

Università degli Studi di Padova



Department of Economics and Management

MASTER PROGRAM IN ENTREPRENEURSHIP AND INNOVATION

**THE USE OF TECHNOLOGIES IN KNOWLEDGE
MANAGEMENT SYSTEMS: AN EMPIRICAL RESEARCH**

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INTRODUCTION & SUMMARY

Companies have always lean on technology to innovate and improve their business processes. But currently with the digital era, the world has seen an explosion of technologies such as mobile, distributed software, social media and big data that may create new opportunities and threats for most business realities, including the management of knowledge in firms.

The initial assumption that will be discussed is that technologies imply not only variations in how companies make business but also alter the importance of knowledge and its transformation process within enterprises.

The new technologies will give importance to company's knowledge as the complexity of information will increase because of the exponential growth of data available thangs to more advance technologies of analysis such as data mining, data processing, artificial intelligence or machine learning.

Instead systems of data integration and the possibility to create online work spaces will change the way companies manage their knowledge as the creation and sharing will no longer occur inside each department – but it will be a widely integrated knowledge across each department in order to encourage the work in teams.

The knowledge of the company and its management may face many other variations thangs to digital technologies - for these reasons the dissertation has the purpose of investing which are the technologies that represent opportunities or challenges for the knowledge management.

The challenges regarding corporate knowledge could be a consequence of advance technology application but also a condition for the implementation - as the new systems need of clear maps of which data, information is used in the company's operations. As consequence companies must be aware of their organizational knowledge evolutionary journey as it is powered by data and information whereby workers create new business knowledge and combine the three resources (e.g. data, knowledge, information) to make decisions.

After a brief explanation of business knowledge types and characteristics of knowledge management systems, the thesis will present the theories regarding new technologies and their implication in knowledge organization field.

The theory will be reinforced by an empirical research based on interviews – cases of ICT companies will make up an expert opinion in this field as providers of new technologies and high-intensive services. They should have the most updated information as being part of the sector and have an interest of managing knowledge as they lead a knowledge-based business.

The purpose of the research is to outline how the system of knowledge management has changed with digital age and create a fuzzy view of which are the practical applications of new technologies in support of creation, acquisition, sharing of knowledge.

THE KNOWLEDGE MANAGEMENT

1.1 Introduction

Nowadays companies must face a highly competitive market as result of global economies and the technology evolutions engaged by many companies to cope with service/product innovation or process innovations enhancer of cost reductions through augmented efficacy and efficiency.

Managing knowledge and developing managerial competencies should enable better execution and implementation of the process. All the processes within the organization can be reduced to three basic processes: processes of effectiveness, efficiency and innovation (Hebibi et al.).

The knowledge management, as stated in the previous sentences, are implemented to increase the effectiveness by performing process in the best way and making right decisions.

Knowledge management enables members of the organization to collect the proper information about company processes and clients that are necessary for monitoring and developed insights for decision-making.

It requires a huge amount of awareness and information, about the internal processes in order to exploit the ongoing businesses in the best way. While at the same time they must deploy exploration processes through market and environment investigation in order to gain competitiveness through service/ product to innovate the offer.

The ability to explore and exploit implies holding structured and managed internal knowledge that implies replication of process and the ability of discover new knowledge to create new ideas which could be services or product, but also new ways of processing the business activities.

In fact, knowledge management could be a real solution for many companies, as the integration within the organization know-how will let an autonomous exploitation. Processes implemented to acquire and create new knowledge strengthen the exploration activity through which companies innovate.

Summing up knowledge management becomes very important to put in practice in a dynamic market, and it will become even more important as technology increases the amount of activities characterized by the usage of high-intensive knowledge.

The last enhance of knowledge management is technology, many companies must learn new modes of doing business because as a market request or compliance about.

New technology applications demand for knowledge management and, at the same time they are also the result of knowledge management mechanisms.

In the next pages, it will be presented how technology and knowledge are connected and feed off one other.

Starting from the technology touch points within the knowledge creation and its management construction, it will be easier to understand the implication that information technologies systems may have on knowledge resource and its management within enterprises.

1.2 The knowledge resources

1.2.1 Knowledge construction

First of diving into knowledge management concepts and related issues, it must be clarified how knowledge is created according the literature. And most specifically, how knowledge within companies can be disassociated from data and information and how it is the consequence of elaborations of these resources.

Data, information and knowledge are the resources that lead to decision making in business realities. The understanding of how data analysis technologies can impact on knowledge requires the investigation of how knowledge and information are related with data availability.

Data and information in literature during these years have been described through many ways. The following sentences sum up the all definitions made and furthermore highlighted the evolution between data and information.

The distinction between data and information consists in the fact that data has no meaning and are only numbers or words, instead information is enriched by context and meaning using the available data and giving it structure.

Data resources are raw numbers or observations without context and significance. Information instead, is the transformation and use of data for the business context and most of these elaborations nowadays are autonomously made by technologies as data analysis software.

Data comprise facts, observations, or perceptions (which may or may not be correct). By itself, data represent raw numbers or assertions and may therefore be devoid of context, meaning, or intent (Becerra-Fernandez, I., Gonzalez, A., & Sabherwal, R.).

Information is a subset of data, only including those data that possess context, relevance, and purpose. Information typically involves the manipulation of raw data to obtain a more meaningful indication of trends or patterns in the data (Becerra-Fernandez, I., Gonzalez, A., & Sabherwal, R.).

Knowledge resource is defined by Liew (2007) as the cognition or recognition or know-what, the capacity to act as know-how, and understanding as know-why that resides or is contained within the mind or in the brain.

The data, information, knowledge chain has been defined as a hierarchical pyramid structure within which every step implies an increase of complexity and insights that elaborate the wisdom of decision-making base.

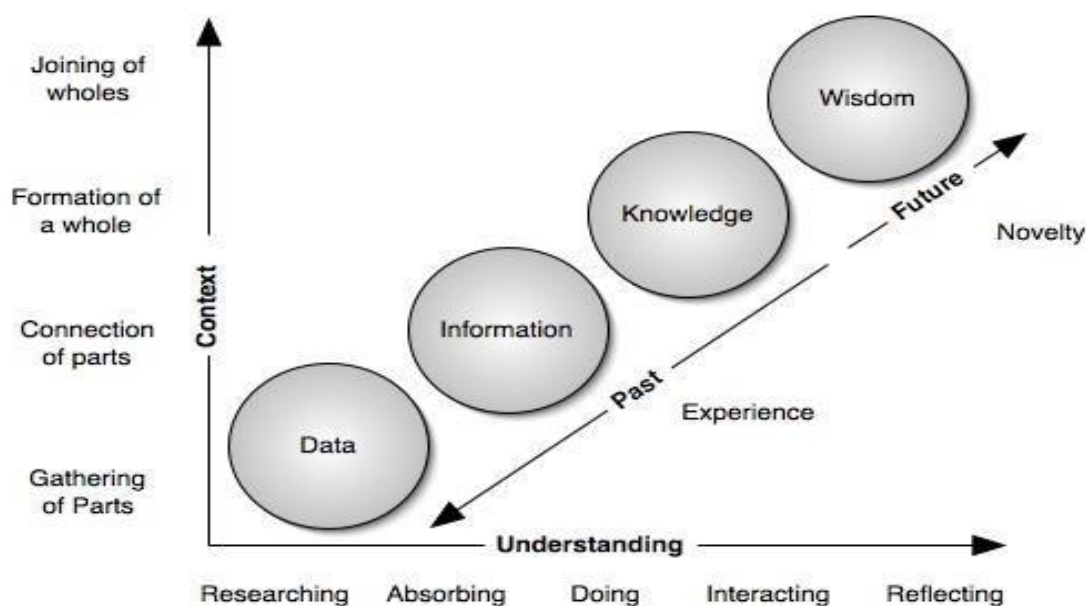


Figure 1 Ackoff's hierarchical pyramid, a view of Clark (2004)

The DIKW pyramid of Ackoff (1989) outlines all the transformation processes of how data is converted into knowledge, and furthermore knowledge into wisdom.

The stored raw data and unorganized facts are contextualized and cleaned of errors, after this process the data acquire meaning and become useful information enrich with description that answer to question as who, where, when and how.

Knowledge instead represents the elaboration of information, which deals with the development of new insights from relationships and patterns understandings. The grouping of different insights and knowledge develops the wisdom of individuals or organization.

The wisdom, furthermore, is field of study in interaction of human and machine, researches reunited at a biannual frequency to a conference focused on Human-Computer Interaction discuss and state new theories. One focus of 10th conference was dedicated to the digital technologies and the future wisdom; special workshops have been organized in order to push further the scholar in figuring out which could be the practical direction of these interactions and this issue will be further treated in the next chapters.

Liew (2013) introduce in the literature the existence of fallacy within the DIKW pyramid and more accurately in the reasonings of the connection between knowledge and wisdom.

He argues that the acquiring knowledge process consists into information interpretation in order to gain meaning. Further, he states that some scholars define knowledge and information as similar and for certain kind of knowledge it could be plausible – information content received through email can be already seen as knowledge and generally can be summed up that all kinds of knowledge collaboration carry knowledge information.

In fact, as confirmed by the author the evolution process from information to knowledge happens through learning and human interpretation and instead when knowledge is converted into information, it takes place through communication of explicit knowledge among people.

Liew (2013) insert a new element between knowledge and wisdom, as he sees that knowledge without what he calls intelligence cannot create wisdom or new knowledge. Using the following definition of intelligence of Albus (1991), he recognizes into intelligence factor the capability of using knowledge in the proper way results into making optimum decisions powered by individual perceptions and understanding.

Intelligence requires ability to sense the environment, to make decisions, and to control action. Higher levels of intelligence may include the ability to recognize objects and events, to present knowledge in a world model, and to reason about the plan for the future. In advanced forms, intelligence provides the capacity to perceive and understand, to choose wisely, and to act successfully under a large variety of circumstances as to survive, prosper, and reproduce in a complex and often hostile environment. (Albus 1991);

It has sense to include intelligence as a variable in the DIKW hierarchy as the intelligence has inseparable relationships with knowledge and wisdom because reconstruct and model knowledge by using the mental processes and give wise in business decisions. Intelligence can be different from knowledge as it is the factor that make people evolve and create new insights and knowledge.

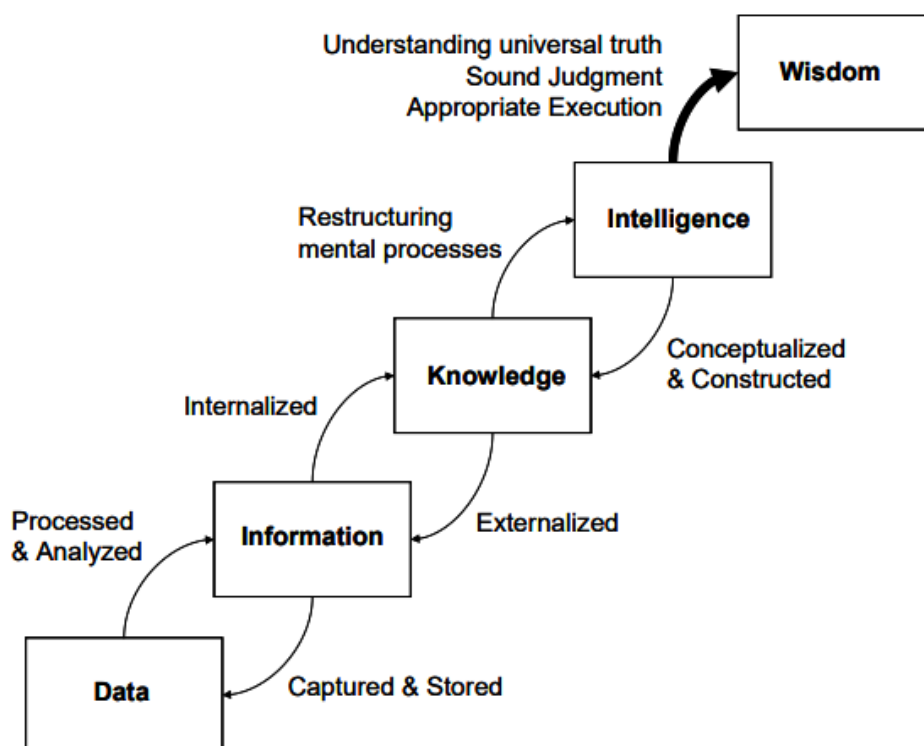


Figure 2 Updated version of DIKW pyramid into DIKIW pyramid of Liew (2013)

Therefore Liew (2013) rename the DIKW acronym to DIKIW as he missed the direct connection between knowledge and wisdom.

Instead wisdom, according him, in practice can be defined in business context as experience and the ability of have enough resources to elaborate concepts and develop critical reflections. Creation of organization wisdom permit companies to deploy long term strategies for their processes as there are resources able to look ahead.

1.2.2 The knowledge role

In business environments, the knowledge acquisition and usage have the main purposes of creating and increasing company's value. The process of using properly the knowledge resource is practically translated into decision making process and know-how of doing the activities that achieve the enterprise and all its stakeholders' aims.

In the next pages it will be consolidation of the role of knowledge and how it functions on information.

Knowledge assumes across scholars' different views, within it takes two different roles - as it could be the subject that is related to individual or the object to use information and consequently being something that can be explained and learnt.

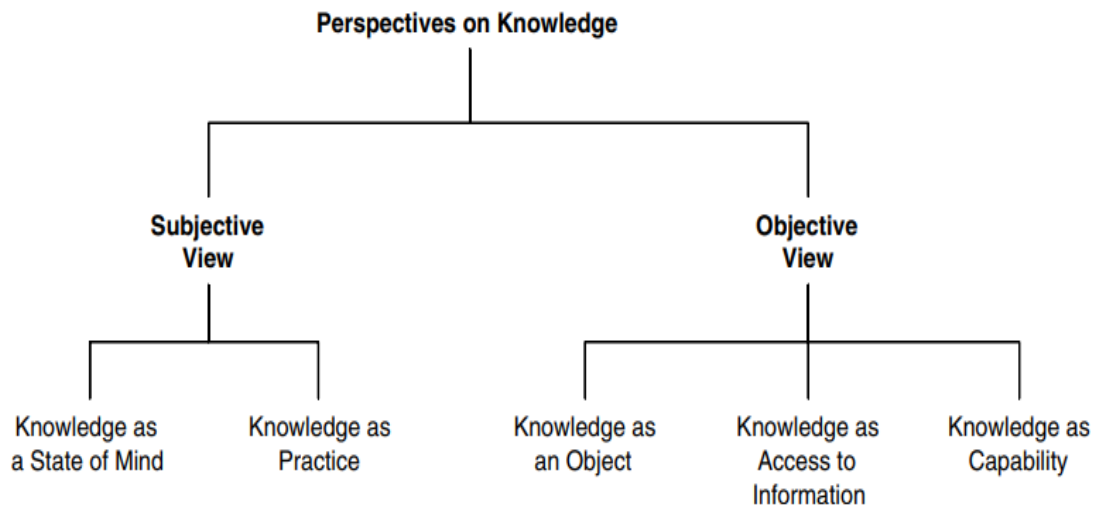


Figure 3 Knowledge Perspectives (From Becerra-Fernandez, I. Gonzales, A., & Sabherwal, R.)

