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Flexible Workplaces Fostering Knowledge Workers Informal Learning: The Flexible Office Case

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***Abstract*—**Organizations face challenges supporting knowledge workers due to their particular requirements for an environment supportive of their self-guided learning activities which are important to increase their productivity and to develop creative solutions to non-routine problems. Face-to-face knowledge sharing remains crucial in spite of a large number of knowledge management instruments that aim at supporting a more impersonal transfer of knowledge. This paper first describes the main criteria for a conceptual and technical solution targeted at flexible management of office space that aims at assigning those knowledge workers to the same room that are most likely to thrive when being brought together thus enhancing their knowledge work productivity. The paper reflects on lessons learned from the implementation and operation of such a solution in a project-focused organization and derives several implications for future extensions that target to foster problem solving, informal learning and personal development.

***Keywords*—**informal learning, knowledge work, office management.

I. Introduction

GUIDANCE of personnel development generally can be supported by a number of instruments, e.g., by formal training, coaching, mentoring or agreements in appraisal interviews [1]. However, many activities of employees' professional development happen within informal situations and most knowledge is acquired informally [2]. As opposed to formal learning which is governed by rules not in the responsibility of the employee, informal learning is unplanned, highly social, contextualized to a certain situation and self-guided by the employee [2]. In professional settings, these informal learning activities happen at the workplace (learning from colleagues) and are not completely understood by management [3]. Nevertheless, management should provide instruments to foster informal learning at workplaces.

The concept of knowledge work(er) has been around for more than 50 years [4-6]. In recent years, the share of work that can be characterized as knowledge work has risen continuously [7] comprising key characteristics of a wide array of activities concerned with creating, translating or applying new knowledge [4-5, 8]. Knowledge work has strong communication, coordination and cooperation needs, is highly mobile, flexible, distributed and requires a strong yet flexible, personalized and adaptable support by information and communication technologies (ICT) [9]. Informal learning is particularly crucial for employees performing a high share of this type of work, also called knowledge workers (KW) [4], whose skills arguably need constant improvement. Knowledge work focuses mainly on ill-structured problems and applies, translates and creates new knowledge. A substantial part of KWs' knowledge is highly specialized and can only be effectively reconstructed in concrete work situations [10]. Consequently, this knowledge can hardly be transferred by formal trainings, but rather needs to be passed on from knowledge worker to knowledge worker by informal learning activities.

In addition to organizational solutions, e.g., application of knowledge management instruments [11], definition of specific roles, such as subject matter expert [12] or community moderator [13], and specific knowledge processes, e.g., concerning the acquisition of external knowledge or submissions to IT solutions, such as knowledge management systems [10, 14], the management of space has long been recognized as important for effective knowledge transfer [15], also in a metaphorical sense such as in Nonaka et al.'s concept of 'Ba' [16]. Informal communication in hallways or the cafeteria is stressed as important for effective knowledge sharing which assumedly is influenced by arrangement of office space, such as size, positioning and design of offices, width and length of hallways and arrangement of meeting space and space for undisturbed work in case of offices holding multiple people. Recently, mobile devices and virtualization of IT have provided new opportunities for increasing flexibility of workspaces catering better to the changed requirements as KWs demand work environments as complete as possible wherever they are [17]. While IT can create virtual spaces, the importance of face-to-face encounters remains crucial in many trust-related issues as good social relationships often are positively correlated with personal encounters. This paper proposes to enrich management of physical office space from the perspective of knowledge management particularly targeting personnel's competence development.

Goal of this paper is to explore how these data stores can be effectively used to flexibly assign knowledge workers to office space in order to improve work-related knowledge

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handling and informal learning. In order to achieve this, section 2 investigates the concept of informal learning at workplaces and thus lays out the theoretical foundation for the Flexible Office concept which is described in section 3 and was co-developed by the authors, implemented as a software solution and deployed in a concrete organizational setting. Section 4 summarizes main findings from practical application of the solution. Section 5 presents future improvements of the Flexible office concept and an innovative office space management solution. Section 6 closes the paper with a summary and an outlook on future developments.

II. Informal learning at workplaces Review Stage

Knowledge work is prevalent in high-tech industries and expert-driven organizations such as in professional services, engineering, IT and telecommunication, chemical or pharmaceutical sectors which not surprisingly were among the first to embrace knowledge management [18-19]. However, we argue that knowledge work can be found in all occupations and all industries with a level of similarity that is sufficient to allow designing instruments to foster knowledge work independent of occupations or industries. This requires information on current business needs concerning knowledge work in real-world organizations. In clear opposition to the abundance of concepts, models, methods, tools and systems suggested for knowledge management [11], many of which have failed to achieve their goals [20], possibly because tacit knowledge [21], socialization and informal processes of knowledge handling [22] have not been sufficiently taken into account.

