The Design of IT Support of Intellectual Capital: Examples from the KM-Practice

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Abstract: Intellectual capital is an essential element in ensuring the sustainability of individuals, companies, and academic institutions and is closely related to knowledge management (KM). In this context, both universal definitions of knowledge and KM including algorithms describing the associated processes are missing. Since the knowledge and KM algorithms are not enough defined, they cannot be used for writing computer algorithms (software). Instead of the bottom-up approach that the technology simulates KM's individual practices, users need in turn to adapt to the available technology. The focus of the IT support is on storing the knowledge in databases, however, the software solutions for processing the knowledge flow are missing. Although it is a key question, no technology can computerize the processes that are not predefined. The challenge is how to simulate the KM processes on the bottom-up approach - to address the technology synchronously with the flow of knowledge. The aim of this article is to present this approach to the technological support of intellectual capital to solve the above-mentioned challenges. It is based on a cybernetic approach to modelling the human processes, on the isomorphism between the human activities and the physical processes of a computer, which is simulated using the concept of “virtual knowledge”. Any computer understands this virtual knowledge as an informatics data type. It is a fixed database structure in the form of a table into which the user inserts tacit and explicit knowledge. This "knowledge table" is controlled using the in-house software. It is important that the computer does not distinguish the content inserted in tables, whether it manages personal knowledge or organizational knowledge. Both the creation of the knowledge base is described, and the support of the knowledge flow is simulated (managing knowledge flow is a key question from the intellectual capital point of view, e.g. exchange, dissemination, and sharing of knowledge). The presented approach supports multitasking of the individuals and increases the speed of processing personal knowledge, which is very rarely discussed in the scientific literature. The synchronization of writing software in parallel with the ongoing KM activities is illustrated by examples at the individual, research community, and organization level.

Keywords: Intellectual capital, knowledge management, personal knowledge management, knowledge management systems, knowledge management software, tacit knowledge

1 Introduction

The market value of an organization creates financial and intellectual capital. The latter is divided into organizational capital (structural), society capital (stocks and flow of knowledge), and human capital (human capital is created by employees, by their inherent and obtained knowledge, skills, abilities, talents, and competences) (Antosova, Csikova, 2011). Choong (2009) describes more details related to the definitions, categorization, and reporting models of intellectual capital. In the intellectual capital, which represents the intangible value of the business, the knowledge and knowledge transfer plays a key role. This also applies to the role of intellectual capital in education (Secundo, Lombardi and Dumay, 2018). In view of the knowledge transfer, a specific study examines the roles of the human capital, organizational capital, and relational capital (Chen, Shih, and Yang, 2009). This study emphasizes the gap in the literature that is lack of empirical examination of the roles of intellectual capital in the knowledge transfer contexts.

Thus, it is important that the knowledge of individuals represents a key element in all kinds of intellectual capital. This is important in view of the knowledge-based organization (e.g. in companies performing research and development), academic institutions (teaching and learning research), including industrial and other

companies (e.g. in context of the relational capital). In other words, any knowledge transfer requires so that the knowledge should be captured, exchanged, and managed. In the nineties P.F. Drucker already predicted the necessity to manage knowledge, which resulted in establishing knowledge management as a new discipline as in (Antosova, Csikova, 2011), where the issue of "Intellectual Capital in Context of KM" is presented. Paliszkiewicz (2017) discusses the future of KM, and 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 an organization". The questions of KM, knowledge innovation and KM information system are also important within the R&D project management processes (Dingyong, Yizhen, Long and Zheng, 2009).

In addition, Drucker (1969), applies the term "knowledge workers" who defines the knowledge workers as the high-level workers who apply theoretical and analytical knowledge. "Knowledge is central to most of the daily tasks of knowledge workers, a large category of highly skilled professionals including consultants, lawyers, software developers, web designers, etc." (Razmerita, Kirchner, and Sudzina, 2008). In this regard, Smith (2001) very aptly describes the role of tacit and explicit knowledge in the workplace, especially in an education setting.

