KNOWLEDGE IN HEALTHCARE

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Abstract

Authors of the article are dealing with the issue of the use of industrial engineering elements in the sphere of healthcare delivery and the issue of sharing knowledge alone. Both of these areas are highly popular subjects of today, and the effort of individual scientists is to merge them together. Article offers insight into global trends in this area and their evaluation. It also describes various benefits associated with these two spheres and the opportunities they offer. The final part consists of solutions that have been implemented in this field and visions for further direction in this area in our department.

Keywords: healthcare; knowledge; knowledge sharing; simulation; industrial engineering

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1. Principles of knowledge systems and the specifics of health care delivery

Knowledge-based systems use elements of artificial intelligence and expert systems technology, with the aim, to support human decision-making processes, behaviour and learning. Databases of expert knowledge, continuity and linkages that are seeking answers to specific questions, should help to fulfil this objective. Depending on these resources, knowledge systems are varied and classified according to different conclusions, which they are able to form[3].

Knowledge management system utilizes information technology (IT) to manage the creation, storing, sharing and using (and reusing) knowledge. Usage of knowledge in healthcare means particularly special challenges, which include, for example, the complexity of the system, the impact of medical errors, a significant increase in knowledge in the field of health care, as well as increased healthcare costs [24].

Health care system is one of the most complex systems in our society [16]. Within the health care system, there are several participants working in different fields. These include healthcare professionals (doctors, nurses, midwives, laboratory technicians, radiology technicians, medical assistants, psychologists, sanitary), but also called "Third parties", for example, administrators and managers of health facilities, Ministry of Health, pharmaceutical companies, health insurance companies, activist groups, organizations for education and research[14]. These participants should cooperate with each other to provide high quality healthcare to the patient. It is clear that all stakeholders in the health care system produce a lot of knowledge. No matter where knowledge arises, it is important, in order to achieve high-quality health care, which is an essential object for all participants in the healthcare system. The use of knowledge management and techniques for recording, communication and dissemination of knowledge in the healthcare field, is therefore critical and necessary [1].

Additional effort in the area of health care is cost reduction. By now, many IT projects in the health sector led to a reduction of health care costs just by using modern information technologies (such as electronic health records - EHR, electronic home care, telemedicine, tele-radiology, tele-dermatology). But it has not been yet developed a common effort for storing and communicating knowledge that are generated by all these different projects in e-Health in order to use it in strategies for reducing costs (e.g. More efficient and effective management of chronic diseases)[4].

2. The critical view at each of the selected areas

The key question is a "will" to create and to record knowledge, because this path is a concept of several time-consuming steps. The real problems are high and exaggerated expectations of the system itself and also the fact that the concept in this area is still being formed, so it is difficult to define whether the offered system is a knowledge system. Just because someone claims that their information system includes document management features, artificial intelligence and knowledge management does not mean that it is really doing so[15].

A substantial part of the chaos stems mainly from an undefined terms, that means the creation of a universal set of concepts, vocabulary standards and norms in the community, which is engaged in a given area. Currently, it is a high trend issue and many providers in this area "jump into a moving train" without any accurate staging of the methodology and technologies of knowledge management. However if, these methods will not be developed to such an extent as to be successfully applied, we can still talk about failure of understanding problematic areas[17].

Even so, if the recognition of knowledge and understanding of their main holders (employees) in the company will not change, but still will dictate the general fact that the market is the only one that decides, nothing will change. Companies that use knowledge management more efficient, are producing higher added-value and strengthen its position in the market and are those that will lead the other companies attempting to keep up. Moreover, companies forget on "gray" workers who are carriers of knowledge [5]. These workers should be the object of interest for capturing and sharing of knowledge, before these experts retire and leave the organization. The problem is also expressed through specific corporate assets, which in this case, have an intangible knowledge nature. Consequently, it is necessary to continue with the development of measures and metrics to quantify the intangibles, instead of plain use of anecdotal evidence. Despite the efforts of many specialists, this part still remains as an open chapter. After the assessment methods will be revised, recognized and approved by the community, it is more likely to be accepted also by top management [23].

The issue of health care sector and the industrial engineering tools is far more extensive also after the acceptance of all the pitfalls of knowledge management implementation and knowledge utilization in this area. Since the service provision is a highly knowledge-based sector, decision-making support in this area and its specific focus may be different. According to the results of studies in the United States it is estimated that medical errors cause a million injuries and nearly a hundred thousand deaths per year [9]. In addition, more than 770,000 people are injured or die each year in hospitals from various side effects[2]. According to this, hospitals may incur significant costs that could exceed up to \$ 3,000,000 per year. However, these costs do not include costs incurred in connection with malpractice, legal proceedings and other economic costs of patients [25].