Learning mostly takes place outside formal trainings, is performed during daily work and is called workplace learning [3]. Due to the intrinsic, pragmatic nature of this kind of learning it is also called self-directed learning [23], problem-based learning [24] or informal learning [2]. Informal learning in workplace situations is embedded in everyday problem solving situations and people learn through mistakes and in interactive negotiations with colleagues [25]. Workplace learning activities are mostly uncoordinated and only few people have reflected about guidance of this process [26].

Flexible support of individuals and facilitating less-restrictive opportunities to collaborate and learn with colleagues seem to be a promising solution. The underlying assumption is that an external impulse can act as a trigger which facilitates informal learning. Thereby, the focus is on work processes with learning as a by-product, e.g. participation in group processes or working alongside others or on learning activities located within work processes, e.g., asking questions or listening and observing [27]. Intensive contact with employees outside their work group and thus learning opportunities are scarce in traditional office situations, although it is exactly those weak ties that seem most important for stimulating knowledge creation and innovation [28]. Furthermore, lack of transparency about other KWs' knowledge and topics they are currently engaged in can be observed. Next to fostering informal learning, another aim is to increase awareness and thus overcome these barriers to effective knowledge sharing. Opportunities for collaborating and learning from each other should be provided. In order to keep the informal style, these opportunities should be initiated by employees themselves and cannot be arranged in formal meetings. The idea is to flexibly bring those employees together in an office for a certain period of time that potentially might benefit most from each other in their concrete working and learning situation by effective triggers for informal learning.

III. The Flexible Office Concept

The procedure taken in order to develop the Flexible Office concept can best be described as a case study [29] employing strong interactions between researchers and practitioners in multiple rounds of close collaboration typical for action research-oriented approaches [30] for co-designing and co-developing conceptual and technical artifacts use [31], i.e. the Flexible Office concept, optimization model and software system. During each round of requirements and context elicitation and concept design, we employed a combination of document analysis, e.g., floor plans, organizational charts or conceptual models of HR data stores, questionnaires and self-reporting, e.g., about times spent in various locations within and outside the company building, interviews, e.g., about the specific perspectives of project managers and team leaders, and workshops, in which we presented our results, discussed them with key representatives of all stakeholder groups affected by the Flexible Office solution and agreed on next steps to be performed. The authors benefited from previous projects that had been successfully co-performed together with the organization and had resulted in a trusted relationship between researchers and several practitioners in the organization even before this project had started.

Flexible Office is a solution for optimal assignment of KWs to office space. "Optimal" refers here to a utility function that uses knowledge management criteria together with criteria describing membership in projects and work groups. This solution was co-developed with and field-tested in a company, an IT service provider, and has now been successfully operational for more than a year. It consultants working in a highly volatile knowledge domain and frequently employed at the client side are the knowledge workers which are the test group of the roll-out project.

The Flexible Office solution consists of a technical and an organizational component. Organizational issues concern selecting employees, designing office space, analyzing requirements with respect to equipment, defining rules as well as assigning roles. Moreover, organizational rules were defined that specify for example the timeframe and deadline in which rooms or single work places can be booked, mechanisms for escalation of urgent bookings or conflicts between projects, requirements concerning distribution of mail and organization of central project repositories.

Additionally, a clean desk policy was established demanding that no personal items are left on workplaces. In order to ensure compliance to the rules, a separate role "Flexible Office manager" was introduced to resolve minor questions and problems, forward problems and escalate conflicts and claims of participating KWs.

The technical component is an Office Space Management Software based on Web Services. Differentials to standard Office Space Management software are that assignments of workplaces consider knowledge management-oriented criteria specifically aiming at facilitating informal learning such as project and theme overlappings between KWs as well as their preferences and reservations by project managers.

The Office Space Management solution was integrated into the B2E (Business to Employee) information infrastructure in the form of an employee self service portal. The software solution consists of (a) user interface for project managers to reserve office space for their projects, (b) user interface for KWs to submit their preferences, to register home office days and for those workspaces that have not been assigned automatically, (c) core optimization component for assigning rooms as well as (d) output components for visualizing the assignment of KWs to offices in the B2E portal and for notifying KWs per email about booked rooms.

