# Healthcare process analysis and improvement at the department of abdominal surgery, University medical centre Ljubljana

Analiza in izboljšanje zdravstvenega procesa v oddelku za abdominalno kirurgijo Univerzitetnega kliničnega centra Ljubljana

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## Izvleček

**Izhodišča:** V zdravstvenih procesih v bolnišnicah, kot tudi v procesih v podjetjih ali v državnih organizacijah, se lahko s časom nakopičjo problemi in ovire, ki povzročajo, da procesi postanejo neučinkoviti. *Business Process Management* (BPM) je postopek za modeliranje, izboljšanje in avtomatizacijo procesov, ki se uporablja z velikim uspehom za izboljšanje procesov.

**Metode:** Namen tega raziskovalnega dela je preučiti možnosti izvedbe izboljšanja zdravstvenega procesa z uporabo BPM. Za uporabo ideje postopka BPM je bilo potrebno razviti nov koncept metodologije *Tabular Application Development* (TAD). To predstavlja pomemben prispevek na področju managementa procesov v teoriji in praksi. V članku so predstavljene prve tri faze metodologije TAD tako, da je vsak korak teh faz obrazložen in nato izpeljan. Prva faza se ukvarja z identifikacijo procesov, druga razvija model "kot-je" z uporabo tehnike tabele aktivnosti, tretja faza pa obravnava izboljšanje procesa z razvojem modela "naj-bo".

**Rezultati:** Ugotovili smo: (a) postopek "izvedba operacije" je učinkovit in dobro organiziran; (b) možno je skrajšati čas okrevanja bolnikov, vendar zaradi človeških in socialnih razlogov vodstvo raje pusti čas okrevanja, kot je; (c) proces je povezan z nekaterimi zamudnimi aktivnostmi, ki se izvajajo v drugih oddelkih in predstavljajo ozko grlo procesa.

**Sklepi:** Ugotovljeno je bilo: (a) BPM je primeren postopek za izvedbo izboljšanja zdravstvenih procesov; (b) prenovljena metodologija TAD se je pokazala kot učinkovita pri izvedbi identifikacije, modeliranju in izboljšanju procesov; (c) proces "Izvedba operacije" je učinkovit in ne potrebuje izboljšanj; (d) glede zamudnih aktivnosti se je vodstvo klinike odločilo obravnavati

ta problem z vodstvi oddelkov, kjer se aktivnosti izvajajo.

## Abstract

**Background:** Healthcare processes in hospitals, likewise processes in companies or governmental organizations, may accumulate problems and obstacles over time, which consequently cause the processes to become ineffective. BPM (*Business Process Management*) is an approach to process modeling, improvement and automating, which has been used with great success for process improvement.

**Methods:** This work was to examine the possibility of improving healthcare process by using BPM. To implement BPM ideas, a revised TAD (*Tabular Application Development*) methodology was developed, representing an important contribution to BPM. The first three phases of the TAD methodology were introduced in a step-by-step approach. The first phase deals with process identification, the second develops the "as-is" model, and the third phase discusses process improvement by developing a "to-be" model.

**Results:** We found that (a) the Surgery process is efficient and well organized; (b) patient stay in the Department could be shortened; however for humane and social reasons the leadership prefers to leave the residence time as it is; (c) the process is associated with some time-consuming activities that are performed by other departments and represent the bottleneck of the process.

**Conclusions:** (a) BPM proved to be a suitable approach to implementing healthcare process improvement; (b) the revised TAD methodology was found to be consistent and efficient in performing BPM approach; (c) the Surgery process was found to be effective and no changes or improvements are needed; (d) concerning time-

consuming activities, the leadership decided to discuss this problem with the management of the departments where the activities are carried out.

# 1 Introduction

Throughout the last years, the field of BPM has been gaining recognition and acceptance. This field includes process modeling, improvement and automating. BPM is the discipline of modeling, automating, managing and optimizing business processes throughout their lifecycle to increase profitability.[1] BPM is based on the fact that a business process is the key element of the organization.

