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Mobile Knowledge Portals: Description Schema and Development Trends

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Abstract: In the paper, the emerging mobile knowledge portals are analysed both from the technological and knowledge management points of view. To this end, a description schema for mobile knowledge portals is introduced. In the framework of this schema, both knowledge management and mobile technology aspects and their impacts both on the user behaviour and on the internal structure and functionalities of the portals are taken into consideration. The potentials of mobile technology to leverage the knowledge portals functionalities are discussed in detail. In conclusion, potentials and future trends in development of mobile knowledge portals are discussed.

Keywords: Knowledge Portals, Mobile Knowledge Portals, Mobile Technology, Knowledge Management
Categories: I 2.4, H 3.3, H 3.5

1 Introduction

Nowadays, knowledge work is increasingly carried out in mobile environments, i.e. outside of offices, at the customer's location or on the road, where *knowledge workers* (KWs) use notebooks or handheld devices instead of PCs and where they often have no access to high-bandwidth networks. According to [MobileAdviser], two-thirds of U.S. workers will be mobile by 2006. A similar situation can be observed in the EC and other countries, too.

These changing working conditions pose new challenges for *knowledge management* (KM) tools that support knowledge work activities. In particular, techniques for content summarization of available knowledge recourses, their automatic adaptation for display on small devices according to user's preferences, conversion of information created or available in one application context (e.g., e-mail, discussion forum) to other application contexts (e.g., phone, voice mail or a handheld device) should be considered among others.

Another clear trend in today's KM are the emerging *knowledge portals* (KP) that are multi-tier single-point-access applications that provide tools for knowledge capturing, analysis, organisation, search, navigation, and distribution. Being very useful for KWs by themselves, KPs can also be considered from the technological point of view as a model for the emerging *semantic web*: all technologies that are typically associated with the semantic web like XML and RDF for knowledge

description, taxonomies and ontologies for knowledge representation, and software agents for knowledge search and communication are actively discussed in connection with today's KPs [see e.g. Hartmann and Sure 04].

Because information and knowledge are especially valuable (or sometimes only valuable) if they are delivered at the right time and to the appropriate location considerable efforts have been put within the last few years into unification of ideas and technologies derived from mobile KM and KPs that are two important areas of research in today's KM. These efforts gave rise to a notion of a *mobile knowledge portal* (MKP). The idea of a MKP is not a new one (see e.g. [Berger and Lehner 02] for description of a prototype of a MKP implemented at the University Regensburg or [Teuteberg and Hilker 03] for a proposal of a generic architecture of a Mobile Knowledge Portal (MKP) and references therein). Still, in part because both mobile KM and KPs are far away from their complete form and subject of active research and development, MKPs are currently in a very early phase of their development.

The aim of this paper is to compile a description schema for MKPs that can be used both for analysis of current MKPs and to identify future development trends. The schema is mainly based on criteria coming from the relevant characteristics of the mobile technology like independence of location and time, anytime accessibility, personalization, context awareness, and permanent connectivity [Martens and Gronau 03] and how they are supported by the MKPs as well as those of KM like the knowledge work cycle [Detlor 04] and the conversion of knowledge between and within tacit and explicit forms [Nonaka 91].

In fact, the first set of criteria, the one connected with the support of knowledge mobility, reflects the user's point of view, i.e. what knowledge recourses of the MKPs users can access via handheld devices. The second set of criteria comes rather from the KM research and determines how the mobile technologies can support the process of transformation between and within the tacit and explicit forms of knowledge. This reflects the impact of the mobile technology on the internal structure of the MKPs and their functionalities. The description schema of MKPs presented in the paper thus takes into consideration the internal (portals structure) and the external (users' access) impacts of the mobile technology on the MKPs.

The rest of the paper is organized as follows. In the second section, the notion of KP and its place within the current KM research is shortly described. In the third section, MKPs are defined. A description schema based on several different criteria coming from both the current research in KM and mobile technology is presented in details. This description scheme is employed throughout the text to deduce some statistics about a few MKPs we could identify. These MKPs are either implemented as prototypes in the academic environment or offered as commercial products. Finally, in the fifth section, some conclusions are drawn and possible developments trends of MKPs discussed.

2 Knowledge Management and Knowledge Portals

Following [Davenport and Prusak 98] KM is defined as a set of systematic actions that an organization or a community (scientific, academic, government, business-oriented, etc.) can take to obtain the greatest value from the knowledge available to it. Knowledge in this context includes the expertise of the people in the organization or

within the community and the information sources, such as documents, reports, papers, etc. available within the organization or community and outside them.

