

# The Role of Information and Communication Technology in Improving the Financial Performance of Hospitals

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**Summary:** We are witnessing that the healthcare system of the Republic of Croatia is faced with numerous challenges, especially financial ones. Many activities are needed to improve the condition. In this paper, the emphasis is on the application of information and communication technology (ICT) as a tool for reducing costs and increasing income. The hypothesis of the work is that with the help of ICT we can directly, but also indirectly, by applying ICT through the so-called Dynamic Balanced Scorecard (DBSC) to influence business improvement. The DBSC method enables the evaluation of financial operations indirectly through employee education, optimization of business processes and increased patient satisfaction. In addition to the DBSC method, analysis of the collected literature, cost-benefit method and case studies are used to test the hypothesis. Regarding structure of the work, the introduction explains the context of the hospital's operations, defines the goals, hypothesis and research methods. This is followed by a description of the conducted research. The conclusion contains final considerations as well as suggestions for future research.

**Keywords:** Balanced Scorecard; business; costs; hospital income; information and communication technology

## 1 INTRODUCTION

The application of information and communication technology (ICT) in all areas of human activity is indispensable if we want to be efficient and effective. It is the same with healthcare. The subject of the research is the impact of ICT on hospital operations. The research aims to determine whether ICT helps reduce/rationalize costs and increase hospital revenue. The hypothesis is as follows: by applying ICT in the hospital, it is possible to reduce/rationalize costs and increase revenues, i.e., increase business performance. The work uses scientific methods, namely: literature study, observation, measurement, analysis and case study (specifically, the work focuses on the in-depth investigation of the phenomenon - the application of ICT to improve the financial result in the hospital, directly and indirectly, through the dynamic Balanced Scorecard (BSC) method; only the correlation coefficient is used from statistics).

The paper presents in detail the so-called Dynamic Balanced Scorecard (DBSC) method, which is a modification of the classical method. It is explained in detail and it is shown how it can be carried out using ICT. It is important to emphasize that the described research "can be repeated with the same effects". Dynamic BSC represents a scientific contribution because it represents an original way of implementing the BSC method. Dynamic BSC method is used for indirectly confirmation the hypothesis by determining the level of education of employees and their lifelong learning, optimizing internal processes, and increasing patient satisfaction. All of the above brings a better business result. The research will show precisely the parts of the business process in which ICT causes resource savings on the one hand and revenue growth on the other. Through the presentation of results and discussion, we will try to show how it is possible to make savings and increase revenue on a monthly basis. In the end, the conclusions summarize all collected data and give recommendations how

to maximize savings. The following is a description of the research.

## 2 RESEARCH

The survey was conducted in May 2022. Research methods are observation and measurement, and analysis of the obtained results. The research subject is the integrated hospital information system, which consists of several components: hospital, laboratory, radiological, pharmacy, and business information system, nutrition system, and reporting system. All components are integrated at the level of data exchanged between components in the form of XML messages respecting the HL7 protocol. During the research, treating patients "from admission to the institution to discharge" was observed. Furthermore, ICT support in certain parts of the business process was observed, and the cost/benefit method showed savings or revenues caused by ICT. In addition to a direct cost reduction and an increase in revenue, there was also an indirect increase in business performance with the help of Balanced Scorecard method [1, 2].

### 2.1 Description of the Process "from Admission to Discharge"

There are two essential admissions to the hospital: admission to the outpatient department and admission to hospital treatment. Admission to hospital treatment can be planned or urgent (through a unified emergency hospital ward). In the polyclinic, the course of treatment is short: the first control examinations and contracted specialist examinations are performed there. The duration of hospital treatment is two or more days. Both in the polyclinic and in-hospital treatment, diagnostic tests are an indispensable part. The two primary groups of diagnostic tests are radiological and medical-biochemical tests. During hospital treatment, patients were provided with medical materials, medicines,

and meals. Upon admission, referrals are automatically withdrawn from the Central Health Information System of the Republic of Croatia (CEZIH), and upon discharge, there is, i.e., a discharge letter sent to CEZIH. All treatment costs are transferred to the invoice and sent to the Croatian Health

Insurance Institute or are invoiced to the patient if there is no health insurance.

Through observation and measurement, elements of the described business process have been identified in which ICT helps reduce/rationalize costs and increase revenues. More details are below.

