Facilitating of knowledge transfer in a software development company

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Abstract. In an organization, knowledge transfer between its members is vital. Most studies conducted up to this date have focused on knowledge transfer in the field of industrial production. If in this branch of knowledge, where operations and processes have a certain degree of standardization and repeatability, this is done through initial and possibly periodic training, in the matter of software development things are more complicated. Tasks do not resemble with each other, most are unique and often require documentation before being resolved. Obtaining documentation from external environments often involves work on adapting to the organization’s requirements and to the project’s requirements also. In an organization without a constant direct interaction between the members, the transfer of knowledge requires much labor. In this paper, we propose the design and implementation of a software solution that will facilitate the transfer of knowledge between the developers of a software development company. This internal database will include the solutions identified, adapted, and used by programmers to solve non-familiar tasks. Also, a collection will be created with the errors encountered throughout the development and implementation process and their resolution, useful for all members of the organization. Every time a team will meet an unfamiliar functionality in an assigned task, it will consult the internal database. In this way, the solution will be easier reached and adapted from the source. External sources of documentation and research will only be used if the internal search has not returned a solution to the problem. In this case, following the solving steps, the familiar solution will be added to the internal database for future use. Finally, we will measure the benefits of the proposed and implemented solution. Ultimately, the rate of use of a solution stored in the database over a period of time will be measured, along with the average time of solving a task in the development process, when making use of the internal knowledge and solutions base.

1. Introduction
Nowadays, in the conditions of high competitiveness in most domains of activity, the difference between companies is most often made by the human factor. It is understandable why every company emphasizes the highest level of human resource training. There are two types of training that can be distinguished. Initial training, the initiation process represents the first period of the activity of an employee within a company. Depending on the domain of activity and the complexity of the job, the initiation process can take from a few days to a few months. Also, there is not a fixed moment in time when it ends. Another type of training is continuous professional training, carried out through courses, training stages, and other types of learning activities.

Knowledge is a crucial source for ensuring the competitive advantage in today’s organizations. It is estimated that in the future the society will be more and more the knowledge society. Knowledge will be
its main source, and knowledge providers will be the dominant group in their workforce. Knowledge management is the key to success and survival of an organization in an ever-changing economic, technological, political and social environment. However, managing knowledge can be challenging to define. First, the word knowledge means different things to different people. Secondly, some researchers focus on managing individual knowledge, while others are interested in managing knowledge at the community or corporate level. The difficulty in defining knowledge management is due to the nature of knowledge that is both complex and intangible. In the last decade’s many definitions of knowledge management have been proposed, sometimes one in contradiction with another. Despite their differences, these definitions have many similarities. On the one hand, the proposed definitions consider knowledge management to be the vehicle of organizational performance. On the other hand, it focuses on knowledge and information, which are often considered synonymous. Although defined in several different ways, knowledge management generally refers to the way organizations create, maintain, and share knowledge. The authors point out that the purpose of knowledge management is to define how quickly the organizations of survival conditions adapt, and these are constantly changing. In the same way that animal and plant species change over time to adapt to changing conditions, natural selection makes poorly managed firms die or to be swallowed by more successful competitors.

Knowledge is a valuable asset that can be leveraged when it is managed and shared within organizations. Knowledge management allows members of the organization to learn essential lessons from experiences. In particular, learning from experiences, through knowledge transfer (figure 1), helps organizations save money and time by avoiding the occurrence of the same mistakes over and over and recurrence of successes.

For example, knowledge management is defined as the process of applying a systematic approach to acquiring, structuring, managing, and transferring knowledge across the organization to work faster, reuse best practices, and reduce costly rework from one project to another. Knowledge management is defined as the way of transforming the intellectual property of an organization into a business value.

Knowledge management tools improve the decision-making process by promoting and activating the knowledge process. Technology supports the knowledge management objectives, and the main objective of knowledge management tools is not knowledge management itself, but facilitating the implementation of the knowledge process by supporting the generation, structuring, and dissemination of knowledge. Even though knowledge management tools can sometimes be used to automate certain types of knowledge work, their primary role is to enable the knowledge process and to ease the burden of people to conduct knowledge activities.

