Modelling the IT Support of Knowledge Workers for Knowledge Management Processes

Stefan Svetsky, Oliver Moravcik, Pavel Vazan
Slovak University of Technology - Faculty of Materials Science and Technology in Trnava, Slovak Republic
stefan.svetsky@stuba.sk
oliver.moravcik@stuba.sk
pavel.vazan@stuba.sk

Abstract: Knowledge management processes, such as knowledge-based processes, represent an important interdisciplinary issue in the fields of industry, knowledge management, education, library sciences and research. Solving the Information and Communication Technology (IT) support of these processes belongs to the preferred topics of current research. The business and industrial Information and Knowledge Management Systems are well-managed at a level of simple data processing. But there is a gap in the software support for the higher top manager level, as well as regarding the personalized IT support for knowledge workers in the knowledge-based organizations. In fact, it is crucial for the knowledge workers to solve the conversion of tacit knowledge to explicit knowledge and to transfer and exchange knowledge both individually and collaboratively. Currently, the IT support is moving to the cloud and virtual environments, so complex software, hardware, and network infrastructures are needed. This requires a design and technology team behind every knowledge worker. The actual research of the authors is focused on automating the knowledge-based processes. A basic question is to define the knowledge as a process parameter. To challenge the above-mentioned gaps, a virtual Knowledge Unit (vKWU) has been designed that is both human- and machine-readable. This knowledge representation enables to design the WPad software, solve the batch knowledge processing paradigm for knowledge creation and sharing, and IT support of the Knowledge Management processes of knowledge workers. The WPad works in practice as a multi-purpose IT tool for conversion of tacit information to explicit information, including the personalized Knowledge Management System, as was presented by the authors in the previous ICICKM conferences. While under research on the technology-enhanced learning, their focus was on Knowledge Management (KM) in education (teaching, self-study, CSCL). Now, the research focus is on testing the online virtual spaces for KM. Currently, Cloud Content and Project Management are tested on the BOX-cloud, including the KM at the faculty's virtual space, where the content and processes are modelled by the V4+ACARD Consortium. The paper explains by examples the research paradigm in the context of KM, and the use of the KM software for text corpora, cloud content management and research.

Keywords: Knowledge management, knowledge representation, tacit knowledge, KM software for knowledge workers, text corpora, cloud content management

1. Introduction

Despite the great progress in computerization of the knowledge-based processes, there are still many challenges particularly regarding the personal IT support of the knowledge workers, including the top managers. According to the authors of this paper, it is a question of "knowledge" because any interdisciplinary definition of human knowledge is missing, including a knowledge representation, which would be suitable for IT support of KM (Svetsky, Moravcik and Tanuska, 2017). As was discussed by the authors in the section "Research Background – Terminology and Challenges for IT Support of KM", regarding the

interdisciplinarity of the issue of knowledge, human knowledge has different meanings in philosophy, education, psychology, knowledge management (Svetsky, Moravcik, Tanuska, Sakal, 2018 - see also e.g. Glasersfeld, 2002, Nonaka and Lewin, 1994). Knowledge has different meanings even in the fields of computer science and information and communication technology (Frost, 2017). In addition, in the Stanford Encyclopedia of Philosophy, some categories of knowledge are distinguished (Fantl, 2017). In view of this, the practical aspects of knowledge construction were described by Svetsky (2012). Due to the absence of the universal definition of knowledge, one can relatively often meet with the criticism that the technology-driven approach in the knowledge-based processes is prevailing (Kinchin, 2012), or that the software design for technology-enhanced learning is inadequate (Martens, 2018).

Because Knowledge Management is generally the process of acquiring, creating, managing, handling, using, and sharing the knowledge and information, each process must be described by appropriate algorithms in order to write source codes or software applications in general. But without having the proper representation of knowledge, which is human-readable, it is difficult to write a personalized software for knowledge workers, i.e. to solve their IT support for KM in a user-friendly way. In the context of this paper, the term "knowledge workers" refers to all those who work with information and knowledge, i.e. teachers, researchers, engineers, managers etc. Specifically, this term also applies to "knowledge workers" as defined by Drucker (1969), who defined knowledge workers as high-level workers who apply theoretical and analytical knowledge.