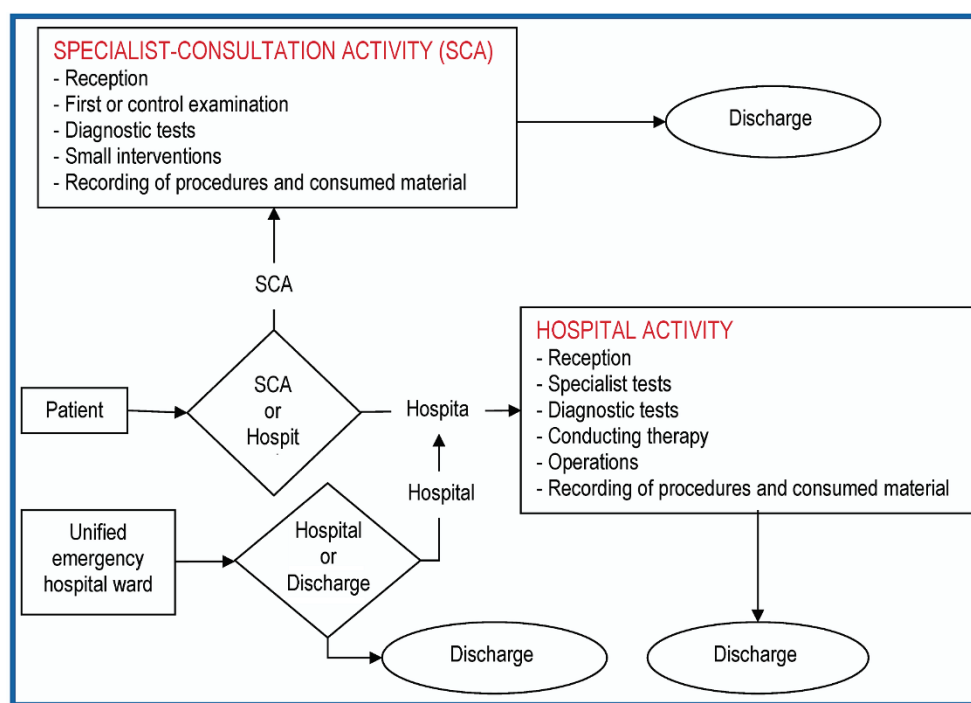


Figure 1 Process "from admission to the institution to discharge patient"; Source author's research

## 2.2 The Role of ICT in the Process "from Patient Admission to Discharge"

All parts of the business process "from admission to discharge of the patient" are computerized, i.e., supported by an integrated hospital information system. The following elements of the business process in which ICT enables savings and increased revenues will be emphasized in the following subchapters.

### 2.2.1 Direct Savings

#### A) SPECIALIST-CONSULTATION ACTIVITY

In inpatient admission activities, the use of ICT, speeds up the process. The administration process is shortened, and nurses have more time for health care. In a unit of time, it is possible to receive a more significant number of patients thanks to the so-called—eOrdering system. There is no need to re-enter general patient data and data from the referral because they are directly transferred from the Croatian Health Insurance Institute (HZZO) information system. Everything is done paperless. The computer equipment and the applications used to receive patients needed to receive patients are a one-time expense. As an example, the paper referral form costs 0,96 €. The hospital has 48 admission sites and an average of 50 patients per site during the working day. In the analysis, we took 20 working days per month. The cost

of paper that disappears with the use of ICT only at admission is:  $48 \text{ (work sites)} \times 0,96 \text{ (price of one referral form)} \times 50 \text{ (patients)} \times 20 \text{ (working days per month)} \times 12 \text{ (months)} = 554.250,45 \text{ € per year}$ , provided that each patient has only one referral (namely, one patient may have more than one referral during one visit). That is minimal savings. In inpatient examination activities, the physician does not have to print referrals and does not have to print the results of radiological or medical-biochemical tests already see it all on the screen. The price of one A4 paper is  $3.32 \text{ €} / 500 \text{ pcs} = 0.01 \text{ €}$ . The savings on printing paper when examining a patient are minimal:  $48 \text{ (work sites)} \times 0.01 \text{ (unit price of A4 paper)} \times 50 \text{ (number of patients during the day)} \times 20 \text{ (twenty working days)} \times 12 \text{ (months)} = 3.187,25 \text{ €}$ , assuming that only one sheet of paper is printed out per patient. In the case of discharge activities, the finding is not printed but is sent as a message to the smartphone and to the CEZIH, from which the patient's qualified general practitioner can retrieve the finding. The savings here are also  $3.187,25 \text{ €} (48 \text{ (work sites)} \times 0.01 \text{ (unit price of A4 paper)} \times 50 \text{ (number of patients during the day)} \times 20 \text{ (twenty working days)} \times 12 \text{ (months)})$ .