In the subjective view, knowledge may be described as a practice or state of mind result; the state of mind is composed by the individual experience and backgrounds, as well as his beliefs are consequences of the life context also knowledge is.

In fact, according Alavi and Leidner, the main company purpose is to enable individuals to enhance their personal areas of knowledge in order to apply it for organizational goals and for do that companies must ensure to collocate the employee in the right position regarding its knowledge resources.

Instead in the practice view, knowledge is held by a group and can be decomposable into elements possessed by individuals. Furthermore, it is composed by practice and beliefs that are collective rather than individual as it is composed by the knowledge emerged from experience and collaboration with colleagues (Becerra-Fernandez, I., Gonzalez, A., & Sabherwal, R.).

In the objective view, reality is independent of human perceptions and can be structured in terms of a priori categories and concepts (Schultze 1999).

Consequently, knowledge can be considered as an object that supports and gives meaning to information use and access to more information, as through knowledge use more information can be reached. Instead another objective point of view sees knowledge as a capability that can be discovered or improved by human resources and consequently

companies can build their own knowledge by defining and recording the best procedures, a structured way of doing in order have the possibility to transfer the embedded knowledge within individuals to the next generation of employees.

1.2.3 Tacit and explicit knowledge

Another important distinction of knowledge resource concerning the form of it, considering if it can be expressed through words and consequently recorded and elaborated by information technology systems or these resources are embedded in individuals and there are no concepts or ways of explaining.

The codified knowledge is called explicit and it refers to knowledge that has been defined into concepts through words and numbers. Such knowledge resource can be diffused formally and systematically in the form of data, specifications, manuals, reports and common way of doing. And consequently, it may become stored knowledge inside the organization's documents, that may be available for everyone within the company.

In contrast, uncodified or tacit knowledge includes insights, intuitions, and wisdom of each single employee. It is difficult to articulate and formalize, and therefore hard to share inside the company.

Tacit knowledge is more likely to be personal and based on individual experiences and activities as is combined by the possession of skills and experiences that brought to certain insights.

When tacit knowledge resource in the organization includes also high level of expertise it may become expensive and difficult to turn into explicit; therefore, the organization chooses to let it lie only within the expert employee. Nevertheless, it increases the degree of addiction to him and the risk of a sudden loss in the company of a necessary knowledge resource.

The knowledge growth-path takes place through processing of tacit knowledge to explicit knowledge and vice versa following the concept of the literature regarding the knowledge transformation or SECI model.

The SECI model was implemented by Nonaka and Takeuchi in order to outline how knowledge is created inside organizations. The model is composed by four modes of converting and combining the knowledge types through which companies benefit through the knowledge creation and the extension of it across the organization.

The following modes of knowledge transformations are the basis of the main strategies and activities developed for knowledge management scopes.

The socialization occurs when new tacit knowledge is created from a previous tacit one, in practice it might be the case of individuals that are sharing experience and knowledge and the exchange of views increase the individual understanding and consequently it keeps being tacit knowledge.

The externalization instead implies a knowledge codification, it happens when the tacit knowledge can be explained or defined through common means by individuals. After this stage the knowledge among groups can be shared and the base of knowledge users become widely.

The combination is the increase of knowledge within companies because of explicit knowledge processing. The knowledge resources might be internal but also external such client information. For example, this process might happen when different organizational departments share their specific knowledge in order to create new insights and integrate the business decisions based on different perspectives.

The internalization happens when knowledge acquires an organizational level, so it becomes company's praxis. This process sets out also new elaborations inside individuals which acquires new perspectives and knowledge as know-how and expertise about the business activities inside the organization. The creation of organizational knowledge implies also an easier way of developing the integration programs for the recruitment processes.

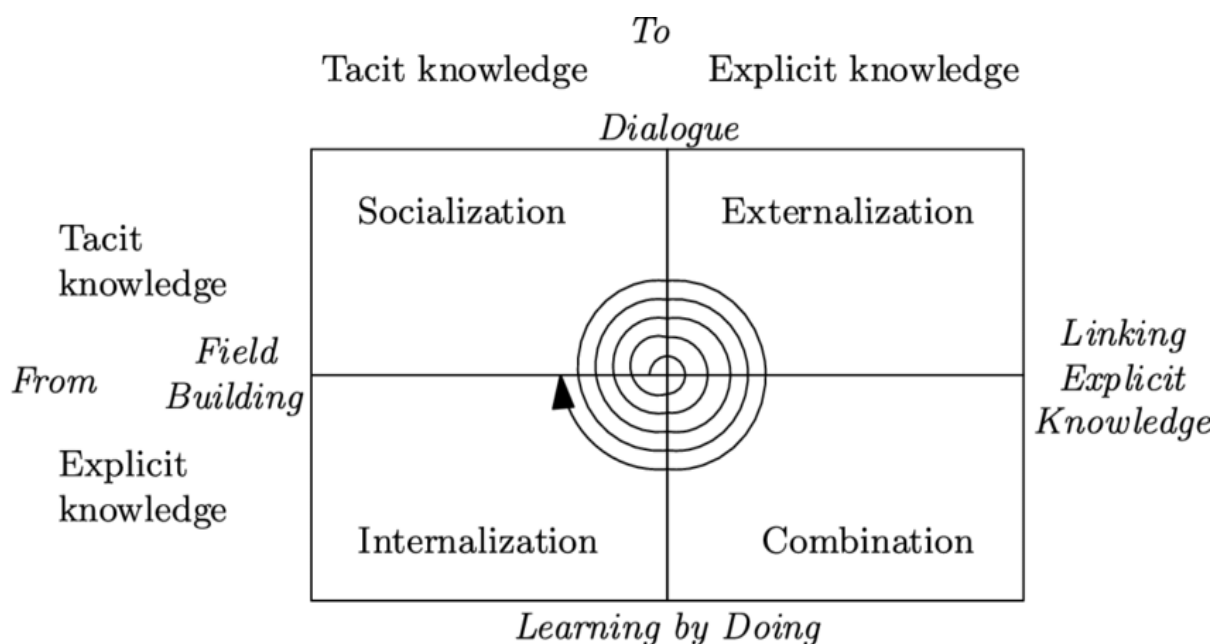


Figure 4 The SECI model of organizational knowledge creation based on Nonaka and Takeuchi (1995), page 71

1.2.4 Knowledge location

At the starting point most of knowledge resources are stored in each company's employee or furthermore within groups as organizations are composed by departments with specific competences and functions (Felin and Hesterly 2007).

The fact that knowledge lie within individuals, engages many companies to look for solutions of knowledge retaining by conversion of it at organization level - as the main purpose is to avoid knowledge loss because of individuals retiring.

Companies start then to integrate knowledge as form of know-how within the organization procedures. As consequence, significant amount of knowledge is stored in organization repositories and assumes forms of practices, organizational routines, or sequential patterns of interaction, as stated by Levitt et al.

Knowledge is embedded in procedures, rules, and norms that are developed through experience over time and guide future behaviours (Levitt and March 1988).

The company know-how is embedded within procedures and reports about client or production ongoing. But it can be also recorded in technologies and systems as storing

data, information technologies and computer-based information systems – becoming a virtual repository of knowledge based on data relationships and business activities information.

For example, a cloud system can store all past client projects in order to make it available for immediate consultancy of the knowledge acquired from that experience and giving information of which human resource is already expert in that field. In the latter case the organization is aware of which are critical knowledge resources and the colleagues can share and make confrontation directly with experts.

Knowledge is also stored within organizational entities as companies are usually divided into functional departments that brought together employees based on specific knowledge possession.

The organizational unit represents a formal group of individuals, within which everyone shares and create common knowledge. The knowledge location is converted from individual level to a group level giving to department a knowledge identity that can be stored and pass on to the next generation of hiring.

Over time, as individuals occupying certain roles in an organizational unit depart and are replaced by others, the incumbents inherit some, but not all, of the knowledge developed by their predecessors. This knowledge may have been acquired through the systems, practices, and relationships within that unit. Moreover, contextually specific knowledge is more likely to be related to the specific organizational unit (Becerra-Fernandez, I., Gonzalez, A., & Sabherwal, R.).

From individual, passing by groups and specialized knowledge departments, the knowledge asset evolves and grow within the organization activities until becomes an embodied critical resource for companies.

As companies must keep up with the market requests, an important knowledge is located within the interorganizational relationships that organizations establish with customers and suppliers.

The consolidate relationships with customers and suppliers are drawn upon knowledge embedded in relationships as it increases the insights about what are the client needs and what are the strengths of supplier's solution.

From the customer opinion the company can increase the knowledge about how their product/service can be improved in order to reach the client requests.

The knowledge about suppliers is also important in order to achieve market analysis of who is the perfect partner for the company's business.

It may be summed that knowledge resources can be founded in all company's relations as it nourishes the ongoing of business activity by supporting the final decision making in each aspect of the company.

The knowledge can be founded at every company's level, within every employee as component of organizational groups, inside procedures as are the result of business activities, inside information technology as it stores the know-how, the data and the information included within company's documents.

1.2.5 Conclusion

In the previous paragraphs it has been highlighted how knowledge is different and more complex than data and information as it is the results of data and furthermore information elaboration.

It must be clarified the process of data-information-knowledge in order to analyse how the extending of data availability and the automation of information creation, which represent the advantages of technology advances, can modify the way and the speed of knowledge creation.

The distinction between tacit and explicit knowledge is useful in order to understand that technology will never take the place of human knowledge as technological tools cannot yet, replicate the reasoning that compose the human know-why or neither the human wisdom. Knowledge evolution will always imply the creation of new insights that first will have the tacit form and will be resided within individuals. In the following chapters will be discussed how technologies can support and be a solution for the processes of SECI model and how it can augment the reasoning capabilities of people.

The knowledge location views have the purposes of understanding that each relationship matters in terms of knowledge creation and through the integration of information technologies within the business processes, it may be stored into virtual repositories as the result of a flow of knowledge used within reports or documents.

1.3 Knowledge Management Systems

Knowledge management systems enable many different processes to continually handle all type of knowledge and encourage the sharing and creation of it.

The implementation process requires the definition of a companywide strategy that treat policy, ways of implementation, monitoring and evaluation.

These actions should guarantee the availability of knowledge resource when and where is useful to business activities. Furthermore, the strategies must consider also the fact that knowledge can be acquired also from external sources as well as from internal ones. The strategies of knowledge management are formulated as solutions for issues regarding the capture, sharing, application and discovery of knowledge.

The knowledge management systems depend on by company's foundation and based on it, the processes are defined in order to create solutions embedded into organizations activities (Becerra-Fernandez, I., Gonzalez, A., & Sabherwal, R.).

The foundation of knowledge management is made by the main factors of the company that have been implement for long term perspectives, such as the organization structure, the business activity or the information technology used.

Based on the foundations, the all system and the following knowledge management process depend on it, consequently the solutions developed by the organisation must be supported by the basis of the company.

The foundation, according Becerra et al., is composed by three blocks connected to each other – the first one is the company infrastructure who in turn depends on the mechanisms and the knowledge management technologies have instead impacts on both organization mechanism and infrastructure.

The infrastructure, according Becerra et al. is mostly affected by the organizational context, whereby the organization culture and structure, information technology infrastructure, common knowledge, and physical environment.

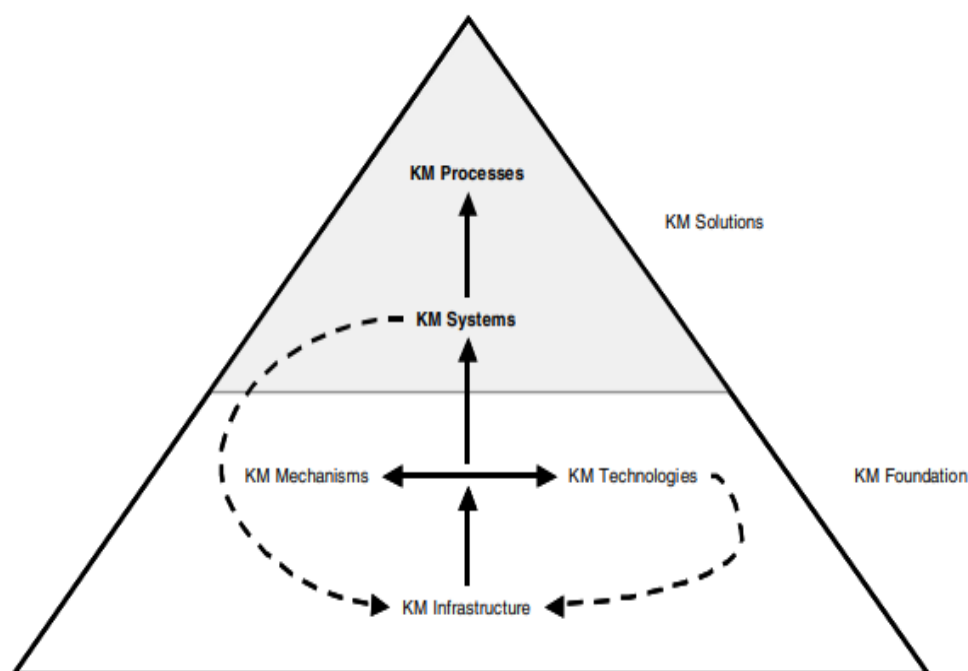


Figure 5 An overview of Knowledge Management Solutions and Foundation from Becerra-Fernandez, I., Gonzalez, A., & Sabherwal, R.

It is easy to perceive that knowledge management is impacted by the context of the company considering the internal but also the external aspects.

The internal context is related with the company's values in running the business and which are the expectations regarding the employees, as example they might be encouraged to bring results. The remuneration on results and the way it is analysed, at individual or group level, has impacts on the people engagement in knowledge collaboration. For sure a collaborative structure and environment will have more probabilities of implementing a sharing knowledge management system.

