E-Procurement in Hospitals – An Integrated Supply Chain Management of Pharmaceutical and Medical Products by the Usage of Mobile Devices

Patrick Bartsch[1], Thomas Lux[2], Alexander Wagner[1], and Roland Gabriel[1]

[1] Competence Center eHealth Ruhr, chair of business informatics,
Ruhr-University Bochum, Universitätsstr. 150, 44801 Bochum
{awagner,pbartsch,rgabriel}@winf.rub.de
[2] University of Technology Chemnitz, Chair of Business Information Systems I,
Thueringer Weg 7 (#222), 09107 Chemnitz Germany
tlux@tu-chemnitz.de

Abstract. The optimization of procurement processes for medical and pharmaceutical products helps hospitals reducing costs and increasing their cost transparency, treatment quality and patient safety. However, due to the great amount of actors and interfaces taking part in procurement processes a structured methodology is required for holistic documentation and analysis. Therefore, this paper elaborates and describes the main optimization goals for procurement processes and develops methods for process analysis and the ability of a goal-targeted optimization using specialized ICT systems.

Keywords: supply chain management, hospital engineering, E-Procurement, cost transparency, patient safety, healthcare process engineering, medical ICT, eHealth.

1 Problem Statement

There are many rough economic challenges for hospitals nowadays. Especially because of the implementation of G-DRGs[1] in German hospitals there is currently a focus on the minimization of costs, so that hospitals can retain their competitiveness. With 12% of the total costs logistics is one of the key cost drivers in the hospital business. 75% of these costs are personnel costs [1]. This high percentage of personnel costs in hospital logistics is strongly correlated to unusual work of the nursing staff which takes up 28% of their regular working time [2]. But supply chain management is also seen as a chance to improve the hospital's organizational aspects [3].

The logistics of medical products and pharmaceuticals in hospitals represents a vast field of activity in which many people of various professional groups are involved [2]. It extends from the identification of needs in the functional areas and

[1] G-DRG: German Diagnosis Related Groups.

B. Godara and K.S. Nikita (Eds.): MobiHealth 2012, LNICST 61, pp. 406–412, 2013.

wards, the consumption of products up to the health care processes in internal supply departments where the used products are delivered from external suppliers. On the one hand pharmaceuticals and medical products need to be administered in accordance to medical or nursing prescriptions at the right time in the right quantity to the right patient, and on the other hand the resulting demand of these products for hospital wards and departments needs to be ensured. There are already many different isolated applications that are focusing on these logistic problems, but a solution facing the total procurement-process of medicine and medical products is missing [4]. When looking at the whole procurement-process – from the external supplier over the purchasing department and the ward to the patient – various potentials for optimization can be identified that not only decrease the costs but also raise the transparency, the patient safety and the global economic efficiency in the hospitals [5]. Most hospitals have no ICT-solutions to record patient-related consumption of products, thus comparisons of DRG revenues with the costs of the consumption of goods are not possible (cost transparency) [6].

Furthermore there are only very few inventory controlled storage facilities in hospital wards – unlike in central storages or external suppliers –as a result it is often unclear which materials are in store and in what quantity. This complicates the planning and documentation of the demand compared to automatic management by ICT, and also leads to the fact that orders need to be placed manually "on paper" and can only be done after "visual inspection" of the storage facilities. Because of these points it is not easy to plan optimized storage-balances with respect to delivery-loops. This results in uncontrollable stocking of products by the nursing staff and inefficient capital-binding. In case of a callback of problematic products the missing location information makes it necessary to get a manually overview of all storages at the site.

The urgent need of ICT solutions in the field of medicine is driven by the doctor's prescription of medication. In this regard, there are possibilities of ADE (adverse drug events) by e.g. a wrong dosing, mistakes in medication setting and mistakes in application of medicine. Studies are showing that up to 10% of the anamneses in hospitals are flawed and thereof 60% pertaining to medication [7]. The implementation of specialized ICT systems aims to prevent these ADEs. Additional special measures and technical equipment (e.g. patient bracelets with barcodes) help to get the right medication to the right patient in the right time [8].