As a result of the above-mentioned, personalized IT support of the personal KM (as the sub-domain of KM) in the context of the intellectual capital is very important. Because of this, a question was given if "Web 2.0 technologies (social software) are a real panacea for the challenges associated with the management of knowledge" to discuss new approaches for managing personal knowledge in the Web 2.0 era (Razmerita, Kirchner, and Sudzina, 2008). Schmitt (2015, 2018) also solves some issues related to the personal KM.

However, it must be emphasized as Wilson (2002) points out that "knowledge management is an umbrella term for a variety of organizational activities, none of which are concerned with the management of knowledge". He argues that "those activities are concerned with the management of work practices, in the expectation that changes in such areas as communication practice will enable information sharing"**.** A specific research focus on automation of the knowledge-based processes presents Svetsky and Moravcík, who consider any KM process as the knowledge-based process (2014, 2017, 2018, 2019). This focus and research outputs will be presented on examples in the next sections of this paper.

2 Automation of KM Processes as Knowledge-based Processes

All individuals mostly intuitively understand a hierarchy of what data, information, knowledge, even wisdom mean. However, it was found in the scientific literature that any universal definition of knowledge and knowledge representation is still missing, which would be suitable for IT support of teaching and KM processes, which the authors consider for the knowledge-based processes, and in which the knowledge is the key process parameter.

The question of knowledge is also very important concerning intellectual capital because even in some definitions, which were found by search engines, it is argued that e.g. "Collective knowledge (whether or not documented) of the individuals in an organization or society. This knowledge can be used to produce wealth, multiply output of physical assets, gain competitive advantage" (http://www.businessdictionary.com/definition/intellectual-capital.html). Or according to the other definition "Intellectual capital is knowledge that can be exploited for some money-ma king or other useful purpose (https://searchcustomerexperience.techtarget.com/definition/intellectual-capital).

To challenge this issue, a universal "virtual knowledge unit" was designed by authors as a specific data structure. Such virtual knowledge isomorphically joins the mental processes of humans with physical processes running on computers. In contrast with state-of-the-art solutions, it is both human-readable and machine-readable (any other specific machine-readable programing language or schemas are not needed). In parallel, an in-house software has been designing by Svetsky (one of the authors of the presented paper), which controls the virtual knowledge. It is very important from a practical point of view because the personal software enables one to convert tacit knowledge of individuals to explicit one in a user-friendly.

This approach, which uses the virtual knowledge concept, own in-house software WPadV4, the virtual knowledge tables/base, the batch-knowledge-based processing paradigm, the online and cloud IT infrastructure, was step by step applied within the research on the IT support of KM. For a better view, the following titles of the contribution to ICIKM conferences are mentioned:

- The Personalised Computer Support of Knowledge Management (Svetsky, Moravcik, Stefankova, 2013)

- The Knowledge Management IT Support: From Personalized to Collaborative Approach (Svetsky, Moravcik, Tanuska, Sakal, 2017)
- The IT Support of Knowledge Management and Transmission within Community of Researchers (Svetsky, Moravcik, Tanuska, Sakal, 2018)
- Modeling the IT Support of Knowledge Workers for Knowledge Management Processes (Svetsky, Moravcik, Vazan, 2019)

From this paper's point of view, it is important that the in-house software, which is presently named WPadV4, was also described in these papers as a convertor of the tacit knowledge to personal explicit knowledge, and also as the personal KM software or the personal KM system. It can be also mentioned that the technical solution of the IT support of KM based on the specific database structure is registered at the Slovak patent office (2014).

Till now, authors were concentrated more on the technological aspect of KM and less than on the question of the knowledge exchange in KM, including the conversion the tacit knowledge (while knowledge is in our heads) to the personal explicit knowledge (after putting the knowledge from our head to the virtual knowledge table of the WPadV4 software).

