Simulation of Administrative Processes in Health Care

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Abstract: The increasing pressure to deliver high quality service is forcing health care organizations to optimize their processes. Majority of the studies in this area is focused on the patient flow, emergency or surgical process optimization, allocation of resources. The administrative processes supporting the health care system have not been widely researched and optimized. Discrete-event simulation (DES) was used to simulate and optimize administrative processes in a health care institution. Three clinical departments were included in the simulation models. Two simulation models were developed to model the behavior of present and proposed organization of administrative processes. Voice recognition solutions for smart phones were tested to decrease text entry time. The results of the simulation confirmed that the centralization of administrative processes would contribute to higher quality of service for patients.

Key-Words: Simulation, Health care, Business process, Quality of service

1 Introduction

In the last couple of years, lack of financial and human resources is forcing health care institutions to optimize not only their core business processes but also their supporting processes. A range of approaches relating the optimization of clinical processes already exists, some of them being presented in[1],[2],[3] and [4]. Some of the presented simulations optimize the patient flow in a health care institution, e.g.[5],[1],[6].Tanck and Heinlein (2012) proposes The integration of medical engineering and information technology (IT), to enable an efficient way of process optimization is proposed in [7]. Discrete-event simulation (DES) has become a popular and effective decision-making tool for the optimal allocation of scarce health care resources to improve patient flow, while minimizing health care delivery costs and increasing patient satisfaction as presented in [8],[9],[10] and [11].

Published simulation models include staff optimization and reorganization[12], but they mainly focus on physicians[9] and nurses[2],[4] or teams[10]. The potential for optimization of administrative processes which may bring shorter reception queues at hospitals and outpatients departments, less wasted effort on searching lost paper documents, and fewer delays in delivery of medical and financial documentation and decreasing overall level of service seems to be neglected. The administrative process including the delivery of written diagnosis to the patient or specialist physician plays a very important part in assuring the quality of service to the patient.

With this in mind, we have started a project of optimization of administrative processes, and set among its goals a higher quality of service for patients, easier management of the administrative processes, better working conditions for the employees and reduction of administrative errors. The project was performed in one of the largest hospitals in the region (more than 100,000 hospitalizations, 750,000 outpatient events and 300,000 health care services in year 2011). The optimization of the health care administrative processes was defined as a) rationalization of administrative processes, b) standardization of process activities and c) introduction information system support for the processes.

The first phase of the project included process analysis, while a detailed simulation model was developed in the second phase. The purpose of the simulation model was to support the hospital management in the decision process.
with the results of simulation of the proposed process optimization solution.

2 Methodology

In the beginning of the project, 15 significant administrative processes were selected for detailed analysis. Different techniques were used to gather information about the processes: interviews, use cases, structured texts, UML sequence diagrams, structured text description, flowcharts and preliminary simulation models. Key performance indicators (KPI) were set to enable the evaluation of the proposed optimization solution:

- Length of patient queue,
- Workload of employees, and
- Costs.

A standard administrative process for the entire organization, which would involve approximately 500 administrators, was proposed. The process could be significantly improved with the use of the integrated information system (e.g. for text entry) with less need for management and control. A large amount of working hours could be spared with the use of the integrated IS. Further on, a centralization of administrative staff was proposed.

Two of the clinics in the hospital decided to validate the proposed improvements based on the results of the simulation. Due to the geographic distribution of clinical departments, the idea of a central administrative location for the first clinic was unfeasible. The project efforts in this clinic were therefore focused on the improvement of working environment.

The development process of the simulation model for the second clinic, where centralization was feasible, included four iterations. In the first iteration, the preliminary model was developed, which included the activities performed by the administrative personnel. The second iteration included the simulation model of outpatient reception for two departments: Clinical department for Hypertension (KOH) and Clinical department for Rheumatology (KOR).

The department of Veterans Medical Unit (CVV) was added to the simulation model in the third iteration. In the final, fourth iteration of the simulation model, activities performed by physicians and other medical personnel were added and the entire process of patient examination was simulated.

