

THE ROLE OF PROCESS-BASED APPROACH IN SHAPING THE LOGISTICS OF E-SERVICES IN HOSPITALS

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Abstract: The execution of medical orders is a special e-service provided in hospitals. The results of studies carried out so far prove that the implementation of IT solutions does not always lead to improved patient service. The purpose of the study was to define the role of the process-based approach and advantages resulting from the use of process analysis in the execution of medical orders. Process analysis and process mapping was carried out with the use of the BPMN standard and iGrafx software. The studies carried out confirmed the problem consisting in the absence of a detailed pre-implementation analysis and proved how significant, in terms of shaping the logistics of e-services in hospitals, the role of modelling the process related to the execution of medical orders is. The studies led to the identification of limitations in the 'AS IS' process and to the definition of possible changes.

Keywords: process analysis, effectiveness, efficiency, safety.

ROLA PODEJŚCIA PROCESOWEGO W KSZTAŁTOWANIU LOGISTYKI E-USŁUG W SZPITALU

Streszczenie: Szczególną e-usługą świadczoną w szpitalu jest realizacja zlecenia lekarskiego. Wyniki dotychczas przeprowadzonych badań pokazują, iż wdrożenie rozwiązań informatycznych nie zawsze skutkuje poprawą poziomu obsługi pacjenta. Celem badań było określenie roli podejścia procesowego i korzyści wynikających z zastosowania analizy procesowej w zakresie realizacji zlecenia lekarskiego. Analiza procesowa i mapowanie procesów zostało wykonane przy użyciu standardu BPMN z wykorzystaniem oprogramowania iGrafx. Przeprowadzone badania potwierdziły problem polegający na braku wnikliwej analizy przedwdrożeniowej oraz wykazały, jak ważną rolę na gruncie kształtowania logistyki e-usług w szpitalu odgrywa modelowanie procesu związanego z realizacją zlecenia lekarskiego. Badania doprowadziły do identyfikacji ograniczeń w obecnie funkcjonującym procesie oraz określenia możliwych do uzyskania zmian.

Słowa kluczowe: analiza procesowa, efektywność, skuteczność, bezpieczeństwo.

1. Introduction

The process-based approach plays an immense role in shaping the logistics of e-services in hospitals and complies with the theory of management sciences assuming a comprehensive analysis of the structure of an organisation and changing the outlook on the organisational structure from a vertical, linear and functional one to a horizontal, process-based one. Logistic processes taking place at hospitals support the treatment of patients and directly condition the final result of the patient's hospitalisation. Hospitals play an important role in the health care system, providing medical services to the citizens. The purpose of the provision of hospital services is above all the execution of the treatment process oriented at maintaining, saving, restoring or improving the health of patients who benefit from these services (Karkowski, 2015).

One of the therapies used in the treatment process in hospitals is pharmacotherapy, i.e. treatment with the use of medicinal products. In accordance with the Polish law, a medicinal product is a "substance or combination of substances presented as having properties for treating or preventing disease in human beings or animals or administered either with a view to making a medical diagnosis or to restoring, correcting or modifying physiological functions by exerting a pharmacological, immunological or metabolic action" (The Act on medical activity of 15 April 2011). Medicinal products are commonly referred to as medicines and the two terms will be used interchangeably throughout the article.

From the perspective of patient hospitalisation and safe pharmacotherapy, the execution of medical orders is a special e-service provided in hospitals. The aim of this article is to present the results of studies oriented at defining the role of the process-based approach within this scope, as well as to verify the results of previous studies showing that the implementation of IT solutions supporting the execution of medical orders does not always result in the improvement of the level of patient service and often leads to a decrease of this level (Marczewska, 2010). Studies have shown that a poorly designed, improperly used or ineffectively implemented IT system does not only not lead to increasing patient safety, but also contributes to an increase in the number of technology-induced errors. The author sees the reason for this phenomenon in the absence of a sufficient pre-implementation analysis of the needs of the future users of the IT system, the legal environment, as well as the available technical and technological solutions (Metzger, 2010; Nanji, 2011).