The issue of tacit knowledge sharing is in detail described in a literature review (Ferratti, Afonso, 2017). It is emphasized that "there is still a greater concern in dealing with the visible flow of knowledge (information) than with the invisible flow or its tacit format". It is also pointed out that organizational knowledge "is composed of personal knowledge, translated by their experience, know-how, and practices developed individually or from within an environment provided by the organization". It is also pointed out that "Most of the organizational knowledge is tacit, and it is estimated at 80% of the useful knowledge of an organization and when not shared brings more problems or difficulties than useful results".

In this context, the content of the virtual knowledge (table) means that it is the "personal" explicit knowledge of the individuals who use the WPadV4 software. However, what is as well as important, if the individuals (knowledge workers, researchers, pedagogues) exchange their explicit knowledge by using the WPadV4 (virtual) knowledge tables, it is more effective way than to exchange the standard formats like a pdf, doc, txt, mails (Note: also images, audio, and video formats – there is a specific way in comparison with the text files), i.e. to send common files. And what is especially important, that the information entropy (human knowledge in files) is radically minimized (human knowledge – tacit or explicit - inserted in the virtual knowledge) because the user or users exchange, share or communicate via the knowledge tables only a key content in contrast with using the standard files (a file can be e.g. in megabytes, but the virtual knowledge contents only the most important part from the content of the file).

There is much software related to KM (see e.g. https://www.zendesk.com/blog/3-best-knowledge-management-examples/), but no one is exactly based on such the personal knowledge model as is the concept of the virtual knowledge, which contains the inputted human knowledge. Hajric (2018) also argues "Within everyday language, within specific fields, and even within the same disciplines, the word "knowledge" often takes on a variety of meanings" – although, when talking about KM, one must start by clearly defining the meaning of the word "knowledge". He also mentions that it is important to understand what constitutes knowledge and what falls under the category of information or data (e.g., for data to become information, it must be contextualized, and knowledge is closely linked to doing and implies know-how and understanding). The concept of the virtual knowledge functions exactly at this principle, i.e. that the virtual knowledge consists of the meta-data/information and the associated content. Fig. 1 illustrates this.

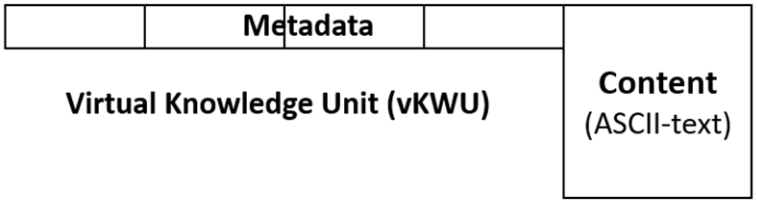

Figure 1: The model of the Virtual Knowledge Unit (metadata + content) (Svetsky, Moravcik, Vazan, 2019)

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. 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.

3 Knowledge flow: Difference between Knowledge Transfer and File (Content) Transfer

The authors' research is based on developing the in-house education-specific software (WPadV4), knowledge representation, KM paradigm, personalized IT infrastructure, and a specific way of solving the knowledge transmission between off-line and online environments to support collaborative activities of teachers and researchers. The authors emphasize the question of knowledge in their research by arguing that teaching and KM are the knowledge-based processes. So, if one wants to computerize these processes, one must design the suitable knowledge representation which is derived from the mental processes of the knowledge workers or individuals in general.

It was solved by the design of the virtual knowledge, which is both human-readable and machine-readable as was mentioned above. It enables the individual to insert his tacit knowledge or any explicit knowledge into the so-called knowledge tables. This means that any knowledge table consists of rows with virtual knowledge, in which the individual has inserted his human knowledge. If a set of such tables is created for a certain domain the user can create a personal knowledge base with own ontology and semantics (relations between tables) system, or a personal information system. This also enables one to perform "multi-tasking", when solving the various personalized managerial tasks, because simply switching between the knowledge tables containing the concentrated domain content gives anyone a quick orientation.