3 Simulation

In the second iteration of simulation model development, the distribution of arrivals in the departments for Hypertension (KOH) and Rheumatology (KOR) was established based on the data gathered from information system (IS).

Discrete-event simulation (DES) language GPSS (General Purpose Simulation Software) was used for the simulation of the patient admittance process. Simulation program itself is implemented in approximately 300 lines of code. Distribution of arrival on an average working day (13 hours) for both departments, KOH and KOR are presented in Fig. 1.

Simulation models of separate reception sites and of a joint reception site of both departments were built. The model with separate reception sites proved less patient friendly than the model of joint reception sites. The average waiting time in KOH was especially unsuitable, however an additional workplace would be economically unjustified. The average waiting time in KOR is 41% longer than in the case of a joint reception site.

From the management point of view, separate reception sites are also more demanding, while employee absence is also affecting the process. Since there are usually two administrators in KOR and only one administrator in KOH, the absence of the KOH administrator would have a significant effect on the entire administrative process if there is no substitution from another department available.

In the case of a joint reception site, the reduction of staff to two administrators radically increases the waiting time of the patients from 178 seconds to 4285 seconds on average. In this case the workload of administrators is raised to 79%, which is ergonomically unfeasible. Therefore the solution with two administrators was not proposed to the
clinic management. If three administrators are employed at the joint reception site of both departments, the average workload of employees falls to 53% which is feasible from the ergonomic aspect.

In the third iteration of the simulation model, a Veterans Medical Unit (CVV) was added to the simulation. Based the data gathered from the IS, the CVV had 97 patients in 20 working days, which can be approximated to an average of five arrivals per working day.

The simulation showed that the average waiting time in the joint reception site is acceptable when 3 administrators are available. In case of only 2 available administrators in the joint reception site, the waiting time is around 4000 seconds which is not acceptable.

The last iteration of the simulation model included processes performed by the physicians and other medical personnel, which also affect the duration of administrative process. The general process of patient examination showing existing and proposed situation with joint reception site is presented in Fig. 2 and 3.

![Fig. 2: existing process with separated reception sites.](image)

![Fig. 3: proposed process with joint reception site.](image)

Not all the activities identified in the process of outpatient examination were included in the simulation model because it was established that the majority of process time is taken by just four out of fourteen identified processes. Therefore the simulation model includes 88.2% of time share in KOH, 86.6% of time share in KOR and 50.3% of time share in CVV. However, the order magnitude of the frequencies in CVV compared to KOH and KOR is 1:10 and 1:20 accordingly.

The activities included in the simulation and their performers are presented in Tab. 1. As shown in table, phone calls have a higher priority in the process than the admittance of the present patient.

**Tab. 1: Processes with the responsibilities for the activities in the simulation model.**

<table>
<thead>
<tr>
<th>Process</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone conversation (priority 1)</td>
<td>Administration</td>
</tr>
<tr>
<td>Administrative reception (priority 2)</td>
<td>Administration</td>
</tr>
<tr>
<td>Medical reception and examination in outpatients department</td>
<td>Medical personnel, physicians</td>
</tr>
<tr>
<td>Diagnosis typing</td>
<td>Administration</td>
</tr>
<tr>
<td>Typing additional opinions and comments</td>
<td>Administration</td>
</tr>
</tbody>
</table>

An example of the administrative reception process defined as a block diagram for GPSS implementation is presented in Fig. 4.

![Fig. 4: The diagram of the simulation process for the outpatient reception and functional diagnostics.](image)
4 Results

The simulation time was 13 hours, from 6:00 AM to 19:00 PM. 103 patients were treated during the simulation run in all the presented cases. Examples of administrators work load (occupancy) in a simulation run are shown in Fig. 5 and Fig. 6.

Fig. 5: Example of administration occupancy in a simulation run with separate reception sites (Source: Leskovar et al., 2011).