This paper presents the paradigm of the human knowledge processing, which is based on the model of knowledge representation, and the development of our own KM software. Some examples are illustrated with focus on using the text corpora for purposes of KM at the level of the knowledge workers. Such personalized solution is not described in the scientific literature yet. The vKWU knowledge representation is a core of the registered utility model related to processing the unstructured data (UV 7340/2016). This knowledge-based paradigm is particularly important for IT support of knowledge sharing. For example, knowledge sharing in organizations can be benefitted from Industry 4.0 enabling technologies, introducing this as Organization 4.0. (Li et al, 2018). The importance of knowledge sharing is also emphasized by Kim et al (2012), Choo and Tan (2017) or Filieri (2010).

Paliszkiewicz (2017) discusses the question of knowledge by arguing that the body of knowledge regarding KM is still limited. According to the result of the literature review, he emphasizes that “Existing literature provides only fragmented insights into knowledge management and further interdisciplinary research is needed” and “A better understanding of tacit knowledge is needed, as is the ability to apply this knowledge in the process of work to solve and identify complex problems in organization”. Regarding the future KM research, see also https://realkm.com/2017/08/11/the-future-of-knowledge-management-research/.

In principle, the described approach of the authors represents a universal paradigm for any kind of knowledge handling and processing for any kind of KM process. Finally, it should be mentioned that this research on the IT support for knowledge-based processes is not theoretical because each solution was operatively implemented into industrial or academic practice (teaching, learning, research, and associated processes), which is performed by knowledge workers (teachers, researchers, engineers, students).

In Section 2, a comparison with state-of-the-art KM software for knowledge workers is discussed. In Section 3, the paradigm of the knowledge processing in the context of KM is presented, and in Section 4, some examples of the use of the WPadV4 software for text corpora, cloud content management and research are mentioned.

2. Comparison with state-of-the-art KM software for knowledge workers

In comparison with several previous and actual studies focused on KM (Wallace, Van Fleet, Downs, 2011; Jokonya, 2018; González-Valiente, Santos, Arencibia-Jorge, 2019), any similar research focus on personal software for knowledge workers based on the human-readable knowledge representation, which enables the conversion of tacit knowledge (KW) to explicit knowledge, has not been mentioned. In Jokonya's study, the extant literature on KM research is reviewed to examine trends in KM research also in relation to the 4th industrial technologies (2018). In the study, the data-driven approach is prevailing, and "still low research on artificial intelligence" indicated, although, newer technologies "brought major impact knowledge management domains in areas such as data storage, data management, integration and behavioural issues" (Paschek et al., 2018). But it must be emphasized that these areas, or the data-driven approach particularly, are suitable only for machines but not for the knowledge workers who work with human knowledge and information rather than with simple data.

The authors' presented concept, in comparison with the existing approaches, is not the data-driven but the knowledge-driven approach. This means that knowledge, information and data are processed within the hierarchy data-information-knowledge-wisdom. "Empty" knowledge is treated as the most primitive information (i.e. knowledge without content), and "empty" information is treated as the most primitive data (numbers, short strings). In principle, this approach is based on the simulation of the knowledge-based processes (mental processes) in the same way as how knowledge workers or common people think. While computers need other technology for data processing than for information processing and for knowledge processing, the presented WPadV4 software enables the knowledge worker to use it as an all-in-one-tool, moreover to use their natural language, their personal computers, and to process a huge amount of files (content). Moreover, this does not require any additional informatics skills when using the KW-tables or KW-bases, as well as their personal or collaborative corpora. In other words, working with the virtual knowledge, in which the human knowledge is embedded, is not the case of the data-driven approach as is in the challenge for using the shared open corpora in relation to "build predictive models to address business problems in organizations" (Pattanshetti, Jasola,, Gupta, Rajput, 2018).