Revenue can be estimated indirectly by applying Balanced Scorecard methods. Because more patients are received and treated in a unit of time, more services and procedures could be invoiced, and consequently, the revenues from HZZO will be increased. So, the total revenue of the hospital will be increased. The most significant savings

are with radiological diagnostics. Only thanks to films, fixers, and developers are not used; the average monthly savings is 66.361,40 €. This means that the average annual savings are 796.336,85 €. This number alone covers the annual cost of the hospital, radiological, laboratory, business, pharmacy information system, and nutrition information system. In addition, these savings cover the annual gross salaries of IT staff. Furthermore, thanks to the prescribed guidelines built into the laboratory system (e.g. that CRP - C reactive protein (type of test) does not need to be done more than 24 hours), it is possible to rationalize the prescribing of medical laboratory tests in hospital treatment and consequently achieve savings on reagents used in the search process. The report obtained from the reporting information system shows that in 2021 the savings on medical materials used in tests within the medical-biochemical laboratory amounted to 27.871,79 €.

## B) HOSPITAL ACTIVITY

When hospital activity is observed, the most significant savings are realized through *targeted therapy*. Namely, the pharmacy and hospital information systems are interconnected, and thanks to that, it is possible to carry out targeted therapy that doctors and nurses prescribe. Thanks to targeted therapy, departmental stocks are reduced by 40%, which amounts to an average of 46.452,98 € per month, i.e., 557.435,80 € average annual savings. In addition to targeted therapy, the hospital information system allows accurate recording of the so-called. "stac" (procedures performed on the patient, medicine and medical supplies used). They also enable accurate recording of diagnostic and therapeutic groups based on which the HZZO pays funds to the hospital. An important item contributing to the hospital's savings is the use of *reserve antibiotics (alternative so-called generic drugs that contain the same active substance as the originals but can be purchased on the market at a lower price)*. The application of ICT enables their precise administration. Annually, savings in the use of antibiotics equal 278.757,90 €. Therefore, thanks to the application of ICT, if used only in the examples listed above, further savings of 2.220.346,41 € is possible. It is important to emphasize that the prerequisite for achieving these savings is for health employees to have appropriate competencies that enable them to use ICT effectively. In addition to the listed direct savings calculated as described above, it is possible to monitor the increase in income with the help of Balanced Scorecard [1, 2] method in the manner explained below.

### 2.2.2 Indirect Savings and Income

Indirect savings and income can be estimated using the Balanced Scorecard (BSC) methods (ibid). The essence of this method is to observe the financial result<sup>1</sup> indirectly through the improvement of internal processes in the hospital, employee competence and patient satisfaction. ICT plays a vital role in all three elements. It enables faster,

efficient, and efficient business processes by optimizing them and reducing redundancy to a minimum. By working with an integrated hospital information system [3-5], employees improve their competencies, become computer and information literate, and have more time to provide medical care. Patients are more satisfied because the whole process is faster, waiting time is reduced, nurses and doctors have more time to dedicate to the patient, and they do not waste time on administration. In addition, patients do not have to come to the hospital just to order or pick up results, which contributes to their satisfaction. All of the above leads to better hospital operations. In order to achieve all of the above, the internal processes and activities must be continuously supervised, the training of human resources must be taken into account, and the quality of health care providers must be monitored.

### 2.2.3 Balanced Scorecard – Conceptually

Since we want to continue showing the innovative application of the BSC method (Dynamic BSC), the intention here is to recall the basic concepts of the method. The Balanced Scorecard (BSC) method was developed by Kaplan and Norton [1], [2]. They recognized that the success of a modern organization cannot be measured only through the observation of financial results. Much more attention should be paid to improving processes, training employees and creating new ways of connecting with customers. The BSC method enables the implementation of the strategy and a balanced view of the organizational goals defined in the strategy. Kaplan and Norton talk about four basic perspectives on the organization: finance, customers, internal business processes and learning [6-9]. Variations of the BSC method add a fifth area (e.g. the environmental dimension) or replace all perspectives with one that is a uniform reflection of their mission and strategy. Nevertheless, the four perspectives described by Kaplan and Norton are generally applicable in different organizations. Thus, BSC can be applied in a general hospital, with the perspective of "Customers" being replaced by "Patients."

