

Geographic Information Systems: Should They Be Used in Public Finance Reform Development?

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Abstract. Public finance reform is one of the most complex areas of decision-making. It requires good implementing methodology and proper tools for visualization possible results of reform for the society. The purpose of this article is to show how geographic information systems (GIS) can be used in the development of reforms in the sphere of public finance.

GIS can become a very useful tool in the development of reforms. GIS could provide a wide range of analysis and provide better support for ideas of reforms. GIS is very useful in the case of public finance reform, because it makes it possible to combine statistical, demographical and geographical analysis. Also GIS provides very good visualization that helps ordinary citizens to understand an idea of reform and its aftereffects. GIS can increase transparency and accountability of government, because it is quite difficult to manipulate open map data.

GIS is not a perfect tool and several challenges should be also considered. Firstly, the software for GIS must be revised quite often. Secondly, GIS software continues to change and improve over time and there are now several GIS applications that range from being relatively free (having limited tools) to being very expensive (for example, ArcGIS 10.). Thirdly, to follow the idea of increasing transparency, all GIS software should have no conflicts between each other. This means that data from one GIS software can be easily exported into different GIS applications.

Keywords: geographic information systems, public finance, reforms, taxpayer funds

1 Introduction

Public finance reform is one of the most complex areas of decision-making. At first glance, the problem is related exclusively to the redistribution of taxpayer money. However, for most post-socialist countries, this problem is not easy to solve. This is due to several reasons, one of which is limited financial resources, so it is often difficult for a government to balance the interests of different members of society in the process of financial resource allocation. The second problem is closely related to the former and lies in the institutional immaturity of society, which makes public opinion relatively easy to be manipulated. Institutional immaturity of society has several characteristics. First is the appearance of democracy in form, but without

substance. This means that democracy theoretically exists, there is an electoral system in the country, elections are held, but in fact, power belongs to a small group of people who successfully manipulate the elections. Second, there is a merger of business and political power, a result of which is a class of oligarchs that captures not only power over the distribution of financial flows, but also control over state regulators. Third, the society's passivity; people do not believe that change is possible in the country. This is a source of a crisis of trust, when people become skeptical and cynical about any reform in the country. The most sensitive area for crisis of trust is public finance.

This problem is not formed in one moment, therefore it cannot be solved quickly. Having carefully studied the process of reforms in the public finances of developed countries, it can be concluded that there are several key success factors. First, it is respect for the taxpayers. This means that the government does not hold to a concept of "government money", but rather of "taxpayer money". Expenditures are made as an expression of the will of the taxpayers, not based on the desires of a small group of powerful people. Secondly, there is maximum transparency of reforms meaning that taxpayers can track the use of their money (Fedosov and Paientko, 2017). To achieve a required level of transparency is not a major problem at present. Using modern IT-technology, accurate information can be available to every member of society. Thirdly, there is an individual approach to the development of a reform mechanism, which ensures high efficiency. In this case modern technology is very useful too.

One of the mistakes of making reform in many developing countries is simply copying the experience of neighboring countries, which can lead to serious errors and irreparable losses of financial resources. The Ukrainian government has been working over the past few years to introduce ideas of fiscal decentralization, but at the same time it is trying to replicate the experience of countries whose decentralization can be considered successful. However, the peculiarities of the Ukrainian economy, the unevenness of regional economic development, and the large physical territory require the development of approaches specific to Ukraine. One such approach can be considered the use of geographic information systems (GIS) in support of the economic feasibility of reforms in public finance and the mechanisms for their implementation. Also GIS could be used for increasing the level of transparency and accountability, because the performance of GIS is easily understandable even for laypeople. Also it is not very easy to manipulate GIS results after being published, because people understand their own geographic areas.

The paper is organized as follows. The next section explores the theoretical background of GIS use in public finance reform. The third section is focused on how GIS can be used in public finance reform in Ukraine. This is followed by a brief discussion on how GIS could help to increase transparency and accountability in public finance reforms. The purpose of the article is to show the possibilities of using geographic information systems (GIS) in the development of reform in the sphere of public finance.