In the narrower sense KM refers to a set of methods and tools for capturing, storing, organizing, and making accessible knowledge and expertise within and across organizations or communities; we use this understanding of KM throughout the paper.

Technology can support the knowledge goals mentioned above, and KPs have emerged as a key tool for supporting knowledge work that consists mainly in solving problems and accomplishing goals, gathering, organizing, analyzing, creating, and synthesizing information, knowledge and expertise.

According to [Mack et al. 01] KPs are defined as single-point-access software systems intended to provide easy and timely access to information and knowledge and to support communities of knowledge workers who share common goals and interests. For detailed discussion of KPs functionalities, their classifications and applications we refer the interested reader to the books [Detlor 04] and [Firestone 03] (see also references therein).

While the KM research focuses normally either on the methods, tools and techniques for capturing, analysis and organisation of knowledge and knowledge search, browsing and navigation or on the models that support interaction and collaboration within an organization, KPs can and should offer support for both of the main KM functionalities mentioned above. Even more: the added value of the KPs compared with other KM tools is in integration of the technologies for storage of and access to information and knowledge with the ones for support of the interaction and collaboration activities in a unique entity. The modern KPs as well as the semantic portals [Hartmann and Sure 04] can use the underlying ontologies not just to integrate all knowledge they provide by themselves but to exchange their knowledge recourses or to build a portal network, too. In this role, the KPs can be considered to be a precursor of the emerging *semantic web*.

3 A Description Schema for Mobile Knowledge Portals

In the paper, KPs of special kind, so called mobile KPs (MKPs), are considered. MKPs are defined as KPs that the user can interact with on the multi-access basis, in particular through a web interface or via handheld devices like PDAs, smart or cellular phones. Because MKPs are an aggregation product of mobile technology and KM selected characteristics of both of these major components should be used to describe them thus making the description schema at least two-dimensional.

The description scheme presented in the paper first takes into consideration the grade of the knowledge mobility supported by a MKP. This means, in particular, that it checks if the users can interact with and access the MKPs via handheld devices. This criterion thus assesses the mobility of MKPs from the users' point of view. The second criterion measures the impact of the mobile technology on the structure and functionalities of the MKPs. In particular, it proves what activities out of those from the knowledge work cycle are (or can be) supported by the mobile technology and what types of conversion of knowledge between tacit and explicit forms are (or can be) influenced by it.

3.1 Mobile Knowledge Portals and Mobile Technology

The most interesting (at least from our point of view) class of MKPs are those that not just provide mobile access to the functionalities of the underlying KPs but also use some specific characteristics of mobile technology like permanent connectivity, anytime accessibility or exploit location-related context of the users to provide them with some additional value like delivering location-related information or providing anytime connectivity to domain experts.

Following [Martens and Gronau 03] we identify the following major specific characteristics of mobile technology and its services that distinguish them from the ones of Internet: independence of location and time, anytime accessibility, personalization, context awareness, and permanent connectivity. Each of these characteristics can be used by a MKP to provide its users with additional services or functionalities compared with ones of the KPs.

The first dimension of our description schema for MKPs takes into account the "grade of knowledge mobility" that is supported by a MKP through the specific characteristics of the mobile technology mentioned above. In [Guretzky 02] the following aspects of knowledge mobility are introduced:

- *Mobility of knowledge users* (MKP provides mobile access to its knowledge recourses),
- *Mobility of knowledge carriers or domain experts* (MKP supports access to the experts' knowledge),
- *Personalization and context awareness of knowledge* (MKP delivers location- and context-related knowledge in accordance with users' preferences).

The first degree of knowledge mobility, i.e. support of the users' access to the knowledge recourses of a KP via handheld devices, is contained in fact in the definition of the MKPs and thus has to be provided by all MKPs according to the definition.

