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REDUCING DELAYS IN THE OPERATION PLAN OF A HOSPITAL: THE DIRECT OBSERVATION APPROACH

Abstract: *The efficiency of the operating ward has a significant impact on the financial condition of a hospital. It is estimated, that the operating department provides two-thirds of the income, while generating 40% of the costs. Any delay in the implementation of the operation plan leads to financial losses for the entire hospital. How can these delays be avoided or at least reduced? Using direct observation of the work day of the operating ward in a hospital in Southwest Poland, we have collected a unique dataset on the duration of individual activities. We have identified activities which do not bring any added value, but lie on the critical path of the process, posing a threat to its timely realization. Application of working day snapshot of the entire operating block staff, introduction of time management and implementation of other corrective actions has reduced the delays by 16 percent.*

Keywords: *Working day snapshot; Optimization of activities; Time management; Operating theatre; Critical Path Method (CPM), Project Evaluation and Review Technique (PERT)*

1. Introduction

Provision of high-quality services in the frame of limited resources, in particular financial and personnel resources, is a big challenge in facilities of the generally understood healthcare. It is a significant optimization problem for every healthcare system. Work optimization in hospitals is important, including also operating wards. It is estimated that an operating ward contributes two-thirds of a hospital's income, however, generating at the same time 40% of costs (Denton et al., 2007). Efficiency of operating rooms has always had a material impact on hospital's financial condition (Pham & Klinkert, 2008). Therefore, optimization of duration and the number of surgeries that are to be performed has a material impact on its finances. At the same time, it is closely related with technical, human-resources and financial capabilities of the ward. It should also be remembered that, although it is quite controversial and not acceptable by the society, each hospital must combine the interest and well-being of patients, taking into account the necessity to obtain positive economic result (Niewiadomski, 2017).

Nowadays, medical technology supports the extension of human life and allows it to increase its comfort. This obviously translates into an increase in the demand for medical care services. Managers must look for new solutions to adapt them to the needs of medical units, while increasing their efficiency. Every hospital process should be optimized. Even a small improvement affects the quality of patient care and the financial situation of the entire hospital. The success of any organization depends on the proper use of resources and ensuring the optimal

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functioning of all its processes). Experts (hospital director, operating theatre director and surgeons, operators from the examined hospital) suggest it is necessary to increase outlays for selected areas of activity in healthcare to maximize their quality for patients. Managers are conscious that there will be more work with increased costs. Indeed, the reconciliation of many material, financial and human factors will be a real challenge (Ozcan, 2005; Gür et al., 2019). It is known that in order for the process to function efficiently, all those involved must cooperate. To increase the throughput at the operating theatre, various solutions are proposed and tested. One of them is the implementation of the so-called dashboard, which is supposed to improve the flow of patients based on real-time data about their location (Martinez-Millana et al., 2019). Papiya Bhattacharjee and Pradip Kumar Ray (Bhattacharjee & Ray, 2014) in their work indicate constantly growing costs of healthcare and related necessity of optimal usage of all resources. They suggest application of modelling to manage the patients flow. They say that it is required to reduce costs and simultaneously increase the quality of treatment to patients.

As in every organization, efficiency of the operating ward will depend on skillful time management. A significant part of this is to plan surgeries for next days in such a manner that they are feasible and, simultaneously, that the plan optimizes work of the ward. That requires the management team to possess skills to manage a series of activities and activities that occur in operating rooms. People who take decisions regarding operating wards may be suggested quite a range of methods which support planning of activities taken in operating rooms and successful completion of given tasks within the determined deadlines.

Management of fairly small and fairly not time-consuming projects, in particular at stages of planning of the process structure, its course and resources necessary for its realization, often involves classic Gantt charts. They allow for simple planning and further control of the course of realization of a given project. Similar results are delivered through the Critical Path Method. It was successfully applied worldwide in hospitals already in the nineteen-eighties (Jones, 1984). In the author's opinion, it allows for planning, scheduling and controlling realization of processes taking place in the hospital, in such a manner that the planned activities were realized within deadlines established by the management. This method is, however, less popular in the economic practice of Polish entities since it is necessary to have precise accurate data to perform calculations. However, it enables quite intuitive visualization of the sequence of activities, evaluation of duration of particular activities and definition of activities key for accomplishment of the plan within defined times. What is important, a simple statistical analysis is applied to indicate the possibility to complete the process on time. Such defined issue of dependence between the balance of outlays and results and punctuality of realization of the planned surgeries occurs also in works of contemporary researchers. It is proven for example by the work of Cecília L. and others (Siqueira et al., 2018). The authors, based on the case study in the Brazilian National Institute of Traumatology and Orthopedics, indicate necessary integration of planning work in operating ward with long-term scheduling of work in the emergency ward.