For example, the issue of knowledge management is especially important in knowledge-based organizations, because working with information and knowledge is the basis for their sustainability and competitiveness. An industrial R&D Centre oriented on materials and technologies consisted of several departments, each of which had its R&D staff and its own testing laboratory. As shown in the schema in Fig. 2, the basis for knowledge management was:

- The internal information flow between researchers and laboratory staff
- Horizontal information flow between departments and laboratories
- Vertical information flow between departments and central management and economic departments
- The external information flow between departments, customers, R&D project partners, also including the flow from information sources (mostly standards and technical documentation – although not from the internet).

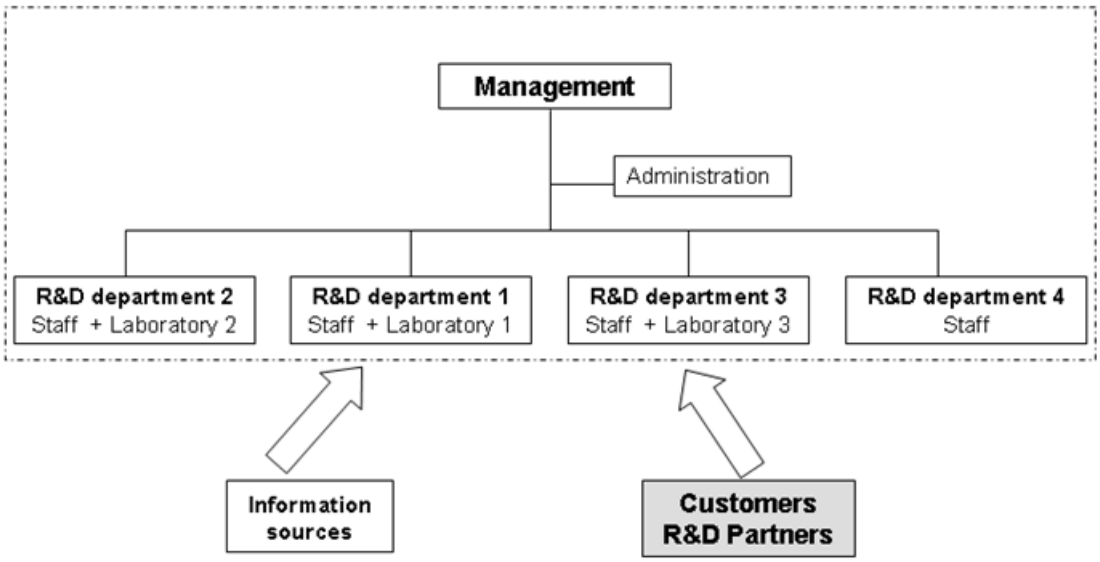

Figure 2: R&D Company's schema related to information flow (Svetsky, Moravcik, Stefankova, 2013)

At this time, mostly files in the HTML, DOC and XLS formats, including database tables, were used for the creation of the laboratory's information system and knowledge base. For the off-line information exchange were

used Windows Explorer and File managers (e.g. FAR 1.65). The web-repositories and clouds were not yet common as is nowadays. In other words, all content management was performed on the basis of the standard computer files.

In comparison with the previous example, the authors' research focus is on testing the online virtual spaces for KM. Currently Cloud Content Management (CCM) and Cloud Project Management (CPM) have been tested on the BOX-cloud, including the KM at the faculty's virtual space, where the content and processes are modeled by the V4+ACARD Consortium.

The research paradigm in the context of KM has been developed, and the use of the KM software (WPadV4) for text corpora and CCM tested (Svetsky, Moravcik, Vazan, 2019).

