THE OPTIMIZATION OF HEALTHCARE ADMINISTRATIVE PROCESSES

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Abstract

The paper presents application of discrete event simulation in healthcare processes. The goal of the project was to optimize several processes in the context of business process engineering. The project in one of the largest hospitals in the region revealed several possibilities to improve quality of service. Besides simulation several other techniques and tools were used. Discrete models evolved in four iterations: a) preliminary model, verified in the first phase of the project, b) iteration 0: a simulation model for the reception in two clinical departments, c) iteration 1: a simulation model was improved by inclusion of the third clinical department and d) iteration 2: doctors at the site realized that medical activities (outpatient examination and functional diagnostics) must be included in the simulation model, since administrative process is interrupted by medical activities. Special attention was put on refining simulation input data, distribution of service times, measurement of average service times and deviations. Two simulation programs model behaviour of the present (separate reception sites) and proposed (joint reception site) process. The simulation results confirm that centralization of administrative personnel would contribute to higher quality of service, improved working environment for employees and decreased possibility of errors, mistakes and lost documents.

Keywords: simulation, health care, business process reengineering.

Presenting Author's biography

Robert Leskovar Ph.D. is an Associate professor at University of Maribor, Faculty of Organizational Sciences. His research focus is the integration of multicriteria decision support, information systems, process simulation and quality.

Introduction

Health care organizations are facing increasing pressures to deliver quality care while facing cutting costs, lower reimbursements and implementing new regulatory demands. Discrete-event simulation 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 [1]. As shown in [2] the number of published papers has increased markedly since 2004. Simulation models are focused in two areas:

- Allocation of assets [3,4] and
- Optimization and analysis of patient flow [5,6,7,8,9,10].

Published simulation models include staff optimization and reorganization, but they mainly focus on physicians and nurses or operating teams. The meaning of administrative processes, causing reception queues at hospitals and outpatients departments, wasting effort on searching lost paper documents, delaying delivery of medical and financial documentation and decreasing overall level of service, seem to be neglected. Another viewpoint showing importance of the administrative processes in health care is time needed to deliver the written diagnosis to the patient and doctor. It is not uncommon in Slovenian health care organizations to send the written diagnosis by mail with significant delay after the examination in an outpatients department or demission from the hospitals department. Even though examination reports are not crucial for emergency department patients that should get treatment as soon as possible, they provide important information for further treatment after examination or demission from the hospital. Organizational process patterns shall help to coordinate interoperating healthcare professionals and organizational units (e.g. handling of a medical order and results reporting) [11].

The project of optimization of healthcare administration business process was performed in one of the largest hospitals in the region (100.000 hospitalizations, 700.000 outpatient events in year 2008). The healthcare administrative process optimization was defined in the project as:

1) Rationalization of administrative processes (shorter flow time, less errors, uniform distribution of effort among employees);
2) Standardization of activities that constitute processes in healthcare institution;
3) Informatization of the parts of the process with the goal of minimizing the efforts for documentation management, increasing data security and contributing to patient’s privacy.

The optimization was performed in two phases. Process analysis was carried out in the first phase. Detailed simulation model was developed in the second phase of the project. Hospital management can make a decision about the location of administrative staff based on the results of the simulation model.

1 Methods, tools and techniques used in the project

In the first phase of the project, we performed a detailed analysis of 15 significant administrative processes. The following tools and techniques were used: interviews, use cases, structured texts, UML sequence diagrams, structured text description, flowcharts and preliminary simulation models. Also performance indicators were set. On the base of the analysis we proposed standard administrative processes for the entire institution with approximately 500 administrators. The significant less time on typing would be spent with the introduction of integrated information system as well as significant less effort would be necessary to manage and control these processes. Preliminary estimation revealed that approximately 274.000 working hours of administrators could be spared. Can we imagine what would happen if these hours would be spent to increase level of service?

We proposed a centralization of administrative stuff functionally but not necessary geographically. The main benefits of the proposal are:

1) Higher quality of service for the patients,
2) Improved working environment for employees and
3) Decreased possibility of errors, mistakes and lost documents.

The second phase of the project was performed on the case of two clinics with several clinical departments. Based on findings of the first phase, it was clear that a decision about joint location for administrative employees was needed. The criteria of the decision tree were elicited with brainstorming and AHP method (Analytical Hierarchy of Processes) was used to determine importance of each criteria. Later it was established that central administrative location for the first clinic was unfeasible. Due to geographic distribution of clinical departments the quality of service for the patients would significantly decrease. Therefore project efforts were focused on improvement in working environment. We proposed the change of the reception layouts. With these changes again quality of service would be improved with minor additional costs. The changed layouts would provide much better privacy for the patients.