2. Material and method

The studies were conducted in three health care facilities in the Greater Poland (Wielkopolska) region, each of which represents a different kind of facility, i.e. a district hospital, a ministerial hospital, and a prison hospital. The profile of each of the facilities is characterised in Table 1.

Table 1.
The profiles of the hospitals participating in the studies

	Hospitals participating in the studies		
Hospital name used in the study	District hospital	Ministerial hospital	Prison hospital
Legal form of the hospital	Limited liability company	Independent public health care unit	Health care unit for persons deprived of liberty
Founding body	District starosty	Ministry of Interior	Ministry of Justice
Number of beds	194	200	86
ICT system	Infomedica	Infomedica	Dedicated software

Source: own elaboration.

The studies were carried out in the period between January 2015 and December 2015. The process of medical order execution was studied, including order completion and issuance of medicinal products to the patient and registration of their administration in the IT system. The adopted methodology involved the following stages and activities:

- a) operational analysis:
 - process analysis and mapping of the medical order execution process and document workflow with the use of the Business Process Model and Notation standard in the iGrafx IT system,
 - analysis of patient and medicinal product identification systems, as well as the possibility of standardising industry identification systems in interorganisational processes of providing medical services,
 - analysis of legal and organisational conditions for the process under study,
- b) defining the requirements for the efficiency of managing the process under study,
- c) defining improvements to the process under study with the use of good practices and the available interoperable standards.

The process-based approach applied within the framework of the adopted methodology complies with the theory of management sciences assuming a comprehensive analysis of the structure of an organisation and changing the outlook on the organisational structure from a vertical, linear and functional one to a horizontal, process-based one. This type of approach is aimed at increasing the competitiveness of the organisation in the rapidly changing environment and streamlining its operation (Żytniewski, Zadora, 2013). This is why the point of departure for the analysis was the patient service process and the identification of bottlenecks in the subprocesses carried out in the so-called grey section of the hospital, related to the

distribution of medicinal products. The top-down approach applied made it possible to focus on capturing “a bird’s eye view” of the entire space related to the area of patient service in order to identify the optimisation potential in the area of execution of medical orders within the hospitals under study.

Process analysis and process mapping was carried out with the use of the BPMN standard. It is a standard developed by the Object Management Group and its primary purpose is to provide a manner of describing business processes comprehensible both to the people monitoring processes in various entities and to programmers responsible for their technical implementation (Drejewicz, 2012).

3. Process mapping and process analysis

The studies were initiated by an operational analysis concentrated on detailed identification of selected processes. Isolated processes were subjected to the analysis, focusing on bottlenecks and limitations. In the first step of the analysis, business roles participating in the processes were specified. Next, process events and activities were attributed to the roles performing them and combined into sequences by workflow. This way, process maps were created from the current perspective, taking into consideration the so-called optimisation potential in terms of the executed activities and the suggested improvements to the activities performed to date. The data was obtained by way of direct interviews and observation of the work of the nursing staff.

The purpose of the process analysis was above all to identify bottlenecks within the analysed processes, resulting from an improper and/or insufficient pre-implementation analysis, and to define improvements to these processes. As a result of the analysis, the following bottlenecks were identified, significantly lowering the effectiveness and efficiency of the execution of medical orders in spite of ICT systems implemented in the hospitals. Table 2 presents the identified limitations and bottlenecks in the processes under study in the three hospitals:

Table 2.

The identified bottlenecks and limitations

Types of bottlenecks and limitations
– overlapping documents, both in paper and electronic form
– overlapping activities
– delays in access to current data on medicinal products administered to patients
– absence of effective and legal methods of patient identification
– lack of use of automatic data collection techniques
– lack of use of identification standards for medicine, patient, and nursing staff identification
– visual inspection of medicines

Source: own elaboration.

From the current perspective, the manner of process organisation in all the hospitals forces the employees to work with documents both in electronic and paper form. Additionally, activities are performed without the support of an IT system and mobile devices. Admittedly, information about what medicines should be administered to the patient can be found in the IT system, yet the verification of the conformity of the completed order for medicines with the medical order issued is often performed based on a paper document and as a result of a visual inspection. In practice, this also means that there is a need to review the available medicine packets by the nurse, which may result in the administration of the medicine with a longer expiry date. The IT system, on the other hand, suggests the medicine with the shortest expiry date. Due to the fact that data is updated in the system after the physical administration of the medicine, there is a risk that the data is not consistent. In consequence, this leads to a distorted image of the level of medicine supplies in the IT system and lowering the level of patient safety.