The external context considers that more dynamic and competitive is the market, the more knowledge is relevant; the companies benefit from developing a knowledge management with purposes of collaboration as it also accelerates the creation of new insights and consequently improve the innovation process. The purpose of it is to guarantee an agile system able to respond quickly to market needs.

The scholars give a riche deepening about all the infrastructure components, based also on how flat or more hierarchical structure enhance different knowledge management strategies.

Now instead, in the following pages will carry on with information technology infrastructure as it is another touch point between technology and knowledge.

Within the knowledge management foundation there are another two types of connections between technology and knowledge.

The most important one it is mentioned previously as part of the infrastructure, the information technologies are developed for information and data processing in order to enforce the decision made into business activities. Practical examples of this typology could be systems as ERP or CRM, which store and elaborate data, but they do not have any feature that enhance the acquisition, sharing or creation of knowledge.

The second type of technology is considered a direct instrument for knowledge management process, it could be platforms that are used as repositories of procedure and praxis of company in order to build the organizational knowledge.

The last touch point considers the mechanisms of knowledge management that can be developed through IT tools applications. The mechanisms are the procedures and the ways of working across organizations.

Considering that knowledge management mechanisms are in practice activities of learning by doing, job training, learning from observation or face-to-face meetings and some of these procedures can be easily developed through technologies systems.

1.4 Technology as Knowledge Management Foundation

The following part is focused on taking a closer look to the main touch points between technology and knowledge within its management that have been mentioned in the previous paragraph.

The information technology infrastructure is implemented mostly to facilitate the flow of organization's information needs. Still, it indirectly supports also the management of knowledge as increase the probabilities of new insights through the benefits of having more information in all the organization and speediness the time of data and information elaboration. The technologies considered by Becerra et al. as infrastructural are:

- data processing, technologies able to elaborate autonomously raw data and convert it into meaningful information;
- storage such data warehouse or enterprise resource planning systems;

- communication technologies and systems, such as the use of intranet to cooperate between the departments.

The IT infrastructure can be analysed also regarding the benefits it offers - there are evidences in the literature of how to consider the technological tools by the following four aspects: reach, depth, richness, and aggregation (Daft and Lengel 1986; Evans and Wurster 1999).

The reach aspect considers the capability to give access to information to everyone in the organization or the possibility to connect as much collaborators as possible. The depth differently, concerns to the amount of information that a technology can give to their users.

The aggregation and richness instead are fundamental characteristic as regards to new advanced technologies. By which as integration capability, they can store and quickly elaborate data and information from each external source and every corner of the organization and sometimes do it autonomously by following the initial structured instructions. The richness stands in the fact that information technology has the capability to integrate all available data and as consequence it has been translated in an augmented richness of information from which everyone can get new insights.

Knowledge management could also be implemented by deciding to integrate into business activities, technologies that have the main goal of being a facilitators of knowledge acquisition, sharing and conversion processes.

In fact, according Gronau (2002), knowledge management processes are supported by IT-base knowledge management which main goals are to support the processes of creation, transfer and application of knowledge in organizations.

Bush et al. divide these technologies into two categories, the first is focused on the repository activity and the other own on activities of networking.

Knowledge repositories have the capability to store all explicit internal and external knowledge useful for business activities. In the case of which, the repository has been well structured, the knowledge management might benefit through an easier retrieve activity.

Hansen et al. state that behind knowledge repositories may lie also a structured codification approach as it implies codification of individual employee explicit knowledge into documents and data attainable from every corner of the organization.

Instead systems of knowledge networking are made to establish virtual way of contact among individuals for creating modalities of knowledge exchanges through personal interactions of expertise (Alavi & Leidner, 2001).

Summing up, any platform or technology able to shorten the distance among branches, but also departments are considered facilitators of knowledge management as increase the possibilities of collaboration.

Virtual collaboration implies the creation of a space where people can exchange insights and cooperate when business issues relates different company fields. The virtual space is developed upon WEB 2.0 technologies and it takes the structure of blog or wiki - where everyone from the company have the chance to meet and confront.

Becerra et al. include furthermore, as knowledge management technologies the artificial intelligence engineering used for acquisition of knowledge and construction of case-based reasoning system.

The integration of technologies within the knowledge management processes enhance many benefits, for example it easier the transmission and exchange of information since increase the information that could be captured. And lastly as all is connected the amount of information obtained rise and the opportunity to share it across organization multiplies.

1.5 Conclusion

In this chapter has been exposed with what knowledge resource is nourished, and the first technology and knowledge touch point has been defined. As technology give the opportunity to organizations to collect and give them context to data resources according the company's KPIs – it implies an easiest way to have information and consequently quicker process of knowledge creation.

The definitions of tacit and explicit knowledge give the perception of which are the boundaries between these two resources; In fact, new discoveries are initially formed inside individuals as tacit knowledge and instead technology can store only data, information or know-how only after knowledge have been codified.

Concerning the knowledge locations, scholars state that also technologies represent a resource of knowledge as it can found data, information and organization procedures useful to spread knowledge and trainings.

Last touchpoints are situated within the knowledge management system, as technologies impact on the infrastructure, the mechanisms and capabilities of the organization.

In the next chapter the analysis of business technologies will proceed with a further investigation of which are these tools and which fields of knowledge management might benefit. Furthermore, regarding the knowledge management which are the challenges and solutions introduced by these tools.

NEW TECHNOLOGIES FOR BUSINESS

2.1 Introduction

With the ascension of new digital technologies, such as social networks, mobile, big data analysis in most all industries domains are leading multiple initiatives to explore and exploit their advantages.

This mostly involves transformations of business operations and affects products and processes, as well as organizational structures; companies need to establish management practices to govern these complex transformations.

The complexity of leading technological process innovation into companies will require high maturity of knowledge management as it is stressed in order to learn new methods and have the capability of renew organization knowledge asset.

The latest report of Gartner concerning technology features, states the ten strategic technologies trends that will impact the world and business as will drive substantial disruption into business opportunity and human knowledge creation process over the next five to ten years.

Since these new technologies are on the edge of going beyond the augmentation that substitute human capability into augmentation that creates superhuman capabilities, meaning a quick increasement of knowledge in term of quantity and complexity.

The trends are based on people-centric and smart-place concepts which evidence the focus on how these tools exchange the world of customer and employee and how even the home and office spaces are affected.

From these two categories is important to mention those regarding the human-centric trends and more particularly those which have impacts on companies' knowledge resource.

Trend as hyperautomation which is made by advanced artificial intelligence and machine learning mechanisms and can be used, according Gartner report, in terms of sophisticated analysis automation designed to measure the ongoing independently. It permits to dispose of a digital twin allowing organizations to visualize in real time how functions, processes and key performance indicators interact to drive value.

The multiexperience trend stands for the idea of a computer evolution from a single point of interaction to including multisensory and multi touchpoint interfaces (e.g. mobile, augmented reality). For example, it could be an immersive training program for new hiring developed through virtual reality or augmented reality tools.

Democratization and human augmentation are the least ones but the most important in knowledge management field; The first one has the aims of give everyone all the instruments to act as anyone can access at technical and business expertise. The human augmentation instead, will raise the cognitive abilities enhancing the human's ability to think and make better decisions.

Through such technologies, knowledge management evolve given the fact that the business world is projected toward a digital technology application; Whereby many scholars are talking about the knowledge management 4.0 era.

The following chapter has the aims of describing briefly which are the characteristics of digital transformation and which are the main technologies.

It moves on by stating which are the impacts on knowledge management considered by the scholars, focusing on the functions and applications of new technologies systems within companies.

After, the role of knowledge management in new technologies development will be discussed.

Lastly, it will be formed the features of knowledge management software market and its diffusion potential.

2.2 Digitalized knowledge society

A conventional definition of 'digital transformation' is the one thought up by Bounfour (2016), defined as 'the change associated with the application of digital technology in

all aspects of human society'. It can be underlined that digital transformation implies that technology application disrupts all aspect of society and mostly of enterprises.

Starting from the way of doing businesses. In fact, scholars as Iansiti and Lakhani stated that digitalization correspond to upgrading operations, tasks and managerial processes through which companies and organisations are affected.

The following definition instead gives a more detailed view of which kinds of technologies are considered as lead to digital transformation processes. Furthermore, they assign to these tools the power of shaking the business and the way of doing of companies. The consequences are so impressive, in fact McDonald and Rowsell-Jones argue that digital transformation may become a critical asset for companies in acquiring market competitiveness.

Use of new digital technologies, such as social media, mobile, analytics or embedded devices, in order to enable major business improvements like enhancing customer experience, streamlining operations or creating new business models (Fitzgerald et al.). As such, the Digital Transformation goes beyond merely digitizing resources and results in value and revenues being created from digital assets (McDonald and Rowsell-Jones).

The systematically review of Reis, J. et al. categorized the Digital Transformation definitions into three distinct evolutions:

- Technological as DT is based on the use of new digital technologies such as social media, mobile, analytics or embedded devices;
- Organizational as DT requires a change of organizational processes or the creation of new business models;
- Social as DT is a phenomenon that is influencing all aspects of human life.

In the sphere of knowledge creation, it is likely that will have some mutations because of new technologies but also because organization processes change.

Many scholars refer to it as the “Knowledge 4.0”, the stage within which applications of digital technologies are widespread in everyday life, leading to a “digital ubiquity” (Iansiti and Lakhani 2014), and contribute a significant share to value creation. Within which the meaning of “digital ubiquity” defines the virtual transformation of each sector because of digital technologies.

Researchers find that smart, connected products with their four capabilities of monitoring, control, optimisation and autonomy transform competition in the digitally enabled knowledge economy (Porter and Heppelmann, 2014).

The technologies contribute in the value creation by reinforcing knowledge management and according the scholars, the features that give the main advantages are monitoring, control, optimization ad autonomy in competition goals.

In the following pages the technologies mentioned by the literature will be discuss and highlighted by their critical functions in the knowledge management field.

2.3 Digital Technologies

2.3.1 Semantic Technology

In this section it will be outlined the developments bases of all technologies able to retrieve and analyse data, information and knowledge within companies. This are the first steps to implement applications of artificial intelligence or machine learning, which first need to store meaning information. The semantic technologies are used to give meaning to information to create the computational knowledge and as Rettinger et al. quoted, these systems represent the key enablers of knowledge 4.0 evolution.

In fact, Rettinger et al. affirm that semantic technologies have the aim of giving sense of data for machine elaboration. Some scholars describe it as the instrument to bridge the gap between human knowledge and computational knowledge.

Their functions may be used in many knowledge aspects, starting from the capture of knowledge into explicit computational knowledge reports which can be approachable to everyone in the organization and besides processable by computers in a meaningful way.

The semantic technologies may lead to many different applications as it is incorporated in this category different products, such as:

- Natural language processing which elaborates the text and extract the useful data and information for business activities;
- Data mining which uses algorithms in order to process the pattern and correlations within a large extract of data;

- Artificial Intelligence, or expert systems which develop advance reasoning model to answer to questions autonomously – it usually is strengthened by machine learning tools, the combination gives improvements to the decision-making process;
- Classification technologies have the aim of tagging and categorising data for further processes of analyses and research;
- Semantic search is used to locate information by concepts in order to give final users the proper information.

Rettinger et al. introduced the latest innovations in semantic technology field by modeling companies' knowledge using knowledge graphs. He outlined how knowledge graphs facilitate value creation by making unstructured content, like text documents accessible for machines and humans reasoning. Furthermore, how semantic technologies help to make hard and software components in virtual and physical systems interoperable.

In semantic technologies field, knowledge graphs (KGs) are nowadays used as an advanced component to realize the vision of explicit and computational knowledge representations. Moreover, they support the construction of KGs through semantic enrichment of all available sources by using functions of data integration and data curation.

As showed by figure 6, knowledge captured from people can be stored in Knowledge Bases (KBs) and used across all the processes of knowledge designing.

Semantic technologies exploit human knowledge from KBs, and computation knowledge encoded in data semantics to construct new knowledge or visual knowledge maps.

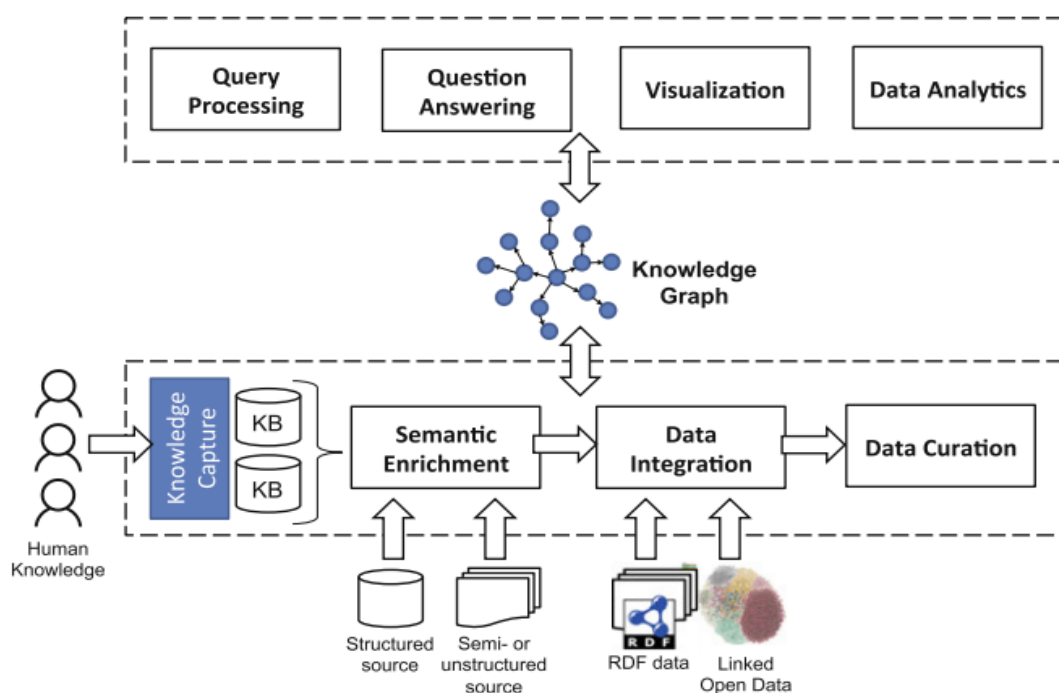


Figure 6 Overview of the application of semantic technologies for knowledge engineering processes (Rettinger, A. & Zander, Stefan & Acosta, Maribel & Sure-Vetter)

The previous figure of Rettinger et al. designs the development of semantics technologies, as a clear overview of which are connections with human knowledge resource and how data are elaborated to define the knowledge graphs to further on create services of information analysis, knowledge visualization or big data analysis.