Similarly, as in other projects, and in particular in hospitals, it is inadmissible to lose the quality of performed operational activities. It is desirable, however, to reduce the time of realization of a given surgery on the one hand – to keep the established deadlines, namely realize the daily plan of surgeries, on the other hand, though, not to allow loss of quality of their performance. The more so because shortening the waiting time for health care is an important postulate of patients. In the Fradgley et al. (2018) study 22.3% of respondents indicate it. In order to

solve such situations, it is necessary to use special techniques. One of them is suggested by Kim Jongyul et al (2012) in their work. He proposes to define a certain time-cost compromise with simultaneous maximization of individual quality of activities. It must be remembered that uncontrolled, excessive reduction of duration of project realization may lead to increased costs and risk, as well as to loss of required quality (Mohammadipour & Sadjadi, 2016). A similar thesis is built by Vahid Khodakaram and Abdollah Abdi (Khodakaram & Abdi, 2014) who point special attention to uncertainty of the size of costs that are forecast and assigned to particular tasks in the project. Higher significance is given to planning and scheduling of work of all players of operating ward processes (Yahia et al., 2016; Dios et al., 2015; Xiang et al., 2015; Martinelly et al., 2014).

Surgeries are characterized with a certain dose of recurrence, i.e. subsequent projects (surgeries) have identical or similar units, in which activities repeat from one unit to another, require schedules which guarantee constant usage of resources (in hospitals in particular human resources) from one unit to another and maintenance of the system logic between activities at the same time. The problem becomes even more complicated and more difficult to plan in line with growth of the number of factors considered by researchers. As presented in the literature, these factors have various influence on the course of processes occurring in a hospital's operating ward. They are not always fully predictable. Also, specificity of work in an operating ward is reflected in occurrence of unexpected events. A part of such factors in many researches is ignored due to excessive complexity of projects (Ozkarahan, 2000; Testi et al., 2007; Marques et al., 2012). In such a situation it is difficult to precisely define the duration of particular activities. In such cases the literature proposes application of fuzzy numbers in order to indicate durations of particular activities (e.g. Shih-Pin, 2007; Lahijanian et al., 2016). Data for calculations are taken from data bases existing in hospitals (e.g. Marques et al., 2012). Such approach to collection of data is, of course, right, calculations are based on reliable historical data. However, on the other hand, this is only data, in such case there is no possibility to make additional observations. It appears from the research presented in this article, indeed, those additional observations have the substantial impact on results of the analysis. They have a huge impact on the conclusions from the research.

The presented research has important and varied contributions to the literature on management issues, quality and optimization of activities. Fill in the gap indicating the importance of personal observation of the studied phenomena. They indicate the possibility of overestimating research based on historical data. In this study the analysis of historical data of the surgical ward did not give an answer to the question posed for the study. A research using a working day snapshot of the whole personnel in an operating ward, which was pioneering worldwide, is of special importance in our study. Thanks to that the authors collected actual data concerning durations of particular activities in the process. Personal conduct of the research directly in the operating ward allowed the authors to observe many various phenomena that, as appeared, have significant impact on performance of the operating ward. Any calculations performed are based on real actual durations of particular activities of the surgery process.

Another significant factor is the fact that the research was conducted in a recipient-friendly manner which brought work of the operating ward isn't closed to people. For example, it appears that, in contrary to general opinions, sudden unexpected events occur very seldom. The applied methodology used in this research allowed the authors to precisely reflect activities being a part of the defined project, namely one surgery occurring in one operating theatre with pre and post-surgery activities. Additional

interviews and analyses of documentation allowed comparison, verification and possible correction of the defined activities in a project. As a result, it was possible to reliable define durations of particular activities and identify data deviating from others and its correct interpretation.

Chapter 2 brings the reader closer to specificity of work in an operating ward and presents the methodology applied in the research. It includes also a description of data and its sources. Chapter 3 presents results of the empirical research and its analysis.
The last chapter presents conclusions from the researches and suggestions, topics for further research and questions the authors intend to raise in future projects.

2. Methodology

2.1. Specificity of work in an operating ward

Work in an operating ward in a selected hospital is performed in line with a schedule, being a pre-defined surgery plan. The surgery plan defines the commencement date of each surgery that will be carried out. The whole surgery process includes activities performed before, during and after the surgery. Chart 1 illustrates these three groups of activities, taking into account the place of their performance and required medical personnel.