Why use other measures in addition to financial ones, such as benchmarks for growth and development, benchmarks for improving customer relations, and internal processes? In today's business environment, the most important resource is information. Only financial measures that measure "tangible" assets do not allow an organization to face market competition in the information age. Namely, managers must have as much information as possible about "untouchable" assets, such as various connections, alliances, and abilities that are becoming an essential factor. Today, in over 75% of successful organizations worldwide, an important factor is the so-called intellectual property, i.e., educated employees [10]. Today, machines do routine work, and labour is not needed for such work, but employees are increasingly engaged in creative work, innovation, analysis, and similar work. The BSC method helps management take into account the above facts and manage critical business processes and intellectual capital.

<sup>1</sup> Perform Magazine, Volume 1.2. (2003), Panorama Business View Inc., London

## 2.2.4 BSC in a General Hospital

In the general hospital, the achievement of strategic goals is monitored with the help of BSC in a specific way [11-13] with the application of the correlation coefficient. For each strategic goal, there is a table in Excel that changes continuously, dynamically (every three months) depending on the observed changes. The dynamic character of BSC management and the use of the correlation coefficient specific to the hospital represents a modification concerning the "classic" BSC. The following will briefly describe the model of BSC in a general hospital. The idea was to create a

simple and functional tool for managers in health care institutions, which would effectively and efficiently define and monitor the implementation of the strategy. The basic assumptions for this are:

- Use a simple, accessible, and understandable tool (Excel)
- Possibility of seeing all critical information on one worksheet
- Ability to run simulations (by changing data to change performance); that is why it is a dynamic BSC.