Moreover, the manner of identifying patients is worthy of notice. Based on an interview with the nursing staff, it appears that in the case of conscious and logical patients¹, their wristbands bear the number of the hospital's main register², and the patient's identity is determined by asking about it. In the case of unconscious or illogical patients³, the wristband bears the patient's name, which goes against the legal requirements in this respect. The problem is also the fact of delayed confirmation of the administration of medicines to the patient. This results in the lack of reliable data on the level and location of medicine supplies in the hospital in real time.

The next stage of the work was to suggest improvements resulting in better process effectiveness and efficiency, taking into consideration the following criteria:

- compliance with the requirements of the applicable law,
- appropriate information and technical-technological conditions making it possible to generate and process documents in electronic form and register the course of the process in real time,
- use of the GS1 standards in selected areas, such as:
 - **identification of medicinal products in unit packets:** in the EAN-13 barcode, the Global Trade Item Number (GTIN), and ultimately, in the GS1 DataMatrix barcode, GTIN, serial/batch number, expiry date, individual serial number,
 - **identification of medicinal products in bulk packaging:** in the GS1-128 barcode, the bulk packaging number, the so-called Serial Shipping Container Code (SSCC), the number of the product contained in the bulk packaging (i.e. GTIN), the number of items included in the bulk packaging, serial/batch number, expiry date,

¹ A logical patient is defined as a person able to maintain verbal contact.

² The hospital's main registry is a way of keeping records of hospitalised patients. Each patient is assigned a number based on the hospital's individual approach in this respect. Additionally, hospital unit registries are also in use, where records of patients hospitalised in the individual units are kept.

³ An illogical patient is defined as a person not able to maintain verbal contact.

- **patient identification:** in the GS1 DataMatrix barcode, the PESEL personal identification number in the internal number structure according to GS1,
 - **medical staff identification:** in the GS1 DataMatrix barcode, staff number in the service relationship, the Global Service Relationship Number (GSRN),
 - **return container/packaging identification:** in the GS1 DataMatrix barcode, the Global Returnable Asset Identifier (GRAI),
 - **medicine cup identification:** in the GS1 DataMatrix barcode, the Global Individual Asset Identifier (GIAI),
- use of standard transaction documents compliant with GS1.

The suggested improvements were formulated based on the modification of the processes currently in use in the hospitals under study and based on medicinal product barcodes provided by the manufacturer. The improvements to the process under study include above all the use of mobile devices, which would support the nurses' work from the moment a medical order appears in the IT system to the moment the medicine is administered to the patient. The introduction of new activities to process organisation, related to the need of scanning barcodes, is aimed at accurate registration of individual events in an automated manner.

4. Simulation studies

As part of the conducted studies, simulations of the processes under study were carried out in all three hospitals, both from the "AS IS" and the "TO BE" perspective. The aim of the simulations was to demonstrate quantitative changes in the form of parameter comparison in the current and target models. In order to carry out the process simulations, analytical models for the mapped processes were prepared and parameters for all the process events and activities were introduced. In particular, the duration of individual tasks was specified. It was determined mainly using the normal distribution and the uniform distribution functions in the time interval determined during the interview, as well as the parameters controlling the flow in decision gateways as the probability of the occurrence of the given decision determining further process flow. The reason for the use of normal distribution is its prevalence in the area of numerous events and phenomena. Normal distribution plays an important role in statistics and if a value is a sum or mean of numerous small random factors, then regardless of the distribution of each of these factors, its distribution will be near to normal. For the purpose of standardising the approach in the three hospitals under study, average data was used – on a daily basis and in the context of the entire hospital.

The measures that were studied and presented further in this part of the article include:

- a) average service time,
- b) average working time,
- c) average use of resources.