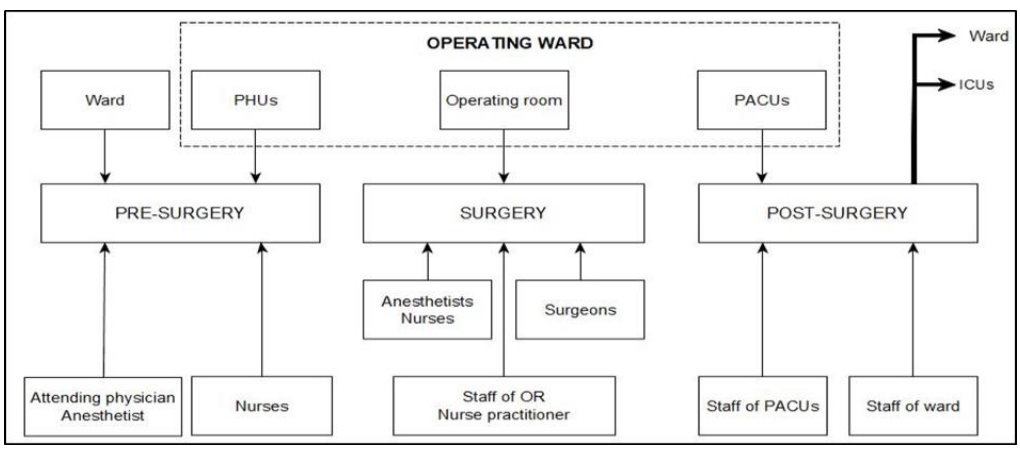


Chart 1. Preoperative, operative and post-operative activities occurring in an operating ward

It should be noticed that an operating ward is an organizational unit whose structure is incredibly complex and at the same time dependent on many aspects of work of the whole hospital. It encompasses cooperation of many professional groups, including: operating room nurses, anesthesiologists, operators of various specializations and associated personnel (e.g. paramedics, cleaning personnel). Particular professional groups create one big operating team with a shared objective being secure performance of operative and perioperative procedures. Consequently, it is to lead to obtain possible optimal results of the treatment (Ciuruś, 2016; Klarman, 2017; Trzebicki, 2017).

The operating ward in the regarded hospital composes of eight operating rooms functioning from Monday to Friday from 7:25 am to 3:00 pm. On Sundays and holidays and on working days from 3:00 pm to 7:25 am there is one operating room available. Procedures applicable in that operating ward assume:

- 7 hours 35 minutes (455 minutes) – working time of each operating room (all surgeries on a given day in one operating room),

- performance of three surgeries in one operating room on one working day.

The total theoretical availability of the operating ward is 303 hours and 20 minutes a week. The ward is used mainly by six specializations: general surgery, orthopedics, vascular surgery, gynecology, oncology, and urology. According to the researches performed by the authors, despite efforts of the personnel, not all surgeries planned for a given day are performed.

2.2. Defining the Problem

The purpose of the conducted research was to check why the daily plan of operations on the operating ward is not implemented? Then time standards were set for process occurring in one operating room of an operating ward of a selected hospital within one working day. It was assumed that a process is one surgery with pre- and post- surgery activities. According to the procedures within one working day in one operating room there should be three surgeries performed, i.e. three processes should occur. The researched operating ward, despite theoretical possibilities, did not realize the assumed daily surgery plan. It brought losses to the hospital, both financial and reputational. It was related with large problems and impediments for patients. Queues of patients waiting for surgeries were becoming drastically longer and longer.

There were fundamental questions posed regarding this process. Which activities are critical, namely activities whose failure to perform in a defined time results in a delay of the whole process? What is the expected duration of realization of the whole process and what is its variance, i.e. expected deviation from the actual time of performance from the expected time? What is the likelihood of performance of the process in time not longer than specified in the procedures? Are there activities whose duration may be reduced, thus, reducing duration of the whole process?

The research included several stages (Chart 2). It was decided to apply several methods. There was a working day snapshot taken to gather necessary data. At each stage there was an analysis performed of the medical documentation and interviews conducted with experts (hospital director, operating theatre director and surgeons, operators, operating room nurses from the examined hospital) and competent persons in the operating ward. The gathered data was subject to statistical analysis. Finally, it was decided to apply the PERT method (Program Evaluation and Review Technique) in order to indicate the critical path and define the time standards for performing work in one room of one operating ward.

The research that provided data for the analysis was carried out in August and September 2016 and consisted of a snapshot of a working day of the whole personnel engaged in the course of processes occurring in the operating ward of the selected hospital. There was an original sheet developed dedicated to that research. A part of it is presented in Picture 1.

It includes all activities performed during an operating ward process. It was used to register commencement and completion times of those activities. The gathered data was used to calculate empirical durations of particular process activities. There was one process selected and determined for the research, which was defined as: a process including performance of one surgery in one selected operating room with all required preoperative and postoperative activities.

The proposed method of working day snapshot with the use of direct observation approach was successfully used in research related to health protection giving very good results (Kopp et al., 2006).