The second clinic was feasible for joint administrative facility. However the project team members in this site were in doubt about expected benefits of such change. The modelling of the simulation program was iterative. Discrete models evolved in four iterations:

- Preliminary model: verified in the first phase of the project
- Iteration 0: a simulation model for the reception in two outpatient departments was built (Clinical department for Hypertension = KOH, Clinical department for Rheumatology = KOR).
- Iteration 1: a simulation model was improved by inclusion of the third outpatient department (Veterans Medical Unit = CVV). The model builders knew that CVV is insignificant for the behaviour of the system due to small number of the patients. However team members on the site insisted to include CVV in the model.
- Iteration 2: team members (doctors) in the site realized that medical activities (especially outpatient survey and functional diagnostics such as EKG) must be included in the simulation model, since administrative process is interrupted by medical activities. Special attention was put on refining data (distribution of service times, measurement of average service times and deviations).

Based on the data, collected from visit records in KOR, KOH and CVV, two simulation models were designed, as presented in Fig. 1.

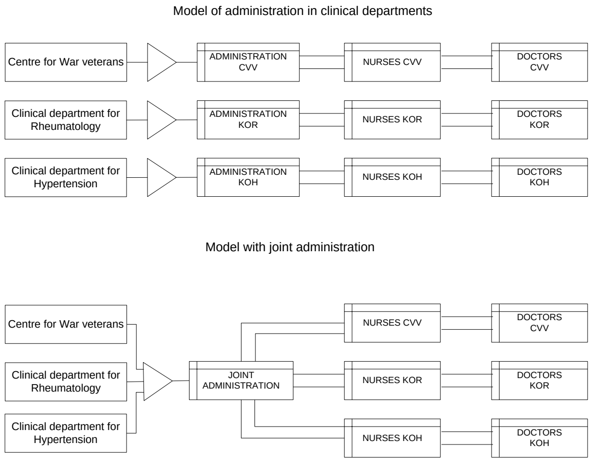

Fig. 1: The concept of the simulation experiment.

GPSS (General Purpose Simulation System) was used to code the concept of the simulation experiment. GPSS as a simulation programming language is well-known, reliable, functional and usable in terms of user perception of software quality.

3 The simulation model

Based on the data, collected from visit records in KOR, KOH and CVV, two simulation models were developed:

1) Three separated reception sites and
2) A central reception site.

Data needed for the simulation were obtained from the information system. Average of 52 patients/day arrived to KOR, 102 patients/day to KOH and 5 patients/day to CVV in May 2009. The distributions of patient arrivals for first examination (P) and control examinations (N) between 6:00 AM and 19:00 PM are shown in Fig. 2.

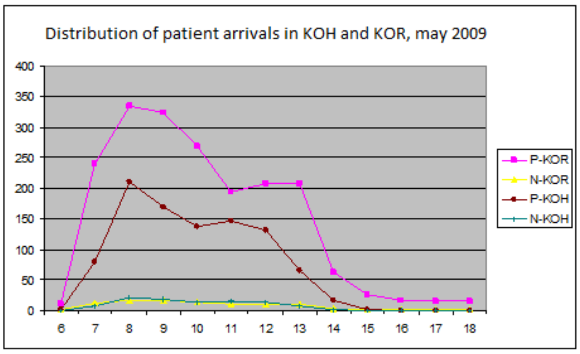

Fig. 2: Distribution of patient arrivals in KOR and KOH.

The distribution of arrivals was included in the programming code. Same distribution is used for both simulation models. The data were modified only for time with no arrivals (at the beginning and end of the workday). In these cases one patient per hour is defined instead of zero arrivals. The reason is logical: zero division generates error at execution time. Corrections of the real empirical distribution do not significantly impact on results of the simulation. Assumptions and characteristics of simulation models built are given in Tab. 1. Maximum length and average waiting time for patients were measured for each simulation model.

Tab. 1: Assumptions and characteristics of a simulation model built with separate yards.

Simulation model	**1**	**2**
Characteristic	Separated reception sites	Joint reception site
Number of workplaces at reception	4 (KOH) and 5 (KOR) and 1 (CVV) = 10	10
Number of queues	2	1

Nonadministrative activities were built in the simulation model as requested by the hospital. Rough flow chart – context diagram as presented in Fig. 3 was used for all three clinical departments. Reception, diagnosis typing with additional opinions and phone call treating is included when considering the administration's workload. Ambulance examination and functional diagnostic are considered among nonadministrative activities. Phone calls have the highest priority, while diagnosis typing with additional opinions has the lowest priority.

