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LEAN RFID APPROACH ENHANCING THE INFORMATION AND MATERIAL FLOWS IN EMERGENCY DEPARTMENT

Modern technologies and technics nowadays play a very important role in optimizing many processes. Healthcare sector is a vital system of every country and it requires great investment and constant improvement, which makes integration with modern technologies and technics inevitable. Efficiency, speed and time savings are thus crucial for achievement of this integration. Lean RFID approach is completely new way of modeling and optimizing healthcare systems. The objective of this paper is to identify, describe and analyze recent trends in merging healthcare (Emergency Department) and Lean and RFID principles into a unique system. Obtained results indicate that the application of certain segments of Lean “thinking” significantly increases the efficiency of focused processes in healthcare. The main idea of the integration of medicine and Lean RFID approach is to constantly create and improve new values and reject all the activities that are categorized as “waste” in order to provide time savings, which are extremely important in this branch.

1. INTRODUCTION

Healthcare has a very important role in moderate society. This is one a vital system of every country and it requires great investments and constant improvement. Optimal functioning of this system means increasing the chances that more patients will be adequately taken care of and that more lives will be saved. Price for the system failure in healthcare is measured in human lives, which is why it is essential that this system always works properly. Nevertheless, with more detailed analysis it is possible to detect feeble spots in the system and eliminate or reorganize them if they are necessary for the functioning of the system, and also, periodic inspection and testing of the efficiency of these processes should not be neglected.

The purpose of this paper is to explore some of the main approaches of Lean and **R**adio **F**requency **I**dentification (RFID) principles reshaping medical branch. Integration of this new approach and healthcare can bring a lot of benefits to medical sector and patients, and increases the level of performance of processes. Each patient requires a unique procedure, paperwork, and direct consultation with doctors and nurses [3]. Although patients usually have their own schedule of coming to the medical facilities, problems with waiting in lines cannot be neglected. That is the reason Lean principles are being used to optimize these processes with the patients point of view and to bring order into chaos. **E**mergency **D**epartment (ED), especially, must function properly at all time, because this sector is designed to treat the most critically ill and injured patients and they are part of the first response to public health emergencies such as natural disasters and terrorist attacks.

This paper is organized the following way. The second Section considers medical informatics models. The third Section provides a brief theoretical background of healthcare and Lean thinking. The fourth Section establishes the connection between healthcare and RFID is, while the fifth Section provides completely new approach in improving ED. Sixth Section shows how Lean RFID approach can optimize ED, and final remarks and conclusion are in the last Section.

2. MEDICAL INFORMATICS MODELS – CHOICE OR NECESSITY?

Nowadays modern technologies and technics play a very important role in optimizing many processes. The use of Information and Communications Technology (ICT) is rapidly expanding in Health sectors [7]. A typical example, and also one of the largest, is the plan of the National Health Service

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(NHS) to implement new ICT services in England at a cost of some £12.4 billion over 10 years to 2013-2014 [6].

Healthcare relies on constant and rapid technical and technological revolutions, because this enables development of new approaches in detecting diseases and improving patient’s treatments. Medical informatics explores all aspects of integration of information with healthcare. Medical informatics models have significant role in a healthcare progress. Healthcare hospitals are expected to constantly apply new knowledge when treating their patients. In the past, difficulties in achieving this development were numerous and frequent, but today new approaches arise constantly. It is important to persistently analyze and test these new models in order to confirm their applicability or inapplicability in real systems. Every modern discovery of a very significant new technology or technic is a sensation, but not an unexpected one. Therefore, those who do not follow “available to all” trends are out of the race with its competitors. Similar analogy can be applied in healthcare, especially with the many clinics in this branch.

This paper shows creation of new optimization model in ED. For this purpose Lean RFID approach has been used. It can be defined as a new approach which uses benefits of both approaches (Lean and RFID) in order to optimize parameters of modeling system.

3. HEALTHCARE AND LEAN

Lean philosophy was created as a set or rules and approaches for dealing with certain problems in corporations and for generating well-organized information and material flows. It has a long history in organizing processes making them more efficient as they were in the past and reshaping systems changing their core philosophy in understanding how to gain benefits. In healthcare several Lean technics may be applied (e.g. Kaizen [4] or Value Stream Map (VSM) [3]). Nevertheless, many healthcare organizations have been learning and applying concepts of these approaches (Table 1) [8], mostly separately, to maintain and improve measured results.

The core values of this new approach include:

1. respect for people (patients, staff members, managers, physicians),
2. continuous improvement (e.g. easier, better, faster, cheaper),
3. human development [10].