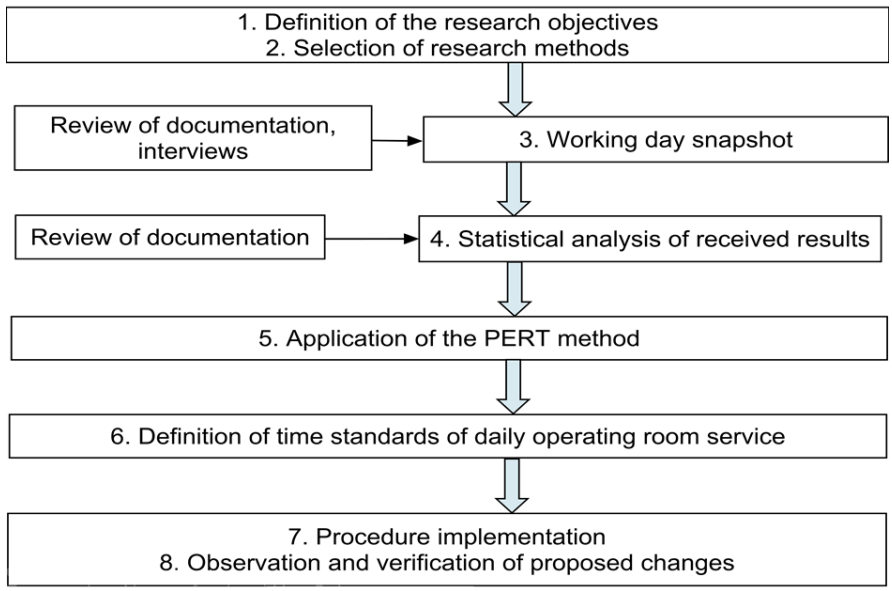


Chart 2. Scheme of the applied research methodology

Date				
Room 1				
Surgery No.	Planned/Emergency	surgery name		
	start time	end time	No.	Activity
Preparation time		----------	1.	taking in the patient to the ward
			2.	the ward accepting the patient
			3.	taking the patient to the waiting room
			4.	preparing the patient by the team of anaesthesiologists
			5.	preparing the operating room by the operating room nurse
Surgery time		----------	6.	patient's entry to the room
		----------	7.	entry of the anaesthesiologist
		----------	8.	entry of the operator
			9.	SURGERY

Picture 1. Sheet for the research of the working day snapshot of the operating ward personnel (part)

2.3. Critical path of the project occurring in one selected room of an operating ward

There was an analysis carried out of a project occurring in a room of the operating ward. The sequence of performance of particular activities was defined. The starting point was to draw up a list of activities with their durations. It was done based on the working day snapshot made by the project authors in the operating ward of the selected hospital. Table 1 includes procedural activities, namely those which must be performed in the operating ward, and the manner of their performance is described in the operating ward procedures. All those were also identified during the research and their commencement and completion times were registered. Also, the sequence of performing these activities was defined, as well as activities preceding each activity. The developed network of activities was presented to experts (operating ward manager, operators, and operating room nurses) in order to re-verify their substantial correctness. There were no corrections or adjustments made. Actions observed in the empirical research were compliant with those

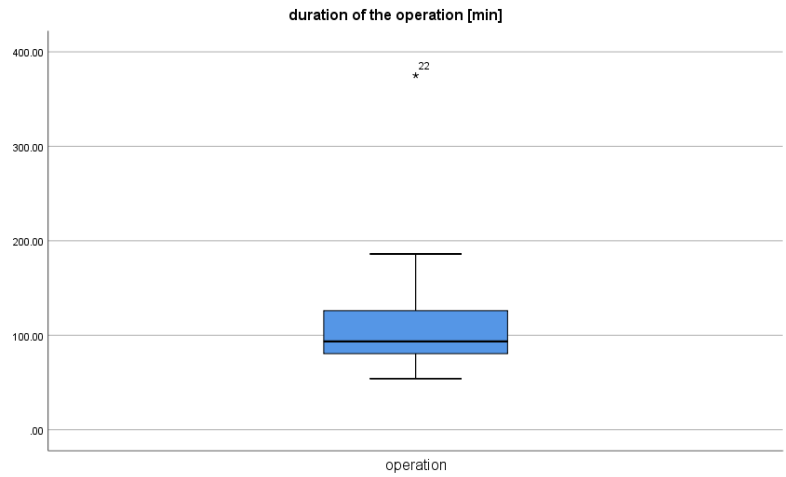
indicated in the procedures and those discussed with the experts from studied hospital (operating theatre director and operating room nurses). Durations of particular activities of the whole project were calculated (in minutes, rounded up).