The process is comprehended as a transformation of inputs to outputs.[2] We are focusing on processes regardless of the organizational form of the research institutions.[3-5] It is the business processes that are the key element when integrating an enterprise.[6]

The aim of this paper is to show the possibility of using the BPM approach to improve healthcare processes in hospitals. The paper focuses on modeling and improvement of a healthcare process using the revised TAD methodology. Evaluation of a patient's health status is an essential part of the healthcare process.[7]

The paper is divided into 4 sections. In Section 2, TAD methodology is discussed. Section 3 represents the results of this work. Section 4 introduces some conclusions. Throughout the paper, the healthcare process of carrying out surgery in the Department of Abdominal Surgery of the University Medical Centre Ljubljana, Slovenia, is illustrated.

# 2 TAD Methodology

TAD methodology consists of five phases;[8] these are process identification, process modeling, process improvement and innovation, system development, and system maintenance. Due to space limitations, the last two phases that deal with process management system, are not considered.

## 2.1 Phase 1 – Process identification

The first phase of TAD methodology deals with identifying the organization's processes starting with core processes, where we do not differentiate between profit or non-profit organizations. The expected number of core or major processes that pass through different functional areas of an organization may be between 10 and 20.[9]

These are horizontal processes that link together the various functional activities that deliver the output of the enterprise.[10] Business process is a collection of activities that takes one or more kinds of input and creates an output that is of value to the customer.[11]

In this phase, a number of interviews are organized with the management at the strategic, business and operational levels. The purpose of the interviews with strategic management is to understand to gain information about the strategic goals of the management and information about the structure of the organization.

Interviews are continued with management at the business level. The purpose of these interviews is to identify the processes of the organization. The result of these interviews is a list of processes, information about the departments through which each process passes and plan of interviews with responsible people at departmental level.

The aim of organizing interviews at operational level is to define the flow of each process identified through various functional areas (departments).

*Surgery Process*: During interviews with the management of the Department of Abdominal Surgery one process was selected, i.e. Surgery. This process is carried out in the following three departments: the Outpatient Service, the Emergency Unit and the Department of Abdominal Surgery.

## 2.2 Phase 2 – Process modeling

The second phase of TAD methodology deals with developing a process model for each process selected in the previous phase.

Conceptual modeling of business processes is deployed on a large scale to facilitate the development of software that supports the business processes, and to permit the analysis and re-engineering or improvement of them.[12] Furthermore, business process modeling is one of the requirements of ISO 9000 international standard for quality management and assurance.[13]

To sufficiently define a process, firstly the process activities and their resources need to be identified, and then the sequence order of the identified activities needs to be established. A process model is a logical representation of a real process that describes its functioning and interactions with its environment. A process model consists of a set of activities and execution constraints between them.[14]

Developing a successful process model depends on appropriate selection of available modeling techniques. For this purpose, in this work a special modeling technique called the "Activity Table" is used.

In order to develop a process model that represents a true likeness of the existing reality of the process, the state of the art of the process should be first discovered and understood.

In this phase, the Activity Table, which represents process model, is developed. This table consists of two parts. The second part provides information about each activity of the process.

### 2.2.1 Activity Table Development – Part 1

The first part of the table is a tabular-graphical representation of the process discussed. To develop the activity table, information about process functioning should be gained during interviews that are organized with experienced employees in different departments. The activity table of the process selected represents its "as-is" model. This sub-phase has three steps.

*First Step*

In this step, the name of the process is written in the first column of the first part of the Activity Table, see Table 1. If the process is large and complex, then it may be partitioned into a set of sub-processes, which are in this case listed in the second column of the table.

*Second Step*

Each business process consists of a number of work processes. Therefore, in the "Work Process" column of the table (usually the second column), all work processes of the process are indicated.

For each work process listed, in the first row of the table, the name of the department to which the work process belongs should be written, see Table 1.

*Third Step*

A work process is a process that consists of a set of activities performed within a certain department. This step deals with identifying the activities performed within each of the work processes listed in the previous step.

An activity is a micro-process that represents well-defined work performed by one resource.[15] An activity may consist of a number of tasks.