Table 1. Examples of implementation of Lean methodology in healthcare

Organization	Impact
Scotland Cancer Treatment	1. Customer waiting times for first appointment is shortened from an average 23 to 12 days.
	2. Improvement of customer flow time for patients of 48%.
Royal Bolton Hospital	1. The time taken to process important blood categories fell from 2 day to 2 h.
	2. Death rate of patients lowered by a third.
	3. Average turn around time in pathology from over 24 h to 2-3h.
	4. Direct savings of £3,1m.
Nebraska Medical Centre	1. Average length of stay decreased from 6.29 days to 5.72 days.
	2. Reduced staff walking by 167 miles a year.
	3. Reduce lab space by 825sq ft and specimen processing turn around time by 20%.
	4. Reduced manpower by 11 FTEs, who were redirected to other critical work.
The Pittsburg General Hospital	1. Change to the procedure for intravenous line insertion giving a 90% drop in the number of infections after just 90 days.
	2. Saving almost \$500.000 a year in intensive-care-unit costs.
Flinders Medical Centre	1. Fewer safety incidents.
	2. 20% more work with the same budget, same infrastructure, same staff, and technology.

It can be seen that one of the results of Lean technics implementation in almost every hospital is time savings. The implementation of Lean in a healthcare setting, particularly a hospital should remove duplicate processes and unnecessary procedures such as: recording patient details in multiple formats and places; patients being moved to wards before beds are available; excessive waiting for doctors and consultants; and uncoordinated, variable discharge processes resulting in a longer stay than necessary [9].

4. HEALTHCARE AND RFID

Radio Frequency IDentification (RFID) is one of the most promising, rapidly developing and easy-to-use technologies which use radio-frequency (RF) signals for automatic identification of objects and items. Radio Frequency IDentification (RFID) relies on RFID tags. These are small transponders (combined radio-receiver and radio-transmitter) that transmit identity information over a short distance, on request [2]. The other piece to make use of RFID tags is an RFID tag reader which can be applied for the purpose of identification and tracking using radio-waves. Some tags can be read from several meters away and beyond the line of sight of the reader. For building up a patient safety care environment, RFID can address to repository for important clinical information, point of care access, and automatic data collection (including medication, products, and patient identification) [5].

Many small healthcare clinics have suboptimal systems for scheduling and locating patients and medical staff, delaying the relay of information and creating poor resource and room utilization [3]. Implementation of RFID technology in medical facilities, such as hospitals and medical warehouses can be very helpful in organizing and controlling information and material flows and movement of people. Thereby, a lot of accidents could be prevented by tracking all important processes in the system. The basic idea is to use RFID tags which can be attached to the patients' or doctors' wrist bands or in the form of passes around the neck (Figure 1).



Fig. 1. Examples of implementation of RFID technology in healthcare

Implementing RFID technology into healthcare could greatly contribute to modeling and reorganization of existing medical facilities. In the first place, material flows can be identified as the path that passes each patient during the time spent in the medical facility. Unique goal is to achieve time savings, eliminate unnecessary processes and improve information and material flows. New approaches bring new results, and in this case the best way to optimize process is to record it.

5. EMERGENCY DEPARTMENT AND LEAN RFID APPROACH

Emergency Department (ED) is a sector which always carries a lot of stress and responsibility. Key factor to optimization of all processes is minimization of time. The first step in implementation Lean RFID approach in this sector is to educate ED managers and other participants employed in this sector.

The primary goal is to define value. In this case, time presents value from a patient perspective. In order to increase time savings there are three projected and theoretically elaborated steps.

The first step is to emphasize activities that don't add value. **The second step** of modeling system while embracing new thinking strategy is to create a process map. From patient perspective, waiting for a laboratory test results or consultant to arrive adds no value, whereas receiving the laboratory test adds value [4]. **The third step** in reorganizing ED sector is to focus on generating new process improvement ideas and to implement new process, refinement and re-measurement.

It is essential to redesign processes in order to optimize benefits of time savings. Although this presents the end of the implementation of new approach it is also the beginning of its long-term adoption. At the same time, training and handling with RFID equipment should be carried out. It is necessary to install and set up RFID equipment in all important places in ED hospitals in order to record all relevant processes which can later be analyzed and optimized.

As a result, customer service can be improved and patient volumes increased, making hospitals more competitive. Computerized ED can reduce costs and increase revenues while improving care and efficiency. Optimization of processes can also reduce time a physician spends looking for charts, tracking down laboratory results, mobilizing staff etc. The results of implementation Lean RFID approach in ED sector are shown in Table 2 [4].