2 Project Goals

The project "e-med PPP – patient safety and procurement-processes" [2] is endorsed by the German State of North Rhine-Westphalia and the European Union and develops integrated strategies and solutions to optimize the logistic processes of pharmaceuticals and medical products in hospitals on the base of the problems mentioned above. The complete ecosystem of the procurement in a hospital is reflected by the partners in the project. There are for example two reference hospitals,

[2] http://www.e-medppp.de

several partners from all steps of the value-added chain like business and industry partners as suppliers, and the patient as customer. One of the project's targets is to find strategies to solve existing problems and as well concrete recommendations for the implementation of ICT solutions. The project goals can be divided in two distinct areas. Firstly, overall-goals concerning all activities and departments, and secondly, direct goals facing the above mentioned problems to optimize single processes in the hospital with potentially structural changes.

One specific objective is the evaluation of technical methods for accurate tracking of each patient's consumption of pharmaceuticals and medical products. In addition to an automated documentation it should be possible to identify every single patient as a single cost unit. In this connection the project aims to identify patients and products by auto-ident-technologies such as barcodes, data matrices or RFID chips. With these, it is possible to integrate these data into heterogeneous hospital ICT systems (e.g. hospital information systems (HIS), stock management). The respective concept that will be developed to fulfill these specs, should integrate Computerized Physician Order Entry (CPOE) Systems. Like mentioned above, for this concrete use case it is also necessary to develop concepts for the efficient integration in the heterogeneous ICT systems in hospitals (e.g. HIS, LIS, stock management).

Another goal in this project is to work out a foundation of conditions and methods to implement inventory controlled ward-storages. This process has to be integrated with other goals like patient as cost unit, automated documentation and CPOE-Systems. Finally, it is important to create the possibility of automated and electronic supply-processes of pharmaceuticals and medical products between all players. This includes, on the one hand, business connections between the hospital and the external supplier, and, on the other hand, the transactions between wards and departments and the central warehouse and pharmacy in the hospital. For each use case electronic order platforms need to be developed that enable integration with the remaining ICT systems, so that orders are integrated efficiently in the process of ordering and purchasing [9].

Figure 1 shows a structural overview of the logistic process chain in a hospital and the respective actors. The ultimate purpose of the logistic process is a secure and efficient realization of a correct consumption of pharmaceuticals and medical products for the patient (process "Consumption"). To fulfill this aim, hospital wards need to report demand of these products (process "Ordering"), which at the end leads to the delivery of the ordered products (process "Supply"). Internal purchasing departments have to order their needed products themselves from suppliers (processes "Procurement" and "Delivery"). In the case of pharmaceuticals, this would be the central pharmacy, in the case of medical products this would be the purchasing department or the central storage.

One of the major goals of this project is to develop recommendations for our reference-hospitals based on scientific studies and process analyses, which lead to better process quality for all procurement processes. For achieving a better process-quality it is important to clear the personnel responsibilities, the binding character of the processes in the departments and the development of escalation scenarios for exceptional cases. With respect to lower costs, there have to be solutions to unburden

the nursery staff from unconventional work (e.g. by delegating the work to other professional groups) in due consideration of process length, process frequencies and process costs.

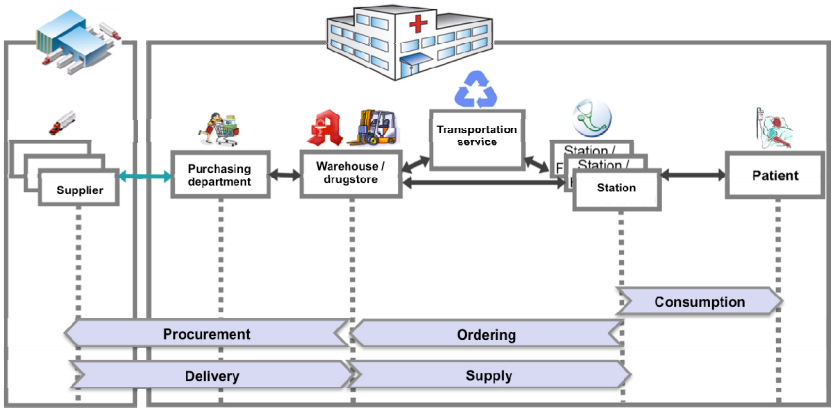

Fig. 1. procurement-process in hospital

To ensure the data safety and security in all steps of the total procurement process, measures for the implementation and integration of data security and safety must be taken and considered in the complete concept [10].