The core component of the Flexible Office Concept is an optimization model calculating the optimal room allocation. Criteria in this model are defined by the project or team managers, employees or by the organization as predefined values. The core structure of the Flexible Office model of optimization and the used criteria are depicted in Figure 1. Criteria from project managers, employees, data from other systems and predefined values are used to allocate KWs to rooms. In the following, the optimization criteria are described in some detail.

project preference: Employees can define on which project they intend to work next week or with which project team they would like to work. Goal is to assign those KWs to the same room as often as possible that are not only members of the same projects, but also work on these projects in the considered time frame.

room preference: Room types offer differing sizes and equipment in the company in which the solution was deployed. Room preference supports different phases of project work, e.g., communicative phases in larger rooms and contemplative phases in single rooms, and different requirements for equipment.

team preference: KWs can submit a preference for a certain team (organizational unit) meaning they wish to work with members of this work group. Main goal of this factor is to improve collaboration and informal learning in work groups.

topic preference: Similar to project preference, employees can define their preference for a certain (predefined) topic. In case of no preference given, an overlapping score considering relationships between two KWs according to topics they intend to work on are used instead. The assumption behind this is that KWs working on similar topics that also have a similar level of skills concerning these themes should be assigned to the same room in order to improve knowledge sharing.

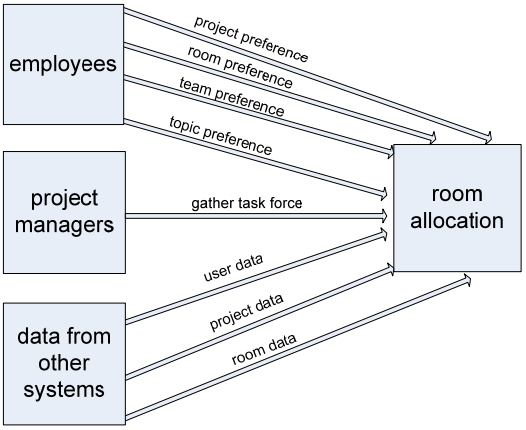

Fig. 1 Optimization criteria considered in the Flexible Office optimization model

gather task force: Project managers can register office space for one or more KWs of a project in order to pull together members of a project for a certain period of time in which this project needs heightened attention. In case there are more reservations than rooms, projects with higher priority will be first served with a room. Due to hierarchical legitimation, reservations by project managers are treated separately as a kind of "K.O."-criterion.

user data: Assigning absent people to rooms does not make sense and would falsify the results. Thus, data from the employee calendar on the MS exchange system are used in order to extract KWs' attendances. These data are part of user data which comprise basic personal data, a skill profile and KWs' working hours. User data are synchronized from the company's LDAP directory containing unified account and contact information which is used in several systems. Skill data were initially imported from pre-existing MS Excel sheets, but are now maintained via the Flexible Office Software.

project data: Projects were rated in order to serve requests from important projects first. A project score consists of a project category reflecting the importance of the project and its customer as well as a time-variant score dependent on the state of activity in the project. These data are imported from the company's project management software.

room data: Attractiveness of rooms was rated because available rooms significantly differ in their attractiveness for employees. Firstly, team leaders rated all rooms, but the rating had to be revised in order to find greater consensus by all stakeholders of the Flexible Office solution. Room attractiveness is part of the data set describing characteristics of rooms. General master data on rooms is synchronized from the company's LDAP data base which contains information about the company's office rooms integrated into the user

data.

Furthermore, KWs have strong preferences for stability if changes are not too significant and they have no room preference. This is why fictive moving costs have been introduced, so that small differences between criteria do not result in a large number of moves between offices without much effect on the utility function.

IV. Flexible Office Realization

Due to the organizational and technical complexity, the described approach has been introduced in several stages. The pilot phase began with four projects and 32 employees testing the approach with regard to its concept. Every participant had a traditional office space as a kind of fall-back solution. Evaluation of the three months pre-test with the help of a questionnaire sent to all participating employees and semi-structured interviews with selected representatives led to the conclusion that Flexible Office was perceived to improve collaboration in project work and promote knowledge sharing. Thus, the project was continued and software was developed professionally based on experiences with the first prototype.

The rollout phase involved three organizational units comprising 15 KWs who used fully flexible office spaces. These KWs used Flexible Office spaces without being able to fall back to the former additional personal office spaces. This phase aimed at testing managerial issues involved in relying solely on flexible office spaces, further adjusting the assignment algorithm and testing functional additions made for this phase. An additional factor was integrated so that bookings of KWs without personal office spaces were rated higher than KWs with a traditional fixed office space. This was necessary to ensure that in case of too few office spaces KWs without fixed office space were served first. Another change was the definition of rooms being assigned to specific organizational units. This was necessary due to the fact that each organizational unit had its own books, product documentations, paper-based mail and administrative documents which had to be stored somewhere accessible for everyday use. Therefore, small rooms with one or two desks and the possibility to store documents were assigned to each unit. The office spaces of these rooms were made bookable via the software. To foster assignments of team members to a defined team room, an additional factor was introduced, boosting the score if such an assignment was made.