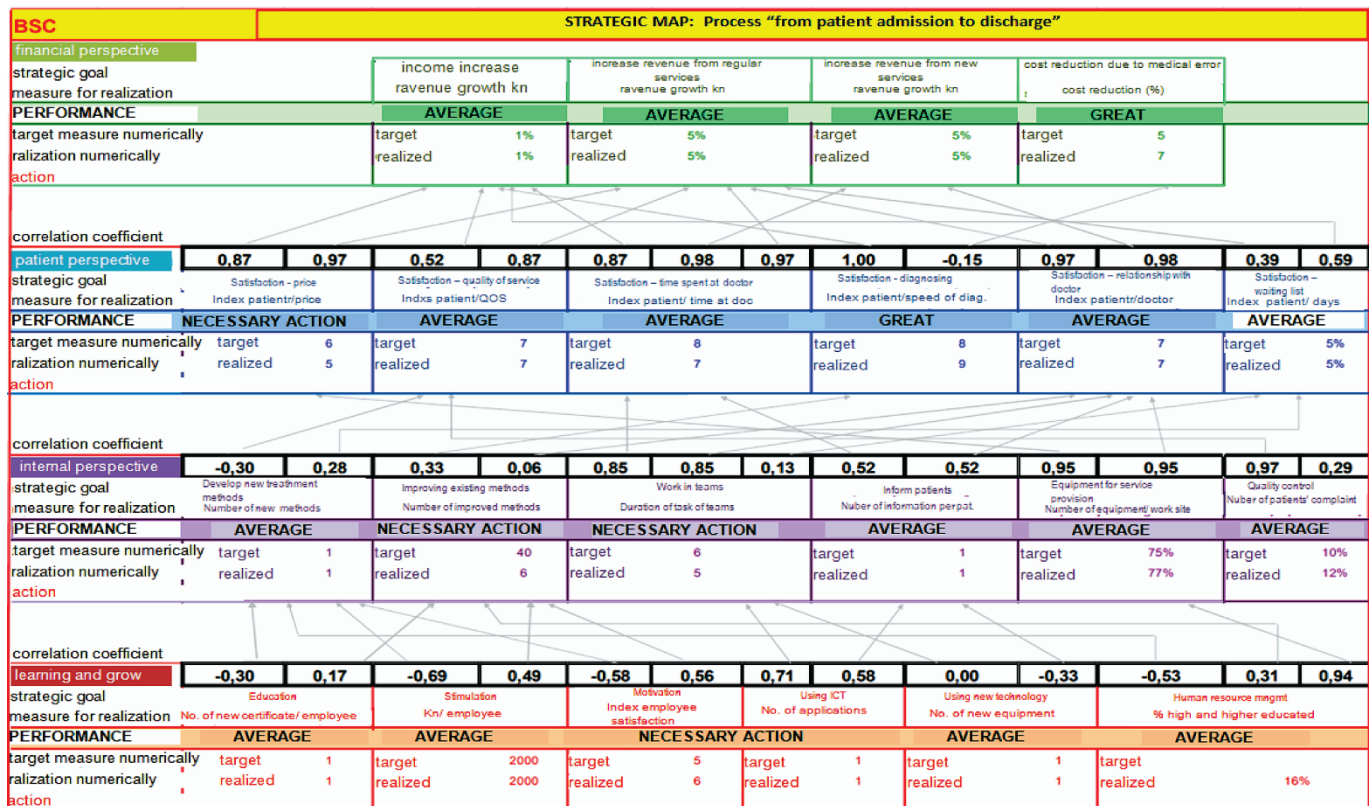


Figure 2 The appearance of a dynamic BSC map; Source: author's research

Background table is defined for every strategic goal

number of new certificate/employee				
	evaluation	target	realized	index
2006	7			
I	7	1	1	100,00%
II	5	2	1	50,00%
III	6	3	2	66,67%
IV	8	2	3	150,00%

Figure 3 Background table; Source: author's research

The display elements of the BSC map, in this approach, are:

- Background tables (for each strategic goal)
- Defined for each perspective (internal processes, employee education, patients, and finances): strategic goal(s), achievement measure, numerical measure set, numerical achievement, action, correlation coefficient, and performance.

- Relationships between strategic goals (their importance depends on the correlation coefficient).

For each perspective within the BSC, the following is monitored:

- Correlation coefficient
- Strategic goal
- A measure to achieve a strategic goal
- Performance (i.e., performance evaluation).
- The planned measure, i.e., the goal expressed numerically (must be measurable)
- Realization expressed numerically
- Action (which must be taken if the correlation coefficient is extremely poor).


correlation coefficient				
internal perspective	-0,30	0,28	0,33	0,06
strategic goal	Develop new treatment methods Number of new methods		Improving existing methods Number of improved methods	
measure for realization				
PERFORMANCE	AVERAGE		NECESSARY ACTION	
target measure numerically	target	1	target	40
realization numerically	realized	1	realized	6
action				
				
correlation coefficient				
learning and grow	-0,30	0,17	-0,69	0,49
strategic goal	Education No. of new certificate/ employee		Stimulation Kn/ employee	
measure for realization				
PERFORMANCE	AVERAGE		AVERAGE	
target measure numerically	target	1	target	2000
realization numerically	realized	1	realized	2000
action				

Figure 4 What is monitored for each perspective; Source: author's research

The procedure of dynamic maintenance of the BSC map (specificity of the hospital - it is not in the classic BSC):

- Four perspectives are observed: financial, patient, internal processes, learning and growth.
- Each perspective is divided into critical processes and indicators relevant to the business.
- For each process or indicator within each of the perspectives, strategic goals and measures have been set through which the achievement of these goals will be monitored (quarterly).
- Monitoring of the achievement of goals is also done quarterly, through actual physical achievements and by using the evaluation system (surveys of patients and employees - the work of all doctors at the workplaces and the satisfaction of all patients who came to the doctor in the same quarter are observed)
- For each quantitative level of achievement, an evaluation is given in the form of a grade, and these grades are updated on a quarterly basis (there are updated formulas in the tables).

Goal setting and performance monitoring are conducted at the level of services and departments responsible for individual indicators, while universal indicators (most from a learning and growth perspective) are monitored by all relevant services and departments. At the end of each month, department managers enter the values achieved, and the goal execution and the grade are calculated automatically. The scale of evaluation ranges mainly from 1-10, but lower and higher values can be obtained, depending on the size of the deviation from the set goal. For example, a score of 1-4 can be interpreted as poor performance indicators, 4-7 as average, and 7-10 as excellent performance.

For the first year of the BSC introduction, the indicators' assessments are based on the assessments from last year.

Expert assessments make them, and each subsequent year is tied to the previous year's grade. When setting a quarterly target for each indicator, one should strive for

actual values, which are not too high or difficult to achieve. If the goal's achievement deviates very negatively from the set values, it is necessary to take action, which is written on the main strategic map. Correlation *coefficients* help diagnose the problem of not achieving goals and taking the right action, i.e., indicators of the strength of the relationship between the interactions of different variables (indicators), primarily strategic goals. The arrows in the BSC map (Fig. 2, Fig. 4) show a cause-and-effect relationship between strategic objectives. Correlation<sup>2</sup> [14, 15] is a function of quarterly achievement between two strategic goals that are causally related. The correlation (trend) of two variables (correlation) can be positive or negative, and the correlation ranges is from -1 to 1. If the coefficient is closer to these values, there is a strong negative or positive correlation. If it is equal to 0, the correlation between the two variables does not exist, and that action needs to be taken. Every action in this model is recorded in an Excel spreadsheet. For each strategic goal, the action to achieve the goal is defined. An example of positive and negative correlation is: greater staff flexibility is likely to result in more patients examined - a positive correlation, and at the same time less expected average waiting time for a consultation or specific patient service - a negative correlation.