3 Method

For achieving the four objectives of the project (high process quality, economical process design, information security and relief of human resources), the knowledge of the current situation of processes was essential. The first milestone was therefore the recording and modelling of the actual processes. After an initial screening of the scope, we interviewed all process owners. In order to detect all logistic and supply processes of the relevant departments of the internal supply up to typical consuming areas, we interviewed the process owners of "standard ward", "general reception", "intensive care unit", "operating room", "warehouse" and "pharmacy". To ensure consistency, we have created a detailed questionnaire.

During the interviews the processes were documented with function templates, and image and sound recordings. The next step was the creation of process models by using ARIS software. We set up an ARIS server, so that all relevant project partners could work collaboratively. The publications of the process models within the project team were done by using the ARIS Business Publisher, a Web-based interface for accessing the model database. The relevant processes are modelled as extended event-driven process chains (eEPC). It was important to describe the processes as detailed as possible with the help of attributes to get a solid foundation for the subsequent assessment [11].

In addition to the description of functions it was also important to document the durations and execution cycles of relevant functions. Then we measured the durations of all relevant functions in the hospital with the time-measuring instruments "Timeboys" of the company Datafox. Each department or station was observed for two weeks. Finally, we evaluated and implemented the results in the analysis of the current situation.

The objectives of information security are also very important in this project. This aim requires a detailed identification, modelling and documentation of all relevant assets in this scope [10]. In addition to the usual elements of an eEPC (roles, data, application systems), we integrated additional elements, such as infrastructural components, devices or transportation elements into the eEPC-models. Furthermore, the documentation of the requirements for the security objectives, threats and vulnerabilities of each asset were necessary. This information has been documented in the object attributes [11].

4 Valuation

To analyse and valuate the current situation was the next step. The focus here was on both, the pharmaceutical processes and also on the medical-product processes. It was based on different criteria: documentation procedures, software and hardware systems, information flows, process costs, etc. The outcome of this step was a detailed overview of the identified weaknesses and potentials for improvement. As expected, numerous vulnerabilities can be uncovered in connection with hand-written documentation, which is a serious hazard in matters of the patient safety and information security. Unreadable or incorrectly written prescriptions can simultaneously affect all the security objectives, threaten the patient's health and in the worst-case even the patient's life.

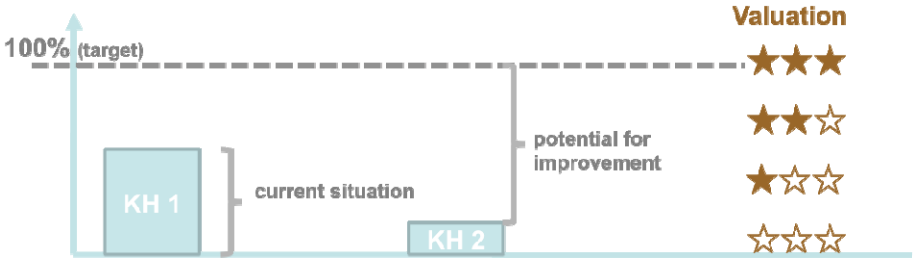

Fig. 2. Current situation

As part of the process-based cost accounting we identified specific cost drivers [11]. A comparison between the two hospitals shows that an electronic inventory of medical products in "KH1" (Figure 2) brings significant cost advantages. Figure 2 also shows the evaluation system that was developed in this project. The 100 % target line lights the best possible status with respect to the project objectives. The distance

between the current situation and the 100% target line represents the achievable potential for improvements [11]. The project is currently in the conceptualization phase of target scenarios. A scientific comparison between the target and actual situation is not yet possible. However, the analysis of the current situation has shown potentials for optimization for both hospitals "KH1" and "KH2". Our next step is to provide an integrated approach along the entire supply chain with the help of a targeted use of ICT like mobile Handhelds (Figure 3) or Smartphones.

