Patient Lifecycle Management: An Approach for Clinical Processes

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Abstract. Clinical processes can be described, inside the Biomedical scope, like a systematic guideline to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances. In industry, Product Lifecycle Management (PLM) is the process of managing the entire lifecycle of a product from inception, through engineering design and manufacture, to service and disposal of manufactured products. Applying the concepts of PLM to Biomedical processes we create a synergy between the product's concept in the industrial case and the patient into the health care environment. This point of view improves the actual clinical processes with a most specific treatment for each patient, by modifying the statements to assist the patient according to the needs of the patient and his illness. This research proposal tries to shift the focus of the eHealth systems onto the patient, adapts the existing and defined clinical processes or clinical paths to the patient's needs, applies Big Data principles to bring even more attentions for the patient, and provides an easy to use system for the medical staff.

Keywords: Biomedical, Biomedicine, Product Lifecycle Management, PLM, Clinical Processes, Patient, eHealth, Big Data, Software Engineering.

1 Introduction

In the last decade, the health care sector has used clinical guidelines and protocols as helpful instruments for decision-making. As defined by the Institute of Medicine, clinical guidelines are systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances [1]. They describe all the decision points and corresponding actions to be carried out depending on a specific patient's state or situation. Furthermore, clinical guidelines identify the clinical tests to be performed in order to confirm or determine the patient's state. Based on the test results, the guideline determines the treatment alternatives. Among the most important potential advantages of documenting and using

clinical guidelines are assessing and improving the quality of care, providing support for medical decision-making, controlling health care costs and reducing both practice variability and the inappropriate use of resources [1,2].

In industry, product lifecycle management (PLM) is the process of managing the entire lifecycle of a product from inception, through engineering design and manufacture, to service and disposal of manufactured products [3]. PLM integrates people, data, processes and business systems and provides a product information backbone for companies and their extended enterprise.

The inspiration for the burgeoning business process now known as PLM came from American Motors Corporation (AMC). The automaker was looking for a way to speed up its product development process to compete better against its larger competitors in 1985 [4]. The first part in its quest for faster product development was computer-aided design (CAD) software system that makes engineers more productive [4]. The second part in this effort was the new communication system that allowed conflicts to be resolved faster, as well as reducing costly engineering changes because all drawings and documents were in a central database.

The main motivation for this research comes from several projects, regarding health care and PLM, in which the research group is involved. After analyzing and identifying the advantages and disadvantages of each research area, we focus on trying to improve health care systems using the main advantages that PLM paradigm brings. Our approach focuses on improving biomedical systems, by merging the main principle of clinical processes, or clinical pathways, with the Product Lifecycle Management paradigm in the industrial case. In this research proposal, we try to improve the attention of a patient with a chronicle illness, adapting the base clinical process, defined by specialist, for the patient. Biomedical informatics [5-12] incorporates a core set of methodologies that are applicable to data, information, and knowledge management across the translational medicine continuum, from bench biology to clinical care and research to public health [13].

The paper is structured as follows: Section 2 describes the PLM methodology as it is in the industrial environment. Section 3 explains our proposal to transform the idea of PLM to Patient Treatment. Finally, chapter 4 describes our conclusions and future work.

2 About PLM

Product Lifecycle Management (PLM) is the business activity of managing, in the most effective way, a company's product all the way across their lifecycle; from the very first idea for the product all the way through until it is retired and disposed of [14]. As it is shown in Fig 1, the lifecycle of a product, in most cases, is cyclical. From the extraction of the raw materials, passing through the manufacturing production and delivery, to the final customers; and once the product is useless, PLM covers the disposal of the product and its possible reutilization to recycling.

One of the most important advantages of using PLM is the interconnection of every phase in the product lifecycle across the World; being easily for the company to handle its products having different factories placed in different countries. Furthermore, all the information is shared, so the knowledge about the product manufacturing does not belong to a concrete sector.