To identify the activities, further interviews are organized with the employees involved in performing them. To do this, the following procedure is used:

- identify all activities that are performed within the framework of each work process;
- for each activity identified
  - define the activity in the Activity column;
  - indicate the resource that performs the activity in a certain column of the second row of the Activity Table under the department in which it is employed;
  - connect the activity to its predecessor activity or activities by vertical arrow(s);
  - if the activity consists of tasks, then list them in the next Task column and use similar rules as in the previous three to connect them.

The Activity Table technique uses a small set of flowchart symbols to model a process, such as: ○, ◎, □, ◊, │, →, ←, ↓, ↑. These symbols have the following meanings:

- symbol ○ indicates the starting point of a process;
- symbol ◎ indicates the end point of a process or a certain path;
- symbol □ in cell(i,j) means that resource(j) performs activity(i), where j ranges from 1 to the number of resources and i ranges from 1 to the number of activities;
- symbol ◊ in cell(i,j) means that activity(i) is a decision activity;
- symbol │ is used to fork outputs of an activity or merge inputs of different activities;
- horizontal arrows →, ← are used to connect the activities horizontally;
- vertical arrows ↓, ↑ are used to link the activities vertically;
- symbol * in cell(i,j) and cell(i,k) mean that activity(i) could be performed by resource(j) or resource(k).

*Surgery Process*: Table 1 introduces the Activity Table – Part 1 of the Surgery process. This table represents the process's "as-is" model. As Table 1 shows, the process comprises 7 work processes, 54 activities, and 13 resources that belong to 3 departments, and 2 external resources.

### 2.2.2 Activity Table Development – Part 2

Simultaneously with Part 1, Part 2 of the Activity Table is developed. The purpose of this part is to describe the process model introduced in Part 1 by providing detailed information of its activities. In the current sub-phase a number of parameters that describe the activities are defined.

### Activity Parameters

In the columns of the Activity Table – Part 2 the following parameters are defined for each activity(i), where i ranges from 1 to the number of activities.

- *Description*. A short and precise description of what exactly is the work carried out by the activity defined in row(i) of the table.

- *Time*. The expected duration needed for activity(i) to be processed and accomplished.
- *Rule*. One or more constraints or rules that must be met in order for activity(i) to be performed.
- *Input/Ouput*. Input(s) and ouput(s) of activity(i) .

*Surgery Process*: Table 2 shows the Activity Table – Part 2 of the Surgery process. Due to space limitations, only the activities of the first work process are shown.

## 2.3 Phase 3 – Process improvement and innovation

This is the key phase in process management. It is closely connected with customer satisfaction. When the customer is satisfied with the desired output of the organization, then there is probably no need for implementing changes in the organization. Otherwise, when the organization discovers the customers' dissatisfaction, then the business processes need to be improved or innovated as soon as possible.

Process improvement is a complex task that may function only if it is continuously planned and implemented. Continuous business process improvement should result in a 10–15 % yearly ongoing improvement in the process.[16]

Process improvement is done on the basis of a precise analysis of the "as-is" process model, which consequently leads to developing a "to-be" process model that is implemented in the end instead of the old process.

### 2.3.1 "as-is" Process Analysis

The aim of this sub-phase is to examine the behavior of the "as-is" model and identify its existing problems. If making changes in the process functioning solves the problems found, then the process improvement is the approach used. Otherwise, if the process requires radical changes, then process innovation is the right solution. This sub-phase consists of four steps.