Software tools used to support knowledge management allow for the capture of knowledge, the storage of knowledge in warehouses, the distribution of knowledge through reliable and secure access from various locations, the search for knowledge, and the retrieval of knowledge through collaborations between people, regardless of their geographical position.[1]

![Figure 1. Knowledge transfer.](image)
Knowledge management represents the relationship between person and organization and defines how the transfer of knowledge is pursued and sustained, exchanged, and created. Information technology can help change the priority from introductory information to the process of disseminating knowledge between a company and a person. The result is a conceptualization of the roles and interactions of an initiation process, through which the discovery of knowledge is supported as knowledge appears in practice.

The result of knowledge management can be measurable in organizational functioning, such as profit, improved efficiency, product innovations, human capital, and product or process-oriented outcomes.[2] Where investing in knowledge is chosen, value is created during software development, especially in the context of human capital. [3]

Social capital and communications networks are essential for beginner and mature teams when dealing with complex, unknown or interdependent tasks.[4]

In order to respond to the rapidly changing business environment, businesses need to integrate business functions into a single system, so-called enterprise resource management (ERP) systems that efficiently use information technology and enable internal information distribution, as well as communication with suppliers and customers.

Knowledge management covers the spectrum of management concerns, from knowledge creation or capturing to knowledge transfer and usage.

Over time, several models of knowledge management have been implemented. If these models are studied from several perspectives, it can be observed that each model is based on one or two aspects of knowledge management. Some of them take only two criteria, such as technology use and knowledge generation, while others focus on other criteria, including knowledge processes, knowledge culture, and leadership. [5]

According to [6], 42% of the knowledge in an organization is stored in the human mind, 26% is found in paper documents, 20% in electronic documents, and 12% in knowledge databases. Knowledge in the human mind is called tacit knowledge, which is the most essential aspect to be understood and achieved by the company. Tacit knowledge (knowledge resulting from experience and practice) was defined as two dimensions, the technical and the cognitive. The technical dimension can be regarded as "handy" expertise and includes information and expertise on "know-how." The cognitive dimension is made up of mental models, beliefs, and values and reflects the image of reality and the vision of the future. However, tacit knowledge is very difficult to transfer compared to explicit knowledge. On the other hand, implicit knowledge can contribute to the success of a company if it has the right approach to transfer knowledge to others in the company.[6]

In order to ensure the successful implementation of a knowledge management system within an organization, it is essential to understand which are the relevant information and which are the objectives pursued. In particular, the rapid integration of employees, the use of existing knowledge, and consistent documentation throughout the product life cycle is a challenge for small and medium-sized enterprises. Another success factor of the companies is the ability of the employees to have access to the existing knowledge.[7]

2. Industrial production vs. software development

In the production activity, the knowledge that an employee must acquire is somewhat limited. In the LEAN philosophy, the parts of a process are divided into simple activities to reduce the causes of defects. Thus employees have to learn and execute simple operations and tasks, which, once learned and practiced, no longer require the accumulation of other knowledge. The need for new knowledge occurs when the employee is moved to another area of production, receives another task for which he must be trained in advance. These rotations are even indicated and beneficial in the LEAN processes because they prevent the professional ceiling and routine.

In contrast to those described above, in the industry of software development, the degree of diversity of processes and activities is infinitely higher. In this case, the initiation process has the role of familiarizing the new employee with the work environment, but it cannot fully prepare him for all
the potential tasks that he will have to solve in the future. Companies can provide training courses, but only principles can be acquired within them.

In this domain, the degree of innovation and change is also very high, the technologies are evolving rapidly, and the employees have to keep up with this evolution. As a result, the company must ensure a working environment orientated to innovation and development. Most of the time, the source of information in the activity of a programmer is the Internet. Of course, there can be training courses, the transfer of knowledge can be carried out possibly through regular meetings between the members of the development teams in which they share their own experience. But most of the time, that answer you're looking for, that piece of code that solves the problem is just on the web.