2 Theoretical and Methodological Background

Different aspects of public finance reforms are represented in recent publications by prominent authors. A careful study of western economists discussing public finance reform shows that there are two main focuses in this field. The first one is how public finance reform can help to fight corruption through increasing transparency and accountability of the government (Allen, R. Schiavo-Campo, S. and Garrity, T. (2004), Gomez, P. Friedman, J. and Shapiro, I. (2004), Hedger, E. and Kizilbash Agha, Z. (2007), Dorotinsky, W. and Pradhan, S. (2007), Fjeldstad, O. (2008), Dressel, B. (2012)). Economists argue that many reforms in public finance failed because of corruption and lack of transparency and accountability. Furthermore, economists have proved that new approaches in public finance reform are needed to increase efficiency. B. Dressel stated, "Citizen participation and a commitment to accountability and transparency have become common in the 'good governance' discourse globally, but the extent of the changes the Philippine government has initiated in terms of how it manages and spends its money is remarkable by any standard" (Dressel, B. (2012)). This means that one of the key factors in increasing the efficiency of public finance reform is citizen involvement in the process of their implementation.

The second focus of recent publications is concerning the signals of poor quality of reforms and their failures and how the quality of reforms in public finance can be improved (De Renzio, P. and Dorotinsky, W. (2007), Andrews M. (2013), Fjeldstad, O. (2013), Paientko T. (2015), Fedosov V. and Paientko T. (2017)). It is believed that the quality of public finance reform could be increased by considering the causes that prompted reform in the first place. For example, fiscal crises (in Tanzania, the UK, Canada, Ukraine, Asian economies), political changes (post-socialistic countries), changes in public expectations (Canada, the UK, post-socialistic countries), and post-conflict situations (Rwanda, Burundi, Liberia) all contributed to the shape of specific reforms. The causes are very different, but all of them are intrinsically tied to the quality of peoples' lives in those countries. It means that people should be involved in the reform process and they have to have access to the all information on how their funds are being used. The words "their funds" must be used, because those funds are collected as taxes, and as such belong to the taxpayers. Even if funds are raised as government borrowings they are also belong to taxpayers, because taxpayers will pay those debts in the future.

Many countries have already started the process of making government activity transparent to the people. A significant impact on this process was made by information technology (IT) development. For example, e-procurement is now standard practice, and this helps to prevent corruption and increase transparency of public fund expenditures. It means that IT could be used in different areas of public finance reform. This is why some economists think that GIS could also be useful in this area. GIS are not completely new in economic science. UK and USA universities started promoting GIS-based economic research in the 1990's (Langran, G. (1992), Laudan, L. (1996), Longley, P.A., M.F. Goodchild, D.J. Maguire, and D.W. Rhind, editors (1999)).

At the beginning of this century, GIS became a part of econometric methodology (Bialynicki-Birula, I. and Bialynicki-Birula, I. (2004), Anselin, L., Florax, R.J. and

Rey, S.J. (eds) (2004)). Later GIS became useful in research related to demography problems (Castro, M.C. (2007), Voss, P.R. (2007)).

Future and new horizons for GIS are represented in the articles of Anselin, L. and Rey, S.J. (eds) (2010), M. Goodchild (2011, 2018), N. Sianko and M. Small (2017). They mentioned that “GIS has been helpful in answering questions related to access to social and health services.... GIS can also be used in demography to study issues related to migration and migration related health problems” (N. Sianko and M. Small (2017)).

GIS is defined most generally as technology for processing a specific class of information – geographic information. Processing is understood to encompass creation, acquisition, storage, editing, transformation, analysis, visualization, sharing, and any other functions amenable to execution in a digital domain (M. Goodchild). GIS is a very good tool not only for visualization of the Earth’s surface information with specific properties, but also as a proper tool for measuring distances considering the quality of roads and characteristics of a particular region (flat fields or mountains). Also GIS could help to prevent fraud in public expenditures in cases of national disasters, for example floods. The information about the number of houses and their characteristics was in the GIS before a flood, so it easy to calculate how much is needed to compensate people who lost their homes.