### Process Simulation

A process may accumulate many problems that lead to its inefficiency and con-

| Healthcare Process | Work Process | Activity | Departments | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Outpacient service | | | | Emergency unit | | | Abdominal surgery | | | | | | | |
| | | | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. | 13. | 14. | 15. |
| | | | Admin | Nurse | Surgeon | Anaesthaesist | Nurse | Admin | Surgeon | Main Nurse | Nurse | Nurse_Intensive care | Admin | Surgeon | Anaesthetist | Other departments | Patient |
| | Presurgery | 1. First medical check | | | | | | | | | | | | | | | |
| | | 2. Get first examinition appointment | | | | | | | | | | | | | | | |
| | | 3. Register patient | | | | | | | | | | | | | | | |
| | | 4. Examine patient | | | | | | | | | | | | | | | |
| | | 5. Write report | | | | | | | | | | | | | | | |
| | | 6. Get medical findings | | | | | | | | | | | | | | | |
| | | 7. Check patient and findings | | | | | | | | | | | | | | | |
| | | 8. Decide on surgery | | | | | | | | | | | | | | | |
| | | 9. Get date for hospitalization | | | | | | | | | | | | | | | |
| | | 10. Pre-surgery check | | | | | | | | | | | | | | | |
| | | 11. Pre-anaesthesia patient check | | | | | | | | | | | | | | | |
| | | 12. Additional tests | | | | | | | | | | | | | | | |
| | | 13. Order additional tests | | | | | | | | | | | | | | | |
| | | 14. Wait for surgery | | | | | | | | | | | | | | | |
| | Urgent approach | 15. Register patient | | | | | | | | | | | | | | | |
| | | 16. Get medical findings | | | | | | | | | | | | | | | |
| | | 17. Check patient and findings | | | | | | | | | | | | | | | |
| | | 18. Write a report | | | | | | | | | | | | | | | |
| Surgery | | 19. Register patient | | | | | | | | | | | | | | | |
| | | 20. Patient reception | | | | | | | | | | | | | | | |
| | | 21. Examine patient | | | | | | | | | | | | | | | |
| | | 22. Get medical findings | | | | | | | | | | | | | | | |
| | | 23. Check medical findings | | | | | | | | | | | | | | | |
| | | 24. Decide on surgery | | | | | | | | | | | | | | | |
| | | 25. Send patient to Clinic | | | | | | | | | | | | | | | |
| | | 26. Issue a release report | | | | | | | | | | | | | | | |
| | Hospitalisation | 27. Confirm surgery date | | | | | | | | | | | | | | | |
| | | 28. Patient reception | | | | | | | | | | | | | | | |
| | | 29. View and organize documents | | | | | | | | | | | | | | | |
| | | 30. Fulfill care documents | | | | | | | | | | | | | | | |
| | | 31. Explain surgery | | | | | | | | | | | | | | | |
| | | 32. Sign surgery documents | | | | | | | | | | | | | | | |
| | | 33. Sign anaesthesia documents | | | | | | | | | | | | | | | |
| | | 34. Prescribe medications | | | | | | | | | | | | | | | |
| | Surgery execution | 35. Prepare patient for surgery | | | | | | | | | | | | | | | |
| | | 36. Carry out anaesthesia | | | | | | | | | | | | | | | |
| | | 37. Carry out surgery | | | | | | | | | | | | | | | |
| | | 38. Wake up patient | | | | | | | | | | | | | | | |
| | Intensive care | 39. Place in intensive care | | | | | | | | | | | | | | | |
| | | 40. Prescribe therapy | | | | | | | | | | | | | | | |
| | | 41. Additional tests | | | | | | | | | | | | | | | |
| | | 42. Order additional tests | | | | | | | | | | | | | | | |
| | | 43. Carry out care | | | | | | | | | | | | | | | |
| | | 44. Check recovery | | | | | | | | | | | | | | | |
| | Recovry | 45. Place in Clinic | | | | | | | | | | | | | | | |
| | | 46.Prescribe therapy | | | | | | | | | | | | | | | |
| | | 47. Additional tests | | | | | | | | | | | | | | | |
| | | 48. Order additional tests | | | | | | | | | | | | | | | |
| | | 49. Carry out care | | | | | | | | | | | | | | | |
| | | 50. Check recovery | | | | | | | | | | | | | | | |
| | Release | 51. Inform about release | | | | | | | | | | | | | | | |
| | | 52. Prepare release report | | | | | | | | | | | | | | | |
| | | 53. Need transport | | | | | | | | | | | | | | | |
| | | 54. Organize transport | | | | | | | | | | | | | | | |

**Table 1:** Activity Table – Part 1

sequently the creation of queues within it. An effective way to discover its real functioning is to use the simulation technique. Furthermore, conducting a precise analysis of the simulation results enables us to identify problems and obstacles in the process.