Nowadays, the introduction of the Web supporting semantic technologies have allowed to put in practice activities such as the acquisition of knowledge from experts, as well as made possible to organizations the creation of semantic knowledge bases in a distributed and collaborative way.

In the next pages it will be presented and discussed the model of Rettinger in order to approach to the essential role of knowledge resource within semantic technology implementation.

The process starts from knowledge capture as it is extracted and loaded from direct or indirect human knowledge reliable sources.

The knowledge asset is patterned as artefacts including rules and conceptual terms that point out physical objects or phenomena of a domain.

An example of successful knowledge capture frameworks that exploit Semantic Web technologies are Semantic Media Wiki, mentioned by Krötzsch et al. (2006) such as an extension to the Media Wiki system that allows users to add various types of ontological information to the wiki, and which forms the basis for collaboration and manage documentation inside companies.

The knowledge captured is enriched relying upon the data available and the resources. It must be highlighted the efforts of dealing with large volumes of data introduce the need of enrichment and conceptualization of the entire content of a source. This enhanced among the researches the willing to figure out advance computerized forms to manage the quantity of data but also its heterogeneity.

The implementation concerns new technologies as Big Data architectures (Auer et al. 2017) designed to solve the semantically enrichment of data by following a structured scheme with purposes of giving means to data meaning, context and categorization.

In most of the cases data enrichment needs furthermore information that can be gather from external sources and for these reasoning systems of data integration are critical factors for semantic technologies.

Data integration is made by different systems from network protocols, data models, and data representation to an offline activity where all the contents of the sources is combined by a pre-processing step, or on-demand based on users' queries as performed by traditional data integration systems (Lenzerini 2002).

The integration of semantic data allows for the construction of knowledge graphs from heterogenous sources – assuming, because of a proper codification, a standard network protocol of data accession and a common graph-based data. It permits to different semantic technology to collaborate and complement each other through data cross-sharing.

After gathering all information and data available inside the physical and virtual locations of organization, the process clean and authenticates data useful for the established knowledge graphs.

Data curation includes the activities of creation, maintenance, and validation of data to check the value of the it.

The data curation performing is based on knowledge-based systems as it may exploit the semantics encoded in the data as well as the information captured through knowledge basis.

The knowledge graphs can contain large amount of entities and these increases drastically as the introduction of new systematic information occurs such as new keywords, new semantic queries to structure entities.

Summing up it can be outlined, that technology can elaborate knowledge by using ad hoc graphs that have the aims of responding to questions, processing the information into queries, visualize the information to final users and analyse it following the defined KPIs.

All this is possible, as explained by Rettinger, through extraction of knowledge that has mostly raw data shape. Whitby the service is given also by activities of enrichment from different sources and validation of all harvest data.

2.3.2 Collaboration technology systems

From literature emerged two categories of technology systems that enhance knowledge creation, acquisition and sharing. Systems that elaborate and analysis data and information and platforms that enhance the collaboration of it. Virtual knowledge collaboration must be built upon strong systems of data and information management to permit teams or individuals to share information in real time.

The words of Kernbach and Bresciani underline the importance of having appropriate systems of visual knowledge mapping to enhance knowledge collaboration values and organize and share more efficiently the knowledge assets.

The challenge for organizations to effectively manage information and knowledge and, enable knowledge-based value creation lies in the way organizations enable their employees to collaborate. In this article, we propose that visual knowledge mapping is a very effective way of sharing, integrating and creating knowledge and thus creating value in collaboration for organizations (Kernbach and Bresciani, 2018).

Papangelis et al. (2019) instead, elaborated an investigation on 865 paper published in the International Conference on Collaboration Technologies and Systems from 2007 to 2016 in order to capture the research trends in collaboration technology field.

They choose to focus on 50 keywords selected based on the frequency level, further they proceed by clustering the papers through groups with analogous keywords based on concepts.

The evidences elaborated by them outline that the largest cluster is the one labelled with keyword of collaboration systems and technologies concepts. Instead, the other significant cluster regards issues as security, trust and access control and it is followed by social network, knowledge management and mobile applications.

The goal of the authors was the examination and arrange a view of methodologies and technologies that are related to communication, coordination, cooperation, and collaboration by introducing some new trends and directions in this field.

According the papers selected by the scholars, there are a large variety of solutions and strategies with which collaboration is developed to support specific-domain tasks, and most of these solutions are related with technology as showed by the systematic review. Nowadays we are living a disruptive moment in this field, considering that collaboration is likely to become an increasingly prevalent aspect in people's daily use of computing technologies and interactions due to the widespread usage and ubiquity of these technologies.

Furthermore, the recent innovations in automation and artificial intelligence (such as chatbots and conversational interfaces, autonomous machines and vehicles, swarm robots, etc.), Internet-of-Things devices and applications with data analytics are accelerating these developments. The authors consequently stress out that the future trends of this multidisciplinary technology area will be driven by the need for smarter, faster, sustainable, and more user-centred tools for collaboration.

From the analysis of the past CTS papers content it emerged some key advancement on collaboration systems, based on it they subsequently outlined the several future trends of collaboration systems and technologies development.

One of trends concerns cloud-connected collaboration, these systems are becoming widespread across industries, government activities and in general business world. It is boosted by the increasement of applications as Big Data and IoT which need of a big virtual repository to store all data but also necessities of the possibility to share it among the different systems. It was for these reasons why connected cloud took root inside enterprises.

Indeed, also the authors state of envisioning that more cloud-based collaborative solutions are likely to represent data centres and infrastructure supports by allowing to collaborators to perform remote monitoring and connections.

The follow trend regards the concept of hyper mobility, it is given by the intensification of smart phones usage and all the wearable smart devices that keep growing at high rate and which enhance the obsolescence of traditional personal computer as also they will become even more advanced. This will affect work and the features of collaboration, as remote working becomes more prevailing and it will be equipped with more groupware tools and technologies which will give users the possibility to be aware in real-time as it permits the information sharing and communication.

Among the collaboration technology systems is catching on also the course of Big Data instruments as a solution to create cooperation applications. Apart from processing huge amount of data and convert it to high-value knowledge and efficient analytics, these solutions can improve collaboration and decisions as make more efficient the business and research communities.

The employment of big data processing and collaboration technologies enabler the knowledge discovery and furthermore, create collective intelligence and improve decision making.

According the scholars, from papers analysis, emerged that a collaborative rich context data analytics enables specific content discoveries.

Collaborative data analytics platforms permit also to be exploited on large-scale as it may support to generate new insights and intelligence, meaning new discoveries and knowledge.

The following trend instead is a consequent of the collaboration technology system, as companies want to share and create virtual space in safe way, the demand for cyber security and privacy has increased. The authors evidenced that regarding enterprise knowledge field will be some investments in create a cybersecurity awareness through suited trainings for employees. Furthermore, they stated that will be developed new processes of monitoring, profile, trace and audit connected devices and accesses in order to assure the right security services within the collaboration projects and tasks. It is provided through the proper adoption of secure system architectures built for cloud based.

The latest issues highlighted by this analysis are about the need of elaborate an integration of collaboration systems inside new technologies, domains and application in order to increase the efficiency of collaboration systems and techniques as they are supported by flow of data.

As collaboration technologies and systems will have a continuous evolution and will cover different activities as service/product developments in order to guarantee efficiency, transparency and user experience to their clients.

It can be summed up that technologies that permits and furthermore are created to ensure collaboration will take an important role within future realities as most of trends enhance for it and it can be used for many different business functions. The incorporation in the other systems brings advances to more immersive experiences because it implies the availability of all data useful and the possibility to set up moments of confrontations in real times by elaborating and reasoning on the latest data.

All the considerations suppose that knowledge will be central to collaboration technology systems as it becomes highly required and the sharing and confrontation processes among individuals is supported by these systems through which all knowledge resources can be reached even if reside within employees, as they have the instruments to collaborate in order to take the right business actions.

2.3.3 Conclusion

In the previous pages it was explained how semantic technologies operate in order to develop collaboration between human knowledge and computational one.

After understanding that behind all technological systems that have to analysis or organize data and information there are semantic technologies which works through knowledge graphs definition.

As second potential category of technology for knowledge management has been mentioned the technology solution that foster collaboration. The advances of these solutions imply the use of cloud systems or web semantic systems that which exploit the application of semantic technology to deliver visual knowledge maps or targeted knowledge.

2.4 Implications for Knowledge Management

Starting from what have been outlined previously can be deducted that knowledge plays a key role in advance technologies contexts. These technologies may give some

knowledge variations and, at the same knowledge resources may take a supportive role in technology systems implementation.

The first aspect that might be considered is the fact that the digitalization in enterprises enhance the quickness of processes and mostly regarding the realization of projects or new service/products which can lead to an easily loss of knowledge.

In fact, Maciel et al. point out that main companies are becoming software dependent and it hence for knowledge management diagnostic processes. They see knowledge management as a major challenge, mostly for software development companies.

Further on it is discussed how according Kohlegger et al. the digital tools, mostly considering the data analysis ones, are enhancers of new knowledge discoveries through the externalisation of it.

Maier et al. conduct their research based on Nick et al. definitions; which affirmed that Experience Management can be defined as a special form of knowledge management and an Experience Management System as a socio-technical system established for managing, reusing and recording experience or lessons learned. For these reasons they research methods and technologies applicable for collecting information of experience from various sources and for documenting, sharing, adapting and distributing it. They find out that technologies as data mining, text mining or process mining can support the experience management and enables the opportunity to give targeted information to workers through process mining each employee is associated to a knowledge-intensive activity. For this kind of implementations, they argue that companies must make a huge effort of process modelling with specifications of which kind of knowledge are needed for each activity.

Wolf et al. summed all the articles and researches regarding the implications of digital transformation within the knowledge management applications. The systematic review helped them to elaborate the following map within which are figured out the main variations in this field.

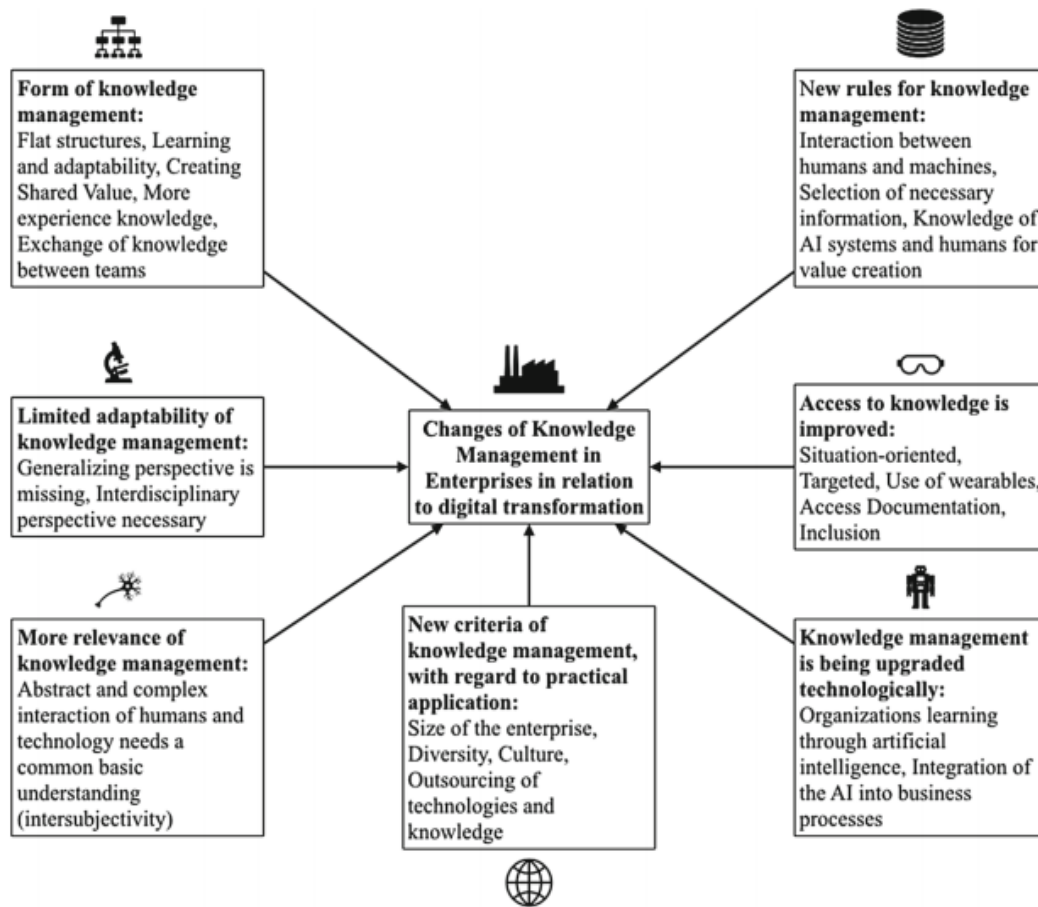


Figure 7 Changes in knowledge management due to digital transformation - From Innovations for Community Services 19th International Conference

I further decide to group these variations following the reasoning of which could be translated as threats, opportunity or solution, strength and new weakness in knowledge management strategies. It is like examining the effect of technology within the knowledge management projects.

Starting from how technology leverages the knowledge resource, Wolf et al. declare that digital transformation will increase the importance of knowledge management in companies and in fact also the literature review that he have done provides proofs that knowledge management has been the object of increasingly number of publication in the recent years as increasing field of study.

The increase of technologies and even more the information technology solutions in business activities make harder the relationship between IT systems and people as the programming languages, artificial intelligence and other new systems and process carry

with itself more data and information availabilities resulting in a rise of knowledge complexity. For these reasons knowledge resources field acquire even more importance within enterprises, as the new technologies increase the high-intensive knowledge activities.

The knowledge collaboration through internal communication systems will become very powerful and required in organizations as the measures of data and the future KPIs will be more and more interrelated and consequently, their interpretation will require the creation of a cooperation that is built upon the combination of different knowledge silos.

Within the process of digital transformation, according Wolf et al. knowledge management may face its weakness as being limited adaptable in practice. As knowledge cannot be always generalised and transferred into practice because not every concept is explicit. Consequently, there are some barriers for technology integration within the all organizational intelligence but for sure this will improve the management of information and consequently the all process of knowledge management.