Fig. 3 illustrates how the KM system and KM software were used. In this case, WPadV4 is installed on the academic cloud (with a virtual machine running Windows 10) and on the work computers and notebooks of tens of researchers from Visegrad countries (EU) working on this project (Poland, Czech Republic, Slovak Republic, Hungary, Ukraine). Fig. 4 illustrates how the BOX folders are structured for the knowledge and files storage and transfer in V4+ACARDC project

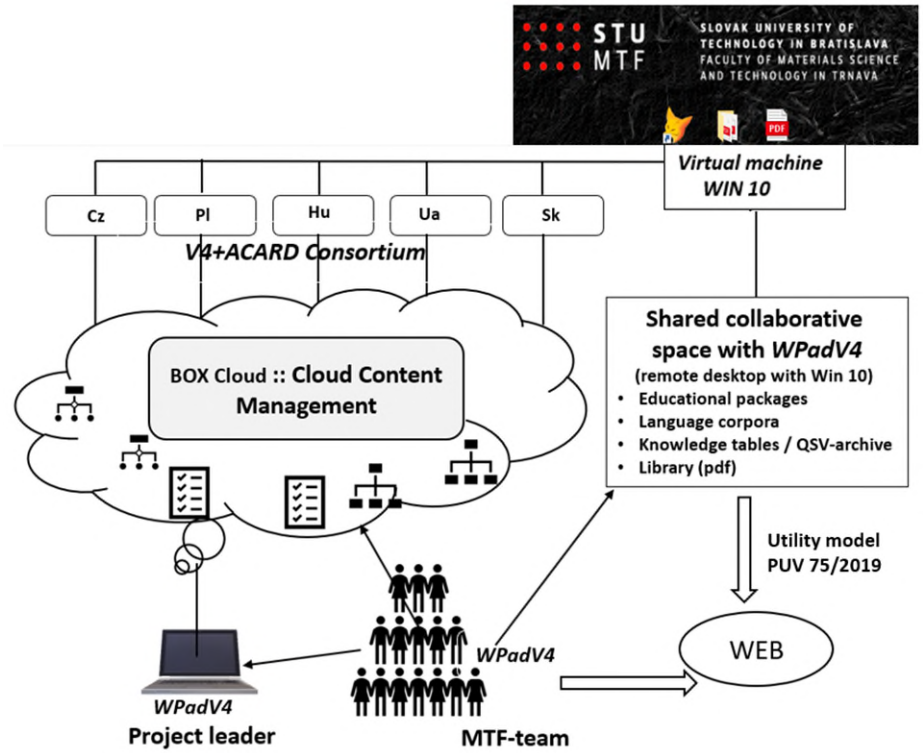

Figure 3: The infrastructure for KM, CCM, and PCM using in the V4+ACARDC project

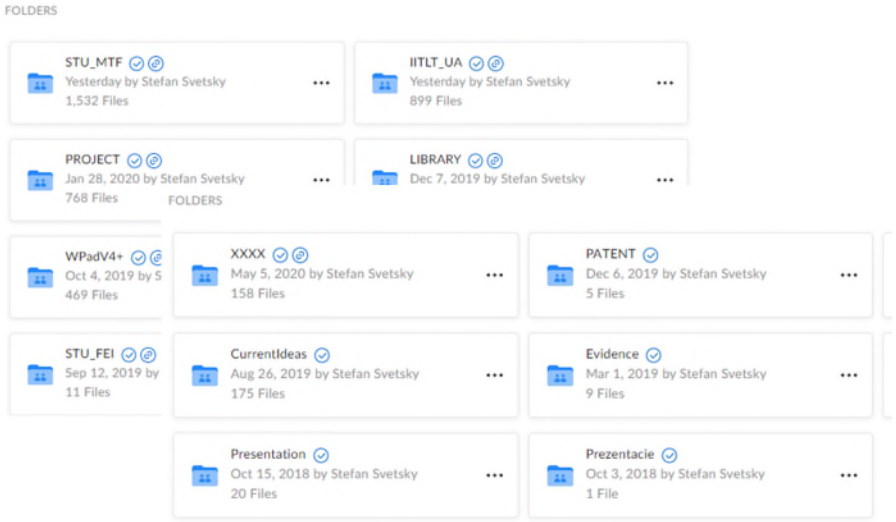

Figure 4: Example of BOX Cloud Content Management space used in V4+ACARDC project (Screenshot of folders of project partners and project leader)