Consequently, the use of knowledge management systems that support decision making in prescribing treatment and management, should have a positive impact on healthcare delivery. The use of knowledge management in healthcare is helping management of financial resources, since it allows the decline (if not complete elimination) of adverse drug reactions and medical errors caused by human factor and reduces health care costs as a result of medical errors. Research has shown that the clinical performance deteriorates over time [7]. Moreover, even we, as humans are fallible. Given

this, it is better to base decisions on solid scientific evidence and research results and not only on personal experience or experience of other colleagues. This approach involves the concept of "evidence-based medicine"[6].

Evidence-based medicine is used to integrate individual clinical expertise and the best external evidence found in research. Therefore, medical knowledge should be available to the whole medical personnel in organization. However, if the availability of this knowledge is a necessary condition, it is not the only one. Knowledge is constantly evolving and therefore there is needed a tool that allows health care professional to find the right information at the right time. In 2000 it was estimated that 34,000 references from over 4,000 magazines were added monthly to the database of the National Library MEDLINE [17]. Since 2005, the number of references added moves from 2,000 to 4,000, and in 2007 the total number of added references was 670,000 [10]. Today, Medline contains over 16 million references to journal articles, which are the source of about 5,200 journals citations worldwide in 37 languages. Doctors need to understand about 10,000 different diseases and syndromes, 3,000 drugs, 1,100 laboratory tests, etc. This quantity of information, however, may prevent the doctor from finding the right information [12]. In fact, it is therefore necessary to provide the right information at the right time to the right person and in the right format. In this context the right knowledge management can play an important role by organizing knowledge and makes it accessible.

3. Use of industrial engineering knowledge in the medical field by means of knowledge

The health care system is like everything else. It has linked components, boundaries, purpose, and environment to communicate with, the interface, input, output, and constraints. However, the health care system contains or includes also inefficiencies. If these inefficiencies are once identified, they should be removed because they represent bottlenecks in the health care system[19]. Such bottlenecks are causing delays, which are delaying the provision of healthcare for patients and increasing healthcare costs. The long waiting time has been identified as one of the common disadvantages of many health care systems. In this context, knowledge management can play a crucial role by studying and reviewing the structure of the organizational processes and sharing knowledge of successful experiences[26]. As mentioned earlier, the area of this issue is highly actual and is now highly discussed. Application of various industrial engineering tools and methods in healthcare is a part of several ongoing projects in our country. The first project was to increase the efficiency of emergency department processes[8]. This project was based on long-term observations and was analysing the activities and processes of a selected department. By mapping and recording department activities and knowledge, a flowchart of the decision making process of patient admission, was created. This chart has then provided an input for the simulation model of selected department.

Fig. 1. Decision process of patient admission.

Industrial or medical systems of present are becoming increasingly complex. To support their design, and to facilitate testing, simulation is an essential method or tool for improving the process of designing, and optimizing their behavior. Simulation is carrying out a number of experiments. Making them directly on the real system would be time consuming and expensive, so that is why the preferred approach is to move these experiments into the simulated world [20]. Based on the method of discrete event simulation, which was applied in simulation software Simio, we were able to see the results of the project in the digital environment. Followed application of all recommendations and changes were verified within the software. The ideal and optimal solutions were introduced, also with the final calculations.

Fig. 2. Simulation model of emergency department

The use of industrial engineering methods in health care continued also to other department, which was held on the basis of knowledge gained from the previous solution, to avoid individual problems and pitfalls. The project shall be solved as cooperation with previous projects. The results of this solution, along with consulting, procedures commenting and processes observing of the previous solutions, were a part of a starting point for improving the effectiveness of health care facility, especially the department of radiology. Like the previous project, also this was applied and validated within the simulation software Simio, via digital environment that reflects the essence of the proposed comments and their meaning.

Fig. 3. Preview of the structure of the simulation model of radiology department[16]

Given that the situation and the state of this sphere are not sufficient and adequate, we are not ending with mentioned projects. Today, the plan is to further optimize other medical and health care facilities. In addition to industrial engineering methods, designed to optimize the current state, we want the project to bring and also to use the knowledge from the previous solutions, to design a standardized model for resolving similar projects, to take advantage of the knowledge and skills to a much greater dimensions than before, while encouraging society to share these knowledge to create a community dedicated to this topic in our area.

Fig.4. The simulation model of radiology department[16]

4. The process of simulation studies

Generally, the process of simulation modeling follows four phases, which range and number can be customized according to given system [22]:

1. Collection and data analysis, where the data is reviewed and accepted according to the study subject.
2. Modeling, where the model is specified and designed.
3. Experiments, where the model is used to produce the results.
4. Reporting the results, where discoveries and knowledge are shared.

The simulation study process begins with the formulation of the problem and the study plan. Each study must begin with a clear statement of the overall objectives and specifications of issues. This provides a clear vision that is critical for success. Overall, the study should then be planned in terms of human resources, costs and time required for each aspect [13].