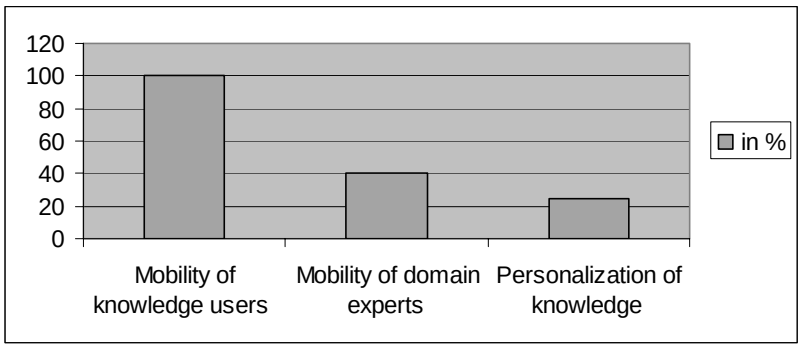

Figure 1: Results of an empirical study concerning MKPs support of the knowledge mobility

Surprisingly, already the requirement to provide a mobile access to the domain experts is a serious hurdle for many MKPs. About 60% of the MKPs we analyzed according to our description schema do not support this functionality. This means that most of the current MKPs restrict themselves to just providing a mobile access to their knowledge recourses. The mobile technology brings no additional value to the portals services; it is just used as an additional access channel.

According to our analysis, only about 25% of the MKPs we evaluated while working on this paper recognized the importance of the personalization and/or context awareness of knowledge and offer the corresponding services in one or another form. In some cases, the technical solution used for implementation of MKPs is based on the middleware that is responsible for mobile access to the functionalities of the underlying KPs like e.g. the SAP Mobile Engine that provides mobile access to the SAP KP that is a part of the SAP NetWeaver platform. In this case, the users can enjoy the advantages of personalization because it is supported by the underlying KPs in the majority of cases. This means that such MKPs are in a position to deliver knowledge in accordance with users' preferences, in some cases even context-related. As to the location-related knowledge delivery in accordance with users' preferences, we could not identify MKPs that offer this functionality.

3.2 Mobile Knowledge Portals and Organizational Knowledge

In the literature, several models of and approaches to KM have been introduced (see e.g. [Probst and Raub 99]). Even if theoretically all of them can be used to characterize functionalities of KPs, the scheme of KM activities introduced in [Detlor 04] especially for the case of KPs is more preferable compared with others because it takes into consideration the organisation of KM within KPs. The idea is to identify the main activities in which KWs are engaged as they interact with the KPs (or MKPs). In the framework of his needs-seeking-use knowledge work cycle [Detlor 04] identifies following phases of knowledge activities that KPs should support: *knowledge needs identification* including capturing, analysis and organisation of knowledge; *knowledge search*, browsing and navigation; and *knowledge usage* including knowledge distribution and collaboration.

To better describe the knowledge work cycle and its support by the mobile technology a very convenient and powerful model of organizational knowledge creation suggested by [Nonaka 91] is employed in this paper. In the model from [Nonaka 91], the notions of tacit and explicit knowledge are used to describe KM processes in an organization in terms of conversion of knowledge within and between tacit and explicit forms. The extent to which MKPs support the transformations within and between tacit and explicit forms of knowledge by employing the mobile technology builds the second dimension of our description schema.

According to [Nonaka 91], tacit knowledge is what a person knows, which is derived from experience and incorporates beliefs and values of the person. Tacit knowledge is very valuable because it is immediately used to manage the everyday working activities of people and forms a basis for generation of the new knowledge. Explicit knowledge is mainly represented by documents or records in different forms that are typically created with the goal to communicate the knowledge to other persons.

In [Nonaka 91] the following processes by which knowledge is transformed within and between its tacit and explicit forms were identified:

- *Socialization* (tacit to tacit)
- *Externalization* (tacit to explicit);
- *Combination* (explicit to explicit);
- *Internalization* (explicit to tacit).

Projected onto the KPs functionalities, *socialization* consists of tools and mechanisms that support communication of tacit knowledge between portal users via both synchronous and asynchronous mechanisms. Within the everyday activities of people in an organisation, knowledge sharing is often done without producing explicit knowledge. The situation is different within the KPs where many of the *socialization* activities can automatically lead to *externalization*, i.e. to conversion of tacit knowledge into explicit knowledge. Indeed, in the majority of cases the communication between the portal users can be recorded, classified and integrated into the ontology-based knowledge repository of KPs.

Mobile technology can essentially contribute to the functionalities of the KPs supporting both the *socialization and externalization* activities by making use of such of its characteristics as independence of location and time, anytime accessibility, and permanent connectivity. These specific characteristics of mobile technology and its services, if used within MKPs, can lead to *permanent socialization and externalization* meaning that the exchange of the tacit knowledge both within portal users and between them and domain experts can take place permanently and independent of location and time. Moreover, the added value that the mobile technology can contribute to the *socialization* functionalities of MKPs is in the possibility to connect a user in the case of problems or questions with an appropriate contact person based on his location, context, or task and his personal preferences.