The established knowledge management structure can be challenged by the new technologies and the companies that are digital born. The competition increases as companies with flat structures can successfully acquire competitiveness. It is possible because nowadays technologies support the exchange of information between teams and it tend to give exchanges of knowledge in any direction, vertical and horizontal beating the knowledge silos and creating new insights. But still, hierarchy must not be neglected as guarantee a filtered flow of information and the decrease of redundant information.

A further challenge for knowledge management concerns the fact that there are new practical applications of knowledge management in technology implementation and organizations must decide between outsourcing looking out to the market of software service providers or developed it inside and buy the software solution as a product. The more technologies are outsourced, the less knowledge management companies must operate on its own in relation to the respective technology.

The size of the company instead, from large to small, will be solved by digital companies through collaborative networks as the new business platforms promote the socialization of knowledge.

The digital changes imply new rules concerning knowledge management in the organizations.

First rules to define the interaction between humans and machines, so that enterprises can focus on individual determinants, which work as key means and enable the targeted exchange of knowledge, as the topic becomes more complex the tags of information and data become more important.

As data and information are elaborated for potential knowledge creation and technologies can extend the availability of these resources, new rule about how knowledge can be nurtured from investigating on past projects and business process using the IT system of the company. Furthermore, the virtual repository of work projects can be seen as the whole experience of the company from which all employees can take new insights and implement their own wisdoms. The elaboration of data instead is useful in order to increase the knowledge about the projects and value which are the aspect that increase the adding value and the quality of the service or product.

Most of technologies helps companies in continuously tracking the defined KPIs, which means data and information selection, used by companies to gather insights about their process status in terms of efficiency.

In practice, the authors established that the rules in this field must be focused on how the interaction between humans and machine should be in order to enable targeted exchange of knowledge based on key meanings.

Considering the technologies as artificial intelligence or machine learning, from the literature emerged that new rules in knowledge management must be developed. The how AI systems and humans can generate value and knowledge from data and information elaboration has still to be implemented. The knowledge creation from these systems should be translated in meaningful decision making and actual business activity within organisations.

Wolf et al. reveal that knowledge management has been upgraded by the technology, analysing the processes of SECI model they outlined how most of them have been improved due to new technologic tools.

Nowadays organizations can learn through artificial intelligence and convert their knowledge members into organisation resource. For example, it can store knowledge from interactions with a company's data storage systems and learn which are the critical

knowledge resource through machine learning and permit organizations to learn independently.

The first possible applications of AI can have the purposes of consulting systems which deliver the appropriate information based on context and time. To benefit from features like that companies must integrate the artificial intelligence systems within all the business processes and allow to interact with each other.

As all business processes are integrated through technological systems the data used and the information gathered for business decision making are recorded within. It implies that the access to knowledge is improved as can tap into a widely amount of data and information repository.

Furthermore, the knowledge can be stored following situation-oriented reasoning and consequently knowledge seekers will have targeted results.

The authors consider that new devices will create new kind of interactions through which working teams, as previously anticipated, is the format that will mostly benefit. It is important in the field of digital or virtual work teams to have access to targeted knowledge in order to guarantee the efficacy of the collaboration.

From the access and first the storage of knowledge resource can be implemented inclusion programs; it will enhance the spread of expertise within a company and avoid the creation of employee exclusion. The interaction with these devices can increase also the willingness of people to share their expertise as they can benefit from new skills and knowledge matured in their collaborators and not reworking advantages are significant. Consequently, a sense of belonging to the organization and mutual growth appears and people are pleasant to share documents and information about their insights.

Wrapping up, as Davenport and Kirby anticipated, the professional expertise will increasingly leverage by cognitive and networked systems, within which cognitive systems stands for technologies that emulates human reasoning and increase the complexity of information.

2.5 Knowledge Management Software

The next pages are dedicated to sectoral investigation within the information technology market in order to check the existence of a unique product solution designed for knowledge management implementations.

As previous quoted the technologies concerning knowledge management can assume a supportive role as they shape the infrastructure of knowledge systems or they may represent a solution for this field, furthermore the category must have the features of essay the knowledge and information flow. As meaning that technological solutions for knowledge management have not functions of data, information processing.

Di Iori and Rossi scholars stated that the functions of knowledge recommenders could be developed through knowledge base platforms that are enriched by data composing the how know-best and find that the best solution is a wiki platform.

They argue that wiki platforms must anyway have the resources to capture the knowledge about the best practices. It hence for the necessity of developing and architecture knowledge map in order to give to the technological system the instruction about where knowledge is created, and which are the sequence activities of the process. This elaboration results as a proper virtual infrastructure of stored and knowledge and can offer to final knowledge seeker the target knowledge.

Furthermore, they suggest that the perfect combination for knowledge management need can be founded within the Semantic Media Wiki solution. The data model of this instrument represents each entity by wiki pages, from which the semantic proprieties give the possibility of matching entities and give sequence views.

Next it will be presented the evidences of knowledge management solutions markets and which are their main company profiles.

First the market researches define the market as the composition of solution delivers of processes and systems used to handle knowledge. The solutions consequently are evaluated based on their capability of establish efficient processes of capturing, sharing, creating and applying knowledge.

Concerning the software solutions, market researches outlined that these tools to be considered a knowledge management solution must have determinant features such as:

- Identification of useful information for knowledge application;
- Captures the information requested for decision making and the sequence information about company activities;
- Elaborate following the architectural knowledge in order deploy the retrieval service and share information inside the enterprise.

All these functions are founded on systems of cloud computing model which give the possibility of collecting and storing the data on servers – it implies different advantages such as remote access, decrease handling time, reduce training times, increase customer satisfaction and others.

The market specialist value that the global market of knowledge management solutions is expected to grow at USD 33 billion by 2023 with a compounding annual growth rate of 12% from 2017.

The main key players are situated in U.S., Canada or Australia, further now it will be outlined which are the main products of these companies concerning knowledge management strategies in order to test if most them offer wiki platforms for knowledge management services.

The first one is called Freshworks and is an American company, they offer software solutions as “Fresh Connected”, “Fresh Team” or “Fresh Release” to make it easy work in teams and permit a lean flow of information. Their solutions are mostly based on cloud systems and have the format of Wiki platform for user experience benefits.

Lucidea instead is a Canadian software company and they three different software products dedicate to knowledge management issue. About them can be argue that differently from the previous company they do not focus the efficiency of working teams. They give knowledge an objective role, as the information must be found in the proper context in order to increase the benefits of sharing and connecting people. Their special feature is that costumers have the change to build their own cloud architecture and organize internal and external following their knowledge management needs; it is supported by the fact that this company offer the possibility to aggregate data through a web based solution and benefits from algorithm connections without being a coder.

Atlassian Corporation has Australian roots and branches all over the world, they offer two distinct products for knowledge collaboration. The most important one is called Confluence and has the aims of handling the company documents and improve work organized in teams because of cooperation within the platform pages. This instrument achieves the organization of company information by label pages implementations. It can be defined as social wiki platform within which enterprise collaborators can cooperate and share their knowledge. The advances of information and all documents are

stored in clouds or hosted way, even if are strongly promoting to move definitively forward to a cloud repository.

Therefore, by getting this market perspective straight it can be highlighted that the three main competitors offer solution for knowledge field by developing wiki and structure the captured knowledge by using cloud systems.

In fact, the different market sectors can be divided also by the software deployment type, which can be from on-premise based to a complete cloud computing base and in between there are hybrid solutions.

The development of production on-premise or cloud computing affect not only the production part but also selling, as the first type implies the selling of the licence and after customers must deploy customization features in house by their own IT resources. Instead, the second options give customer an ongoing software service solution because the data are stored in clouds and the providers can handle the updates of every customer needs.

About this issue, the scholars Boillat et al. (2013) build a business model analysis to outline the effects of the migration toward cloud computing solutions of all software solution providers.

Their findings reveal that cloud computing's introduce the opportunity to deliver an online software and it hence the pricing model of pay-per-use or a subscription revenue model. In the customer viewpoint, the cloud technology comprises new functionalities, such as analytics of big data or social media platforms and they can benefit from converting CapEx into OpEx one.

Instead, the vendors can extend the customer segments and build relationships with customer through new virtual channels and direct access to solutions. The software vendors have also to provide a development platform installed in the cloud-based enterprise software that is offered within online stores platforms.

According a cloud computing survey, the migration to this new way of delivering computing resources encourage the implementation of three different business models which correspond to different supply of services:

- IaaS stands for Infrastructure as a Service because the service consists of delivering cloud infrastructure that has the aims of servers, storage, network and operating systems and data. Clients buy only the outsourced service on demand without needing

of implementing in house the data centre space. Cloud consumers directly use the information technology infrastructures provided in the IaaS cloud as it all guarantee by the providers cloud and servers;

- SaaS, in this model the customer uses the service on demand and the licenses applications and are carry on by the provider. The services are processing on the provider's infrastructure and customer can access through a public network connection. The applications may be a browser formats or they must be downloaded and synchronized with user devices;
- PaaS means platform as a service and it is the delivery of a coded platform to manage the application systems. The deployment of applications does not need to buy and manage the underlying hardware and software layers because service cloud companies provide all the facilities required to support the complete life cycle of building and delivering web applications and services entirely available from the Internet.

In line with the new trend also the knowledge management software market reported this transition. In fact, the main key players offer they wiki platform as pay-per-use and all the infrastructure is developed with cloud computing technologies inside the organization. It permits to profit of remote access to knowledge base and update promptly the IT tools based on customer needs.

Another advancement regards the visual search approaches, the algorithms of information seeking were perfectionated in order to give a targeted result. It is possible as the repository has its own architecture knowledge, as example the cloud may be tagged.

The companies of this market are struggling to find the perfect solution that enhance a minimum viable product model by developing basic systems which can be integrated in different organizations by shaping the modules based on the customer request. In fact, Lucidea find the proper solution of implementing a user-friendly technology that can be modified according client needs and furthermore they can do it autonomously.

They expected that within the sector will gain even more foothold the integration of social media and knowledge management software as the flow of knowledge sharing happens mostly on social platforms.

For this market the rising mobile phone adoption has become a challenge, most of the main players in fact are offering their software solutions updated to mobile adoption as

mobile technology is expected to be at the forefront of all enterprise tools. They already distinguish the market by software solutions for mobile android, mobile IOS native and others.

Furthermore, customers will increase the demand for an integrated knowledge management software – it must combine activities of communication, scheduling, project management and content creation in order to develop a knowledge management strategy applicable in the all enterprise aspects.

The specialist stated the most competitive factor of knowledge management software will be the user interface – the easier is to exploit the instrument for customer the more market shares the company will gather. In fact, one of the reasons of why knowledge management software has the characteristics of a social wiki software.

2.6 Conclusion

In this chapter have been outlined the main digital technologies systems and their applications in the knowledge management and in the business activities.

From it emerged two kinds of technologies, the first one improves the activity of data analysis through the extension and more complex elaboration of this resource. Consequently, the knowledge better too, as based on the DIKW pyramid data creates information and this last one brought to new insights.

From it emerged that these technologies, called semantic, to be implemented also their need of knowledge graphs in order to give meaning to data for proper analysis therefor knowledge represents a requisite for the advances in this field.

The second category instead, are technologies aimed to increase and improve the communication channels and enable knowledge collaboration. It has been showed how a more efficient collaboration system is built upon technologies of web semantic kind.

In the following pages it will be presented the empirical research and furthermore it will develop an integrative view based on the practices in companies and on of what have been found in the literature. It gives the opportunity to examine which are the practical considerations and how much these agree with theories.

THE EMPIRICAL RESEARCH

3.1 Introduction

The research has the aims of collecting information through structured survey interviews about knowledge management aspects regarding challenges, solutions and other aspects in companies' nowadays. It will permit to gather new perspectives and compare the theories with practice.

The research model follows the guidelines stated by the scholars Voss et al. in operations management field and which state through the following sentences why implement the analysis through a case-study research may be reasonable.

In the early stages of many research programmes, exploration is needed to develop research ideas and question. Many doctoral theses begin with one or more cases studies in order to generate a list of research questions that are worth pursuing further (Voss et al., 2002).

The research explores an issue quite new as it has the purpose of investing how knowledge management has changed considering a world business in which advance technologies are widely used in all departments and industries.

The choice is confirmed by the fact that the theory resources in this field are scarce and not all focused on the issue. The exploration research has the intention of developing new insights about the argument and construct the basis and the direction for new studies.

The interview structure was defined starting from designing which are the information regarding knowledge management necessary to explore new practical aspects but also to provide proof of scholar's theories and extending it.

The elaboration of interview questions composes the core protocol, as stated by Voss et al. it serves both as prompt for the interview and as a checklist to make sure that all topics have been covered.

The selecting sample of case studies has been chosen from ICT sector with the particularity of not only provide information technologies to enterprises but also give them a consultant service on how their process may change with technology integration.

The sample was moreover pre-selected based on distance convenience, as the interviews are preferable to happen face-to-face; the companies are placed in Padua city. Furthermore, selection is also based on the availability of the firms to participate in the research, following common opportunistic sample formation in qualitative research as acknowledged by Voss et al. guidelines.

After the development and collection of the interviews, the next step consists in make a transcription of the information gathered.

In a second period, the documents of transcription are evaluated through a tool of text analysis of qualitative data; As Voss et al. affirm, these tools allow on screen coding of documents and exploration of patterns and relationships of words and phrases.

The coding process is fundamental for the validity of the research, it is important to be able to categories data into. (Miles and Huberman, 1994; Glaser and Strauss, 1967). Each data in this research case can be related to determined codes as business needs, tools functions for knowledge management, industries or certain events that have direct or indirect correlation with knowledge resource handle.

Data codification supports the schematization of each case in order to construct a clear description of it and furthermore to cross the evidences gathered investigating for similar or opposite points of view.

The case study research observation could be the basis of new investigations with wide range of cases and tailored information as now there is a clearer view of how the changes in knowledge management are due to the technology adoption.

3.2 Cases and evidences

Managers and co-founders of technological-knowledge intensive business services companies have been interviewed about issues regarding knowledge management.

Table 1 List of interviewed companies and role specification

Company	Role of interviewed
Miriade	Business Intelligence Analyst
Nethive	Co-founder
Sanmarco Informatica	Business Intelligence Developer
Azzurro Digitale	Co-founder
Dedagroup	Enterprise Solutions
Uqido	Co-founder

After an introduction phase in which it is stated the knowledge management scholar definition and how it could be translated in strategies or company procedures, the interviewed people must answer to the ordered questions that can be founded in the appendix.

The interview starts approaching the challenges of knowledge management that their sector or their clients must face nowadays.