Measures a) and b) were presented in minutes, and measure c) as a percentage. The obtained numerical data concerning the first two measures was rounded to the nearest whole number. Based on the obtained values, the difference between the current and target values was calculated, and the obtained result was presented as a percentage. The simulation of the medical order execution process in three hospitals made it possible to obtain the numerical results presented in Table 3.

Table 3.

Results of the simulation of the medical order execution process

Measure	District hospital			Ministerial hospital			Prison hospital		
	“AS IS”	“TO BE”	Change ⁴	“AS IS”	“TO BE”	Change	“AS IS”	“TO BE”	Change
Average service time in minutes	13	6	-54%	14	4	-71%	12	3	-75%
Average working time in minutes	7	5	-29%	8	3	-63%	12	3	-75%
Average use of resources as a percentage	15	12	-20%	18	9	-50%	15	7	-53%

Source: own elaboration.

The results of the simulation of the process under study show that the implementation of the suggested improvements carries with it significant optimisation potential. All **three parameters** decrease. The lower level of change in terms of the use of resources in the case of the district hospital results from the difference in the number of nurses handling the process and thus the number of medicine administrations per nurse. In the case of the district hospital, one nurse performs about 12 administrations a day, while in the ministerial hospital, this number amounts to about 17. Based on the parameters taken into consideration in the processes under study, it may be assumed that in the case of the medical order execution process, the implementation of the assumptions of the reference model will make it possible to ultimately save from 25 to 84 minutes of the nurse’s working time during one shift (ca. 8 hours).

The introduction of these improvements will also contribute to **qualitative changes**, such as:

- increased transparency of the internal medicinal product distribution chain and increased level of patient service through access to data on the level, type, and location of supplies for the purpose of:

⁴ The result was calculated as the percentage share of the obtained difference between the “AS IS” and the “TO BE” duration of the process during the course of the “AS IS” process. In the case of a decrease in the duration of the “TO BE” process, the change was marked with the minus sign (-), and where the duration of the “TO BE” process was extended, it was marked with the plus sign (+).

- execution of the process of medicinal product withdrawal,
- limiting the number of expired products,
- limiting the number of lacking products,
- increased patient safety and increased comfort of nurses' work through the introduction of a mechanism of verifying the correctness of order completion in the context of the individual medical order sheet.

5. Conclusions

Medical order execution management is a complex and multidimensional issue. These characteristics have a direct effect on the manner of executing the process from the point of view of its efficiency and the level of service provided, as well as from the point of view of the patient and the level of patient service, in particular patient safety. Moreover, due to technical, technological progress and greater expectations of the patients, but also the risks resulting from errors related to improper administration of medicines, there is a highly justified need to create mechanisms to tighten up the flow of medicines. The challenges that the hospitals face are also complex and the growing number of legal regulations makes it more and more difficult to combine all the aspects which are crucial for providing the appropriate level of efficiency and effectiveness of the processes carried out.

The conducted studies confirmed the real needs and challenges that the hospitals face in terms of medical order execution management. The research work carried out, in particular the analyses, show the importance of the role that the modelling of processes related to the management of the flow of medicinal products in a hospital plays in terms of shaping hospital logistics. An in-depth analysis of the process results in positive effects from the perspective of a comprehensive approach to the process of patient service. It makes it possible to clearly understand the limitations and difficulties in the currently functioning processes and determine the direction of changes and improvements. Its absence, on the other hand, leads to situations in which – in spite of the availability of technical and technological solutions – the processes carried out are ineffective and inefficient.

The studies conducted in three hospitals, as well as more than ten years of the author's experience in cooperating with the hospital industry, clearly indicate a problem existing in the ICT systems currently in use in hospitals. In most cases, IT companies which deliver these systems do not conduct in-depth pre-implementation analyses, which results in the opportunity of buying software at not the highest prices. In many cases, hospital staff becomes a slave to the IT system currently used in the hospital. Meanwhile, the IT system should be configured so as to support the staff in meeting the ultimate objective, that is patient treatment and medical service, in the most reasonable manner. Experiences of other industries show that in order to

implement user-friendly software supporting the processes carried out by that user, 80% of the time allotted to the planned implementation should be used for the pre-implementation analysis (Bahar, et. al., 2016). Then, hospitals would be able to avoid high costs of software modifications while it is already in use.

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