The next important activity in knowledge creation is *combination*, i.e. sharing of the explicit knowledge and its transformation into new explicit knowledge. *Combination* is closely connected and often goes in parallel with *internalization* that means the process of conversion of the explicit knowledge into the tacit one.

Within the *combination and internalization* activities the mobile technology can be used to essentially improve the services of MKPs and facilitate both the usage of the explicit knowledge and the generation and management of the new knowledge. In the field of knowledge usage the added value of the mobile technology is that MKPs can offer their knowledge recourses anytime and to users at any location. Furthermore, technology already makes possible to deliver the knowledge to the portal users based on their preferences, current location, needs, and situation they are currently in. All the dependences mentioned above are critical in many cases and as a rule cannot be properly managed without using of the mobile technology.

Whereas *socialization and externalization* activities are basically supported by the collaboration tools of the MKPs and cover the communication and collaboration parts of the knowledge work cycle as defined by [Detlor 04], the *combination and internalization* involve a variety of techniques and functionalities that mainly deal with the knowledge repositories of the MKPs. They cover the remaining parts of the knowledge work cycle including knowledge organisation, search, browsing and navigation, and knowledge usage.

The criterion we describe in this section can be used both to classify and forecast the future development trends of the MKPs and to analyse the functionalities of the existing portals. In our empirical study we could identify only few solutions that already employ some of the characteristics of the mobile technology mentioned above to add value to their functionalities that support the knowledge work cycle. One of the best examples of MKPs we could find is the FieldWise MKP described e.g. in [Fagrell et al. 00].

FieldWise employs the mobile technology to support both the main activities from the Detlor knowledge work cycle and all main steps of organizational knowledge creation according to the Nonaka classification. In particular, FieldWise dynamically supports evolving tasks and notifies users of interdependencies between their own tasks and the tasks of other users. Like the most others MKPs, FieldWise offers an overview of knowledge recourses contained in its repository including annotations of documents via handheld devices. Moreover, Fieldwise enables adaptation of content and knowledge delivery and presentation both in accordance with the users' preferences and handheld devices capabilities they use to access the portal. FieldWise filters information before sending it to the user based on his task and long-term interest. The collaboration functionalities are supported by FieldWise e.g. through suggestions concerning domain experts and their current availability in case of problems or questions the portal users face with while being out of their offices.

4 Mobile Knowledge Portals: Development Potentials

The conclusions presented in the previous section shows that the emerging MKPs are still at the very beginning of their way to become useful tools for KWs. In fact, what the most today's MKPs do is just providing of restricted mobile access to some of the functionalities of the underlying KPs. Potentials offered by mobile technology that can lead to additional services like permanent access to domain experts or delivering of location- and context-related knowledge are barely used. On the other hand, as has been demonstrated on the example of FieldWise MKP, these topics are sometimes taken into consideration not only in theory but in implementation of MKPs, too.

The main point of criticism while considering implementations like FieldWise is that they try to develop their own solutions that take advantages from employing some special characteristics of the mobile technology (that is a good idea if considered separately) and mostly ignore the current state of the art in research and implementation of KPs, like using RDF for knowledge description and taxonomies or ontologies for knowledge representation.

On the other hand, in many cases (see e.g. the SAP implementation with SAP Mobile Engine and NetWeaver platform) an opposite approach is taken: a MKP appears just as a result of providing mobile access to some of the functionalities of an underlying KP that can exhibit all characteristics of the modern KM. This approach cannot lead to a perfect solution too, because the mobile technology plays a secondary role in this approach and does not provide any added value.

These are the reasons for another, combined approach to design and implementation of MKPs that seems to be interesting for the future: the potentials of mobile technology can be used with added value only if they will be taken into

consideration on the early stages of the KP conception and design while thinking about knowledge description, knowledge representation and its structural elements.

Another topic that will likely play an essential role in further development of MKPs is personalization issues including e.g. the opportunity to change access devices and protocols on-the-fly, depending on users' current location and environment. MKPs should provide advanced tools for device and session management to guarantee seamless and device-independent interaction with KWs. This means in particular, that an interaction session that a KW started with the MKP in his office via a web-interface can be continued without any loss of information and value when the KW decides to move to another location. In this case, it should be possible for him to continue the session via his handheld device. Ideally, the mobile technology will even add value to the functionalities of the KP the KW interacted with before, in his office, by providing him with the location- and context-related knowledge both through the push- and pull-based mechanisms.

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