Table 2. Examples of improved processes in ED sector

Technics		Processes in focus
Lean RFID approach	<i>Time savings</i>	Patients' waiting times for reception is shortened.
		A resident, and the attending physician get the patient history at the same time, when possible, thus reducing duplication of history and saving staff time.
	<i>Staff satisfaction</i>	Redefined responsibilities of registered nurse, nursing assistants and intake coordinators.
		Laboratory tests/X-ray studies ordering and sending done earlier in the process which facilitate diagnosis.
	<i>Patient satisfaction</i>	Immediate placement of patient in the rooms.
		Bedside registration whenever possible.

From this potential reorganization of ED it can be concluded that redesign of every process needs time and full commitment to analyze every entity in the system in order to achieve the goal. ED is very specific sector because in some cases human lives depend on the "value" – time savings. Therefore, it is necessary to be very careful in redesigning these processes, because when mistakes occur, the price can be too high.

6. EMERGENCY DEPARTMENT OPTIMIZATION MODEL

Every process which embraces Lean RFID principles must be quantified with some unit and in this case it is time saving. It can be noticed that technology plays a very important role in this projected system considering input, output and the processes between. Processes in the ED can be largely simplified using information technology. It is worth mentioning that computers at the various levels of the hospital are connected through a network of fiber optics. Utilizing computers, medical software already in use, and networking, various activities can be eliminated or simplified and hence save time and effort [1]. ED optimization model is discussed, as envisioned, in three steps.

The first step in this new approach implementation should be to appoint RFID readers at several locations. In the projected system these are the receptionist's office, waiting room and exam room. The

basic idea is to use RFID tags which can be attached to the patients, as mentioned before. The patients receive tags when they check in, and return tags when they leave ED. Every patient's tag is in correlation with the identification number on each patient and its health registers. When the person receives wristband, the interaction between their tag and reader is enabled (Figure 2) [3], and collection of information can begin.

Recorded data can be categorized in three groups:

1. data concerning the amount of time a patient spends making his/her way through the appointment process,
2. data concerning the amount of time nurses and doctors spend performing their tasks
3. and centrally display the location of the patient and personnel within the facility at all times [3].

Collected data are than processed in the Base Station and obtained results can be analyzed. Base Station can be defined as a unique database where all the results are assembled. In this approach, the most important group of data is about time patients spend in ED. The reason for this is unambiguous: if patients spend less time in the system (ED), and get the same treatment as before, they will be more satisfied. In some cases, this fact may even seem irrelevant in comparing with savings of human lives, but small - time savings can sometimes be important in situations which require immediate reaction.



Fig. 2. Example of RFID reader application in ED

The second step of implementation of Lean RFID approach should be oriented to create VSM (Figure 3) [4], based on the results from the data collected. This enables waste identification and its elimination in order to achieve time savings. Special team of experts should be trained to do these tasks.

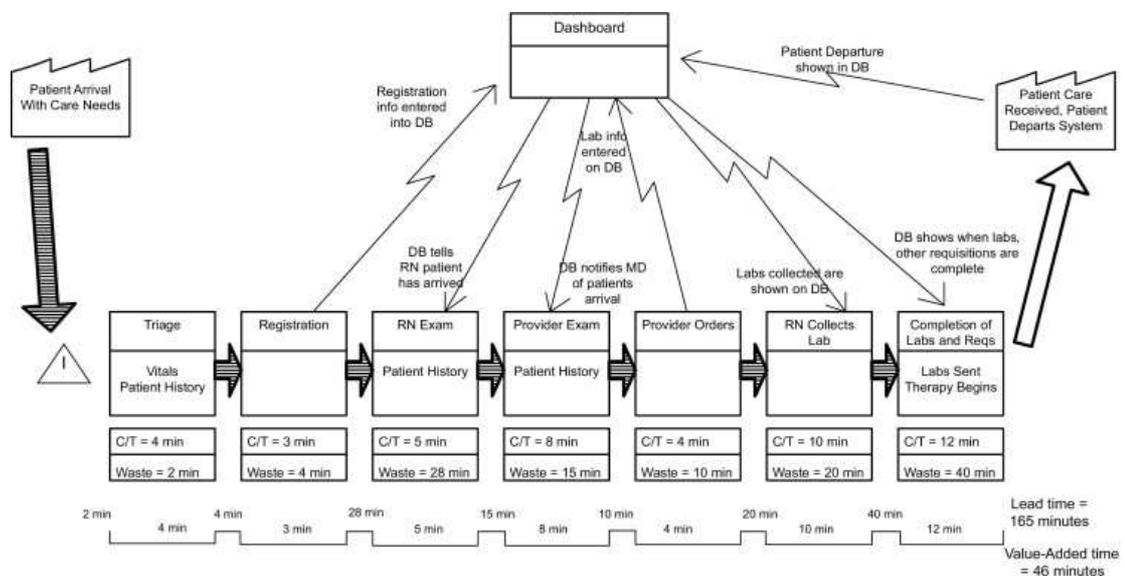


Fig. 3. Example of VSM application in ED

Although in ED (and hospitals in general) doctors' efficiency and competence play very important role, the objective of this approach is to reduce or eliminate every unnecessary process and to maintain the level of services. Sometimes, it can be very difficult to implement this objective, because every segment in ED needs to be adjusted and optimized. Nevertheless, each time saving has extremely significant role in ED, because very often human lives hang on a thread and every second counts.