Some issues of using the corpora for KM have been discussed in the previous ICICKM conferences. For example, "managers from different hotel departments/divisions were motivated to create a corpus of a rich collective guest-related external knowledge" (Choo and Tan, 2017). In another case, a corpus containing over 1000 peer-reviewed articles was used for "Interdisciplinary Cooperation Management in Research Clusters" (Müller-Abdelraze, 2018). In compliance with the trend of using the clouds for shared KM, the authors and researchers of the V4+ACARD-Consortium practice it when using the BOX-Cloud and remote desktops for sharing some categories of the corpora.

In addition, to better understand the design of the IT support for the knowledge workers, information systems (IS) should be mentioned that are important in view of KM field. The

lowest level of IS is used for very well-defined problems, for mass processing of well-structured sharp data (e.g. for economic IS, production control). The higher levels of IS are systems consisting of individual data or non-sharp data (e.g. customer relationship management /CRM/). IS for the managerial decisions are focused on the key-data extraction from common IS of companies (Smejkal, Rais, 2007).

3. The paradigm of the knowledge processing in the context of KM

The authors' research focuses on the automation of processes based on human knowledge, which is simulated in their research by means of a model of the virtual knowledge unit (vKWU). This knowledge representation is machine-readable as a data type consisting of a default structure of zeros and ones. The computer processes such virtual knowledge extremely quickly and delivers the human-readable outputs. This enables simulation of the knowledge-based processes, allowing them to be semi-automated or automated.

The principle of this simulation is based on how an ordinary person thinks. For example, a meeting of schoolmates after years, the person would describe as "metadata" (which indicates what school, class, year, names), and the content of this event as "knowledge" (which indicates how was the meeting, what happened). In the case of the virtual knowledge, the knowledge worker can write such metadata and content simply into the fields of the classic database table, as illustrated in Fig. 1. The vKWU consists of metadata and content as ASCII-text, which is written into this default structure in natural language. If the user inserts his personal metadata and content into the vKWU, this means that tacit knowledge is converted to explicit knowledge, which can be handled by the WPadV4 software.

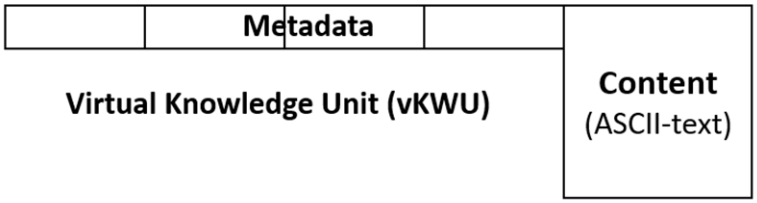


Figure 1: The model of the Virtual Knowledge Unit (metadata + content)

This approach is universal, that is, the knowledge representation does not have to be primarily in the form of the database table (it could be e.g. a set of arrays). However, the great advantage of it is that each database platform enables one to write source codes or database applications. In this case, the vKWU represents one row of the database table, and more rows represent the "knowledge table" (KW-table) or "knowledge-cell" (KW-Cell). Each empty KW-table is in principle an empty knowledge base. Fig. 2 illustrates the KW-table "ICICKM19" that was created for the purpose of writing this paper.

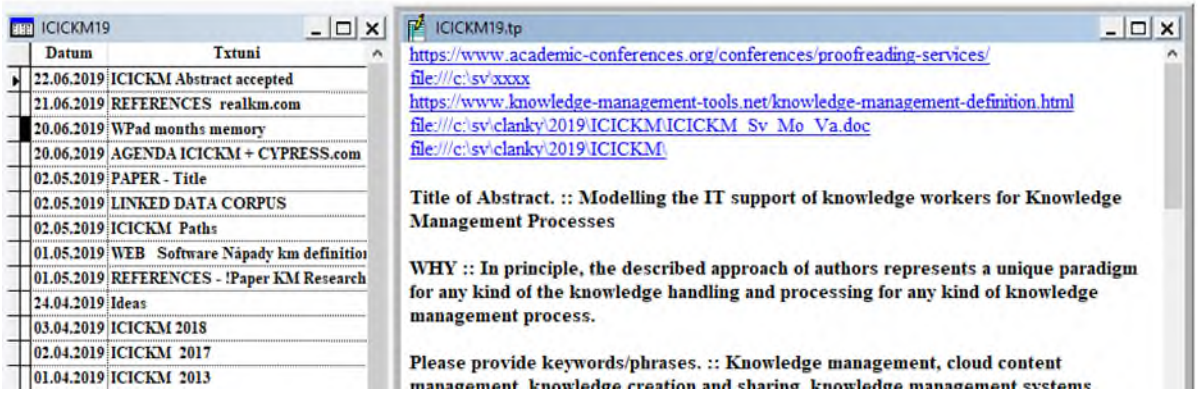


Figure 2: Example of the knowledge table ICICKM19 (metadata – left window, content – right window)