The previous figures enable us to explain the difference between the (virtual) Knowledge Transfer and File (Content) Transfer in more detail. Namely, within the infrastructure as in Fig. 3, the knowledge and information are exchanged through the shared collaborative space with WpadV4, i.e. via the faculty's virtual machine with the operating system Windows 10 where the WPadV4 is installed and used together by all researchers. They also have installed the WPadV4 software application on their personal computers. The researchers can also switch to the BOX cloud from this shared collaborative space. On the other hand, the BOX cloud (Fig. 4) does not contain any Windows 10, thus it functions as a more sophisticated file manager with basic functions for emailing also synchronization of the online cloud content and off-line content in the personal notebook or mobile. In other words, it functions as a mixed tool for information management (a simple transfer of files) and KM (more sophisticated activities with the files).

Here, it must be emphasized that the WPaV4 activities and tables simulate the cognitive functions of mental processes associated with the activities of the knowledge workers. Therefore, a distinction must be made between knowledge transfer of the knowledge tables and common files in the standard formats (PDF, TXT, HTML, DOC). To the best of the authors, they have not found any similar solution to the knowledge transfer till now. In the field of computer science, it belongs to the field of human-centered computing. The difference between the virtual knowledge/table and the common file is illustrated in. Fig. 5.

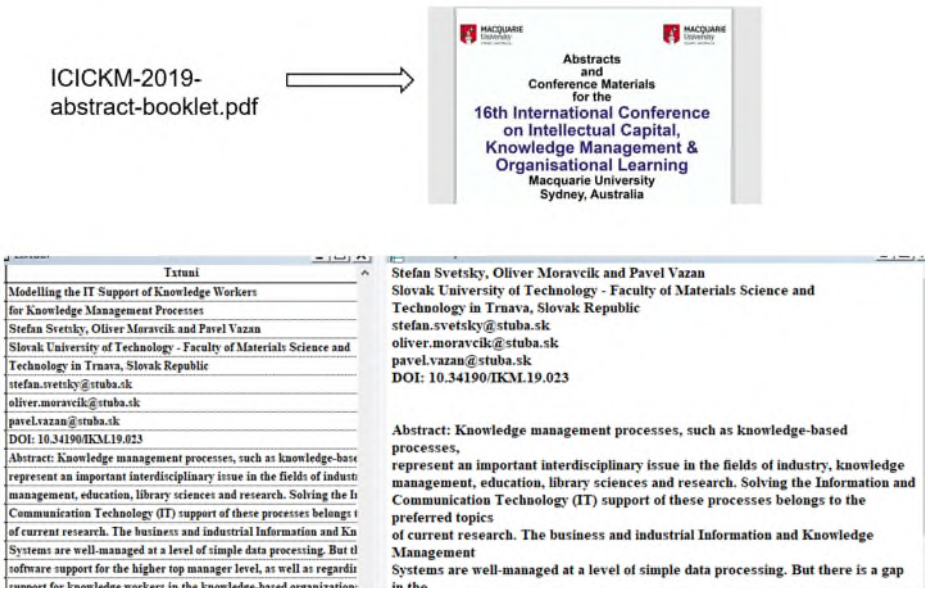

Figure 5: Difference between Virtual Knowledge Table and common pdf-file

It is an example of the PDF-file containing the abstract-booklet from the ICICKM 2019 conference, and how the content of this PDF-file is inserted into the knowledge table. This table can be browsed or controlled by the reach user menu of the WPadV4, e.g. for exploring which papers relate to the authors' research field. It can be mentioned, that the table can have only one row, in which the whole content (text) of the pdf-file is inserted. It is useful in such cases of KM that the knowledge workers perform only a quick orientation by using the standard CTRL-F function.