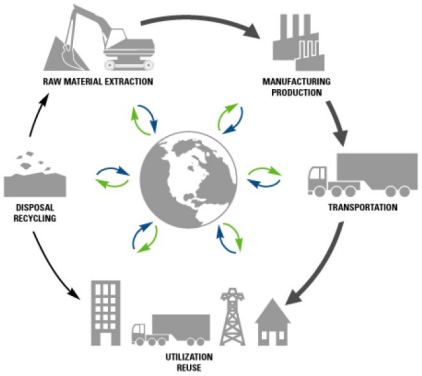

Fig. 1. PLM Overview

PLM manages both individual products and the Product Portfolio, the collection of all of a company's products.

PLM manages products from the beginning of their life, including development, through growth and maturity, to the end of life.

The objective of PLM is to increase product revenues, reduce product-related costs, maximize the value of the product portfolio, and maximize the value of current and future products for both customers and shareholders [14].

However, the benefits of operational PLM go far beyond incremental savings, yielding greater bottom line savings and top-line revenue growth not only by implementing tools and technologies, but also by making necessary, and often tough, changes in processes, practices and methods and gaining control over product lifecycle and lifecycle processes. The return on investment for PLM is based on a broader corporate business value, specifically the greater market share and increased profitability achieved by streamlining the business processes that help deliver innovative, winning products with high brand image quickly to market, while being able to make informed lifecycle decisions over the complete product portfolio during the lifecycle of each individual product.

The scope of product information being stored, refined, searched, and shared with PLM has expanded. PLM is a holistic business concept developed to manage a product and its lifecycle including not only items, documents, and BOM's (Bill Of Materials), but also analysis results, test specifications, environmental component information, quality standards, engineering requirements, change orders, manufacturing procedures, product performance information, component suppliers, and so forth.

On the other hand, modern PLM system capabilities include workflow, program management, and project control features that standardize, automate, and speed up product management operations. Web-based systems enable companies easily to connect their globally dispersed facilities with each other and with outside organizations such as suppliers, partners, and even customers. A PLM system is a collaborative backbone allowing people throughout extended enterprises to work together more effectively.

Operational efficiencies are improved with PLM because groups all across the value chain can work faster through advanced information retrieval, electronic information sharing, data reuse, and numerous automated capabilities, with greater information traceability and data security. This allows companies to process engineering change orders and respond to product support calls more quickly and with less labor. They can also work more effectively with suppliers in handling bids and quotes, exchange critical product information more smoothly with manufacturing facilities, and allow service technicians and spare part sales reps to quickly access required engineering data in the field [15]. Nowadays, PLM is used in most of industrial sectors, like automotive, naval and aeronautical industry, and architecture among many of them.

3 Patient Oriented Clinical Processes

Nowadays, all the biomedical systems are based on new technologies and the interaction with the doctors and medical staff, defining processes for different kinds of illness [16]. This kind of system improves the health systems by making them more efficient and easy to use for doctors. However, these systems overlook the most important factor in an eHealth system, the Patient. The next image shows the three vertex of a triangle of any eHealth system.

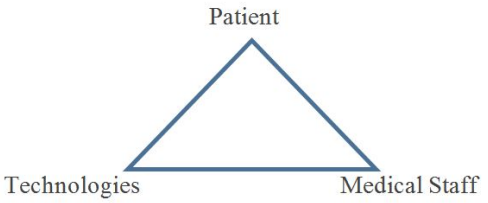

Fig. 2. eHealth System Organization

As it is shown on Fig. 2, an eHealth system can be represented by three vertex of a triangle. The base of the triangle is focused on Medical Staff and the Technologies used in the system. The third vertex, called Patient, provides the information for the system. Nowadays, all the studied systems are focused on the base of the triangle, and are trying to improve the communication between the system and the medical crew or the system itself, by doing it in a more efficient way.