A simulation is the imitation of the operation of a real-world process or system over time. A discrete system is one in which the state variable(s) changes only at discrete set of points in time.[17]

Simulation is a technique that enables us to imitate a real process by developing its model whose attributes are the same as the attributes of the original. For this purpose, real input data is used in conducting experimentation on the overtime behavior of the process.

*Surgery Process*: Figure 1 shows a simulation model of the Surgery process, which was created on the basis of the "as-is" process model given in Table 1. The simulation of the

**Table 2:** Activity Table - Part 2

| Activity \ Parameter | Description | Time | Business Rule | Input/Output |
|---|---|---|---|---|
| 1. First medical check | Administrator registers patient for first med. check | 1 min | Check doctor's order | Doctor's order |
| 2. Get first examinition appointment | Patient gets an appointment date for first medical check | 10-15 min | | Doctor's order |
| 3. Register patient | Administrator in Polyclinic infirmary registers the patient | 10-15 min | Check medical card validity | Doctor's order, Medical card |
| 4. Examine patient | Surgeon examines the patient | 10-15 min | Check patient's medical record | Medical record |
| 5. Write report | Surgeon records information about patient's health and issues med. test orders. Admin. issues a report on the basis of the information recorded | 10-15 min | Issue medical test orders | Medical report, Medical test orders |
| 6. Get medical findings | Infirmary in Polyclinic recieves patient's medical findings | 60-100 min | | Medical finding |
| 7. Check patient and findings | Surgeon checks patient's medical findings | 10-15 min | Check medical findings | Medical findings |
| 8. Decide on surgery | On the basis of the medical findings, surgeon decides whether the patient needs a surgery | 10 min | Decide for surgery if needed | |
| 9. Get date for hospitalization | Administrator informs the patient about her/his hospitalization date | 10 min | | Hospitalization date |
| 10. Pre-surgery check | Surgeon checks patient's medical state before hospitalization | 15-20 min | | Medical findings |
| 11. Pre-anaesthesia patient check | Anaesthetist checks patient's staeprior to hospitalization | 15 min | | Medical findings |
| 12. Additional tests | Surgeon and Anaesthetist may decide for additional tests | 10 min | | |
| 13. Order additional tests | Surgeon and Anaesthetist issue med. orders for additional tests | 10 min | If necessary issue additional med. orders | Medical orders |
| 14. Wait for surgery | Patient waits for the surgery until is called a day before | 1-14 days | | |

process was run taking into consideration the following assumptions.

- Outpatient service
  - 1 patient enters the abdominal surgical infirmary every 25 minutes;
  - 79 % of patients are registered for a first medical examination;
  - 21 % of patients have a medical control after surgery;
  - 90 % of the patients who have the first medical examination are scheduled for surgery;
  - the resources in this infirmary are 1 administrator, 1 nurse, 1 anesthetist, another department, and 2 surgeons;
  - waiting for surgery is defined by the function TriangleDist(1, 14, 10), which means the minimum wait is 1, the maximum 14, and the most likely 10 days.
- Emergency Unit
  - 1 patient enters the abdominal surgical infirmary every 60 minutes;
  - 25 % of these patients are sent to the Department to carry out urgent surgery;
  - the resources in this infirmary are 1 administrator, 1 nurse, another department, and 1 surgeon;
- Department of Abdominal Surgery
  - patients are sent to the Department either from the Outpatient Service or Emergency Unit;
  - the capacity of the Department is 75 beds and most of the time it is completely occupied;
  - the number of patients hospitalized daily is equal to the number of patients that are discharged;
  - prior to surgery, every patient needs 1 day for internal cleansing and possibly 1 day for additional medical tests;

- seven resources are defined in the Department, these are 6 nurses, 6 nurses in Intensive Care, 2 head nurses, 8 surgeons, 1 anesthetist, and 1 administrator;
- recovery in Intensive Care is defined by the function TriangleDist(3, 5, 4), which means that the minimum stay is 3, the maximum 5, and the most likely 4 days; and
- recovery in the Department is defined by the function TriangleDist(4, 8, 5), which means the minimum stay is 4, the maximum 8, and the most likely 5 days.