4 Intellectual Capital: KM algorithm Design and IT Support

The authors' approach to research on ICT support for KM is based on the same methodological steps as they applied in their research on technology-enhanced learning (since the KM processes are as well knowledge-based as the teaching processes). In this context, it is based on parallel and synchronized KM-informatics research that is related to three methodological pillars: (i) identification of KM algorithms or other processes associated with KM; (ii) modeling "informatics" algorithms and applications; and (iii) the "adaptation" of WPadV4 software for Windows, web programming and cloud computing. Namely, it was found by modeling the computer-supported collaborative learning that the identification of pedagogical-didactic algorithms is primarily crucial for this kind of IT support. This logically should relate to the KM-processes and any knowledge exchange or transfer within a community of the knowledge workers. From a layman point of view, if a sequence of "KM-steps" is not known and defined it is not possible to write any source codes or KM-software for collaborative and shared activities. In view of the KM support via IT however, the algorithms of the KM-processes are not enough described.

The question of the KM algorithms relates to defining the common managerial activities. So, a list of the most important activities or terms, which are associated with the knowledge, has been identified accidentally as follows (Antosova, Csikova, 2011):

searching --- using --- origin --- choice --- processing --- formalization --- transformation --- saving --- sharing --- dissemination --- finding --- choosing --- organization --- concentration --- presentation of knowledge ---spreading information --- further development --- effective use --- KM level --- personal --- organizational --- national

Any design of the IT Support of KM or Intellectual Capital in general requires that all of these activities must be identified and defined in the KM algorithms. The concept of the virtual knowledge, which is understandable for any computer, enables to write the programming codes synchronously with the running KM activities. In this context, the user menu of the WpadV4 software, which contains hundreds of items, covers the above-mentioned KM activities.

For example, each knowledge worker (researcher, manager, teacher) obtains many emails daily. He can simply copy them to the knowledge table as Fig. 6 illustrates.

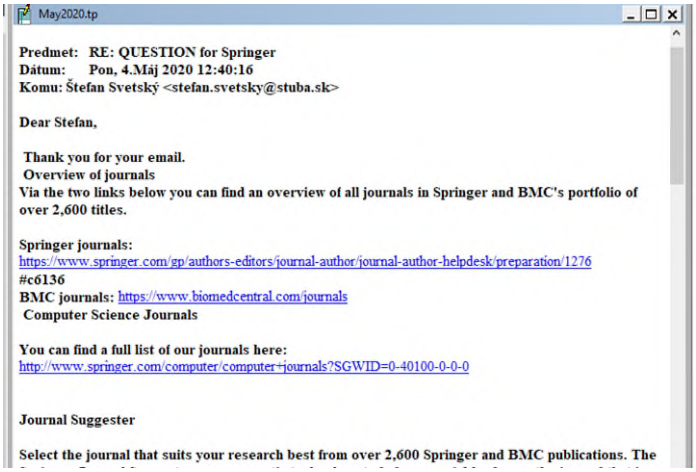

Figure 6: Example of copying email content to one row of knowledge table

In this way, any WPadV4 user can create own personalized KM tables, either tailored for a specific purpose or combined topics. Such the KM table itself represents a small knowledge base.

In addition, more such tables could build a personal or organizational knowledge base. It is also important that the hypertext links also function from the knowledge table as in the email in Fig. 6. Moreover, off-line hypertext links also function from each knowledge table, i.e. the table can be used for navigation paths to the folders of individuals notebooks or client computers.

The latest research of the authors is focused on simulation and managing knowledge flow and the synchronization of writing software in parallel with the ongoing KM activities. It could be explained in designing so-called KM packages as Fig. 7 illustrates. Such a KM package was automatically created for the purpose of writing this paper. In this case, the XXXX table was created, which has enabled the navigation to the existing folders (from the previous ICICKM conferences), related files, proceedings, and other sources, to concentrate any content associated with the topic of this paper. For example, in Fig. 7 the cursor is in the fifth row, where the whole text of the ICICKM 2018 proceedings is uploaded (as a plain text). Similarly, ICICKM proceedings from previous years can be read by pressing ALT-F9 (as the PDF files). The first trial was also started with the conversion of speech to text to accelerate the transfer of tacit knowledge to explicit knowledge and control the managing the knowledge tables by using a specific Speech Recognition software.