Furthermore, GIS can help to create data visualization. GIS data could be easily shared with other researchers and with people who are interested in the results of research. It could help to increase transparency in the public finance reform process, because every citizen could have access to the data, which are presented in an understandable way. GIS helps to create different maps which are good tools to show the interaction between different variables. GIS can help to improve analysis, and this will help to avoid mistakes in developing ideas for reform.

As an example of how GIS can be used in the public finance reform process, health care reform in Ukraine has been chosen. The methodology of research was as follows:

1. Create a questionnaire on social networking sites to ask people to express their opinions.
2. Analyze peoples’ opinion and mapping.
3. Analyze government ideas for health care reform and mapping.
4. Draw conclusions.

3 Efficiency Estimation Procedure

The first step of the research was the creation of a questionnaire for the social network survey and choose the target group. It should be noted that in Ukraine the age of active users of professional social networks is between twenty and forty-five years old. The target group consisted of 2500 people, 55% women and 45% men, with 30% having an economic science background, and 70% with a background in medical care, school teaching, farm production, social services etc. Because of Ukraine's size, target groups were chosen from two oblasts (Zhytomyr and Chernihiv). The results of the survey are presented in Table 1.

Table 1. Results of survey, %

Question	Strongly disagree	Disagree	Agree	Strongly agree	Cannot decide
Do you think that information about public finance in Ukraine is not transparent enough?	2	2	78	14	4
Do you think that information about public finance reforms is not fair?	1	3	56	28	12
Do you think that information about public finance reforms is not easy to understand?	3	4	61	31	1
Do you think that citizens should be more involved in public finance reforms?	3	2	55	12	28
Do you think that citizens can prevent bad public finance management?	12	28	26	10	24
Do you think that government can manipulate information about public finance?	4	3	58	21	14
Do you think that citizens should be able to track each UAH paid as a tax?	1	2	85	10	2

As can be seen from Table 1, many people are interested in tracking public finance reform, but at the same time roughly 20% people cannot decide. This group of people cannot make a decision about whether they are interested or not in how government uses their money. It proves the existence of a group of people who are “passive”, because they do not understand information about public finance or they do not trust government, or because of the other reasons. This is a large percentage for a society that wants to follow democratic ideas. It should be noticed that many people think that information about public finance in Ukraine is not transparent enough and information about reforms in public finance is not fair or not understandable.

The second poll was about the establishment of hospital districts in Ukraine (Table 2).

Table 2. Results of survey, %

Question	Strongly disagree	Disagree	Agree	Strongly agree	Cannot decide
Do you think that the establishment of hospital districts will improve health care in Ukraine?	48	36	8	2	6
What kind of risks do you see in establishing of hospital districts:					
Bad access to the health care facilities	2	2	72	18	6
Absence of medical care in villages	2	3	68	21	6
Lack of doctors, because they will leave Ukraine	4	6	45	44	1

According to the project on health care reform in Ukraine, a district hospital center will be located in a settlement with 40,000 inhabitants and more and serve a region

with at least 200,000 inhabitants. Taking into account the amount of population served, five hospitals should be located in Chernihiv oblast, but according to the requirement that the hospital must be located in a town with more than 40,000 inhabitants, only one hospital will be funded by the government. In contrast, in the Zhytomyr region six hospitals should be located, but according to the minimum population requirement, only three hospitals will be funded by the government (Table 3).

Table 3. Main characteristics for hospital districts in Chernihiv and Zhytomyr oblast

Indicators	Chernihiv oblast	Zhytomyr oblast
Territory, square kilometers	31865	29832
Population, mln people	1.056	1.240
Number of towns with a population of more than 40,000 (equal to the number of hospital districts in the oblast)	2	4