One can create a set of KW-tables and write source codes to handle, manage and control the virtual knowledge (KW-tables), as well as write database applications or even a KM-system. In this context, the main author of this paper has been developing the beta in-house software WPad (presently WPadV4) which works as the multi-purpose all-in-one tool for personal IT support of knowledge workers. It should be emphasized that from the KM point of view, any kind of knowledge management processes can be supported, and because the knowledge representation (vKWU) is interdisciplinary, any kind of knowledge can be processed. However, a user must always find his own way how to insert his human knowledge into the default data structure of the virtual knowledge (vKWU). In this context, the knowledge worker can produce a set of tables for the purpose of teaching and learning, KM, e-Learning, self-learning, or research, project management, writing papers, thesis, and so on. The users can also create KW-tables with ten thousand rows or more and use it as a text repository or text corpus as the basis for their personalized and tailor-made KM.

Modelling the IT support of knowledge workers for KM-Processes is based on using the above-mentioned knowledge processing paradigm when using the model of the vKWU and writing source codes and user menus of the WPad software application. In other words, this modelling depends always on an existing algorithm (sequences of steps) of KM-processes. If the algorithm of the managerial processes is known, informatics algorithms can be written as source codes. The activities can be simple (e.g. creating the knowledge base, filtering or searching) or more sophisticated (e.g. creating KM-system, KM-portal, writing client-server application). By using the user's menu items, the human knowledge, after its insertion into the KW-table, is handled, managed and controlled (filtering, searching, saving, converting to html-files, sending to other KW-tables, etc.), or executable applications can be made by using a combination of the sequences of the user's menu items (client-server solutions; adoption to Windows, clouds and remote desktops; English support). This is illustrated in Fig 3. by an example of one of the categories of the user menu of the WPadV4.

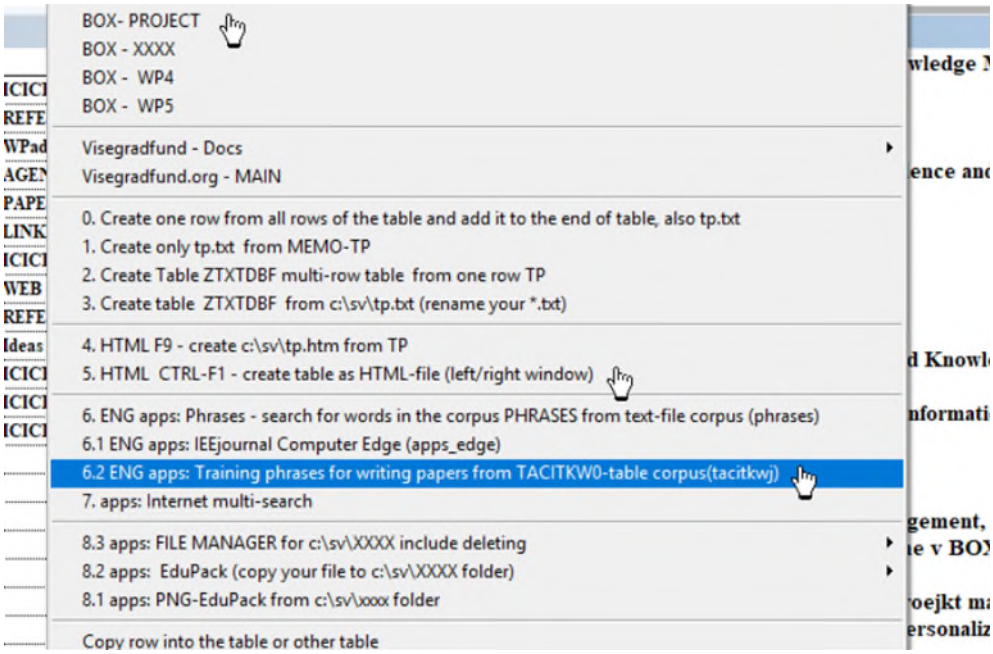
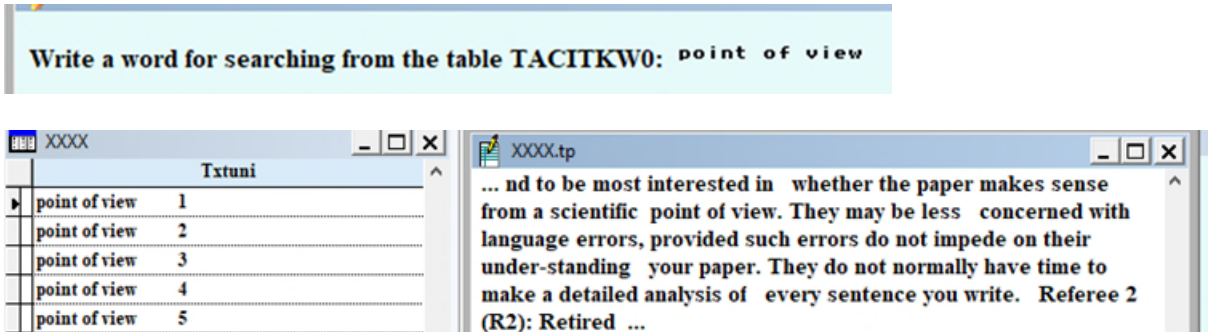