The third step refers to re-measurement and analysis of data that are constantly updated in order to evaluate processes frequently.

Figure 4 shows Lean RFID general approach discussed in this paper integrated in one unique system. In combination with different types of technologies ED optimization model has a potential to achieve small time savings and optimization of flows in shorter period of time and to provide new approach in reorganizing healthcare. Model is consisted of input, output and processes between. Input is RFID technology which enables data recording and output is VSM which enables visualization of recorded data. Processes between presents selected places in ED where RFID reader should be set. In this model, these places are entrance to ED, waiting room and exam room. Wired or wireless exchange of information between the Base Station and the RFID reader in the apartment is the key element for the proper functioning of the monitoring and rehabilitation system [11].

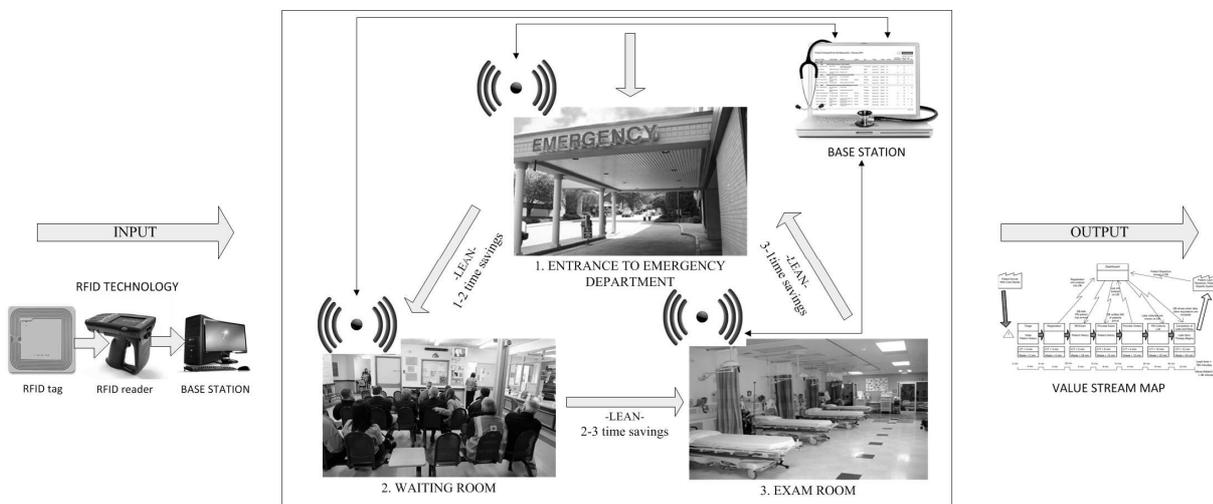


Fig. 4. Correlation between approaches

Nowadays, technological advances are happening so fast that it is necessary to be constantly linked with the latest updates. Correlation of different trends is inevitable in order to increase benefits and respond more quickly in emergency situations.

7. FINAL REMARKS AND CONCLUSION

It could be argued whether this new approach has sustainability in application in real systems. Nevertheless, merging of Lean RFID approach and healthcare provides a new method for reorganization of processes in medical facilities and strategic advantage for those organizations that embrace these new trends. The whole approach is patient oriented.

The conclusion of this paper is that integration of healthcare and Lean RFID approach is significant from the point of achieving time savings and optimization of information and material flows. Providing such benefits to medical sector will bring about a change of awareness and acceptance of new values in system organization.

Future research can be extended in direction of analyzing the application of Lean RFID approach in other healthcare sectors. For example, analyzing the storage of medications and equipment in warehouses and material input-output flows in warehouses can be very useful for healthcare. Also, the approach discussed in this paper hasn't been conducted in practice in Serbia, yet. It would be very interesting to analyze obtained results from potential merging of Lean RFID approach and Serbian healthcare, because

Serbia is the country in transition. Nevertheless, this integration is desirable and potentially significant, as well as the results of process improvements, but there are many factors which affect this.

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