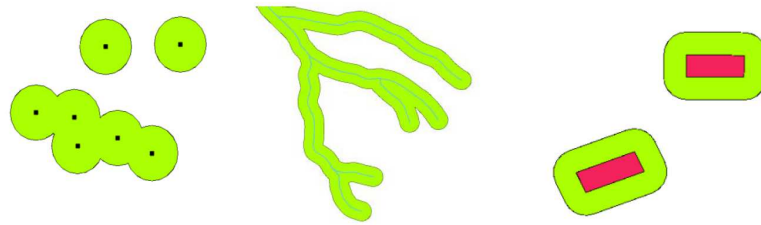
It appears that Ukrainian citizens may have reasons to be unhappy with the coming healthcare reform. The district council will decide for itself how much it needs hospitals. The idea of reform is based on the amount of people and does not take into account how people are able to reach the hospitals. Another problem is related to the possibility of a district council deciding how many hospitals are needed. Because of a lack of funding and differences in the economic development of different districts, this decision becomes almost impossible. The idea of creating hospital districts is not wrong, but its implementation must be based not on the number of people living in some town, but on equal access to the hospital for every citizen. It becomes critical because Ukrainian infrastructure is in very poor condition and public transportation is not available for everybody.

According to general healthcare requirements, in case of emergency, access to a hospital should be provided in 15-20 minutes. This is not possible to provide if only one or two hospitals are located in a territory of 30,000 square kilometers. This is a case in which GIS could be helpful. One of the most common tools of GIS is spatial analysis. Spatial analysis comprises a set of techniques and tools designed to analyze data in a spatial context. A GIS database captures not only links between properties at the same place, but also such spatial concepts as proximity, containment, overlap, adjacency, and connectedness. Visualization in spatial context (commonly in the form of a map) is an obvious and powerful way of detecting pattern, anomaly, and even causation (M. Goodchild, (2011). It means that by using GIS, the planning of new hospital districts could be improved by better analysis and data visualization. Proper analysis and better visualization will help to prove that health care reform is reasonable. This will help to decrease tension between government and society and help to build a relationship based on trust, responsibility and accountability.

Today, several software products are available. The best one is ArcGIS 10. ArcGIS 10 provides spatial querying, attribute querying, tabular visualization, statistical analysis, advanced mapping, map publishing in pdf format and map printing, etc.

The idea of using GIS in establishing hospital districts is as follows:

1. An analysis of the population in a district and population density.



A buffer zone around vector points.

A buffer zone around vector polylines.

A buffer zone around vector polygons.

Fig. 2. Buffering in GIS

Multi ring buffering was used here (fig. 3).



Fig. 3. Multi ring buffering

Multi ring buffering helps eliminate facilities that have similar accessibility factors and are located close to each other, as shown on the right of fig. 3. Also this is a good tool for visualizing data, because people are able to see where they live and where a hospital could be located and how fast they could reach it. If such data is kept open to the public, it cannot be manipulated. Also, every interested citizen can view the map and understand if the governmental decision about facility location (health care or educational) was reasonable or not. If people disagree, they can easily voice their opinion (for example, for reasons of lack of public transportation or bad quality of roads requiring more time to get to a certain facility).

Overlay analysis and summary statistics were then used. These tools help calculate optimal distances between hospitals and residences. Overlay and vector analysis also include characteristics of earth's surface and quality of roads in its calculations.

This analysis was completed for two oblasts in Ukraine (Table 4).

Table 4. Results of GIS analysis for Chernihiv and Zhytomyr oblasts

Indicators	Chernihiv oblast	Zhytomyr oblast
Area square kilometers	31865	29832
Population, mln people	1056	1240
Number of hospital districts	5	6

As can be seeing from table 4, the results of GIS analysis show the necessity of establishing a larger number of hospital districts than could be possible according to government requirements. The difference appeared because the governmental project did not include the poor condition of roads in its analysis.

4 Conclusions

GIS can be a very useful tool in the development of reforms. GIS could provide a wide range of analysis and provide better support for concepts of reforms. GIS is very useful in the case of public finance reform, because it makes possible a combination of statistical, demographical and geographical analyses. Also GIS provides very good visualization that helps ordinary citizens understand how reforms would affect them. GIS can increase transparency and accountability of government, because it is quite difficult to manipulate by open map data.

GIS is not a perfect tool and several challenges should be also considered. Firstly, the software for GIS must be revised quite often. Secondly, GIS software continues to change and improve over time and there are now several GIS applications that range from being relatively free (having limited tools) to being very expensive (for example, ArcGIS 10.). Thirdly, to follow the idea of increasing transparency, all GIS software should have no conflicts between each other. It means that data from one GIS software can be easily exported into different GIS software.

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