Figure 3: Screenshot of the user menu of the WPadV4

4. The use of the WPadV4 for text corpora, cloud content management and research

4.1 Applications for using text corpora

There was an intention within proposing the PanEULangNET project (the ICT17 call of the Horizon 2020: https://ec.europa.eu/programmes/horizon2020/en) to join engineers and computational linguists to create corpora from engineering and expert information for automatic machine translation. Within solving the V4+ACARDC project, this idea was now implemented for support of writing research papers in English, which is not the native language of the research team from five European countries. To test it, the proceedings from the ICICKM 2018 were inserted into the KW-table XXXX as the text corpus. This text corpus has functioned as a basis for extracting sentences containing the required phrases. For example, the menu item 6.2 extracts the required phrase from the personal training corpus consisting of the proceedings' content. Fig. 4 illustrates inserting the phrase "point of view" and the resulting KW-table and HTML-file with sentences containing the phrase.



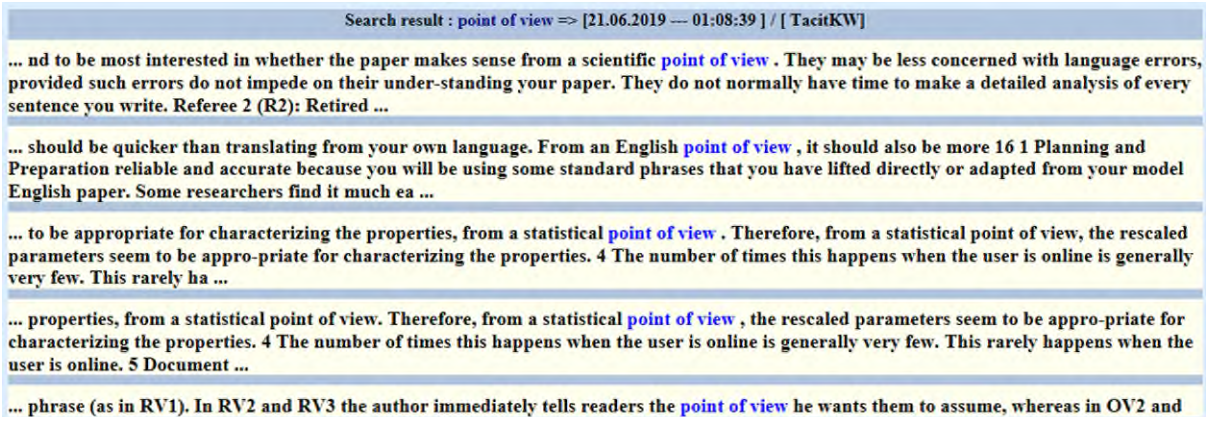


Figure 4: Screenshots from extracting the phrases "point of view" from the text corpus (proceedings)

The following Fig. 5. shows the possibility of using the same text corpus for searching whether a similar research focus was presented at the ICICKM 2018 conference. As shown in the right window, the sentences were marked (tagged) with the pair "(((" "))", then automatically extracted to the new row at the end the KW-table, and then used as the reference in Section 2.