In addition, in several rooms occupied continuously by the department of application management, one office space was designated for Flexible Office use. Up to this point, the Flexible Office project had focused on work in projects. These seats should foster sharing of knowledge between colleagues in consulting and application management, especially in the phase were projects' results would transform into working applications. However, this possibility was used quite rarely. One reason was that integration of KWs in the application management department was looser and they disagreed with having software decide on the use of office space in their room instead of being asked in person. When these rooms where needed full-time by the department of application management due to the company's growth, this type of office spaces was abandoned.

Also, KWs participating in this phase regarded the decision that calculated assignments became available during Friday inconvenient. Therefore, KWs which were away on business or KWs already gone home when room assignments were communicated did not know where to work on Monday morning. When having a permanent working space, it was rather effortless to look up the room assignment on one's regular working space. By not having such a fallback, it was rather inconvenient for KWs to get the information regarding their assigned room. This obstacle was overcome by providing Blackberrys to all KWs participating in the Flexible Office project. Now, it was possible to conveniently read the e-mails containing room assignments, e.g., on the way to work.

An attitude we noticed in the starting phase was that KWs tended to regard a room as "theirs" if they spent continuous time in it. But after working in the Flexible Office environment for several months, KWs got used to the public nature of the rooms, most of them realized the benefits and changed or shared rooms more willingly.

Due to the continuous additions done on the Flexible Office Software, weights on individual criteria had to be adjusted regularly. This led to several occasions where assignments came too late for being used in the respective week. We noticed that if there was no new room assignment, most KWs stayed at "their" working places assigned to them in the previous week.

Questionnaires and interviews revealed that, these criteria led to improved communication and coordination in projects, decreased search time, improved knowledge transfer, improved work place learning and improved handover of projects between project teams and organizational units responsible for operation and maintenance of resulting application systems. These, questionnaires send out weekly during the roll-out phase are used to evaluate the employees´ satisfaction with the model on the one hand and to calibrate the optimization model according to different managerial aspects (informal learning vs. project management) on the other hand.

After eight months of incorporating the Flexible Office solution into daily work practice, the next expansion towards additional units was planned. This phase aimed at integrating three more organizational units of the company's consulting department and fulfilling more requirements. Especially KWs without a fixed working space, regarded booking rooms as administrative work, when not working in a specific project. Therefore, "automated" bookings were introduced. KWs could store their preferred criteria equivalent to personal bookings. When calculating the room assignment, the system automatically created bookings for KWs according to their stored preferences if the following criteria were met: they are marked as having no fixed working space, do not have another booking for the relevant day and are not marked as absent.

An additional requirement concerning equipment needed for work emerged due to including more organizational units. Especially KWs involved in programming needed special printers or special computers in their working space which they needed to test their work. This issue was solved by incorporating this equipment into room preferences. Due to the importance of the equipment for the daily work these aspects are considered as constraints in the optimization model.

In addition, the user interface aimed at the Flexible Office Manager was improved considerably. With growing usage, the graphical representation was improved and assignments could be edited via Drag&Drop. Finally, the Flexible Office Solution was extended to include the whole department of consulting.

V. Discussion and Future Improvements

The Flexible Office solution was successfully rolled out in the company and according to the following example statements taken from a survey and results from the evaluation, the participating KWs have been satisfied with the solution. KWs said that "it is much easier to collaborate in projects together and to learn from each other" and that they "broaden their horizon". The Flexible Office manager said "Flexible office is more than a tool, it is a style which is lived by the employees". Especially, informal learning activities are stimulated as employees "selectively sit together in order to learn from each other". Employees use this possibility to follow their interests and curiosity without liabilities. Thus, intra-organizational knowledge transfer is stimulated and as some employees point out "the effectiveness in teams with members from different work groups clearly improved".

One project manager highlighted that "Flexible Office enriches the project culture". Due to the fact that members of short-term projects can easily work together in a room, communication, knowledge exchange, coordination and collaboration within these temporary teams have increased. Furthermore, due to collaboration with employees who are involved in customer projects, project culture and knowledge about clients increased and employees could instantly contribute to creative ideas, concepts and design artifacts put forward by their peers. One KW highlighted that the collaboration and especially the development of new concepts with external staff, i.e. customers and external consultants are much easier and more fruitful.

However, after half a year of pilot phase and more than one year of productive use, several additions and refinements were made to the original concept. Despite constant development to this point, there are still a number of further improvements have been identified which are briefly sketched in the following.