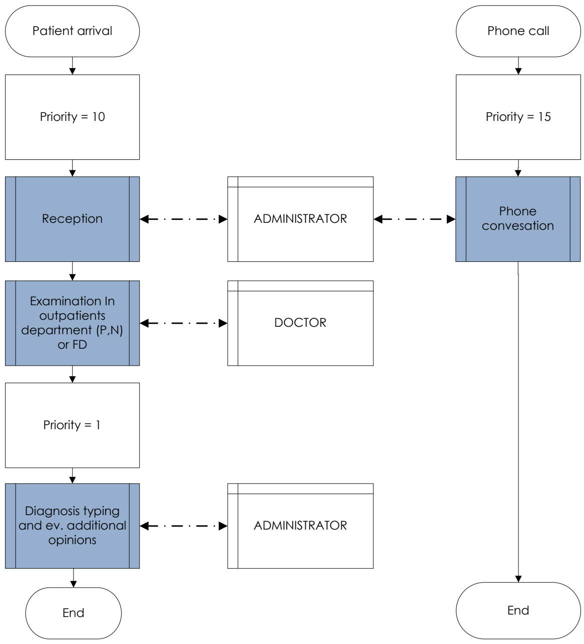

Fig. 3: Flowchart of simulation model.

The shares of time used by specific activity in three clinical departments are presented in Fig. 4. Only main activities were considered when building the simulation model. 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.

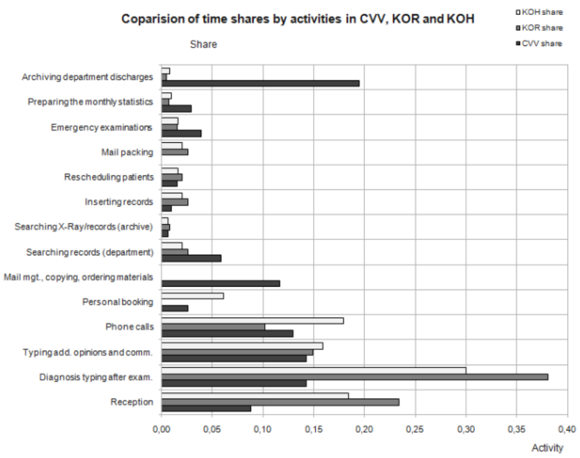

Fig. 4: The structure of time used by individual activities.

The first simulation model is defined with three separated reception sites. Segments of GPSS code in KOR processes are presented in Fig. 5. It defines the number of storages (administrators, outpatient rooms, functional diagnostic units), patient arrival function, phone calls generator, etc.

```
AKOR    STORAGE 5
KORFD   STORAGE 3
KORAM   STORAGE 7
PrihR   FUNCTION C1,C14
0.0,1/3600,11/7200,10/10800,16/14400,15/18000,13/21600,10/252
00,10/28800,10/32400,3/36000,1/39600,1/43200,1/46800,1
...
GENERATE V$StPacR, 600
PRIORITY 10
TRANSFER ,RevmaT
...
GENERATE KlicMR,KlicSR
Rtf              PRIORITY 15
                 QUEUE KORAQ
                 ENTER AKOR
                 DEPART KORAQ
                 ADVANCE TMKlicR,TSKlicR
                 LEAVE AKO
                 TERMINATE
…
RevmaT           TABULATE Cas
                 QUEUE KORAQ
                 ENTER AKOR
                 DEPART KORAQ
                 ADVANCE TMSpreR,TSSpreR
                 LEAVE AKOR
                 TRANSFER 0.169,Rambul,RFundia
…
RTipIzv          QUEUE KORAQ
                 ENTER AKOR
                 DEPART KORAQ
                 ADVANCE TMTipIR,TSTipIR
                 TRANSFER 0.6,RTipDod,Rkonec
RTipDod          ADVANCE TMTipDR,TSTipDR
                 LEAVE AKOR
                 TERMINATE
RKonec           LEAVE AKOR
                 TERMINATE
...
                 WRITE SR$AKOR,1,Done
...
```

Fig. 5: Segments of GPSS code for Clinical department of Rheumatology.

Patient arrivals are defined as functions for each clinical department. After the definition of variables and constants, patient arrival generators and phone call generators are defined. Specific processes are defined on the basis of detailed flowcharts for simulation models. The average utilization of administrators is stored for each department before the end of transaction in GPSS.

Simulation program itself is implemented in approximately 300 lines of code. The second simulation model uses a joint reception site, employing all 10 workplaces in all clinical departments. The difference in the GPSS code in case of KOR is presented in Fig. 6.

```
ASKU     STORAGE 10
...
RevmaT           TABULATE Cas
                 QUEUE SKUAQ
                 ENTER ASKU
                 DEPART SKUAQ
                 ADVANCE TMSpreR,TSSpreR
                 LEAVE ASKU
...
RTipIzv          QUEUE SKUAQ
                 ENTER ASKU
                 DEPART SKUAQ
                 ADVANCE TMTipIR,TSTipIR
                 TRANSFER 0.6,RTipDod,Rkonec
RTipDod          ADVANCE TMTipDR,TSTipDR
                 LEAVE ASKU
                 TERMINATE
RKonec           LEAVE ASKU
                 TERMINATE
...
```

Fig. 6: Changes in GPSS code for the second simulation model.