Table 1. Procedural tasks – activities composing one surgery occurring in a selected operating room of an operating ward, with the preceding activities

Action	Action description	Preceding activity
A	Taking over the patient to the operating ward by operating room nurses and taking him to the waiting room	--------
D	Preparing the operating room by operating room nurses	---------
E	Preparing instruments in the operating room by the operating room nurse	---------
B	Preparing the patient by the anaesthesiologist team	A
C	Preparing the patient by the nurse in the preparatory room	A
F	Taking in the patient to the operating room (time between the patient's readiness in the waiting room and taking the patient to the operating room)	B, C, D
G	Anaesthesia	E, F
H	Performing the surgery (duration is counted from cutting the patient until suturing)	G
I	Filling in documentation by the anaesthesiologist	H
J	Filling in documentation by the operating room nurse	G
K	Postoperative activities with the patient performed in the operating room	H
L	Taking the patient to the recovery room	K
M	Postoperative activities performed by operating room nurses in the operating room	K
N	Preparing instruments for sterilisation by operating room nurses	H
O	Cleaning of the operating room by the cleaning personnel	I, J, L, M, N

Bearing in mind the multiplicity of factors that have influence on work in the operating ward, their degree of complexity, it should have been checked whether any of them may be excluded so that calculations become more transparent. There were so called emergencies identified that require immediate surgical intervention as those whose occurrence may disturb work of the operating ward. Frequency of occurrence of such events and their duration should have been checked in order to interpret them in the further research. It turned out that during the research such event occurred only once and was cancelled after a dozen of minutes or more. At the same time, usage of the gathered data in further analysis was preceded with its statistical analysis. There were charts and descriptive statistics of variables prepared.

Example charts are presented in Picture 2. Thanks to that, one could have taken detailed assumptions as to the manner of calculating time required to apply the PERT method. For example, analyzing the box plot graph of the activity 'surgery', it may be noticed that extreme situations when a surgery lasts longer than planned, occur, but very rarely. During the described research such situation occurred only once – deviating observation No. 8, duration of the surgery was then 375 minutes. It was, therefore, assumed, that such situations occur very rarely. It was confirmed by the analysis of medical documentation and interviews with the medical personnel of the operating ward.



Picture 2. Box plot graph and descriptive statistics for the variable 'surgery'

3. Results

As a result of the research in person using the snapshot of a working day and own observations, certain activities have been identified. They do not add value to the process and consume a significant unit of time. These actions are undesirable and are not procedural. One should strive to eliminate them from the process. They were called additional activities in this study. It should be emphasized that their identification would not be possible if the study was based on data collected from the hospital's database. Table 2 presents the observed 'additional' activities which may be identified among the process activities with their durations. The description of activities includes also example events clarifying how and why those 'additional' activities occurred in the first place. The reasons for their occurrence are various and without observation of the actual work, there is no possibility to spot them. Taking numeric data from the computer system, the researchers would not be able to identify them.

In the applied PERT method there were three estimations used for duration of particular activities. The following assumptions were taken as to the calculations:

- optimistic time (t_a) – assumes no sudden and unexpected incidents, time of deviating observations was excluded, there are no 'additional' activities – their duration time was excluded;
- most likely time (t_m) – was assumed as time of realization of activities in standard conditions, i.e. time of 'additional' activities was reduced by 50% (as it was already mentioned, the authors, having analyzed the documentation and after consultations concluded that the identified 'additional' activities cannot be completely eliminated, for the purpose of this research, this time was reduced by half), in all activities occurring in the project, the duration of the deviating observations was replaced with their average values;
- pessimistic time (t_b) – assumes possible sudden and unexpected incidents which influence extended duration of activities, calculations of the averages included also all occurred 'additional' activities and deviating observations.

Table 2. "Additional" activities – "non-productive" observed in an operating room of an operating ward

Activity	Description of the 'additional' activity	Activity including the 'additional' activity	Average time [minutes]
I	Patient waiting to be taken in the waiting room reason: e.g. lack of patient's documents	A	15
II	Waiting for the first anaesthesiologist reason: occurs only before the first surgery as anaesthesiologists have the morning briefing at 7:30 am	B	12
III	'Prepared' patient's waiting to be taken in the operating room (time between completion of anaesthetic preparation and taking the patient in the operating room) reason: e.g. unprepared room, unprepared instruments, no instructions,	F	11
IV	Waiting for the operator reason: e.g. the operator is in the ward, fills in documentation,	H	17
V	Waiting for the cleaning service reason: e.g. cleaning rooms as they are located, not according to priorities	O	12
VI	Change of surgeries in the daily plan, related with e.g. change of instruments	F	8