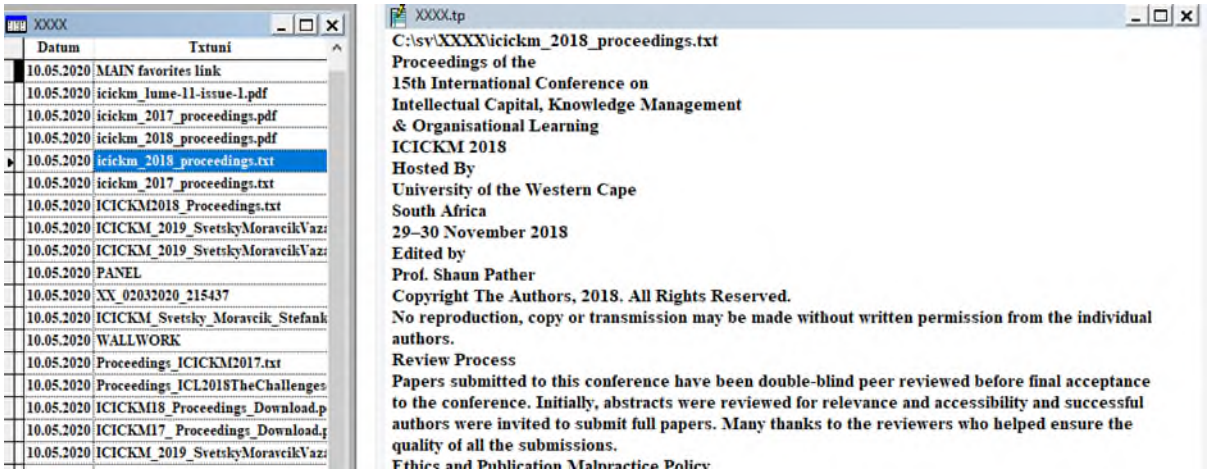

Figure 7: Example of creation of KM-Package table (XXXX)

5 Conclusions

This paper presented the design of the IT support of intellectual capital when using a concept of so-called virtual knowledge in which the human tacit and explicit knowledge is inserted by the knowledge workers. Since the virtual knowledge is both machine-readable and human- readable, it enables the individuals to automate KM processes as the knowledge-based processes in which the knowledge is the key control parameter. In other words, if a user can insert his tacit or explicit knowledge into the knowledge tables the computer performs the KM algorithms much more quickly than a human being. It enables the user to build a huge personal knowledge base, mass knowledge processing, including performing the knowledge transfer within clouds, repositories, and personnel notebooks or client computers. The authors have demonstrated it on some examples from the KM practice, e.g. how the (virtual) knowledge transfer and sharing has been performed in the community of researchers within the IT infrastructure consisting of the shared virtual space with the installed the in-house software WPadV4 and the Box cloud which provides for cloud content management. It has been especially emphasized that the knowledge exchange is performed in two ways, so not only by exchanging the standard files format (e.g. PDF, HTML, DOC, TXT) but also by exchanging the knowledge tables. The use of the virtual knowledge tables represents the added value of the authors to the state-of-the-art in the field of KM, or information and knowledge processing respectively. It has been also especially emphasized that the effectiveness of the IT support of intellectual capital depends on the proper KM algorithms design. So, describing the managerial processes by proper algorithms synchronously with updating the in-house WpadV4 software is a key issue for the future progress and updating the software, including processing the knowledge embedded in the image and audio formats (e.g. by improving the KM packages design, which has already been worked out by the authors, and by using the speech recognition software for the conversion of tacit knowledge to explicit one).

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