Fig. 6: Example of administration utilization (occupancy) in a simulation run with joint reception site (Source: Leskovar et al., 2011)

As the simulation models did not include all the activities performed, some corrections were necessary after 100 simulation runs. Further corrections of results included the corrections factor to simulate 8 hour working days (simulation run was 13 hours as the data was gathered) and possible absence of employees. The final results of administration utilization are shown in Tab. 2.

Tab. 2: Final results of the simulation models with separate and joint implementation of activities.

<table>
<thead>
<tr>
<th>Clinical Department</th>
<th>KOR</th>
<th>KOH</th>
<th>CVV</th>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Utilization</td>
<td>83.76</td>
<td>61.92</td>
<td>47.15</td>
<td>74.30</td>
</tr>
<tr>
<td>Waiting time in administrative activities [s]</td>
<td>46</td>
<td>53</td>
<td>807</td>
<td>38</td>
</tr>
</tbody>
</table>

Descriptive statistics about administrator’s utilization in the case of separate and joint implementation of activities are given in Tab. 3.

Tab. 3: Descriptive statistics for administrator’s work load in separate and joint implementation of activities (Source: Leskovar et al., 2010).

<table>
<thead>
<tr>
<th></th>
<th>CVV</th>
<th>KOH</th>
<th>KOR</th>
<th>Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>14.03</td>
<td>31.84</td>
<td>43.85</td>
<td>36.03</td>
</tr>
<tr>
<td>Std. deviation</td>
<td>1.22</td>
<td>0.97</td>
<td>1.12</td>
<td>0.66</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.31</td>
<td>0.13</td>
<td>0.04</td>
<td>0.37</td>
</tr>
<tr>
<td>Asymmetry</td>
<td>0.00</td>
<td>0.02</td>
<td>0.32</td>
<td>0.10</td>
</tr>
<tr>
<td>Minimum</td>
<td>10.91</td>
<td>29.04</td>
<td>40.83</td>
<td>34.28</td>
</tr>
<tr>
<td>Maximum</td>
<td>17.38</td>
<td>34.48</td>
<td>47.11</td>
<td>37.99</td>
</tr>
<tr>
<td>Number</td>
<td>103</td>
<td>103</td>
<td>103</td>
<td>103</td>
</tr>
</tbody>
</table>

Text entry of diagnosis and additional opinions and comments, dictated by physicians and typed by administrators in KOH and KOR presented 53% and 46% of time share. Therefore, we have proposed that physicians are to use voice recognition applications for text entry. Since health care organizations are facing increasing pressures to deliver quality care while facing cutting costs and some physicians use business mobile devices, several mobile device voice recognition applications were tested.

Siri is a voice recognition application that can be used by the users of iPhone 4S and iPhone 5. Nuance Mobile solutions and iSpeech service enable text to speech synthesis and automated speech recognition for dictation purposes. Nina (Nuance Interactive Natural Assistant) changes the smartphone to a voice driven digital assistant. The main obstacle of using a mobile device for voice recognition proves to be the lack of support for Slovenian language. Testing showed that even if the physicians used English, there is a high possibility of errors in the generated text and therefore additional supervision of an administrator would be necessary.

4 Conclusion

As presented in [11], the health-care sector is not enjoying the full benefit of a wide variety of simulation methods available and therefore efforts to promote the capabilities of various simulation methods within health-care sector and efforts to develop method selection tools may unlock hidden potentials for optimization of processes. In the project of modeling and simulation of administrative processes presented in this paper we have developed several simulation based solutions at a major health care institution.
The results showed that with no additional cost, a joint reception site for three clinical departments would contribute to lower utilization of administrators working in the Clinical department for Rheumatology (KOR). Since the administrators rotate their working positions, their work load would be more balanced. Additionally, the management of the process in the case of absences is easier since no substitutions from other locations are necessary.

Trials of mobile voice recognition applications proved unsuccessful, and the process of text entry could not be optimized by replacing administrators with applications. Commercial voice recognition solutions were however implemented in some clinical departments of the health care institution.

Since the research is limited to the optimization of administrative processes, the next step is to optimize the process of administrative reception, which represents approximately 20% of the time spent for the examination of patients.

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References:


