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Source / Izvornik: **The NISPAcee Journal of Public Administration and Policy, 2019, XII, 199 - 216**

Journal article, Published version
Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

https://doi.org/10.2478/nispa-2019-0009

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:184:948711

The NISPAcee Journal of Public Administration and Policy, Vol. XII, No. 1, Summer 2019

10.2478/nispa-2019-0009

Effectiveness Measurement Using DEA & BSC Methods in Public Health Services

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Abstract

It is well-known that health-care systems all over the world try to improve efficiency and effectiveness due to high pressure to pursue rational performance. Many of the health-care reforms in different countries are conducted with the objectives to rationalise costs, to make health services more available, and to increase, or at least not to reduce, the quality of health services. Adequate efficient metrics used in assessing health-care services are critical for the quality of decision-making. The subject of this research is efficiency measurement in the institutes of public health in Croatia oriented to preventive activities, i.e. monitoring, analysis, and evaluation of the health of the population. Diversity of the programmes and temporal variability are the characteristics of public health services, and it is therefore harder to measure the effects in the long run. This research aims to analyse and propose a new approach to the measurement system using two methods: the Data Envelopment Analysis (DEA) and the Balanced Score Card (BSC), combined into the DEABSC integrative model, which can be an efficient method for the decision-making process. The starting point of this research is the analysis of the measurement system in public-health services in Croatia. The results confirm a weak and inadequate efficiency measurement system and very low effectiveness measurement. To enhance the efficiency measurement, we have developed the conceptual integrative DEABSC model which has been tested at the Teaching Institute of Public Health – the Department of Health Ecology. Using DEA for 2017, we have identified relatively efficient units that helped establish future goals set in the BSC strategic map. The combination of DEA and BSC allows identifying options for improving the effectiveness of public-health service programmes. The study confirms that it is possible to determine the relative efficiency of different DMUs within the Department

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of Health Ecology and use best practice for each perspective in the BSC Cause & Effect conceptual model. This paper also provides recommendations for an easier establishment of performance measurement in order to achieve the mission of public health institutions, but also indicates some limitations in the application of the methods.

Key words:
efficiency measurement, DEA, BSC, public health services, health ecology

This work has been fully supported by the Croatian Science Foundation under project IP-2014-09-8235 – A Model for Measuring the Efficiency of Public Health Services (2015–2019).

1. Introduction

The public health system faces new challenges of the digital age, resulting in changes in organisation, regulation, and management. Management is moving towards more objective performance evaluation and decision-making. The task of public health services is to improve the population's health, and therefore they comprise a series of improvement measures. Many of the health-care reforms in different countries are conducted with the objectives to rationalise costs, to make health services more available, and to increase, or at least not to reduce, the quality of health services. In the development of health services, health policy pursues three key objectives: effectiveness, efficiency, and equity (Saltman and Figueras 1998, Saltman 2002, Toth 2006, Fineberg 2012). A successful health system must meet several criteria. The quality of health services stands out in particular; it is a fundamental starting point for improving the health status of the population. Very good, secure, timely, and patient-focused care results in the effectiveness of the health-care system. It is impossible to assess the efficiency of health services if the services are not successful. It sometimes happens that both components and the objective are incompatible, and their research therefore requires certain attention and a balanced view (Toth 2006, 43). This means that health-care management and performance should be defined as an appropriate combination of efficiency and effectiveness. An efficient health system is the one that meets an acceptable standard of quality using a minimum combination of resources. Effectiveness evaluates the outcomes of health services and can be affected by efficiency or can influence efficiency. Health-service performance can be efficient, but not effective, and vice versa. The aim is to be both.

In recent years, Croatia has improved its health-care system, like most other European countries. In the decade after the proclamation of independence, the Croatian health-care system underwent a series of reforms. Their aim was to transform the fragmented and largely decentralised health-care system (Džakula et al.

2012). The Croatian health care system is designed on compulsory health-insurance principles. The system is mostly financed from public funds. After the year 2000, the ownership of primary and secondary health facilities was distributed between the state, regions, and municipalities. Tertiary health-care institutions, which include clinical hospitals, clinical hospital centres, and national health institutes, remained in state ownership. Secondary health-care institutions (general and special hospitals) and regional health-care institutes became the property of the counties. Most general health-care institutions were privatised or became the property of counties and municipalities (Zrinščak 2007). Each of the Croatian municipalities has an ambulance that provides primary health care for the residents. Among the weaknesses of the system is a lack of efficient supply, which is the result of an excessive number of health-care institutions. These are operating losses, and the institutions do not have enough professional and managing staff. Projections show that the ageing population will require more financial resources from the budget, while private insurance institutions contribute only a small part of the total resources (National Strategy 2012–2020). All of this shows that the monitoring of the efficiency of human, material, and financial resources in the health-care sector is a necessary and important task.

The aim of this research is to analyse the efficiency in public health services and propose a new approach to the measurement system using two combined methods: DEA and BSC. To enhance efficiency measurement, we have developed a conceptual integrative cause-effect DEABSC model which was tested at the Department of Health Ecology of the Teaching Institute of Public Health in one of the Croatian counties. Using DEA we identified the relative efficiency of each of the 12 units within the Health Ecology Department in 2017. The results are used as a starting point for goal-setting on the BSC strategic map. Combining DEA with BSC helps identify the possibilities for improving the effectiveness of public health ecology services. Ecology health services have the same goals and tasks everywhere, so the model can be applied for internal efficiency measurement purposes, regardless of whether it is a public or a private service.

The paper is structured in five chapters. The first is an introduction to the performance of the public health system and the subject of the research. The second chapter presents a literature review of efficiency and effectiveness measurement in health care, while chapter three introduces the use and significance of DEA and BSC. Chapter four presents the results of the conducted empirical study at the Department of Health Ecology, using data for 2017, as well as the presentation and description of the developed conceptual DEABSC model. Finally, chapter six forms the discussion and conclusion, along with limitations and suggestions for further research.

2. Literature review

Continued improvements in the efficiency and effectiveness of health care are a prerequisite for the population's health and measuring conditions for progress. However, measuring the effectiveness and efficiency of the health-care system is not easy. The biggest issues are methodological (Hollingsworth 2008, Asandului et al. 2014). The citizens' health status affects the level of well-being, productivity, and social and economic stability of the country. Therefore, improving the health-care system is an important goal, both for the countries with a low or medium level of development, and for highly developed countries, since they all provide citizens with effective and quality health care.

The ability of a health system to provide equality and efficiency is of crucial importance for more sustainable improvement of the health status of the population. Sometimes the authors have incorrectly equated the effectiveness of the health care system with expenditures for health care (Heller and Hauner 2006, Asandului et al. 2014). Musgrove (1999) identified several important criteria that should be taken into account when making decisions on major expenditures for health. These are the economic efficiency criteria (public goods, cost-effectiveness), the criteria of moral nature (fight against poverty, vertical and horizontal equality), and adherence to the policy (special requirements of populations).

Asandului et al. (2014) explored the efficiency of European health-care systems. The authors state that some of the more developed countries are more effective in using investments in health, but there are also a few developed countries that are on the border of efficiency. Romania and Bulgaria are good examples. Romania, which has the highest rate of infant mortality in Europe, is one of the countries with the largest number of doctors per 10,000 inhabitants. At the same time, there are also more developed countries that are technically inefficient, although they have a high GDP. The authors believe that similar research should be continued and simultaneously complement and test a set of new input and output variables. Ultimately, efficiency also depends on good governance of the health system. It is a series of organisational aspects that can have an impact on efficiency and effectiveness of the health-care system and, consequently, on the quality of health services. European countries have developed some common strategies and different ways of regulation in health care (Lodge 2014; Lunn 2014). One of the biggest levers of change is the changed role of the private sector in the financing and implementation of health services.

It is a very important area of public health, focused on the provision of prevention programmes to citizens. A special "story" in this field is the Netherlands. This country was ranked highest in the year 2015 in the European index of health-care users (Björenberg 2016), which has been monitoring and measuring 6 areas in 36 countries since 2005. Good results were achieved by Sweden, Slovenia, and Croatia.

The European index of health-care users has also involved the field of provision of information to users of health services and the possibility to exercise their rights. The Netherlands is among the top European countries in this area, as well. Sweden and Great Britain are also well-organised, as well as Slovenia and Croatia, but they both have some shortcomings in certain areas. In general, the influence of consumer rights and the rights of patients in Europe are improving.

Croatia has a long tradition in the field of public health. During the two world wars, the Andrija Štampar School of Public Health was established in Zagreb; the first public health school in Europe. Today, among its most important projects are the system of vaccination against infectious diseases, prevention of smoking and alcoholism, promotion of physical activity of citizens and viral vaccination as well as concern for health ecology. In all of the observed countries, there are independent contractors or special institutions for public health care. However, in the Netherlands and Great Britain, many of the key areas of public health were transferred to and organised at the local level, while in Croatia and Slovenia, the national and regional levels are predominant. The field of public health receives relatively scarce resources in all selected countries (Björenberg 2016). This is also a fundamental challenge, not only for these countries, but for all of Europe. It is necessary to implement the following measures to enhance the effectiveness of the health-care system in Slovenia: establishing a national system for evaluating health-care technology, reforming mechanisms for paying providers, introducing a system that rewards employee excellence, developing the digital platform for health-care users and ensuring its usage, improving primary medical care by limiting referrals and putting in place a system for long-term care (Setnikar Cankar and Petkovšek 2011). However, at the same time, it should be possible to include better information on the effectiveness of established programmes in the field of public health to ensure the maximum effect of the funds.

3. Efficiency measurement using DEA BSC

By introducing a "new public management" concept (NPM) in the public sector thirty years ago, the measurement of efficiency and effectiveness has become the interest of scientists and practitioners. This has led to public-sector reforms inspired by the idea that private-sector management techniques and marketing mechanism increase the efficiency and effectiveness of public services. Service quality improvement has become crucial for a new public management (Enquist and Edvardsson, 2006), and reforms are characterised by improving the public services with the focus on efficiency, effectiveness, and responsive services, which are close to their customers (Pollitt 2002). The emphasis is on performance-management targets, indicators and results – output, outcome, and impact. The classic concept of efficiency implies transformation of inputs to outputs, where, in the public sector, outputs are mostly services. The quality of service outputs directly

or indirectly affects individual consumer satisfaction according to the set goals and objectives, in which case we speak of outcomes. Looking beyond, the level of achieved outputs and outcomes affects the society as a whole. Thus, effectiveness is the final and crucial ratio of the result obtained and the one programmed to achieve. According to Drucker (2001), there is no efficiency without effectiveness, because it is more important to do what you have proposed well (effectiveness) than do well something else that had not necessarily been concerned. In their study of hospitals, Solà and Prior (2001) distinguish efficacy and effectiveness, wherein the former term is defined as achievements of targets, and the latter term is defined as "the degree at which production reaches the final targets".

Modeling efficiency in a non-parametric way was first introduced by Farrell (1957). Since then, researchers have increasingly used Data Envelopment Analysis (DEA) in the public sector introduced by Charnes et al.(1978) for measuring relative efficiency. In addition to other public sectors like education, sports DEA has been one of the most widely used decision-making tools in health care. There are also studies in which the authors use DEA methods to evaluate various aspects of the health field (for example, the structure of the field, the efficiency of the hospitals, public policies or medical devices) by Coppola et al. (2003), Hollingsworth (2008), Nedelea et al. (2010), Amponsah (2013), Asandului et al. (2014), Vitezić et al. (2016), Amponsah and Amanfo (2017).

For more than twenty years, the Balanced Scorecard (BSC) introduced by Kaplan and Norton (1992) has been the prevalent and most discussed conceptual framework for transforming strategic objectives to a set of measurable and tangible performance measures. The model is based on four fundamental and logical factors, called perspectives, in the business process: financial, internal business process, customer and innovation, and learning. The point is in the balance between financial and non-financial, short-term and long-term, and internal and external goals and objectives. The model was developed several times and criticised, too. Over time, studies focused on the Balanced Scorecard in the public sector (Azizi et al. 2012), which got Kaplan and Norton to modify the original model by increasing the number of perspectives and measures depending on the concrete vision and strategy of the organisation. BSC is widely used in the health-care system all over the world, exploring BSC as a management tool that can help organisations to effectively implement strategies (Bisbe and Barrubés 2012), or develop practical conceptualisation, mainly for hospitals (Lovaglio and Vittadini 2012, Chang et al. 2008, Yilmaz and Erdem 2015, and many others).

From the perspective of health services, the BSC has some advantages, such as improvement of the information-management system, emphasis on the relationship between quantitative and qualitative indicators, relatively few selected measures that can be checked at any time (Hemati et al. 2012). However, there are some disadvantages or limitations, such as a one-way causal relationship, a missing time

dimension when programmes in health services are considered, inability to select the best measures, insufficient dynamics for simultaneous control (Jalali Naini et al. 2011). The BSC could not identify inefficiency in the use of material and human resources, but in combination with DEA, some limitations could be avoided.

Therefore, some researchers found a great potential in the integration of DEA and BSC (Rouse et al. 2002, Eilat et al. 2006), especially when quantitative and qualitative data are used to obtain a comprehensive performance and efficiency management system (Kádárova et al. 2015). This new conceptual framework for monitoring performance and assessment of process efficiency is somewhat new in health care, especially in other health services. Therefore, we have conducted this study to gain insight into the benefits of such an integrative model with the aim to improve performance measurement by focusing on the efficiency and effectiveness of health services.

Health-care services are often the subject of research from the aspect of efficiency assessment, because there is sufficient evidence of widespread inefficiency in the health-care system in the EU (Medeiros and Schwiers 2015). However, there is no research relating to the efficiency of other, preventive health services that are of great importance for the society as a whole. Accordingly, we carried out the research in an attempt to find an appropriate model for the measuring of efficiency of public health services in one of the public health institutes in Croatia. Public health services in Croatia are carried out through various programmes and projects organised at the national level along with twenty county-level institutes. Their primary tasks are monitoring, analysis, and evaluation of the population's health, as well as planning, proposing, and implementing measures for the preservation and enhancement of the population's health. The public health institutes' activities according to the Healthcare Act (2008) include: the epidemiology of communicable and chronic non-communicable diseases, microbiology, promotion of health, public health care, ecology, school medicine, addiction prevention, and mental health. Significant roles of the institutes include the evaluation of the population's health, the evaluation of health-care needs, the evaluation of health-care service results, as well as the introduction of health programmes and their coordination at the county and national levels.

The variety of programmes and projects within these activities significantly complicates efficiency measurement at the level of the Institute, but allows their measurement at the level of individual organisational units. The selection of common inputs and outputs required for the DEA demanded professional assessment and selection of perspectives and measures necessary for the development of BSC. The ultimate goal of the research is to determine application possibilities and propose a conceptual framework of a DEABSC model adapted to the activities of the Institute of Public Health.

4. Empirical study and results

The research was conducted at the Institute of Public Health in one of the Croatian counties oriented to prevention activities, i.e. monitoring, analysis, and evaluation of the population's health with emphasis on health ecology services. The Institute has six health departments (epidemiology, microbiology, health ecology, mental health, school medicine, and social medicine) as well as the department for quality assessment, department for controlling and internal audit responsible for financial management controls and performance measurement, and the head office. Due to organisational complexity, only the Department of Health Ecology, which covers 12 DMUs, was included in the model testing. The mission of the Department of Health Ecology is to preserve and promote health of all citizens and visitors in the County through more efficient supply of health services. Accordingly, their vision is: long-term improvement of the quality of life of all citizens in the County.

The starting point of this research was a survey by which we wanted to examine the type and content of information as well as the reporting system used in public health services provided by institutes of public health. A questionnaire was sent to all 21 institutes of public health in Croatia, and we discovered many different statistics and financial reports these institutes had collected and sent to the authorities. Institutes collect and analyse statistical reports according to their public health activities and programmes at the level of local (regional) government, i.e. county for the purposes of the Croatian Institute of Public Health. Additionally, most of the institutes inform other authorities (Director and the Board of Trustees, County Department of Health, Croatian Health Insurance Fund, Ministry of Health, etc.). They submitted to these bodies mainly financial statements, but very seldom or never reports about the achieved goals. Larger regional institutes collect statistics and report using numbers (for example, numbers of analyses, samples, examined patients, users, etc.) or descriptive statistics. We found a lack of efficiency and effectiveness measures, which are of great importance for the assessment of impacts on the society, which is the primary goal of these public health institutes. These findings were the basis for the research on the possibilities of measuring the effects of activities and programmes of individual departments within the Institute of Public Health.

Taking into consideration that the main objective of the research is the application of an innovative approach to efficiency measuring through a DEABSC model, the following phase in the research was to determine the possibility of application of the DEA. The DEA requires determination of inputs and outputs at the level of each operating unit of the Institute (DMUs), which operate in similar conditions and are equally important. That was the most difficult step due to the complexity of activities within the Institute. Some departments are oriented to the patients they treat, or to a broader population in which they conduct prevention activities. Activities of some departments are linked with legal obligations (prevention of epidemics,

vaccination, examination of workers in the production, processing or distribution of food), some conduct diagnostic tests, and some analyse and monitor the environmental factors and are not in direct contact with the population. Some activities provide results immediately or in a short period of time (vaccination, microbiological analyses), and some programmes are conducted for a number of years and their end results are difficult to evaluate (cardiovascular diseases prevention programme, prevention and early detection of melanoma, prevention of osteoporosis …). When prevention programmes are carried out on the entire target population (e.g. determined according to gender or age), the results are monitored through outcomes or end results set by the programme. A dynamic number of analyses, findings, examinations, lectures, etc. can be monitored by comparison with previous time periods or a plan within a time period; they therefore indicate an increase or decline, but not the effectiveness of the services. The ultimate goal of all the services provided by the Institute of Public Health is the provision of better-quality services in order to improve health and health conditions, so the outcome is the achievement of the desired end results.

The aforementioned complex research related to DEA applicability was tested at the Department of Health Ecology, which covers 12 DMUs. This department provides prevention services for people's health regarding different environmental factors (water, air, food, soil …). They operate in the same conditions with regard to the given capital and human resources and have secured income.

We posed the following research question: could the results obtained by DEA be applicable to the units within the Department of Health Ecology? In this case we used the data for 2017 that were collected in the Department of Controlling and Internal Audit. For inputs and outputs, we used financial data (costs and revenue) and statistical data (samples and analysis) which are reliable and comparable for all department units. The inputs and outputs used are the following:

INPUTS: total costs and number of samples,

OUTPUTS: total revenue and number of analyses.

Total costs include the material cost, overall expenditure for wages, and expenditure for investment in new equipment. Gross wage costs make up the largest share (55 per cent) and direct material costs 45 per cent, mostly referring to laboratory equipment, services, and other expenditure used in the assessment. For this reason, the number of samples is critical.

The Department of Health Ecology collects and analyses various environmental samples (air, water, waste …) as well as food samples and items of general use. Sample analyses can be carried out according to chemical, physical, biological, and microbiological parameters. Certain types of samples can be processed with only one kind of analysis (e.g. microbiological parameter in food, biological parame-

ter in honey), while in some others, various types of analyses can be carried out simultaneously: physical, chemical, and microbiological analyses. In most cases, the legislator prescribed the type of analysis and parameters which must be carried out, while in fewer cases the client requested specific analyses and parameters to optimise his/her (industrial or craft) process or improve his/her service through development and research. In some samples it is possible to analyse over a hundred parameters (e.g. pesticides, polycyclic aromatic hydrocarbons …). Therefore, it is possible to analyse one parameter in one sample, but also in over one hundred.

The number of analyses is directly linked to revenue generation due to the financing policy. The Department of Health Ecology is mainly financed from revenues from services realised on the market (water, air, food, air emission testing). These revenues make up over 60 per cent, and the rest are revenues from the budget. From the financial aspect, revenues have the largest share. Generating revenue is very important, because it allows investment in knowledge and equipment and consequently results in better quality of services.

Using the DEA, we want to measure relative efficiency between twelve organisation units within the Department of Ecology. The focus is on internal efficiency improvements and better managerial decision-making. We used the BCC – an input-oriented model that includes the returns on scale variable due to limited resources and aspirations for rationality. The focus is on minimising the inputs used for processing the given amount of outputs. Most DMUs have a potential to increase their revenue and number of analyses using current resources or to increase the number of samples.

The goal is to analyse the relative efficiency related to revenue generation and number of analyses. The relevance of selected inputs and outputs was estimated using the correlation coefficient, which is high. For example, in 2017, the correlation coefficient of total costs and number of analyses is approximately 43 %, total costs and total revenue are, on average, correlated approximately 73 %.

Using two inputs and outputs, some of which are not financial (number of samples and number of analyses), five DMUs were relatively efficient in 2017: Water Control, Food Control, Air Emission, Biological Monitoring, and Exposure Unit. Nine of them have an increasing scale and the possibility to improve efficiency by scaling up their activities, and three of them (Water Units, Food Units and Environment Units) have a constant scale.

The Water Unit was a reference unit for the comparison of efficacy with respect to other DMUs in the Department of Health Ecology. According to the financial information (income), but also the other indicators (number of samples and number of analyses), the Water Unit is most efficient and records a constant rise. It has the highest income, the largest number of samples and analyses carried out, and can be a pattern for other DMUs.

The Croatian legislator prescribed that all raw spring water, water monitored for human consumption in the water supply network, and tap water sampled for the issuance of building permits must be sampled randomly and frequently. Also, all objects under sanitary control are obligated to secure safe and healthy drinking water. That is why water samples are the most frequently tested environmental samples.

Table 1
BCC Model Projection for Inefficient DMUs

Unit	Difference in %		Referent unit
	Cost	Number of samples	
OUTDOOR AIR	–33.44	–87.86	WATER
WASTE	–46.68	–	–
FOOD	–19.65	–	–
MICROBIOLOGY	–47.70	–90.30	WATER
TECHNIQUES	–75.85	–82.14	
ECOTOXICOLOGY	–15.00	–29.88	MONITORING
SAMPLES	–55.63	–90.39	

The usefulness of DEA is in the projection, i.e. movement of an inefficient unit on efficient frontier. The benchmark units for inefficient units with regard to inputs (costs and samples) and outputs (revenue and analyses) are the DMUs Water and Monitoring. According to their results, which are considered benchmarks, other units need to decrease their costs or could realise the same amount of revenue in 2017 with fewer samples. For example, in order for outdoor air to be as efficient as water, it has to decrease costs by 33.44 %, or the revenue they gained could be achieved with 87.86 % fewer samples. Monitoring is the benchmark for two departments (Ecotoxicology and Samples); for example, Ecotoxicology has to decrease costs by 15.0 %, or the same amount of revenue can be achieved with 29.88 % fewer samples.

The obtained results were used when considering Balanced Score Card (BSC) and, furthermore, for the development of the DEABSC model that was the aim of this research. Taking into consideration the complexity of activities within the Institute of Public Health, we proposed BSC developed at the level of the Institute and the level of each public health department. According to the already identified mission and vision of the Institute of Public Health, we developed the BSC model through four perspectives: users and other stakeholders; financial management; quality of the processes and organisation; learning and innovation development. The first and the crucial one is the perspective of users and other stakeholders (local community, suppliers, investors …), for whom the Institute exists. Continuing

investments in staff and innovation development should increase the quality of the process activities and ensure more funds for strengthening the quality of services.

In accordance with the general strategic map at the Institute level, each department developed its own BSC and strategy map based on the results obtained by DEA. For example, the strategic map of the Department of Health Ecology is the following:

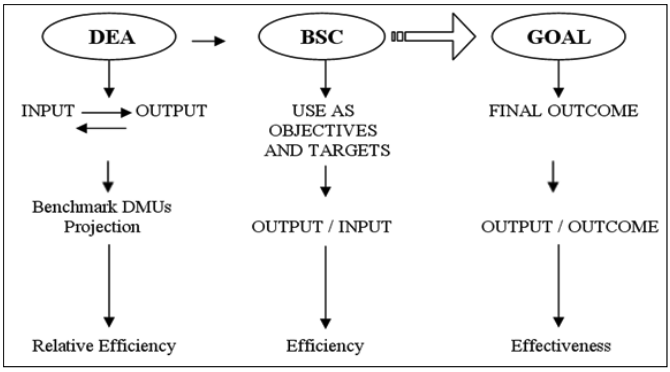
Figure 1
Strategic Map of the Department of Health Ecology

Perspectives	Objectives	Measure
Users and other stakeholders	• to ensure users' satisfaction through higher quality of services • to increase the number of new types of services	• rating of users' satisfaction • number of new services/total number of services .....
Financial management	• to increase revenues from services on the market • to maintain financial sustainability	• the share of market revenue in total revenue • revenue/costs .....
Quality of processes and organisation	• to certify, accredit, and integrate new management systems • to improve the efficiency of internal processes with new organisational and IT solutions	• number of implemented management systems/number of planned management systems • number of accredited methods/total number of methods • number of conducted analyses/effective hours of work .....
Learning and innovation development	• adoption and dissemination of knowledge • increase in innovative solutions	• number of specialised educations/total number of employees • number of innovations • number of scientific and professional papers .....