Many interesting simulation results were obtained after running this simulation, Table 3 shows some of them.

*Process Flow*

Process flow starts when a flow unit (job or transaction) enters a process from its environment, continues throughout the process's activities and buffers, and ends when it leaves the process as its output. The flow unit on its way through the process may join other flow units at the end of one or more queues waiting to be processed by the process's activities.

To calculate the process flow, three key measures are used:[18]

- the average flow time or cycle time (T) is the average of flow times (cycle times) across all flow units that exit the process during a specific time span;
- the average inventory (I) is the number of flow units within the process boundaries at any point in time; and
- the average flow rate (R) is the average number of flow units that flow through (into and out of) the process per unit of time.

**Table 3:** Cycle Time

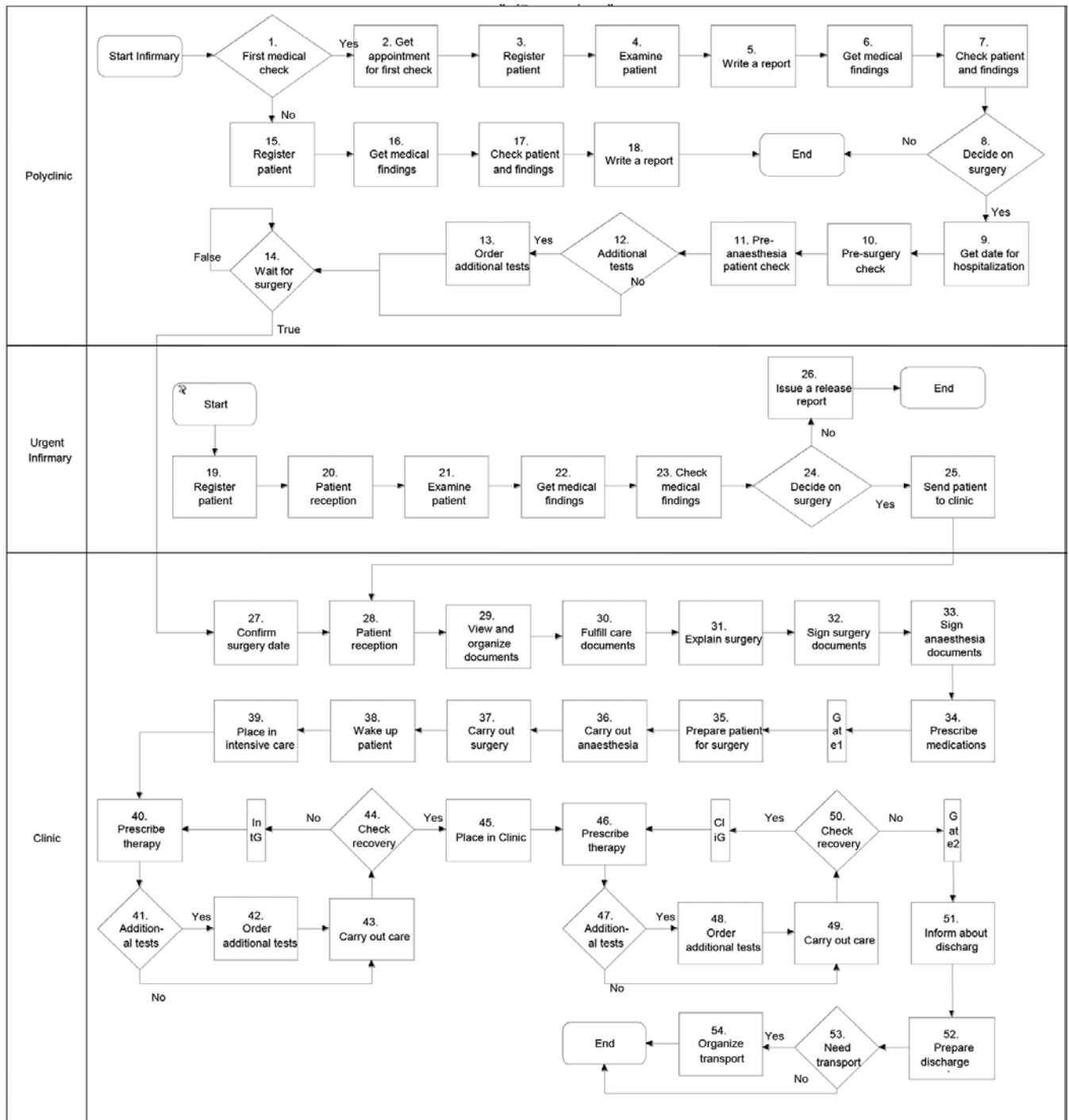| Department | Min Cycle Time | Avg Cycle Time | Max Cycle Time | Avg Wait | Avg Work |
|---|---|---|---|---|---|
| Outpatient service | 3,13 d | 8.09 d | 12,74 d | 7.97 d | 0.12 d (2.97 h) |
| Emergency Unit | 2.38 h | 3.45 h | 5.38 h | 0.70 h | 2.74 h |
| Abdominal Surgery | 7.93 d | 12.05 d | 15.04 d | 10.85 d | 1.36 d |