One idea to improve the Flexible Office concept is to introduce "virtual" projects. A virtual project would consist of several projects which could be specified for bookings. Project leaders have the possibility to set an exclusive flag for their bookings. Exclusive means, only people from the project are assigned to one room even if the room's capacity is not fully used. Especially for projects dealing with sensible data, e.g., human resource management projects, this criterion is important. During rollout for the company's consulting department, the requirement emerged that a softer exclusivity-criterion was needed. Although, some project leaders stated that the exclusivity criterion is needed for projects handling human resource data, these projects would allow for sharing their room with other colleagues handling human resource data as well. To accommodate this requirement in a general way, "virtual projects" are to be utilized.

After all additions done in the course of development, the optimization model has grown rather complex. Thus, the tuning process for adjusting weights required comprehensive knowledge of all interdependencies in the optimization model. In order to ease system configuration for the Flexible Office Manager, a more light-weight approach is necessary. Therefore, it is planned to simplify the formula by merging variables or shifting variables into the application logic responsible for the initial setting of the optimization model. For example, instead of factoring the degree of a booking's fulfillment into the room score, a room-project-combination only achieves a full score if all requirements are met or receives a zero score if not all requirements are met.

Another planned improvement is the integration with the company's time record and key card system. Currently, Flexible Office rooms have traditional lockers and employees have to pick up keys from the Flexible Office manager. This inflexible approach requires a lot of administrative effort and coordination among KWs sharing one office room. In an extension, room assignments calculated by the Flexible Office System will be transferred to the card system which uses the information to update users' keycards. Therefore, users have to activate keycards via time recording terminal when a new room assignment was calculated, e.g., first day of the week. Subsequently, the KW can use the keycard to unlock the assigned room.

As appointments usually are managed using the company's collaboration system (MS Exchange/MS Outlook) and office spaces are assigned via the described solution, a certain degree of redundancy has been created when dealing with appointments involving project work like status meetings or meetings in which customers participate. A suggestion for improvement is to enable KWs, e.g., a project manager, to create a meeting in the collaboration solution and mark the meeting place as 'Flexible Office'. The software creates an according booking and, after completing the assignment, updates the meeting place with the specific Flexible Office room.

Up to now, users can only select specific days for their booking or provide a range of dates. But due to the fact that the company's employees are usually members of several projects, it has become common practice to designate weekdays for specific projects. In order to accommodate this practice, the possibility to create series of bookings is needed.

Another improvement would depend on the use of an advanced Skill Management System, e.g. [32].

Due to the basic principle that more important projects gets rooms first, there are calculated room assignments possible where not all employees will have a working space in favor for a higher benefit score fulfilling the exclusiveness criterion in the optimization formula. Therefore, the software could use an alternative utility function and thus calculate an alternative solution with reduced influence of factors resulting in unused office spaces. The Flexible Office Manager would have to decide whether the alternative solution is appropriate or the regular result is to be used.

Analysis of Flexible Office´s usage data has been disregarded up to know. One reason could be a missing reporting component which is planned to be added in the next release. Company's executives think about allocating costs for office space by actual usage instead of using a factor decided by the size of an organizational unit. Thus, interface and data export to the company's controlling department are intended.

VI. Conclusion and Outlook

In this paper, we explained the criteria used for a software-based solution that targets assigning KWs to office space with the explicit goals of fostering informal learning. In a project-driven organization like the one in which this solution was installed, the most important learning activities take place on the job, i.e. in the projects. The fact that KWs typically are engaged in four projects on average at the same time called for a more flexible solution as merely drawing project teams together. Thus, the benefit of a solution was high which brings those people together on the workplace that intend to work on the same project, informally learn from each other or collaboratively create knowledge concerning a topic of interest. The paper presented a number of lessons learned from roll-out and operation of the software which are intended to support similar initiatives in other organizations. One of the most important conclusions is that the sincere and on-going involvement of users has led not only to high acceptance rates, but also has sparked a number of fruitful debates on the weights given to criteria which were fully taken on board in the solution.

The Flexible Office solution extends office space management software by a component that should attract interest of HR managers, particularly of those strongly involved in personnel development. With an average time on a single job of around three years in many large organizations, the need to reduce time-to-proficiency [33] is not only important for newly recruited, but also for the large numbers of employees who take on a new role during their career. While formal training, coaching and other measures will continue to play their role, flexible assignment of office space might be worth to look at when designing an environment supportive of workplace learning. Flexible Office uses the potential of available HR data for fostering personal encounters between those employees who benefit most from each other concerning problem solving, informal learning and personal development.

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