The Balanced Scorecard is created to identify causes and effects between the objectives and perspectives derived from the department's vision and mission. In a complex system of provision of public health services, it requires proper identification of objectives, measures, targets, and initiatives using a quantitative and qualitative approach. The combination of the DEA method and the BSC model allows institutions to measure relative efficiency used as a target size and efficiency through the indicators expressed in the BSC matrix. Knowing that efficiency and effectiveness are the key measures of success and fulfilment of the objectives of

public health services, a DEABSC model could be developed to express cause and effect between efficiency and effectiveness as a bottom-line result. We propose the following two-phase model for the purposes of public health-service measurement:

Figure 2
DEABSC Cause & Effect Model



The DEABSC cause-effect model could be developed at the level of the Institute and the level of each department if it has at least six DMUs. Relative efficiency obtained by the DEA will be used as an objective or target within each perspective. Efficient DMUs (water and monitoring) will be considered benchmarks and used to measure efficiency in each of the perspectives relating to the strategy map at the department level. The cause-effect approach in each perspective will be measured using the DEA. Relative importance of the selected inputs and outputs will be taken into consideration. For example: through the DEA analysis, we have found that two departments (water and monitoring) were the most efficient in 2017. The results of their performance are used as a benchmark for determining the target size. Thus, for example, in the learning and innovation development perspective, adoption and dissemination of knowledge as one of the objectives should increase by 5 per cent by 2020, or the number of implemented management systems relating to the number of planned management systems is targeted at 100 per cent by 2020. The share of market revenue in total revenue should increase to 5 per cent by 2020, the rating of user satisfaction is targeted to 4.5 by 2020. Using BSC, we have defined a strategic map by which certain objectives are causally linked and their inputs and outputs could be tested by DEA, for example: in the learning and innovation development perspectives, inputs are the number of employees and education costs, and outputs are the number of innovations, the number of internal and external education. In the second perspective – quality of processes and organisation, inputs are effective hours of work, and the output – number of analyses per hour, number of accredited methods. More analyses and accredited methods as outputs with the same or fewer

costs (input) will increase revenue, which is the output in the financial management perspective. Sufficient financial funds for quality services will have an impact on citizens' satisfaction and a healthy environment as the final output or outcome (from the users' and other stakeholders' perspective). This is the final result or outcome, and therefore, by combining the realised outputs with the set outcomes, we will measure the effectiveness of the programmes and activities in the long run.

5. Conclusion and discussion

Public health systems are very complex because of a variety of services and different stakeholders – patients and other users, regulators, government, and other authorities. Public health as the science and art of disease prevention is organised on the community level aiming to provide the best services while respecting the principle of rationality. Therefore, it is important and necessary to measure efficiency in all functions of health services. The fact is that the health-care system is at the beginning of quality-performance measurement due to a lack of effectiveness measures. This paper is based on a real case study, i.e. public health organised in the Institute of Public Health in Croatia. Aiming to provide an efficient method for the decision-making process, we combined two methods creating an integrative cause-effect DEABSC model tested at the Department of Health Ecology. Using DEA, we have determined the relative efficiency of different DMUs within the Department of Health Ecology, identified inefficient units and made a projection on the efficient frontier. The water department could be a benchmark for another five departments if efficiency is estimated through revenue generation, because all departments sell their services on the market. The results of the monitoring department are considered a benchmark for another two departments with similar revenue generation. The results of these two benchmark departments (Water and Monitoring) are taken into consideration when determining the goals set in the BSC model created for the Department of Health Ecology. The BSC was created according to the mission and vision of the Institute through four perspectives, and DEA results are incorporated with regard to the objectives and targets. The study confirms that it is possible to determine the relative efficiency of different DMUs within the Department of Health Ecology and use results as the best practice for each perspective in the BSC cause-effect model. More importantly, the study confirms that the combination of two DEA and BSC methods in the DEABSC model is possible and useful for preventive public health services when measuring efficiency and effectiveness.

However, exploring the possibilities of implementation of the DEABSC model, we identified some limitations at the level of the Institute of Public Health. Firstly, the complexity of public health services and their processes does not allow the use of DEA in all departments, only in those that consist of at least twelve units (minimum of two inputs and two outputs that can be considered). Secondly, within some organisational units whose activities are connected in the process, it is neces-

sary to determine the importance of certain inputs and outputs by expressing them through a common measurement unit; for example, the necessary performance time, effective hourly rate. In this way, measuring relative efficiency will result in a more realistic target value that will be used as an individual input in the strategic map at the level of the Institute and individual departments. This will allow comparability between all DMUs within the Institute of Public Health or within all Croatian institutes, which will be the objective of further research. What is more, a DEABSC model can be used in any other public institution that intends to implement the BSC and use the DEA as a benchmark for target size.

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This work has been fully supported by the Croatian Science Foundation under project IP-2014-09-8235 – A Model for Measuring the Efficiency of Public Health Services (2015–2019).