**Figure 1:** Simulation Model

Process flow is defined by the listed variables, which are calculated using Little's law; see formula 1. Little's law defines the important relationship between average inventory, average flow rate and average cycle time in a stable process.

$$I = R \times T \tag{1}$$

*Surgery Process*: Our main task was to carry out process improvement in the Department. In addition to the simulation results shown in Table 3, the rest of the calculated process performance measures of the Surgery process are shown below.

From the assumptions given in the previous section, we know that the average inventory is 75; this is the number of patients in the Department at any point of time.

Furthermore, the simulation results showed that the average cycle time in the Department is 12.05 days, the minimal cycle time is 7.93, and the maximal is 15.04 days. Therefore, the flow rate (throughput) of the process is calculated using Little's law as follows:

Average R = 75 / 12.05 = 6.22 patients/day

This result means that 6 patients per day enter the process and the same number of patients leaves it.

### Cycle Time Efficiency

A flow unit on its way from the start to the end of a process goes through a sequence of activities and buffers. Thus the cycle time of a flow unit within a process actually consists of the times spent within the process's activities and the waiting times spent in buffers.

In order to calculate the cycle time efficiency, we first need to understand the meaning of term theoretical cycle time. Theoretical cycle time of a process is the minimum amount of time required for processing a typical flow unit without any waiting.[18] The cycle-time efficiency is the ratio between the theoretical cycle time and the average cycle time. This ratio enables us to evaluate the waiting time in the process, which indicates the possibility of carrying out process improvement by reducing the waiting time in it.

Cycle Time Efficiency =
Theoretical Cycle Time / Average Cycle Time
(2)

*Surgery Process*: The simulation results show that the average theoretical cycle time is equal to 1.36 days. Using formula 2 yields:

Cycle time efficiency =
1.36/12.05 = 11.29 %

This result means that the patient waiting time is 88.71 % of the average cycle time of the process. This is an expected result because by waiting time we may understand a patient's waiting and recovery time.

### Process Capacity

The capacity of a process depends on the process resources that perform its activities. In order to understand the process capacity, let us define the following terms:

A resource pool is a group of resources that perform similar kinds of activities. Each member of a resource pool represents a unit of this pool.

The unit load of a resource is the sum of the times of the activities performed by a certain resource unit in processing a flow unit through the whole process.

Capacity utilization measures the degree to which resources are effectively utilized by a process. Capacity utilization is defined for each resource pool.

*Surgery Process*: Table 4 shows the capacity utilization of each resource pool. These values are obtained from the simulation results and apply to the resources' capacity utilization in this process only.

### 2.3.2 "to-be" Process Model Creation

Improvement of the existing "as-is" process is done depending on the problems identified by analyzing the simulation results and the calculated process performance measures. A number of different possibilities should be studied in order to improve the process, such as removing work processes that fit within other processes, minimizing the waiting times, shortening the times of time-consuming activities, and reducing the number of repetition loops.