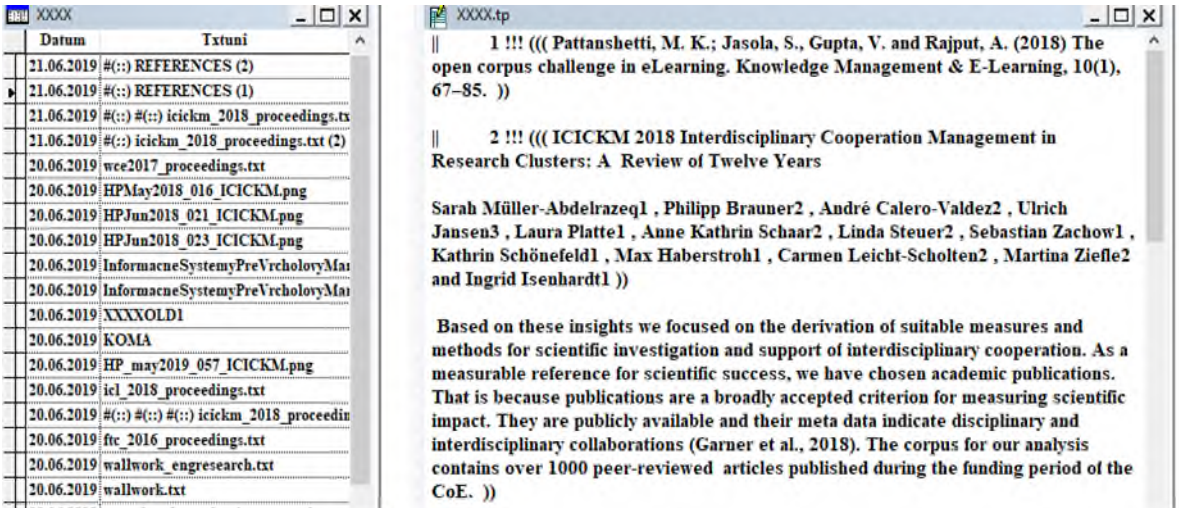


Figure 5: Screenshot of the use of the method of "natural text marking" that is developed by the authors

4.2 The personalized KM paradigm for designing heterogeneous off-line/online corpora

The previous example has illustrated using the text corpus, i.e. the KW-table which is on the user's computer or virtual remote desktop with Windows 10 (virtual machine). Each knowledge worker has their human knowledge (personal content) embedded not only in their KW-Tables but also in the thousands of computer files, which are stored in many heterogenous formats (pdf, doc, txt, mp3, jpg, etc.). Additionally, in our case, the knowledge worker uses a set of the KW-tables, which can be joined and transmitted between off-line and online environments by using the WPadV4 software (the WPadV4 is the updated WPad-version). From the informatics point of view, this required to solve a concentration of both the KW-tables and computer files by joining them into one "knowledge package" (KW-package). But the problem was that while the KW-tables are only textual corpora, the computer files consist of many heterogeneous formats. This required the designer to solve the adoption of the WPadV4 to the Windows and hardware by adding several functions typical

for file management tools to the user menu. Fig. 6 illustrates the resulting KW-package, which was created as the HTML-output (after converting the KW-Table "XXXX"), which enables browsing through the heterogeneous files, e.g. after clicking on the ICICKM-model paper (i.e. on row 10 in the KW-table), the user can read the model paper for this conference.