Advantages of using the correlation coefficient:

- They give a dynamic picture of the business - business indicators are constantly changing - assuming for the better if a decision is made to accept the goals and measures according to the BSC methodology, their monitoring, and evaluation. In this way, it is possible to get the up-to-date parallelism of changes in the variables, and the strength of their possible correlation (this reflects the dynamism of this BSC map)
- When the correlation coefficient is more significant than, for example, 0.8 (a series of measured data greater than, say, ten quarters for reliability). It could be concluded that the two variables correlate significantly and that changing the causal variable can positively affect the target variable. This could be tested, for example, by keeping all other causal variables believed to affect the target variable constant, increasing or decreasing the selected variable, and measuring its impact on the target variable in the future. For example, if it is assumed that productivity is affected by all variables from the lowest perspective (learning and growth) and certain variables from the second (upper) perspective, such as investment, service structure, diagnostic errors, etc. Accordingly, it is possible to change only the age or educational structure in a given period (while keeping other variables that can be influenced as constant) and measure the impact of their changes on the change in productivity. Thus, this approach allows for a good and reasonably precise management tool which can influence key objectives at a minimal cost.

<sup>2</sup> Connectivity Analysis. Retrieved May 20, 2022, from <http://statinfo.mefos.hr/1920/pdbstat/PDBS-V4.pdf>

Advantages of the displayed BSC map:

- Since the correlations of variables are entirely intertwined, and there are many variables and different data sources (actual data, surveys, etc.), it is almost impossible to manipulate the data, and even if such a possibility occurs, it is detected very quickly
- Easy and fast access to all important data for the user manager, practical (only one page), all data is automatically updated when department managers enter achievements for each quarter - no man needed to control and change it all (avoiding human factor errors)
- Easy to enter execution data; each responsible person will have approx. 5 - 10 tables, i.e., 5 - 10 data sets that will need to be entered quarterly, which does not require much time, and the tables are made in the well-known MS Excel program.

Disadvantages of the displayed BSC map:

- In order to obtain some correlation coefficients between pairs of variables, it is necessary to have a fairly long series of data (it is recommended to have data from at least ten periods, i.e., quarters, in other words, 2.5 years) to be able to draw a correlation conclusion with a certain degree of confidence. This represents a relatively long period of the entire operation of such a BSC.
- It will never be possible to completely isolate the influence of all other variables on the target variable, so it will never be possible to say with 100% certainty that the correlation coefficient between two variables involves the interaction those two variables only.
- This model of BSC assumes a cause-and-effect relationship in only one direction, which is often not the case in practice.

The general hospital-adapted BSC model is used because:

- The presented method of monitoring the implementation of the strategy is defined quarterly but can also be on a monthly, weekly, or even daily basis.
- It is convenient because it is easy to use and intuitively clear
- It is suitable for simulations because by changing the input parameters in the background tables, the map also changes
- "Bottlenecks," i.e., critical performance, can be seen very clearly, so it is possible to react quickly.

### 3 CONCLUSION

This paper pointed out the possibility of using ICT to influence the financial result of the hospitals. Research of parts of the business process "from the admission of the patient to the hospital to discharge" shows exactly how much savings can be achieved. In addition, a modified BSC model is presented, which is applied in the hospital to better manage the achievement of strategic goals through monitoring the implementation of specific activities and thus affecting the improvement of financial results. Finally, the aim of the research was achieved, i.e., it was determined that ICT

implementation helps to reduce costs and increase hospital revenues.

It is important to emphasize that in order to exploit the full potential of ICT, hospital staff must have specific digital competencies. This means knowing ICT (in this case, Excel) is necessary, but this is not enough. Namely, a digitally competent person should know how to place the collected information in a mutual relationship and create new knowledge. Digitally competent employees are able to make optimal use of the ICT at their disposal and thus better implement the dynamic BSC method, which indirectly enables the improvement of the hospital's financial results. Further research should be directed on the new application of the dynamic BSC method throughout the health system. The presented method should be standardized in terms of the strategic goals that will be followed, the fulfilment of the key performance factors of health institutions. Standardization would enable the application of the method in other health institutions that have certain specificities in relation to hospitals.

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