## 3 Results

Analyzing the simulation results enabled us to identify the following difficulties or problems:
a. a time consuming activity in the Outpatient Service that causes days of waiting, this is the activity "Get Medical Findings", which is indicated by 6 and 16;
b. the same activity in the Emergency Unit, which is indicated by 22, causes hours of delay;
c. in the Department we found that the cycle time of the patient's stay in the Department is relatively long, between 7.93

and 15.04 days, with an average stay of 12.05 days.

In order to find ideas for improvement of the "as-is" Surgery process, we did the following:

- Firstly, we carefully analyzed Table 1. The result of this analysis was that no redundant work processes or activities exist in the Surgery process and also there are no activities whose duration could be shortened.
- Secondly, we tried to find solutions for the above given three problems:
  - concerning problem (a), activities 6 and 16 are performed in other departments of the hospital Institute of Clinical Chemistry and Biochemistry, Institute of Radiology, etc. and therefore these activities were not accessible to our team;
  - the same conclusion is valid for problem (b);
  - problem (c) of the relatively long stay of patients; it was found that the recovery time could be shortened by a few

days but the leadership prefers not to do so because:
- most of these patient are old people and have nobody to take care of them;
- the majority of them have different kinds of abdominal cancer and therefore they need longer recovery times.

## 4 Conclusions

There are a number of techniques that are used to carry out process modeling, such as the Flowchart and UML (Unified Modeling Language).

A flowchart is commonly used to show the flow of a process. It usually consists of different symbols connected by lines. The disadvantage of this technique lays in its flexibility as it allows each modeler to unite various parts of the process together to obtain the whole picture as she/he feels they fit best. In addition, the technique does not have any mechanism for discovering gaps or deficiencies existing in the model developed. For this reason we agree with those researchers

**Table 4:** Average Resource Utilization

| Department | Resource No. | Resource Name | Resource Utilization |
|---|---|---|---|
| Outpatient Service | 1 | Administrator | 58.71% |
| | 1 | Anaesthetist | 76.40% |
| | 1 | Nurse | 57.09% |
| | 1 | Other Department | 99.30% |
| | 2 | Surgeon | 76.02% |
| Emergency Unit | 1 | Administrator | 16.67% |
| | 1 | Nurse | 5.05% |
| | | Other Department | 31.95% |
| | 1 | Surgeon | 25.09% |
| Abdominal Surgery | 1 | Administrator | 23.00% |
| | 1 | Anaesthetist | 24.63% |
| | 6 | Nurse | 39.63% |
| | 6 | Nurse (Intensive care) | 48.76% |
| | 2 | Head Nurse | 45.08% |
| | 8 | Surgeon | 35.30% |

who argue that the flowchart technique is too flexible.[19]

UML uses 14 types of diagrams (7 structure diagrams and 7 behavior diagrams), which makes the modeling process difficult to manage. The purpose of UML is to develop software systems.

Meanwhile, the activity table modeling technique of TAD methodology is less flexible as it allows the modeler to define the business process activities only in connection with resources. In addition, it has a mechanism to discover gaps or deficiencies existing in the table. This is achieved by using the vertical linkage to put the activities in a determined order.

Furthermore, the purpose of TAD methodology is to implement the process management approach, which includes process modeling, improvement and system development.

Implementing the first three phases of TAD methodology enabled us to uncover a number of findings, such as:

a. BPM is an approach that has proved to be an important way to carry out healthcare process improvement and is capable of keeping processes in hospitals as effective as possible.

b. There is no process owner recognized in the hospital, and this role is carried out by the leaderships of the departments. Because the healthcare process may pass across different departments, we suggest that the leadership of the hospital determines a process owner for each healthcare process. The process owner is the person responsible for the process, solves its problems and obstacles, and takes care for continuous process improvement.

c. The proposed concept of TAD methodology was shown to be a consistent and efficient approach that implements process identification, modeling and improvement in an easy manner, particularly after extending it by the use of the simulation technique and process performance measures.

d. The healthcare process discussed was found to be effective and the patients as well as the leadership of the Department are satisfied with it. Nevertheless, there are possibilities for further improvements such as shortening the patient's stay in the Department.

e. The Surgery process is associated with some time-consuming activities, which are performed in other departments. Therefore, the Department has no influence on accelerating their performance.

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