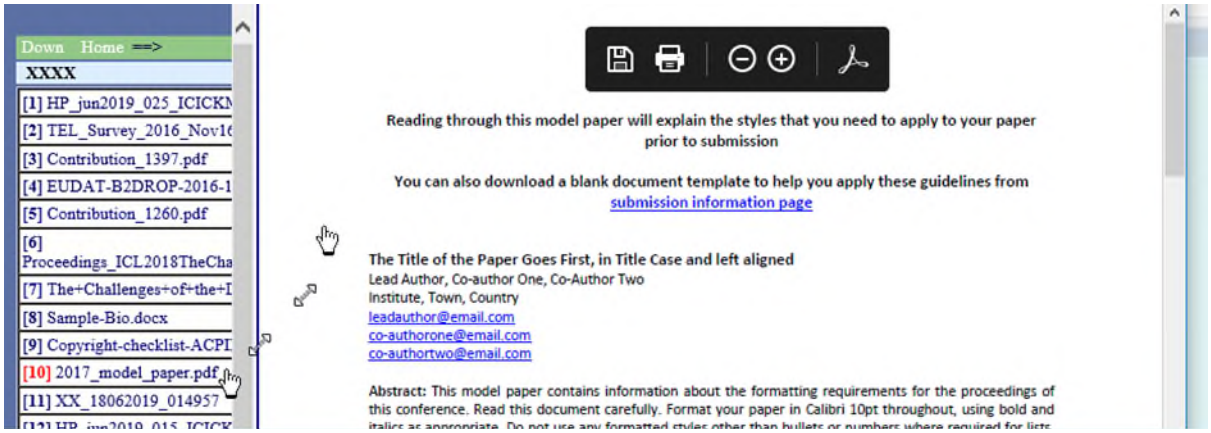


Figure 6: Example of the single KW-package which is browsable in the Microsoft Edge browser

4.3 Cloud content management

At the beginning of the V4+ACARDC project, it was needed to join the researchers from the five European countries in order to enable the knowledge flow and exchange for the purposes of the KM-Processes. In collaboration with IBM Slovakia, the shared area on the BOX-Cloud was implemented that enables users to perform Cloud Content Management (CCM). This CCM service enables the users to create folders and sub-folders, as is common when using Windows Explorer or file managers at their personal computers. The CCM also provides for synchronization of the folders by ensuring automatic transfer of files from personal computers to the main folders of the BOX-cloud. Of course, each partner has also their own folder. The project manager of the International Visegrad Fund (https://www.visegradfund.org/) has direct access to the project's folders, so she can overview the progress operatively within the entire duration of the project. The synchronization, the way of structuring the content, using the file manager's functions, and the possibility to send internal mails within the Consortium was a good background for using the BOX-Cloud for shared KM-Processes, and for testing the Cloud Project Management.
It should be mentioned that the WPadV4 is not installed on the BOX-Cloud because the cloud service does not have Windows, in which the WPadV4 could work as the client-server solution. However, in combination with the BOX-Cloud, due to the possibility of synchronization (automatic transfer of the files), the project leader, as well as the designer, can browse the BOX-Cloud content from their computers and project partners from their notebooks (see also the previous screenshot of the user menu). Fig. 7. shows the infrastructure used for communication within the V4+ACARD Consortium (MTF-team are researchers from the Faculty of Materials Science and Technology, which leads the project).