As mentioned before, there are a large number of published guidelines since each guideline is focused on a desired health care outcome. Furthermore, guidelines may vary from hospital to hospital since they reflect variations in resources, staff and the design of the protocol, as well as in the working philosophy of the hospital in question [17]. Because of the vast amount of clinical guidelines, several organizations have undertaken efforts to publish them (using text formats such as HTML or PDF) in the literature and on the Internet to make them more accessible and to enable evidence-based knowledge to be reused [18, 19].

Our approach tries to explore the possibility of including the patient into the process, and shift the clinical pathway focus onto the patient. Using this proposal, called Patient Lifecycle Management, the first input of the clinical process is the patient - based on the assumption that the treatment is the proper one for this patient and this illness. Besides, this 'input' provided by the patient will be measured by using indicators, that show some characteristics of the disease (for example headache, nausea, etc.), providing to the system the state of the patient compared with all the patients with the same issue, using Big Data [20] techniques.

Big Data processing technologies allow sharing and using the patient information between different centers, providing to all the biomedical processes the possibility of evolves using the patients' needs. In this way, we get the most important factor of our research; the processes are adapted to the patient, instead of being the patient who has to adapt to the process for his illness.

The baseline for this research starts with the Product Lifecycle Management paradigm, which defines the whole lifecycle for a product into the industrial environment. The PLM paradigm has years of experience into the industrial sector, improving the management of the products, since the definition to the disposal phase, reducing time-to-market costs and production times. In this proposal, we will use some base concepts of the classical PLM paradigm to enrich the biomedical system to develop. Figure 3 summarizes the main overview of our initial research proposal, mapping it with the current PLM paradigm.

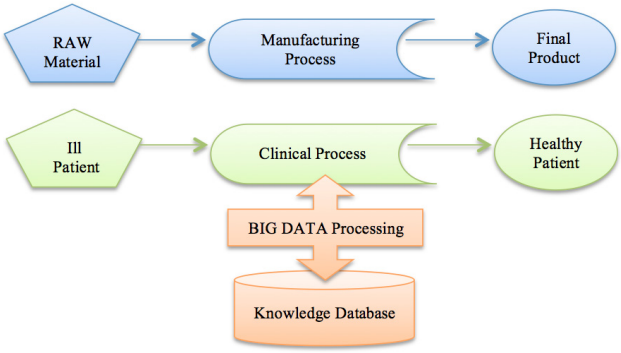

Fig. 3. Mapping between PLM and Patient Lifecycle Management

4 Conclusions and Future Work

As conclusion, our research team is working on this proposal, which applies the Product Lifecycle Management behavior to Clinical Processes, and tries to improve the flexibility of the biomedical systems for clinical pathways, by adapting them to the patient. This flexible pathway eventually improves communication between the patient and the process for his own illness, and hence the efficiency of the patient treatment.

One of the critical points of this proposal could be the adaption of the process to the patient, which is also the focus of our research; it is needed to define common

indicators for specific cases on each clinical process. These indicators could be misinterpreted because the proper patient may indicate a wrong value for its pain. For example, we could use a one to five scale to measure patient's pain, if the patient is frightened about his illness, could indicate that its pain is five. Another factor is the patient thinks that the most painful is his state will be attended faster, so he will always say that his pain is the maximum value. To avoid this false value of the indicator, we will use Big Data principles to analyze the indicators of one patient according all patients with the same issue. Also it is very important to define the correct indicators and algorithms to avoid mistakes during the patient analysis, providing the best process for each patient.

Due to the high amount of data regarding clinical pathways, for our further research we will focus on three main illness and its treatments; Endometriosis, AIDS and Malformations of spinal cord. Thereby we could reduce the scope of this research project focusing into three concrete cases.

As for the future work for this research project, we will start analyzing the State-Of-the-Art technologies in this domain by conducting a Systematic Literature Review [21, 22], and based on the review result, we will try to improve the Biomedical System by applying the proposed method as mentioned previously.

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