The procedure assumes that distributions of likelihood of the time of realization of particular activities are beta distributions, therefore, the expected time of realization of particular activities was defined with the formula:

$$t = \frac{t_a + 4t_m + t_b}{6} \quad (1)$$

Variance was calculated with the formula:

$$\sigma^2 = \left(\frac{t_b - t_a}{6}\right)^2 \quad (2).$$

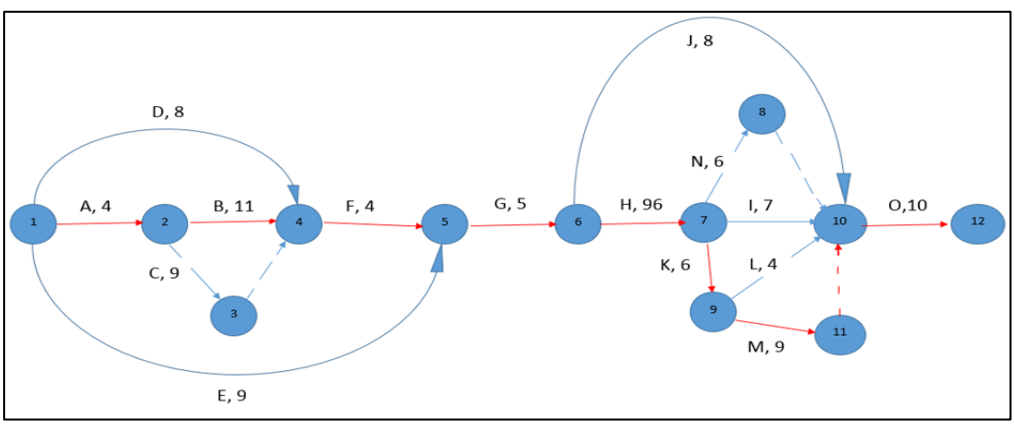
Duration of activities calculated in this way, together with the expected time of particular activities and variance are presented in Table 3.

Colored cells – marked critical path of the project, namely the series of those activities whose duration is the longest and for which the time reserve R is zero. Its calculation included expected durations of particular activities. The project, together with the defined critical path, was presented in a form of a network diagram presented in Picture 3.

The arches stand for activities, peaks of the activity (numbered in line with topological structure), which mean the start and finish of particular activities. Over the arches there are symbols placed of particular activities and the expected time of their duration. Arches marked with a dotted line stand for apparent actions, their purpose is only to enforce the order of realization of activities, their time equals zero. The identified critical path was marked in red.

Table 3. Procedural activities with their durations (optimistic, likely and pessimistic) and variance and critical path

Activities	Optimistic time (t_a) [minutes]	Most likely time (t_m) minutes]	Pessimistic time (t_b) [minutes]	Expected time (t) [minutes]	Variance σ^2
A	2	2	12	4	2.78
B	10	11	20	11	2.78
C	7	9	9	9	0.11
D	6	7	15	8	2.25
E	7	8	14	9	1.36
F	2	3	5	4	0.25
G	2	4	10	5	1.78
H	82	94	114	96	28.44
I	7	7	7	7	0.00
J	8	8	8	8	0.00
K	4	5	9	6	0.69
L	2	3	5	4	0.25
M	5	9	12	9	1.36
N	5	5	8	6	0.25
O	7	9	12	10	0.69



Picture 3. Technological-organizational structure of a process occurring in one operating room within one working day with the critical path (red) – PERT method, expected times.

Results of the calculations:

1. The expected time for the critical path is 145 minutes – was calculated according to formula No. 1.
2. The variance for the critical path is 38.78 and the standard deviation: 6.23 – the values were calculated based on the formula No. 2.
3. The critical path is defined with the activities: A, B, F, G, H, K, M, O.
   Activities in the critical path are:

A – taking over of the patient to the operating ward by operating room nurses and taking him to the waiting room, there is also an 'additional' activity, I, included in this activity including the patient's waiting to be taken to the preparatory room,

B – preparing the patient by the team of anesthesiologists, includes an 'additional' activity, symbol II, including waiting for the first anesthesiologist,

F – taking in the patient to the operating room (time between the patient's readiness and taking him in to the operating room), includes an 'additional' activity, symbol III, being the 'prepared' patient waiting to be taken in the operating room and an 'additional' activity IV including change of a surgery in the daily surgery plan,
G - anesthesia,
H – performance of the surgery (time of the surgery is calculated from cutting the patient to suturing), includes an 'additional' activity, symbol IV including waiting for the operator,
K – post-operative activities with the patient performed in the operating room,
M – post-operative activities performed in the operating room by operating room nurses,
O – cleaning of the operating room by the cleaning personnel, includes an 'additional' activity, symbol V including waiting for the cleaning service.