The second question is focused on knowledge management solutions or tools that can help the knowledge management systems and more specifically through which functions.

The interview proceeds demanding to state the solution or consultancy providers of knowledge management and if there are aware about the existence of this sector, it is required to outline how the supply chain is developed.

Further on it moves to questions about information on who the excellent cases in this field are or who is very devoted to solutions for knowledge-based strategies.

The interview closes with a look to the future, questioning what could be the next knowledge management development and which will be the effects of artificial intelligence and machine learning in this field.

3.2.1 Miriade Case

Miriade is a company of 70 people situated in Padua and Vicenza and their core business is providing solutions of cloud systems, automated business intelligence analysis, database administration and integration.

The person interviewed has the role of business intelligence analyst, she collaborates with clients in order to understand their requests and develop the final product. It makes

her be a perfect candidate for this interview as she knows what people expect from new technologies and if it is correlated with knowledge management. In fact, from the beginning she states that knowledge management will become important in organizations due to new technologies – because analysis technologies are data-based, and the first step implies the definition of data used and the classification of it through metadata. The companies must map the flow of data, information and knowledge to understand what are the fundamental KPIs of their business in order to explain their needs to data-analysis developers.

“In case of company’s clients that have not a defined knowledge management and do not store the data following a system of codification such as metadata requires more time and work to understand how develop the right solution based on their needs.”

From the previous sentence, a new hypothesis emerges - knowledge management is required for analytic technologies application and for that knowledge-based strategy can obtained more awareness among business activities.

Knowledge management improves the feasibility of new technologies adoption, but it is also affected. The interviewed affirms that these instruments support indirectly the knowledge handle. Tools as ETL, BI have the functions of gathering all company data and analyse it with the final purpose of delivering customized KPIs. The knowledge creation increases as can take advantages from widely base of data and information regarding their business processes. Instead emerged that they do not use specific tool for knowledge management development and the most solution dedicated to it could be considered the cloud system – it helps to update the state of projects making it collaborative among the different departments and store knowledge about their activities.

Due to the fact they do not face knowledge issues or even their clients, they are unaware about which could be the providers of knowledge management solution in terms of strategic consultancy or in terms of software developers. Even if she cannot recognize providers of this type of solutions, she states that there are adopters of knowledge management systems and many of them belong to manufacturing sector or are engage in digital transformations. According her could be declared that engaging in knowledge management increase the awareness about importance of data and consequently the desire of

having information from every business process increases implying the wish of having digitalized processes.

Merging the answers regarding challenges and profiles of knowledge-based strategy adopters, it can be recapped that there are two types of relationship between knowledge management and new technologies; Companies that use knowledge management are facilitated in new technologies implementation, but also new technologies require companies to look out to knowledge-based strategy.

In the closing phase, the interviewed approaches which could be the future evolution of knowledge management – the cloud defined by knowledge-based will have a key role for knowledge storage and for deliver the right knowledge to users based on circumstances.

3.2.2 Nethive Case

Nethive is a local company, 10 collaborators are engaged in finding the right solution for their clients in terms of integration systems and software development.

In this case I had the honour to interview the co-founder of this micro enterprise, which is focused on satisfy precise market niche. In fact, for them their client portfolio is very important as they achieve economies of scale by storing client knowledge from each project and it is their main business strategy- focus on clients that have some common features in order to use the expertise based on past experience.

Their software has the final purpose of delivering automatically KPIs to their clients – the indicators in most projects are developed in order increase knowledge about processes. The storage of process data has the aims of supporting the decision to change, data concerning efficiency and quality can lead to different points of view and new knowledge about which are the right ingredients for their business.

The co-founder and its company are conscious about knowledge management as a medium to approach business and he finds that companies face many challenges in this field. First they feel that in their business reality, need to find a solution of converting individual competences and knowledge to organizational level – it implies for them the opportunity to achieve economies of scale as replication is a possibility and decrease the level of risk concerning human resources management.

According to him creation of universal knowledge coding is becoming a priority among international companies as they must manage processes and documents in different lan-

guages, he argues that the creation of unique codification at least for the part of digital storage will improve the operativity among the different branches.

In connection to the question about tools and solution for knowledge management, the interviewed declares that they implemented solutions such as placement programs to introduce to new employees the know-how of company and learn the main company procedures. The same platform has also the function of store manuals of good practice and reports of past and ongoing projects.

The tool mentioned is a wiki platform type and it is based on knowledge-based cloud meaning that has a structure defined by types of knowledges stored. The benefits are translated in a better management of projects with the possibility of engaging all company's collaborators and consulting past projects.

They encounter positive results also in terms of service quality, as the responsiveness to client's need has become faster because every available collaborator can solve the situation by consulting the reports and information about the project – it is possible because the knowledge about the projects is stored following determinant rules and the skills bases of collaborators are the same.

The wiki platform is mostly used for knowledge management solutions is developed by Atlassian, the product is called Confluence and has the main purpose of helping the team working. Atlassian company has Australian roots and worldwide branches and vendors, they provide software solutions to improve team collaboration as they are strong believers of team efficiency and make based on it their core business.

With regarding of advanced companies in terms of knowledge management systems, he outlines that there is a connection between knowledge-based strategy and digital transformation of processes as new technologies increase the amount of available data and the complexity of knowledge related increases.

Telecommunication companies has been declared by the interviewed as an excellent case of knowledge and technologies combination. Big call centre companies apply artificial intelligence to their business and knowledge about their clients, based on all client information the technology elaborates a behavioural algorithm to give the right answer based on client and context. According to him this will be the next evolution of knowledge management, the predictive function to reach the best output will be the future of this management field in all types of companies.

The implementation of technologies such as AI or machine learning will increase knowledge complexity to keep up with machine logics as data analysis will increase and machine will be able to elaborate more data connections.

3.2.3 Sanmarco Informatica Case

Sanmarco Informatica is an Italian company engaged in offering consultancy and development of software solutions for companies that want to rearrange and innovate their processes.

I interviewed a business intelligence analyst in order to gather information about their knowledge management in operations and information about their clients' approach to knowledge-based strategy.

He affirms that in terms of knowledge-resources, many companies want to know more about their production and processes. The challenge is to acquire more data and information as possible through process digitalization in order to increase the knowledge about the inputs and variables that are correlated to their business efficiency. Starting from these needs, the solutions are technologies as data integration that permits to elaborate all company data and increase the company knowledge. These tools and all development stages are clearly explained in the following respondent's sentence.

“Software devices as ETL permits to export all company's data used for management issues (e.g. ERP, CRM, Galileo) and load it on solutions as BI or the new power BI. These tools are developed for their client analysis based on customized KPIs, defined through client collaboration. The formal report is made by Qlik View, it allows clients to use their knowledge combined with complex data; It helps to have different perspective about business processes and create new knowledge improving the decision-making process.”

According the interviewed, the tools of business intelligence will increase the resources of data and indirectly knowledge through new process considerations. Despite this, he highlights also a reverse connection - it is request to companies to know well their processes and map data related to knowledge in the making-decision process to set the KPIs that business intelligence software must deliver.

In terms of companies that demand for new solutions to increase the knowledge about business process, he states that most of their clients are winegrowing enterprises. This

sector is investing a lot in business intelligence solution with aims of improving the quality of their products – to achieve it they must explore which are the trigger factors and for it they need a technological solution able to explore big quantities of data but also able to elaborate nested variables.

The future of knowledge management according the interviewed will imply the adoption of machine learning with neural network; This combination of technologies can connect a lot of units and develop deep learning software with aims of final output prediction on longitudinal analysis.

3.2.4 Azzurro Digitale Case

Azzurro Digitale is an innovative start-up located in Padua, they offer consultancy and digital solutions for manufacturing companies mostly in operations field of their clients. Their business consists in guiding companies in digital transformation management – they update the client process in order to be aligned with the software solutions advised and create economies of scale from technology application.

In this case I had the opportunity to discuss about knowledge management with the co-founder of the company.

After the brief explanation of what are considered knowledge management fields and activities inside organizations, he immediately quotes one of his past projects related with knowledge management issues and state that many challenges concerning this field may be solve trough software solutions and process rearrangements. The projected consisted in finding a solution to track which are the knowledge resources owned by the organization and which are used for business processes. They developed a software able to define not only the company's knowledge assets but also those that they will need based on the project agreements of the next six months – furthermore it gives the opportunity to consult from where outsource the knowledge asset needed.

Apart from this positive case of knowledge-based strategy adopters, he states that many companies are unconscious about knowledge management benefits and consequently first of talking about knowledge management issues we can talk about how knowledge-based enterprise can achieve awareness.

He considered that apart from developing specific solutions for particular knowledge management needs, data integration systems undoubtedly favour indirectly the organizational knowledge – it implies the possibility to store all company data in one place,

elaborate it by a single software and spread the data analysis among all departments. These features will increase the information availability and the knowledge, furthermore it will permit collaboration among all company departments.

To the question regarding companies that provide knowledge management consultancy or solutions, he states that cannot be able to recognize any company engaged in this type of business. Instead the companies that represent most of knowledge management adopters belong to manufacturing sector and those that adopted new technologies in their business activity. The introduction of advanced technologies based on big data analysis will change the know-how of business activities, and the next features of knowledge management will be focused on how develop efficient learning process and unlearning.

3.2.5 Dedagroup Case

Dedagroup is an Italian company that provides information technology solution and consultancy worldwide through its eight foreign branches.

Their most important product is Stealth, it is developed to satisfy the needs of fashion and luxury industry.

Stealth is a software solution able to track every stage of the supply chain and permit the omnichannel strategy to brands. They analyse all process information of their clients in order to give them a personalized solution.

The person interviewed has the role of the enterprise consultant of Stealth software solution. He affirms that knowledge client in his job is fundamental, learn from past projects is important to increase the expertise even if the customized solution does not permit to fully exploit knowledge replication. Anyway, past experiences create the knowledge bases for future projects.

He admits that in high technology companies the knowledge internationalization process takes too long - when it becomes organizational knowledge is already obsolescent and according to him this happen because technology evolution transforms the way of doing business faster than knowledge internalization.

He states that many companies want to increase their knowledge about company processes in order to increase the efficiency. Many of their clients have realized that they need to gather as much information as possible about the supply chain in order to know

how and where to act in order to become more efficient and give clients a better service in terms of quality and time.

Their work-life is determined by client project and for the company it is fundamental to have always a record of the evolution and the difficulties of it; For this reasons they choose a cloud system to keep updated report about projects but it also permits to have a record of past experience and check it. It could be a knowledge company repository that can be consulted at any time by everyone.

This platform that is based on cloud system for them has many functions from the initial placement program to tracking the knowledge resources relevant for project success based on the human resources involved and the kind of knowledge useful to manage complexity.

The product cited previously is called Share Points and it is developed by Microsoft company and further on designed based on their needs by a national company. It is one of knowledge management software provider case and as companies engaged in knowledge management consultancy, he mentions PWC company that has a dedicated business team to this field.

The interviewed states that for what regarding companies engaged in knowledge management and technology adoption to increase the knowledge resource, the luxury fashion industry represent a good example. The majority of these are brands belonging to international groups as LVMH or Kering, the aims is to offer the best service to their clients and for this they must track and know everything about their supply chain in order to make evaluations and strategic decisions on how can improve their business processes.

Together with luxury fashion industry, he quotes also the international consultancy companies as having a level of process formalization higher and consequently a defined system of knowledge management.

The interview closes with future reflection about knowledge management and how it will be affected by new technologies adoptions. According him, first we must consider that most companies has not a system of knowledge management and are not willing to implement it as they do not realize the benefits and the functions. Instead talking about new technologies such as artificial intelligence and machine learning, he considers that

the development in business application are not well defined and companies are still waiting an advanced version of these technologies.

3.2.6 Uqido Case

For the last case of the empirical research I had the pleasure to have a talk about the knowledge management issues with one of the Uqido founders.

Uqido is a local software house which has the mission of developing solutions through immersive computing technologies, IOT systems, artificial intelligence and machine learning technologies. Their business model is the creation of simple software or engineering solutions on customer demand, their value added is created through a strong collaboration with their client in the project development.

After the introduction of the research and purposes of it, we start from knowledge management challenges which according him are strictly related with technology evolution.

New information technology system and, technologies integration within the development stages of product and service or in the supply chain have brought considerable changes in the business world. Furthermore, he recognized that technology advances increase the amount and the need of knowledge and its complexity; technology implementation is what gives to knowledge a prerogative role. The meaning was that knowledge management must be able to keep high levels of knowledge integration and creation across the organization in order to be able to successful implement and benefit from new technologies.

For these reasons they consider that collaboration and formation among employees should be one of the first challenge of knowledge management.

Different from what discussed before, he affirmed that knowledge management is struggling because information and its efficient handle is something difficult to achieve. Many times, it happens that inside companies the information is elaborated twice, as perhaps two different collaborators have worked on the same tasks but for different clients within different teams. A challenge therefore is to find a solution that let employees know that someone else among their colleague have already worked on it; This should avoid work redundancy, but it may also increase the opportunities of knowledge socialization through view exchanges.

He stated that in order to apply what mentioned previously, companies must have the consciousness of mapping information or give it meaning in order to implement technologies systems with the proper metadata definition.

They find some solutions for the challenges previously cited that can bring to a more efficient way to manage the information issues; for example, the formalization of each working activities by reports implementation and the storage of information in the company intranet using hashtags.

As solution to increase their knowledge asset, they experimented that offering the freedom to learn to their employees has brought benefits also to all organizational knowledge.

Any collaborator in fact, has some scheduled time to dedicate in further investigation and study in something new. They called it “Side Projects” and consists in giving to all science projects 20% of their time for new knowledge creation and investigation looking for the best solution.

As it is something useful for individuals but also for the organization, the knowledge is captured within documents that have the function of learning and sharing knowledge across organization.

“The management of these procedures and documents are supported by technologies as cloud systems which store the knowledge elaboration and through appropriate hashtags all the documents acquire metadata in order to easier the search of knowledge resources kept within the company.”

It is important for the organization to internalize what have been discover in order to build up the resources of knowledge and experiences harvest with past projects.

As they work mostly through projects for their clients, they have the necessity to improve the collaboration through the different teams of the organizations. In order to increase the channels and efficiency of collaboration and enhance knowledge sharing, they implemented within their activities the technological tool Slack.

Slack can be used to establish for immediate confrontation and collaboration within teams, giving the possibility to share the documents and information as it can cooperate with other software solutions.

The usage of this software avoids also the redundancy of asking information and knowledge already treated by utilising technologies of text mining on past discussions.