4 Simulation results

The simulation time was 13 hours, from 6:00 AM to 19:00 PM. Examples of administrator‘s utilization (occupancy) in a simulation run are shown in Fig. 7 and Fig. 8.

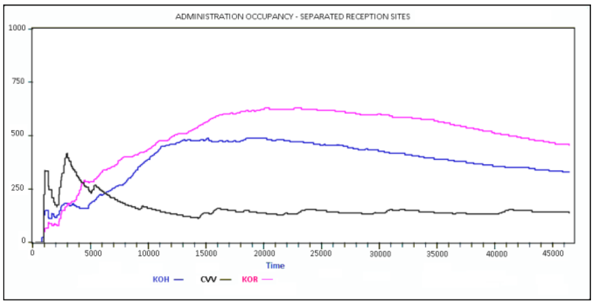

Fig. 7: Example of administration occupancy in a simulation run with separate reception sites.

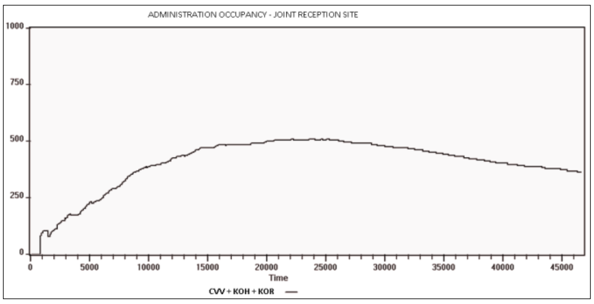

Fig. 8: Example of administration utilization (occupancy) in a simulation run with joint reception site.

After running over 100 simulation runs average scores were computed. Some further corrections were necessary to make proper interpretation of the simulation model:

1) The simulation model did not include all activities of the administrative employees. Non-implemented activities were considered in refining scores for specific server.
2) In the simulation model, the working shift took 13 hours long. Correction factor was used for all three departments, since legislation permits only 8 hour working day with very stiff restrictions for overtime. In rush hours students are employed partially.
3) Public accessible sources of workers absence (illness, vacation, professional development) were used to refine scores in all three departments. Correction factors were different since the share of absence depends on the number of employees.

The final results of administration utilization are shown in Tab. 3.

Tab. 3: Final results of the simulation models with separate and joint implementation of activities.

Clinical Department	**KOR**	**KOH**	**CVV**	**Joint**
% of Utilization	83.76	61.92	47.15	74.30

Descriptive statistics about administrator’s utilization in the case of separate and joint implementation of activities are given in Tab. 4.

Tab. 4: Descriptive statistics for administrator's occupation in separate and joint implementation of activities.

	CVV	**KOH**	**KOR**	**Joint**
Average	14.03	31.84	43.85	36.03
Std. deviation	1.22	0.97	1.12	0.66
Skewness	0.31	0.13	0.04	0.37
Asymetry	0.00	0.02	0.32	0.10
Minimum	10.91	29.04	40.83	34.28
Maksimum	17.38	34.48	47.11	37.99
Number	103	103	103	103

5 Discussion

The results of the simulation models showed that separated reception sites are less patient friendly. The average waiting time is especially long at KOH. An additional reception workplace for the department is economically unjustified. Separated reception sites are also more demanding from the management viewpoint and more burdening for the employees in case of sick leave, vacations or education. In the case when only two administrators are present in the KOR department, the process cannot be performed without replacements.

Waiting time is acceptable in the case of three administrators working in a joint reception site. With only two administrators present at the joint reception site the process can still be performed, even though waiting times are unacceptable from the patient’s viewpoint. A joint reception site enables easier coordination of the workload in case of employee absence; process management is easier and cheaper. The level of service is higher (with no extra costs) in the case of joint reception site than in the case of separated receptions sites.

6 Conclusions

Even though there is a lot of research done in the field of simulation at health care institutions, there is a gap in the optimization of the administrative processes. Based on a process analysis simulation models for three clinical departments were developed. The first simulation model includes separate reception sites for each clinical department, while the second simulation model joined the administrative staff in one reception site. Only main activities of the process were included in simulation models. To make the interpretation of the simulation model results proper some corrections were necessary.

In terms of costs and workload the second model, including a joint reception site for all three clinical departments, is more appropriate. The process can still be performed even though only two administrators are present at work. The joint reception site also ensures easier coordination and management of the process. Further research needs to be done on optimizing work at joint reception site.

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