As critical activities do not allow any flexibility in scheduling, a delay in any of them will certainly delay accomplishment of the whole single process defined in the operating room. Therefore, it will disturb realization of the daily surgery plan. It should be emphasized that a delay in one room adversely influences work of the whole operating ward;

4. It becomes significantly more and more important that those 'additional' factors were identified. As it was proven, they do not bring added value to the process. Unfortunately, their occurrence brings along large threat in a form of material impact on delay in the process. As it was shown in the research, in majority of cases they lie in the critical path. Due to the fact that they not always occur and that they are not procedural activities, they were not defined as separate activities. It was defined which procedural activities they are a part of. Due to that reason, only thanks to taking the snapshot of a working day in the operating ward, their identification was possible.
5. Table 4. presents results of the performed simulations regarding the likelihood of accomplishment of the project in the defined time, not longer than 150, 155 and 160 minutes. The likelihood of accomplishing the project within 150 minutes, based on the simulation, is around 79%, and within 160 minutes the likelihood grows up to 99%. The calculations of the likelihood of accomplishing the project within the defined time show that there is high probability of accomplishment of the operating ward procedures assuming realization of three surgeries in one operating room within one working day.

Table 4. Likelihood of realization of the project in the predefined time

```
> pnorm(150,145,6.23)
[1] 0.7888878
> pnorm(155,145,6.23)
[1] 0.9457681
> pnorm(160,145,6.23)
[1] 0.9919734
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Basic corrective actions were introduced, which did not require financial outlays from the hospital. In a short time this allowed to reduce delays in the implementation of the daily plan of operations by 16 percent. The actions implemented together with the achieved goal:

- release of anesthesiologists participating in the first operation on a given day from morning check-in - delays in starting the first treatment on a given day were removed,

- instruction of the cleaning staff about the need to clean the rooms according to the schedule of the next operation - the waiting time for the cleaned up room has been reduced,
- informing the cleaning staff in advance about the operation that will cause the room to be shut down for the rest of the day, cleaning of such a room takes place after cleaning the remaining ones the waiting time for the cleaned up room has been reduced,,
- receiving a plan of operations for the next day by 12 o'clock (so far it was about 2 p.m.) allowed for more efficient preparation of both personnel and necessary equipment for next day.

Of course, there are side effects that require cooperation of other hospital organizational units. Corrective actions will be jointly developed and implemented at a later date. However, it can be said that the biggest problem causing the failure of the entire operational block of the examined hospital is, of course, the lack of sufficient auxiliary and medical staff. It is unfortunately not possible to replace it in a short time due to financial reasons as well as the lack of appropriate staff.

In the conditions of the research performance of the plan in the given 150 minutes is a problem. It appears that reduction of a given process by 'only' several minutes may give measurable effects. According to the research, one needs to have at least 160 minutes to have the plan highly probable. Saving those several minutes is possible if there are 'additional' activities identified in the facility, and later, actions undertaken aiming at their elimination or minimization of their duration. Of course, it should be here assumed that no unexpected incident occurs, i.e. a sudden accident and required urgent surgery that was not planned. This data shows only the possibility of realization of three planned surgeries. Based on own observations by the authors one may almost be certain, that some of the 'additional 'activities will occur and will disturb this schedule. Therefore, it is so important to identify them and then implement correction and preventive measures.

As it was noted before, 'additional' activities do not bring any value for the project, and even deregulate it, are redundant and incompliant with the regulations. However, own studies and deepened analysis of work in an operating ward confirm the authors' conclusions that its complete elimination is not possible. This is confirmed by experts from examined hospital (operating ward manager, operators, and operating room nurses). It is impacted by both the financial and personnel policy of the hospital, which to a large extent is dependent also on the policy of the country in that scope. Despite this, one should pursue maximum elimination of these activities from the project, and if they occur, minimization of their duration. It should also be noticed that work in the operating ward requires close cooperation of all people engaged in that process and coordination of their work. That regards not only the very operating ward, but also other organizational units which have their share in and influence on work in the hospital's operating ward.

The results obtained may not be a direct basis for optimizing operations at every operating ward of any hospital. However, they provide a good basis for other entities to recognize their own problems and identify critical and unnecessary actions. However, it should be remembered that hospitals in each country operate under specific legal, economic and financial conditions, which unifies their functioning. Research focuses on only one hospital from Poland, however, all public hospitals in Poland operate on the same principles set out by government laws (also in other countries they are similar, e.g. in Spain). This has a major impact on the way work is organized at the hospital's operating suite. For example, in all public hospitals, the way of employing surgeons is the same, i.e. they are

employed full-time in their home hospital departments, and work in the operating theatre is an extra job. They come to the operating theatre at designated times only when they have scheduled operations.

In each unit, you can observe the working day along with a snapshot test. In particular, it is recommended where there are irregularities, delays in the implementation of the operation plan, and managers are interested in finding the reasons for this situation and implementing improvements.

4. Discussion of findings