The next step of simulation studies is data collection and model definition. Information and data should be collected in the interest of the system and should be served to determine the operational procedures and the probability distribution for the random variables used in the model. Once enough data is collected, it is possible to start designing and validating the model. When designing the model, it is necessary to involve people who are intimately familiar with the operation of the current system. This will provide the desired accuracy, credibility and validity of the study. The construction of model was created by a computer software Simio. The software provides an alternative and interchangeable templates of graphical simulation modeling and analysis that can build a relatively wide range of simulation models.

Once the model is validated, pilot runs can be launched. These runs represent a tool that is used for testing the sensitivity of outputs of the model by changes in input parameters. If the outputs vary widely, user must obtain a better estimation of input parameters.

If the pilot runs confirm the validity of the simulation model, first experiments can be designed. The first step in the design process is to determine which of the many possible structural parameters and assumptions have the greatest impact on performance measurement. In other words, the user must determine which set of model specifications seems to lead to optimal performance. He must therefore determine the answers to the following questions such as: initial conditions for the simulation runs, the length of the reaction time (if any), the length of simulation run, the number of independent simulation runs for each alternative.

The subsequent simulation runs will give us the system performance data. These generated data are then processed and analyzed by statistical methods. The analysis decides which are the best simulated alternatives, with respect to the specific performance parameters [13].

5. Purpose of knowledge based simulation

The main purpose of the simulation is to produce data that will then be analyzed and identified from various aspects. The amount of data is often bulky, and the analysis then requires good skills. By implementing the knowledge based simulation system, the analysis will be automated. This fact can apply and spread expertise knowledge in many other applications and studies[21].

The main objective and benefit of the knowledge based simulation system usage, is the reduction of the total time of simulation study lifecycle. Additional benefits include improvements in the quality of results by making the knowledge available to all users of the system[12].

Fig. 5. Comparison of our simulation study lifecycles 1. a 2.

The sequence of subtasks is managed by a system, which oversees if all required subtasks and single steps were fulfilled so the user can go to the next section. Some types of analyzes that we have applied in order to achieve the desired objective:

- Static analysis is used in cases where the information did not depend on time.
- Performance analysis was used, when it was desired one of:
 - Evaluation of the scenario.
 - Detection and analysis of the causes of inappropriate model behavior.
- The scenario generation was used, as in the previous study was used and tested a range of scenarios, by which we can "prescribe new proposed scenarios.
- Scenarios comparison. The individual scenarios were compared and their suitability and similarity has been assessed.
- Learning. If the system has recognized the scenarios, the model is made in "learning" mode.
- Mathematical analysis was performed when the analysis has determined that the current request can be performed by mathematical analysis, rather than by creating the simulation model.

6. Knowledge in study process

The main point of this process was to concentrate all the efforts on the interaction with the model. One advantage of using a simulation model is its ability to work and process faster than in real time - more quickly. So the acquisition of the decisions and knowledge of the model from the previous study was much faster. Interaction with the simulation model was thus much stronger than under normal conditions under which decisions are made, which indicates potential impact on higher quality decision-making. In the acquisition and learning process, the simulation model played a central role, as shown in the Figure 6.

Fig. 6. The status of the simulation model in the learning process

From our studies, we were able to identify other potential uses of simulation model or knowledge based system for knowledge management. Hospital managers, supervisors, healthcare staff can use the simulation model as a part of the training. This represents the sharing of knowledge by others, but can also involve the acquisition of knowledge from that source[11].

7. Conclusion

Areas that we mentioned in this article are currently very popular. Their solutions, however, do not reflect only by this fact, but also by the fact that for the company it is highly beneficial and useful. The sector of health care and its individual departments can be characterized as highly demanding process for addressing the provision of services. Degree of choice for workers on the basis of knowledge, intuition, and their own judgment is very high. These are a high complex processes, in which human error may have far-reaching consequences. That is why the need to optimize, enhance and support of these processes is in place.

It is possible to state that these sector workers are knowledge workers, their skills are derived from knowledge acquired during their studies and deepen the practice. Creation of a system, supporting decision-making processes, carries out a number of steps such as, knowledge collection, project development and standardization of these processes and that is why we can talk about years of investment in this issue. This is a very special area in contact with people, so the idea of replacing a person in this position is very demanding. We are talking not about the promotion of human decision-making, which could be the level of risk eliminated to the minimum, but also about the decision-making process that could be faster, more efficient, more accurate and substantiated by historical data, experience and results. Health care knowledge systems, would ensure this issue.

Our department tries with these projects to show that the area of Industrial Engineering is also applicable in the field of health care and gradually applied methods from other sectors seeks to highlight the benefits of solutions.

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9. References

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