Other tools useful to manage information across organizations could be Trello powered by Jira of Atlassian, these systems are used to keep on tracking the team projects and have a wide knowledge of projects status.

Furthermore, he quotes Obeya Room which is a model of organizing teams and elaborate visual planning. It guarantees the reduction of time spending in communication and decrease the probability of having misalignment within organization. In knowledge management field it implies a better collaboration and to manage efficiently the knowledge resources.

They believe a lot in training potentialities, in fact they have implemented projects of internal tutoring and managed it through a blog platform at internal level. It implies definition of experts and sharing across organization of knowledge resources.

Regarding the question about mentioning possible suppliers of knowledge management solutions, as consultancy or software, he stated that is not familiar with this particular sector. Anyway, there are web platforms that offer services and programmes of trainings and formation for companies, this could represent a solution to increase the knowledge asset even if it does not represent a provider for all knowledge management fields.

Instead, concerning the demand side of the market he argued that there is not a defined sector/ industry focused in looking for knowledge management solutions. Despite this, he affirms that efforts in knowledge management field are further and further related with the amount of information available and the importance that companies give to it. Consequently, for sure companies that are embracing the digital integration within their processes and have the possibility to exploit the knowledge generated through big data analysis; as new insights about their process are elaborated and as it enhance a wiser solution of managing the business activities, they invest in knowledge resources to achieve this results.

About advances in knowledge management field, he focused on the learning part of knowledge management. According him, many companies are turning to virtual training with technological systems as VR that emulates virtual realities.

For example, Nokia as having to develop services of local repairing in the 4G/5G cells all over the world and in order to make it quicker they approached the virtual training to prepare resources and guarantee the cooperativeness. Also, in the fashion industry there are some cases, for example Hugo Boss for the plant establishment in Turkey used virtual dojo through which employees can to learn quickly but also increase their tasks inside the organization as through this methods individuals increase the amount of skills more efficiently.

Closing with possible application of IA and ML within knowledge management, he affirmed that firstly it should be found a good software solution for manage the information in order to see effective result on real software solutions of knowledge management.

3.3 Evidences from case-cross patterns

The cases presented in the previous chapters highlights common concepts concerning knowledge management aspects, but there are also opposite affirmations which build up confrontation evidences.

In the next sections will be outlined a general idea for each question based on the concepts more ranked among the cases in order to summarize the critical aspects of knowledge management nowadays in a technological reality.

After the building of a general opinion, it will be compared the ideas that stand out as being completely different.

3.3.1 Challenges of knowledge management

The first question has the aims of detecting which are the challenges that companies must face in terms of organizational knowledge. It could be related to human resources management but also to how companies increase knowledge or need to have more information about a determinant issue of their business.

Most cases, in fact, underlined the need for companies to know more about their business processes. It appears to be the same for all types of business, independently from the circumstances of managing tangible output or intangible such the knowledge used by employees in consultancy companies; The issue can be similar, companies have the willingness to know and analyse which are the critical factors in their process.

Many industries are interested in technologies as data mining or data processing in order to understand better the business process, increase their knowledge and fix the operations as consequence.

Table 1 outlines that most of challenges mentioned are related to the fact that in practice there are very few cases of knowledge-based enterprises. Indeed, most of them stated issues related to the necessity of creating a system and define the resources in relation to knowledge management.

The other part instead considers that companies are striving to find a way to integrate knowledge in order to build an organizational knowledge and some of them added that this process should be faster in order to benefit and not be surpassed because of business innovation and technology evolution.

Table 2 Cross-case analysis categorization and coding: knowledge management challenges

Interview extracts	Category	Code
Miriade		
A challenge that all sectors must face is to structure a map of data used inside the company and across the different processes.	The challenges of knowledge management	Data Mapping
The implementation of advanced technologies within business processes requires the formalization of data storage (metadata) and knowledge management. In case of company's clients that have not a defined knowledge management and do not store the data following a system of codification such as metadata requires more time and work to understand how develop the right solution based on their needs.	The challenges of knowledge management	Knowledge resource definition
Nethive		
The company finds as primary challenge the need of converting individual competences and knowledge to organizational level in order to achieve economies of scale through replication.	The challenges of knowledge management	Knowledge Internalization
The respondent states that international companies have operative troubles as they have employees of different country and must manage knowledge and documents for different cultures.	The challenges of knowledge management	Knowledge Codification
Sanmarco Informatica		
Based on work experience he ranks the knowledge about production or supply chain as more important for their clients. They ask for software able to forecast which are the inputs and variables that guarantee the efficiency of their product and services.	The challenges of knowledge management	Increase Process Knowledge
Azzurro Digitale		

There is a need of software solution able to track and map knowledge used within company processes to understand which are the most requested and take actions to increases and share across the company that knowledge.	The challenges of knowledge management	Knowledge re-source definition
There are companies that are unknown about knowledge management and their benefits, it is still an actual challenge for knowledge management to achieve awareness among companies – as most of client struggle in defining which are the knowledge resource used, from which human assets come from and which are the data combined with.	The challenges of knowledge management	Achieve Awareness
There are companies that are unknown about knowledge management and their benefits, it is still an actual challenge for knowledge management to achieve awareness among companies – as most of client struggle in defining which are the knowledge resource used, from which human assets come from and which are the data combined with.	The challenges of knowledge management	Knowledge Internalization
DedaGroup		
The challenge about knowledge is that mixes technology and knowledge to give a service and knowledge formalization takes too much time regarding technology evolution. The solution could be an automation of knowledge formalization.	The challenges of knowledge management	Knowledge Internalization
They have realized that the knowledge more required is concerning the supply chain and the possibility to analyse better their processes in order make process innovation for efficiency reasons and client responsiveness	The challenges of knowledge management	Increase Process Knowledge
Uqido		
The challenges that companies are facing are related to the speediness of technology evolution – the internalization of knowledge management must keep up putting on the first line the need of making internal formation and process aimed to collaboration.	The challenges of knowledge management	Knowledge Internalization
Also, the fact that technology is becoming more present as business competitive factor, the advances require to put knowledge as a prerogative asset as more complex knowledge will be treated inside organizations and continuous learning will be necessary to stay alive.	The challenges of knowledge management	Achieve Awareness
Another issue concerns the management of information inside the company, we struggle in trying to not make work replication because might happen that a collaborator takes charge of a client with which another one has already work on it and have more information.	The challenges of knowledge management	Information Tracking

3.3.2 Solutions for knowledge management

To the question: “which kinds of solution are nowadays used for knowledge management?”, most of the respondents had some difficulties in determining specific tools instead all realized that new business technologies have a support function for knowledge management field.

They mentioned mainly two types of business technologies, cloud system and business intelligence. The combination of the answers outlines a general idea of which are the functions and the positive aspects of this tools regarding knowledge management.

The cloud system can be used for project collaboration as increase knowledge creation giving companies the possibility to share knowledge through updated reports and the knowledge can be transformed from individual to organization in a faster way.

Many of them use knowledge-based cloud to make inclusion programs and record which types of knowledge are more requested in their business activities by analysing the past projects; or furthermore to store the information elaborated by all enterprise collaborators.

The second category of tools is composed by BI and ETL, their function is to extract data from all company's processes and elaborate it. The knowledge might benefit as these technologies analyze all data and find different connections. As data and information about their business increase also the opportunity to create new knowledge does. Some of them stated that these technologies have the function of data integration and the indirect consequence of improving collaboration among the different departments because all information are at disposal of all.

It must be highlighted that from interviews emerged that with technologies of big data analysis the knowledge will become more complex because will be related to advanced machine reasoning such as elaborate models with nested variables.

In table 2 there are recapitulated the main functions of the tools mentioned previously, as it can be realised all functions have the general aims of organize knowledge resources and guarantee that these last one are accessible to all company's employees in order to create the general knowledge of the company.

Table 3 Cross-case analysis categorization and coding: Functions of technological tools

Interview extracts	Category	Code
Miriade		
By technics of data mining or data processing, its deliveries knowledge about data in KPI format or knowledge about processes. It supports the knowledge management increasing the research and development process and consequently knowledge creation is faster.	The role of mentioned technologies or solution in knowledge management system	Increase Knowledge Creation
Nethive		

They use technological instruments to ease the placement of new hires and to avoid stops in the business process because of lack of knowledge. They store the company know-how also as form manuals of good practices, on a cloud platform.	The role of mentioned technologies or solution in knowledge management system	Knowledge Collaboration
They use technological instruments to ease the placement of new hires and to avoid stops in the business process because of lack of knowledge. They store the company know-how also as form manuals of good practices, on a cloud platform.	The role of mentioned technologies or solution in knowledge management system	Placement
The benefits are in a better management of projects with possibility of engaging different departments – it has also a collaborative function. It permits to improve the quality service as company can increment the responsiveness to client's needs because each employee can access to information about the projects at any time being able to be updated through lasts reports and have the knowledge to solve the client request.	The role of mentioned technologies or solution in knowledge management system	Knowledge Collaboration
It permits to improve the quality service as company can increment the responsiveness to client's needs because each employee can access to information about the projects at any time being able to be updated through lasts reports and have the knowledge to solve the client request.	The role of mentioned technologies or solution in knowledge management system	Knowledge Organization
Sanmarco Informatica		
These tools are developed for their client analysis based on customized KPIs, defined through client collaboration. The formal presentation/report is made by Qlik View, it allows clients to use their knowledge combined with complex data; It helps to have different process perspective and create new knowledge improving the decision-making process.	The role of mentioned technologies or solution in knowledge management system	Knowledge Advances
Azzurro Digitale		
They find the right solution developing a software able to define not only the company's knowledge assets but also those that they will need based on the project agreements of the next six months – furthermore it gives the opportunity to consult from where outsource the knowledge asset needed.	The role of mentioned technologies or solution in knowledge management system	Organize Human Knowledge Resource
They consider that the right application of data integration software supports indirectly the knowledge management, as it permits to access at all companies data and be able to acquire and share knowledge more widely and differently as all departments can check all data and favour collaboration.	The role of mentioned technologies or solution in knowledge management system	Knowledge Collaboration
DedaGroup		
It permits to collaborate and solve problems of knowledge and have the possibility to track the progress of the project	The role of mentioned technologies or solution in knowledge management system	Knowledge Collaboration
The platform is useful also for who's manage the project in order to understand which kind of knowledge are needed and where are the complexity in the development	The role of mentioned technologies or solution in knowledge management system	Organize Human Knowledge Resource

A part of Share points is dedicated also for inclusion by organizing within the platform a programme of learning in order to be able to gain the know-how of how projects are developed.	The role of mentioned technologies or solution in knowledge management system	Placement
Uqido		
The management of these procedures are supported by technologies as cloud systems which store the knowledge elaboration and through appropriate hashtags all the documents acquire metadata in order to easier the search of knowledge resources kept within the company. In all science project they invest the 20% into creating new knowledge and deepen to find the better solution.	The role of mentioned technologies or solution in knowledge management system	Knowledge Collaboration

3.3.3 Providers of knowledge management solutions

To the question about the possible market of knowledge management solution providers, most of respondents were not able to identify some companies engaged in this type of business. The fact that the respondents are not familiar with this type of solutions and who could be the providers, make reasonable the assumption that it is too early to talk about knowledge management consultancy or knowledge software solutions. However, there are also cases that represent exceptions; Nethive company is aware about knowledge management software and it is one of the adopters of this solution.

They decided to implement within their process the use of Wiki Confluence of Atlassian, it supports work teams and permits organizations to keep all knowledge resources in structured hierarchy repository.

Atlassian is worldwide company and it is considered a key player of the global knowledge management solution market.

3.3.4 Companies with knowledge-based strategy

Many cases identify the manufacturing sector as being adopters of knowledge management strategy or at least they have a higher propensity to manage data and information through a systematic mode.

Some of them states that there is a relation between companies with knowledge management and adopters of digital technologies such as data analysis. According to them these technologies request to define the knowledge resource used and the data on which the last ones are used.

It could be recapped by the following reasoning, the manufacturing sector is the biggest investor in new technologies and as consequence of data analysis software, knowledge

asset is gaining importance because of increasing availability of information about businesses. At the same time however, there is an inverse correlation determining that for new technologies development, companies must first know which the fundamental business data are to elaborate and gather knowledge in order to take decisions; It implies also to be aware about knowledge resources.

3.3.5 Future of knowledge management

The interviews outline that the use of advanced technologies of analysis will increase the complexity of knowledge as data will increase and machine will be able to elaborate more data connections.

Process mining and machine learning will permit to have predictions based on which new knowledge and decision can be made.

Companies will start to approach a new way of taking business decisions based mostly on machine's predictions, the issue will be related on how exploit better this opportunity and how employees should be prepared.

In contrast, there are respondents considering that in the future most of the companies will start to develop a knowledge management system as knowledge resources will gain much importance because of digital technologies.

The future of knowledge management from the evidences gathered can be outlined as an integrated and complex scenario. Cloud platforms and data integration will support the knowledge collaboration and at the same time will be required to knowledge to be updated to machine logic in order to understand the reasoning of data delivered.

The knowledge delivered to employees will be targeted by context because of systems of data processing.

All these evidences have been discussed also by scholars that have been engaged in the field of knowledge management and its evolution because of new technologies.

The following pages continue with these practical considerations in comparison with what theory states about it.

