing. *Managing Knowledge: An Essential Reader*, 51.
6. Brown, J. S., & Duguid, P. (2009). Organizational Learning and Communities of Practice: Toward a Unified View of Working, Learning, and. *Knowledge and Communities*, 99.
7. Gamble, P. R., & Blackwell, J. (2001). Knowledge management: A state of the art guide.
8. Hubert, C., & Trees, L. (2018). Exploring APQC's Knowledge Flow Process.
9. Massingham, P. (2019). *Knowledge management: theory in practice*. Sage.
10. North, K., & Kumta, G. (2018). *Knowledge management: Value creation through organizational learning*. Springer.
11. Milton, N., & Lambe, P. (2019). *The knowledge manager's handbook: a step-by-step guide to embedding effective knowledge management in your organization*. Kogan Page Publishers.
12. Tryon Jr, C. A. (2017). *Managing organizational knowledge: 3rd generation knowledge management and beyond*. CRC press.
13. McDermott, R., & O'dell, C. (2001). Overcoming cultural barriers to sharing knowledge. *Journal of knowledge management*.
14. Storey, J., & Barnett, E. (2000). Knowledge management initiatives: learning from failure. *Journal of knowledge management*.

15. Duffy, J. (2001). The tools and technologies needed for knowledge management. *Information Management*, *35*(1), 64.
16. Lang, J. C. (2001). Managerial concerns in knowledge management. *Journal of knowledge management*.
17. Evans, M., Dalkir, K., & Bidian, C. (2015). A holistic view of the knowledge life cycle: the knowledge management cycle (KMC) model. *The Electronic Journal of Knowledge Management*, *12*(1), 47.
18. Mishra, J. K. (2009). *Knowledge management: complexity, learning & sustainable innovation*. Global India Publications.
19. Dalkir, K. (2017). *Knowledge management in theory and practice*. MIT press.
20. Tomé, E. (Ed.). (2010). ECKM2010-Proceedings of the 11th European Conference on Knowledge Management: ECKM2010. Academic Conferences Limited.
21. Wilde, S. (2011). *Customer Knowledge Management: improving customer relationship through knowledge application*. Springer Science & Business Media.
22. Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company: How Japanese companies create the dynamics of innovation*. Oxford university press.
23. Vollmar, G. (2007). Knowledge gardening. *Wissensarbeit in intelligenten Organisationen. Bielefeld*.
24. Gourlay, S. (2006). Conceptualizing knowledge creation: A critique of Nonaka's theory. *Journal of management studies*, *43*(7), 1415-1436.
25. Bereiter, C. (2005). *Education and mind in the knowledge age*. Routledge.
26. Choo, C. W. (2001). The knowing organization as learning organization. *Education+ Training*.
27. O'Dell, C., & Hubert, C. (2011). *The new edge in knowledge: How knowledge management is changing the way we do business*. John Wiley & Sons.
28. Charron, C., Favier, J., & Li, C. (2006). Social computing: How networks erode institutional power, and what to do about it. *Forrester Customer Report*.
29. Chandra, R., Iyer, R. S., & Raman, R. (2015). Enabling organizations to implement smarter, customized social computing platforms by leveraging knowledge flow patterns. *Journal of Knowledge Management*.
30. Li, C., & Bernoff, J. (2008). Groundswell: winning in a world transformed by social technologies. *Language*, *13*(286p), 25cm.

31. Springer, N. (2018). *An Analysis of James Surowiecki's The Wisdom of Crowds: why the Many are Smarter Than the Few and how Collective Wisdom Shapes Business, Economics, Societies, and Nations*. Taylor & Francis
32. Badpa, A. (2020). *Knowledge Management System for Petroleum Industry*. Omniscriptum Publishing.
33. Badpa, A., Salim, J., & Yahaya, J. (2018). *Understanding the effective factors of knowledge management system usage in petroleum industry in developing economy.* Journal of Theoretical and Applied Information Technology, 96(14).
34. Badpa, A., Salim, J., Yahaya, J., & Kotamjani, S. S. (2018). *The determinant factors of kms usage towards organizational performance in oil and gas industry.* Journal of Theoretical & Applied Information Technology, 96(9).
35. *Knowledge Management in the Oil and Gas Industry '98*. (1996). First Conferences.