Fig. 3. Mobile Barcode Scanner

5 Target Scenarios and Outlook

On the base of the above mentioned valuation we will create concepts that bridge the gap between current and target situation in total or partially. However, our goal is not to develop a monolithic solution. We want to develop different, customizable scenarios as a modular system with various potentials to achieve the project goals. For example, the use of RFID offers enormous potential for improvement especially in the logistics of medical products [12].

The supply chain in reference to the pharmaceutical processes can be optimized by using a unit-dose system in combination with identification technologies, patient wristbands and RFIDs or data matrix. In the medicine supply a unit dose system is conceivable in conjunction with scanners and patient wristbands. This allows to record, which drug is given to which patient at which time. Alternatively, a CPOE system could already trigger a demand of pharmaceuticals as the medication is prescribed on the ward, assuming that a modern ward storage system is used. In all scenarios, the solution is connected to the existing software systems in the hospital through defined interfaces. The developed "modular solutions" will be tested and valuated regarding their potential and practicality in laboratory experiments and exemplary applications in the real environment. The outcome is a flexible solution, because at least the hospital decides about the optimal configuration for its own scenario.

References

1. Siepermann, C.: Stand und Entwicklungstendenzen der Krankenhauslogistik in Deutschland. Verlag für Wissenschaft und Forschung, Berlin (2004)
2. Blum, K.: Pflegefremde und patientenferne Tätigkeiten im Pflegedienst der Krankenhäuser. Deutsche Krankenhaus Verlagsgesellschaft mbH, Düsseldorf (2003)
3. Schneller, E.S., Smeltzer, L.R.: Strategic Management of the Health Care Supply Chain. Jossey-Bass, San Francisco (2006)
4. van de Castle, B., Szymanski, G.: Supply Chain Management on Clinical Units. In: Hübner, U., Elmhorst, M. (eds.) eBusiness in Healthcare - From eProcurement to Supply Chain Management. Springer, London (2008)
5. Holmes, S.C., Miller, R.H.: The strategic role of e-commerce in the supply chain of the healthcare industry. International Journal of Services Technology and Management 4, 507–517 (2003)
6. Kreysch, W.: Verzahnung von Pfad- und Budgetkalkulation als Basis für das prozessgesteuerte Krankenhaus. In: Hellmann, W. (ed.) Praxis Klinischer Pfade: Viele Wege führen zum Ziel, pp. 214–227. Ecomed, Landsberg (2003)
7. Sauer, F.: Patient & Medication Safety. EJHP-P 11 2005-4 (2005)
8. Hellmann, G.: Elektronische Arzneimitteltherapiesicherheitsprüfung. Deutsche Krankenhaus Verlagsgesellschaft mbH, Düsseldorf (2010)
9. Oppel, K.: Elektronische Beschaffung im Krankenhaus – Nutzung, Gestaltung und Auswirkungen von B-to-B-Marktplätzen. Deutscher Universitäts-Verlag, Wiesbaden (2003)
10. Lux, T., Wagner, A.: Informationssicherheit im Gesundheitswesen – Eine prozessorientierte Analyse. Competence Center eHealth Ruhr, Bochum (2010)
11. Junginger, S., Kabel, E.: Business Process Analysis. In: Hübner, U., Elmhorst, M. (eds.) eBusiness in Healthcare - From eProcurement to Supply Chain Management. Springer, London (2008)
12. Mohr, J., Sengupta, S., Slater, S.: Marketing of High-Technology Products and Innovations, 3rd edn. Pearson Education Inc., New Jersey (2010)