Table 4 Cross-case analysis categorization and coding: knowledge management evolution

Interview extracts	Category	Code
Miriade		
Knowledge in order to have the possibility to check information based on the type of knowledge user needs.	View and perceptions about KM advances	Targeted Knowledge
There will be a big investment in knowledge management because power BI implementations as it updates reports made by KPI automatically and improve the collaboration among departments.	View and perceptions about KM advances	Advances in collaborative platforms
There will be a big investment in knowledge management because power BI implementations as it updates reports made by KPI automatically and improve the collaboration among departments.	View and perceptions about KM advances	Predictive Knowledge
Nethive		
According to the respondent there are already applications of machine learning and AI, but further steps must be done, such realising that machine logic is different from human one and consequently data have connected differently, and it can analyse also dependence of second degree.	View and perceptions about KM advances	Knowledge Logic Updated
These new technologies will be used mostly for predictive functions, software solutions help predicting what a person cannot – it analyses variable connected but also these variable relations of second degrees and based on history stored is able to define a normal process conditions which guarantee the optimal output.	View and perceptions about KM advances	Predictive Knowledge
Sanmarco Informatica		
The use of machine learning with use of neural network which connects a lot of units permit to develop deep learning software predicting the final output based on the longitudinal analysis	View and perceptions about KM advances	Predictive Knowledge
The artificial intelligence will decrease the time of data elaboration and so the information will be delivered instantly where is needed in order to take the right decision. The knowledge management will change because it will be constrained to be mapped and codified for software application.	View and perceptions about KM advances	Knowledge Logic Updated
Azzurro Digitale		
The introduction of new technologies will change the how-to-do business leading new work habits and procedures, as consequence learn something will imply issues in knowledge field concerning dis-learn – it could be a knowledge issue that has to be manage, update the employees and make them change their habits.	View and perceptions about KM advances	Learn and Un-learn

The application of machine learning in enterprise reality will change the way knowledge is created and knowledge will become more complex as machines capacity of make data connections increases.	View and perceptions about KM advances	Knowledge Logic Updated
DedaGroup		
It is too soon to talk about future of KMS as companies still not realized the benefits of this type of management - they do not already make the step to knowledge asset recognition	View and perceptions about KM advances	Increasing role of knowledge
Uqido		
I see new advances in the learning part of knowledge management, many companies are turning to virtual training with technological systems as VR that emulates virtual realities	View and perceptions about KM advances	Virtual Reality for Learning

3.4 Discussion and implications of the empirical evidence

3.4.1 Knowledge management challenges

From cases researched emerged that companies want to know more about their process, the study of their processes based on data has in fact acquired lot of importance as it may guarantee efficiency through data driven model in decision making.

This trend appears also in theory, the digital transformation introduces a lot of technological systems able to broaden the amount of data and analysis.

Empirical research and literature agree on the fact that data mining technologies need of knowledge definitions and maps. As, how mentioned in the literature chapters, all technologies of big data analysis are built upon semantic technologies systems which give, through knowledge graphs, meaning and machine logic to data and information captured.

Instead, the cases added that companies are struggling in managing the information and the explicit knowledge stored within the company intranet. And, it causes most of time work replication within organizations.

Even if, the need of having a structure for the repository of information and knowledge was stated also by some scholars in collaboration tools field. As they affirm that for the efficiency of this tools, the application of knowledge-based cloud will enhance within teams to implement collaboration on targeted information based on context.

It is important to underline that from evidences come out that regarding knowledge management, some business realities must develop knowledge awareness and a knowledge management culture.

3.4.2 Differences in knowledge managements tools and solutions

The practical tools emerged from the investigation are now categorized by the different types of digital technology systems encountered in literature.

Following the literature definitions of systematic technology, among the cases are detected in some software solutions with the same functions and characteristics.

In fact, many of people interviewed have stated that tools as Business Intelligence, Microsoft Power BI and all types of solutions of big data analysis are spreading in all business environments. Literature and empirical research agreed on their functionalities

such as data integration which increase the efficiency of processes as knowledge creation or data driven which enhance new ways of decision-making processes.

The main difference instead, stands into the role that these technologies in knowledge management field. According scholars, semantic technologies and collaboration tools are good instruments for knowledge management strategies and represent a solution for many issues of it. Instead, from case analysis emerge that these technologies are only supportive to knowledge management as are used only to give structure to the knowledge resources that are captured.

After it can be affirmed that the theory regarding tools for knowledge collaboration with the support of the cloud systems and other technologies of information storage has many practical applications within enterprises. Furthermore, the evidence highlighted that these platforms are used also for placement programs.

3.4.3 Knowledge management software

Unlike the market researches that declare the existence of knowledge management software service market and that it is facing a huge expansion, most of the cases declared of not being aware about this type of solutions.

Only one case has affirmed of using a software solution for their knowledge management, they affirmed that the wiki platform, Confluence of Atlassian, can solve most of their needs regarding the knowledge resource handle.

In fact, Atlassian is one of the key players in the market of knowledge management software services. This tool that works as a service platforms and customers pay-per-user as a general SaaS business model. Which have been explained in the types of business models that can implemented within this market and in all software service market. Summing up, the awareness of this type of solution has not yet spread in the local environment and the market analysis confirmed this as quoting that most of adopters are in North America.

But despite everything, the fact that on a sample of six cases one is a client of this market, lead to suppose that many other companies are using these technologies, or this solution will soon acquire reputation also in our business realities.

3.4.4 Views of knowledge management future

Literature and cases highlight the power of data analyses technologies as contributor of importance and complexity to knowledge resource. The cases added also that data analysis through technologies as artificial intelligence and machine learning will update further on the computational knowledge by delivering predictions. This implies that data will become more and more data driven knowledge exploration and new insights about the business activities are developed through data.

New researches should be engaged in analysing the implementation of total data driven models of business through which the decision making is based only on data and not elaboration of new insights or wisdoms (Fawcett et al.).

There are common opinions about future knowledge collaboration with targeted and process-oriented knowledge, the cloud system will permit to deliver the right knowledge resource based on the algorithms related to the research key word but also because calculations-based context and business process.

The empirical research introduces other aspects, such the need to create efficient ways of learning and mostly of unlearning the old ways of doing, as they are strongly embedded within individuals. Furthermore, about this field, it emerged that implementations of virtual realities training will be one of the most powerful trend in knowledge management field; as it not only decrease the time and the cost of learning, but it has the efficacy of learning-by-doing knowledge creation. And furthermore, from the case study emerged that through VR systems people can learn activities of more than one task in less time and with more efficacy.

CONCLUSION

It all started from wondering how knowledge management changed, or it will change because of technology system advances.

In order to understand better the impacts that technology could have on knowledge resources and its management, first it must be outlined how scholars define knowledge and which are the other ingredients in the process.

It emerged that according the DIKW pyramid of Ackoff, the knowledge is cultivated also from and combined with data and information. The nowadays technology systems can deliver much more data and more elaborated one because of technologies as data mining, process mining or text mining.

Further on, the knowledge types specifications used in the SECI model of Nonaka and Takeuchi, have been used to realize that not all knowledge can be stored within organization repositories, but most of them are embedded into human resources. Regarding the knowledge that can be explicit through numbers, words and concepts, it is stored not only through physical documents and repositories, but as most of the companies are converting, to the virtual repository of forms, way of doing or reports.

Later, it has been highlighted how technology matters also in knowledge management system field, as the decision about how implement and which mechanisms develop inside the organization depends also on which are technology infrastructure or the technologies for sharing information.

Bush et al. in fact explained the existence of two distinct technologies in the world of knowledge management. The first one could be represented by technologies such data mining which elaborate information or create KPIs. The second category instead has the aim of guarantee the proper store of information and knowledge and the opportunity to share it across the organization.

Subsequently it has been showed how these technologies work and from it results that most of them are based on semantic systems, meaning that even technology systems to be correctly implemented need of knowledge graph (Rettinger et al.).

For example, data processing is developed through logical connections among data, which can be constructed only combing human knowledge and data integration which enrich and give meaning to data resources.

Instead in technology systems for knowledge storage and sharing, the knowledge can be useful to store knowledge in structured way in order to easy the future knowledge consultation thanks to targeted knowledge delivery.

Also, the collaboration system might benefit, when the platforms of sharing are integrated with cloud system; this last one can be powered by semantic features which give metadata to all exchanged and elaborated information within the platform in order to alert when there are work replications.

Finally, from market analysis emerged first that there are software solutions for knowledge management and furthermore that this market is growing significantly mostly in North America.

It can be summed up that according the theories, the connections between technology and knowledge are strong. As the system and procedures of knowledge management are depended on the technologies adoption and these for their part need of knowledge resource definition and mapping.

The second part of the dissertation is focused on the empirical research, starting from defining how it was developed and concluding with the evidences that emerged from the interviews.

The most direct insight is that technologies as data analysis, increase the importance of knowledge and its complexity. The basis of DKIW pyramid, which has been discussed previously, are broadened in terms of quantity but also meaning, consequently also knowledge must update and evolve. Some of the cases stated that there are companies that even do not consider knowledge resources - from Miriade case emerged that concerning the implementation of Business Intelligence tools they have issues with some clients as they do not know which are the critical data , which information can be developed from it or which are the systems of storing data, information and knowledge. It is

useful and necessary to implement the technological system according the same structure logic and create the historic data.

Despite this, many of the cases affirmed that it soon will change as everyone will realize the necessity of knowledge and its management within environments of data driven knowledge exploration.

Data increases, and the information from it and consequently new knowledge is a daily occurrence to manage it with success many companies have adopted new technologies systems of collaboration and models of team organizations.

In order to manage the information and knowledge already elaborated and avoid work replications, the collaboration systems are related with cloud knowledge-based which permits to map all the knowledge resources for future applications of retrieve.

The future of the knowledge management will be very interesting, for example the usage of computational knowledge prediction will increase the intelligence and cognitive abilities of individuals. New ways of learning more easily with lower costs will be implemented through systems as virtual realities and technologies as process mining will give the possibility to create the organization knowledge more dynamic and proactive. These two trends have huge impacts on the management of knowledge resources, as the knowledge capture is facilitated and through the new learning systems the creation of experts and placement is improved.

For sure the empirical research has some limitation because of the number of sample and the selection of ICT companies. In fact, the selection of this sector was intentional in order to carry out an explorative research on the new information technology innovations in knowledge management field.

It will be interesting to analyse the impacts of different systems of knowledge management which differ because of the different level of information technology system integration. Unfortunately, it is not possible as there are no variables that could isolate the effects of an efficient knowledge management system.

This research outlined many issues that should be developed in further researches. For example, the need to investigate the efficiency of models of data driven decision making and find why knowledge is still the critical resource in decision making process.

Another relationship that emerged is that knowledge management is a consequence and at the same time a requirement of digital transformation process.

Further researches on knowledge management characteristics first and after the digital transformation, could be useful to model the relation between these two issues and state different models of technology implementation within knowledge management system.

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APPENDIX

6.1 The outline of the structured interview

The following questions have been used as the fixed format for the interviews.

- Which are, nowadays, the knowledge management challenges for the companies?
- Which are the instruments or solutions (even software) adopted for knowledge management issues? Furthermore, which are the distinct functions or fields that these tools cover in matter of knowledge management? Which are the main benefits of these instruments?
- Which are the main suppliers of solutions or products for knowledge management? (At global level or national)
- Which are, nowadays, the companies that require and adopt mostly solutions or products for knowledge management? There are excellent company profiles in this field?
- Which are the advances of knowledge management? A new horizon could involve also the adoption of advanced technologies such as artificial intelligence and machine learning?

6.2 The codebook

The challenges of knowledge management

- ◆ Knowledge resource definition
Knowledge resources definition inside companies, also as mapping the knowledge for each activity.
- ◆ Data Mapping
There is the requirement of data definition and logic maps to implement tools as data mining.
- ◆ Knowledge Internalization
Internalization process, as the activity of capturing and formalizing knowledge within organizations
- ◆ Knowledge Codification
Universal knowledge codification to improve the management of companies that face a complex operativity because of large dimensions or internationality.
- ◆ Increase process knowledge
It is expected from knowledge management more elaboration about the business process, in particular from process as supply chain or production.
- ◆ Achieve Awareness
Knowledge management have to achieve awareness, the company culture have to change and perceive into knowledge management a powerful tool to use properly their data, information and also their human asset.
- ◆ Information Tracking
The tracking of information already elaborated in order to avoid work replications.

Solutions, technics or IT tools for knowledge management

- ◆ Data Integration
Systems of data integration as semantic technology to elaborate and capture data and information for further knowledge creation.
- ◆ Cloud System
Cloud systems used as repositories for informations and knowledge used within organizations.
- ◆ Learning Program
Learning program to increase the knowledge and skills of workers but also the knowledge assets of the company.
- ◆ Collaboration Platform
Use of platforms that guarantees the collaboration among teams and keep tracking all information of issued solved in the past by teams, it improves the efficiency of business activities.

The role of mentioned technologies or solution in knowledge management system

- ◆ Knowledge Collaboration
Collaboratio function implies that the solution bring new channels and ways of communication and exchange knowledge or could be application of strategies aimed to encourage the knowledge sharing.
- ◆ Increase Knowledge Creation
Some technologies may have the power to increase and speed up the knowledge creation because of data and information resources expansion.
- ◆ Placement
It represents tools that have the function of storing the knowledge through reports and modules and create a program of placement for new comings.
- ◆ Knowledge organization
When the solutions have the aims of giving structure to captured knowledge in order to easier the access and research of knowledge.
- ◆ Knowledge advances
When technologies increase the complexity of knowledge as it can elaborate big amount of data. It can be stated that human reasoning is augmented by technology ability of calculations.
- ◆ Organize human knowledge resource
For those solutions able to organize the knowledge resources, as the ability to track the expertise within organizations or to check which are the lack of the company in terms of knowledge resource.

Companies that are offering solutions, consultancy or software, on knowledge management

- ◆ Atlassian
- ◆ ND
- ◆ Share Points
The use of IT tools as Share Points, which is a web platform of Microsoft that enhance work team and information sharing.

 **Which are the main companies that represent the demand of knowledge management solutions.**

- ◆ Manufacturing sector
Manufacturing companies with developed knowledge management or that represent high share of the demand for knowledge management solutions.
- ◆ Digitally transformed companies
When adopters of digital transformation are stated to be also users of knowledge management strategies or solutions.
- ◆ Telecommunication sector
Mostly the call centre sector which gives answers based on behavioural algorithms.
- ◆ Wine Industry
High adopters of predictive knowledge to ensure their harvest.
- ◆ Luxury Fashion Industry
Experts in supply chain knowledge adoption, more they know about their chain and more they can guarantee the quality.
- ◆ International Consultancy Sector
Most of this sector invest in organizational knowledge creation to implement efficient training programs for new hirings.

View and perceptions about KM advances

- ◆ Increasing role of knowledge
Knowledge-base strategies gain more importance within business environments.
- ◆ Knowledge Logic Updated
Knowledge and its management will be updated to machine logic.
- ◆ Targeted Knowledge
The implementation of solutions that gives employees targeted information and knowledge based on data processing.
- ◆ Advances in collaborative platforms
The future collaborative knowledge will improve the collaboration among departments.
- ◆ Predictive Knowledge
Predictive knowledge will become very important, thanks to AI and ML companies will be able to fix processes ongoing and find new solutions for their business through gathering predictive information.
- ◆ Learn and Unlearn
Learn and unlearn, technologies will introduce new ways of working and making decisions. Most people may struggle in unlearn the old know-how and knowledge management should find a solution for this kind of issues.
- ◆ Virtual Reality for Learning
The part of knowledge management concerned about trainings and learning by doing would be further improved, as systems that emulate virtual realities will be developed for placement programs and trainings.