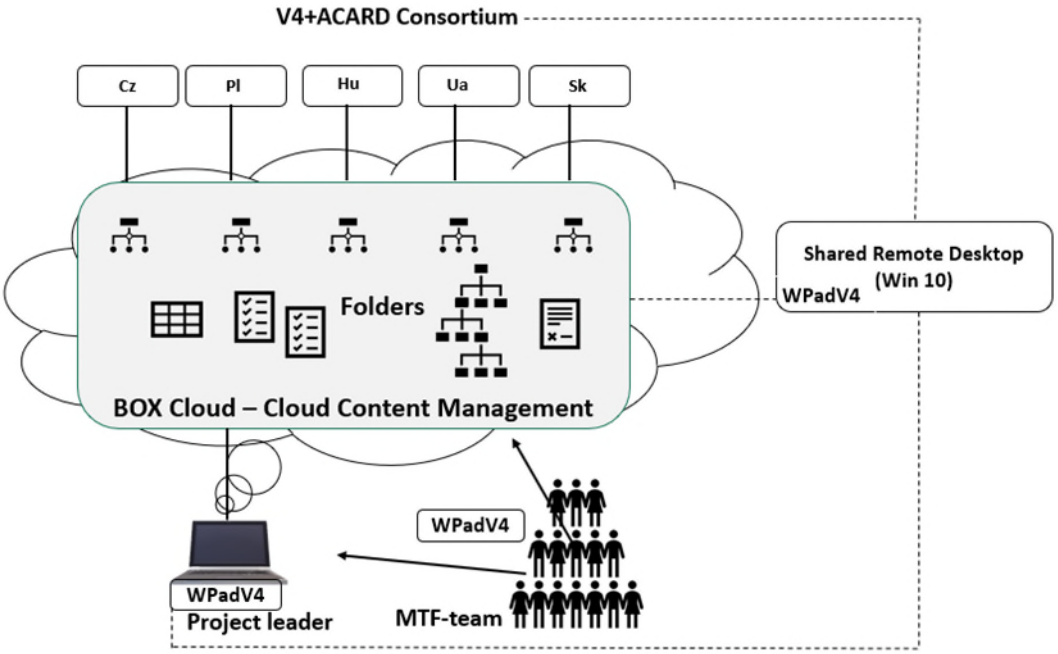


Figure 7: The scheme of the communication paths for transmitting the KW-flow within the infrastructure

5. Conclusions

The state-of-the-art of the IT support for the KM-Processes is characterized by a gap in the software support for the personalized IT support of knowledge workers for KM-Processes, including the higher top managers in the knowledge-based organizations. The authors have presented some examples from their research results, i.e. how the IT support for the KM-processes were solved in the real situations in the university teaching and research. In this context, this paper presented as the added value:

- the paradigm for the information and knowledge processing in the context of KM, which is based on the model of the knowledge representation by using the vKWU;
- the all-in-one, multi-purpose WPadV4 software for performing this paradigm at the level of individual knowledge workers;
- the new approach for using knowledge corpora within the Knowledge Management, and Cloud Content Management.

It should be emphasised that the knowledge-based paradigm and WPadV4 software is developed as the all-in-one, multi-purpose KM-tool particularly for IT support of individuals to enable them knowledge creation, sharing, exchange and transfer, as well as, within community of researchers via technological infrastructures. In this context, Nonaka (1994), with his dynamic theory for organizational knowledge creation, defines interactions between individuals as the foundations for knowledge creation.

Despite the authors' research is empirical, the added value is also to the theory of knowledge, because authors have found a suitable interdisciplinary representation of knowledge, or universal "definition" of knowledge respectively, as the "meta-information and content" that is both human and computer readable. To the best of authors' knowledge, any similar representation or definition was not described yet in the scientific literature. In general, computers are machines for information processing, therefore computers do not understand human natural language, so any human knowledge must be converted to machine

information. This has been solved up by the above-mentioned “virtual knowledge unit”, which represents the needed isomorphic relationship between mental processes and physical processes (computers). Namely, a necessary condition must be fulfilled that isomorphic relationships exist between the specific system abstractions and real physical systems (Glaserfeld, 2002).

From the KM point view, the limitation of the authors’ research is given how any knowledge worker is able to insert tacit and explicit knowledge into the knowledge tables, including linking the content of computer files that are in many formats and contain heterogenous data. It is also very important, if people are willing to collaborate and share their knowledge. From the informatics point view, the file size should not be larger than 250-MBytes for a convenient work (max. 1-Gigabyte). The content of the knowledge tables is needed to consider as a smart content or smart data in comparison with the content of files (e.g. pdf/ doc-files) and big data.

The KM-processes are associated with mental processes, i.e. they are knowledge-based. Due to the above-described paradigm, which enables the knowledge worker to process a large amount of human knowledge without additional informatics skills, the future work represents a never-ending story, also in view of the IT support of TOP-level managers. According to the comparison with the state-of-the-art, the presented paradigm seems to be beyond the state-of-the art regarding the personalized approach for developing the WPadV4 as the KM software.

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