3. Developed solution – practice

We used as a case study a software company where developers are physically located in several locations. Work from home is also practiced, so the interaction between members of different development teams; working on different projects is limited. In this case, the transfer of knowledge, of the experience from one to another is difficult and requires time.

The main product of the target company is an ERP (Enterprise Resource Planning) software application, structured on several modules in direct connection and organized around the main accounting module. The application is developed in Java and uses Mysql or SQL Server databases. It is a client-server application and uses a number of open-source libraries for various functionalities.

As in many other areas, the clients of the company are pretentious, and they want high-quality products, made as quickly as possible. Given that most of the time, the client is not limited to what the standard application offers, but they want customized applications, the need for adding new features to the application often appears. From the discussions with the application developers, it was found that the blockages appear when it is necessary to implement new functionality, by using one or more external libraries. In this case, it is often the case that the first solution found is not always optimal or compatible with the rest of the components used.

The problem is that most often, the respective functionality exists in another application or another module, implemented by another member, or development team, who may not be at the same location as the one who needs it. Due to the lack of communication and the mechanisms of knowledge transfer and information, the members of the company do not know all the functionalities newly implemented in applications, to use them when the opportunity arises.

To solve this shortcoming was proposed to create a database to which each member of the team contributes and which he can use and interrogate as needed. A small application has been developed internally, through which to insert and extract information from this database.

When a programmer has the task of implementing new functionality, the first step will be to check in the internal database, whether that functionality has been used by a colleague before. If the information is not found in the internal database, they will look for other sources of inspiration, in principle, in the online environment. In this second case, after solving the assigned task, the programmer will introduce the knowledge acquired in the internal database, in order to be used by other colleagues in the future. In the application will be introduced some keywords that best describe the functionality in the case, application/module/class in which it was implemented, a few words to describe how to implement, and also external files can be attached (libraries) (figure 2).

In practice, we have taken as an example the addition of new functionality within the developed applications: reading and writing of files from an FTP (File Transfer Protocol). In the first phase, several programmers received the task of implementing this new functionality using each of their own knowledge and experiences and the documentation found on the web. It should be noted that the sample was chosen consists of both programmers with several months’ experience, as well as senior programmers, with years of experience. In the next step, a project manager verified the results obtained by the programmers. It was found that even for the most experienced programmers, the task was completed in about 2 hours. For the less experienced programmers, the task was solved more than double the time. When asked about the difficulties they encountered, most of them claimed that more
tests were needed until the solution found on the web worked in the application developed by the company and was compatible with the rest of the components used. The test was repeated on another sample of programmers, this time, having available the internal database in which they could find an example of almost similar implementation. In this case, almost everyone managed to solve the task in half an hour. In conclusion, the solving time has decreased not only for beginner programmers, but also for senior programmers, and the bottlenecks in the development process have been eliminated.

In software development, no one can say that it has the solution for any situation in the real world that requires transposition into a software application. So it is very important and useful to know what to look for and especially where to look when it is needed. This database and internal application have become a collection of data to which each member of the team contributes and in which they most often find the solution.

![Figure 2. Screenshot developed application.](image)

After about 6 months of use, it was found that in a proportion of 68%, the solution for implementing a new functionality was found in this collection of knowledge accumulated over time. About 8% of the database accesses returned solutions that were only partially used, but still useful (figure 3).

![Figure 3. Chart success rate.](image)

4. Conclusions
The benefits of implementing and using the knowledge base can be translated in time saved, because the solution is quickly identified and in the absence of errors because the solution has already been adapted to the requirements of the application, becoming compatible with the rest of the components.
of the developed application. It remains to study and estimate what is precisely the time gained, but until this moment, a decrease of the closed tasks with delay was observed.

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