This article presents results of the research that was conducted in the operating ward of the selected hospital. The aim of study was to check, why the daily schedule of operations is not executed in the studied hospital? For this purpose we were to identify activities which occur in the project which was defined as one surgery in a selected room of the operating ward. Then, the authors defined critical activities which form the critical path for such defined project. In consequence, the authors verified the likelihood of accomplishment of a surgery within the defined time. Procedures of the operating ward assume realization of three surgeries in one room within one working day.

Identification of activities which do not bring any added value to the project but use time units appeared to be key. They were here called “additional” activities. Those activities were identified thanks to performance of the working day snapshot. Only the analysis of historical data did not give answers. There were some activities observed which were identified by the authors as ‘additional’ activities, they are not described in the ward procedures. These activities were defined as ‘non-productive’ as they use time units but do not bring any added value to the process. During in-depth research and numerous consultations with experts from examined hospital (operating ward manager, operators, and operating room nurses) it appeared that they are inevitable, will always occur. Authors of the research decided to separate them all but at the same time leave them in the process as occurring in procedural activities. It appeared that they are a significant part of the process as they are included in activities being parts of the critical path. Their occurrence results in extended time for activities composing a project of one surgery. That results in disturbances in realization of the whole project and, in particular, extension of its duration. After analysis of the data from operating ward documents it appeared that it has a material impact on the failure to accomplish the daily surgery plan. It causes delays in the planned surgeries, longer waiting lists for patients, their discomfort and loss of trust towards the healthcare system. It obviously directly translates to the financial condition of the operating ward, therefore, the whole hospital.

It should be emphasized that, even though it is not possible to exclude these activities completely, one should aim at minimization of their duration. They significantly extend duration of the project, and indeed they are redundant, moreover, having a high impact on failure to realize the daily plan of surgeries. What is worth noticing is the ‘additional’ activity II including waiting for the first anesthesiologist. This characteristic of the occurrence was taken into account for the purpose of this research in such a manner that its duration, when taking into account for calculations, was divided by three (this activity occurs only with the first surgery, whereas, theoretically, in line with the procedures, there should be three surgeries performed in one room of the operating ward). Basic corrective actions were introduced, which did not require financial outlays from the hospital. In a short time this allowed to reduce delays in the implementation of the daily plan of operations by 16 percent.

Improvement of feasibility of the daily plan of surgeries will depend on timeliness of accomplishment of particular surgeries,

namely also on the possibility to minimize occurrence of useless but time-consuming activities. It is, of course, a process strictly related with hospital-dependent capacities in providing material, human and financial resources. For example, hiring more employees entails extra costs. Probably, it will allow more efficient realization of the surgery plan, but it needs to be checked what impact that would have on the financial condition of the operating ward. Therefore, there appears another natural question: is the pursue for minimization, or even elimination of 'additional' activities always cost-effective and always recommended? Another interesting direction for research posed already by the authors is verification whether there is, and if yes – what is, the relation between minimization of the times of particular activities and the whole project and the related costs? One should verify to what extent improvement of feasibility of the daily plan of surgeries is effective from the point of view of incurred costs? It should be remembered that in the current circumstances in which hospitals function, effective operating ward management is not only feasibility of the planned surgeries, but also analysis of costs borne for their realization.

5. Conclusions

Optimization of activities in an operating ward remains an important topic often undertaken by researchers in literature. It needs to be emphasized that it is a difficult topic, requiring cooperation among many people, with a large number of variables and factors, which embrace uncertainty related among others with: frequently unpredictable duration of a surgery, personnel being late, lack of patients' documentation, occurrence of emergencies and many others. Theoretical proof suggests that cooperation and engagement of all groups participating in a surgery process has the potential to reduce duration of particular activities, therefore, the whole surgery process. Mobilization and proper allocation of resources, both material and human, have a chance to have positive impact on the financial performance of the operating ward, which directly influences the financial standing of the whole hospital. The introduction of basic corrective actions, which do not require financial expenditures on the part of the hospital, allowed to reduce delays in the implementation of the daily plan of operations by 16 percent in a short time. An important factor turned out to be the use of a working day snapshot of the entire operating block staff. This allowed to identify activities that are undesirable and unproductive ('additional' activity). The analysis of historical data turned out to be insufficient.

At the same time, it needs to be emphasized that each hospital operates in strictly defined economic and political conditions. Legal regulations and the level of economic system development of a given country, therefore, financial capacities of a given country, have direct influence on the quality of medical care, quality of public healthcare institutions, but also possibilities to optimally use all human and material resources. Time management is key during projects realization. What is important is the time of realization of every surgery, but also each activity being a part of a surgery. Even the slightest optimization of all durations of a single surgery may have significant impact on increase of income of the whole operating ward, therefore, the whole hospital, in the scale of the whole year.

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