

PATIENTS FLOW SIMULATION THROUGH CONFIGURABLE MODELLING OF PATHWAYS: APPLICATION TO A SHARED OUTPATIENT DEPARTMENT

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ABSTRACT

The simulation of patients flows in a hospital makes it possible to evaluate improvement solutions in an objective way before implementing them. However, conducting a simulation study presents many difficulties due to the multitude of pathways followed by patients and the lack of a common language between the hospital staff and experts in simulation. The purpose of this article is to introduce the use of a pathways configurator coupled with a discrete event simulation tool. The configurator, which can be used by hospital staff not expert in simulation, allows to describe all the pathways on the basis of medical care or administrative activities and waitings. The data of the configurator are then used as input data of a customizable model, which allows to carry out simulations without it being necessary to intervene on the model itself. Simulation and pathways validation is then performed using a process mining tool.

1 INTRODUCTION

This case study focuses on the reengineering of seven outpatients' clinics in order to group them on the same platform. Currently, these departments are located in several different places and each one has its own admission office and its own discharge office. The regrouping should not only allow to pool the administrative activities of admission and discharge but also to make more consultations (currently 55 000 / year) while improving the quality of care for patients, as well medical as administrative. The simulation aims to evaluate the performance of this new platform whose design was done empirically on the basis of existing departments. This results in a checking of the capacity of the resources allocated to ensure that it is sufficient to absorb the flow of patients. As in any simulation study, a preliminary work of data collection and modeling of the main pathways in each department is required before performing a simulation run. Unlike industry where there are very often manufacturing process sheets that facilitate this step, the pathways followed by patients in an outpatients' clinic are seldom formalized. Moreover, the number of pathways is often very important. We also made the observation that the medical and paramedical staff does not have a shared vision of the pathways, which is an additional problem for the simulation expert whose mission is to build a model whose behavior is to be the closest possible to reality.

2 APPROACH PROPOSED AND RESULTS

So we started by defining what is a patient pathway. Following a very macrographic point of view, a consultation pathway has systematically three main blocks: (1) an administrative admission, (2) a medical care and (3) an administrative discharge. In a more detailed way, each block of a pathway can be decomposed into a sequence of activities (administrative or medical) and waitings. The travel time between ac-

tivities and waitings can be easily calculated by using the site map and the travel speed. A patient can be directed to a pathway or another according to a percentage. Each medical or administrative activity corresponds to a location (or a room) where the patient is. It can decompose in a generic way into one to four steps, with for each of them, one or more human resources used with cycle time described in a random distribution law. Figure 1 shows an example of a pathway (#8) thus described which is followed by 15% of patients in the nephrology department. The columns labeled 1 to 6 show the various activities or waitings. Rows "Step #1" to "Step #4" correspond to the four possible steps of each activity. For example, activity 2 is performed in a room called "ExamBay" and proceeds in two steps: (1) Patient installation with "AS or IDE or MED" human resources for a cycle time corresponding to a triangle distribution; (2) Consulting with "MED" human resource for a cycle time corresponding to a beta distribution.

		1	2	3	4	5	6	
		Location	WaitingRoom_5	ExamBay	WaitingRoom_5	FlowmeterRoom	WaitingRoom_5	ExamRoom
Pathway #8	Step #1	Title		Installation		Flowmeter		Installation
		Duration		$\text{triangle}(0.16,0.5,1.16)$		$\text{triangle}(1,2,3)$		$\text{triangle}(0.16,0.5,1.16)$
		Human Res.		AS or IDE or MED		AS or IDE		IDE or AS
% of patients following this pathway	Step #2	Title		Consulting				Preparing
		Duration		$2+7*\text{beta}(1.2,6)$				$\text{triangle}(5,10,15)$
		Human Res.		MED				IDE
15	Step #3	Title						Medical care
		Duration						$\text{triangle}(2,5,10)$
		Human Res.						MED and IDE
% cumulative	Step #4	Title						Uninstall
		Duration						$\text{triangle}(2,5,11)$
		Human Res.						IDE
88								

Figure 1 : Example of a patient pathway

We have developed a prototype of a pathways configurator with a spreadsheet (Excel) allowing to describe all the pathways with the necessary data. For each medical specialty (or department), there is a worksheet which includes a description of all feasible pathways as explained in the previous example.

About the simulation model, it is built with Witness and is fully configurable using the data described in the configurator. A patient pathway is randomly assigned to each item "patient" who enters in the simulation according to the percentage indicated in the configurator. Technically, they are attributes "embedded" by the item "patient" that are assigned to values corresponding to the data of patient pathway. A particular attribute is incremented at every stage of the pathway and allows to "push" the patient to the next stage. Thanks to this connection between the pathways configurator and the customizable simulation model, it is easy to describe a new pathway or edit an existing one before running the simulation with a minimum of manipulations in the model itself. For the case study presented, 47 different pathways within 7 consulting departments have been taken into account in the simulation.

3 CONCLUSION

Regarding the results provided by the simulation (use of resources, occupation of the waiting rooms, length of stay, etc.), they make it possible to obtain the expected objective information to evaluate the performance of the future consultation platform. On the other hand, model validation was a major challenge because of the multitude and variety of pathways that take place simultaneously. Actions have therefore been programmed into the simulation model in order to write activity start and end events in a log file. Thanks to this log file, a process mining tool (Disco) was used to rebuild the simulated pathways before being compared with the theoretical pathways defined in the configurator.