ARCHIVES OF ACOUSTICS
31, 4 (Supplement), 261–274 (2006)

GIS-CLASS SYSTEMS OF SPATIAL INFORMATION AS THE BASE FOR CREATING STRATEGIC ACOUSTIC MAPS OF URBAN AREAS

J. KAŹMIERCZAK

Silesian University of Technology
Roosevelta 26, 41-800 Zabrze, Poland
e-mail: Jan.Kazmierczak@polsl.pl

A. LIPOWCZAN

Central Mining Institute in Katowice

W. BATKO

AGH University of Science and Technology in Kraków

B. RUDNO–RUDZIŃSKA, K. RUDNO–RUDZIŃSKI

Wrocław University of Technology

(*received June 15, 2006; accepted September 30, 2006*)

The subject of this paper is an issue of strategic acoustic map creation in cities in accordance with the, so called, EU Noise Directive (END 2002/49) and Polish law related to this directive (act "Environment Protection Law"). The authors of the paper represent a consortium of research entities which since autumn 2003 have been implementing a research project No 6T07 2002/C.05779 "Development of the national system of creation and exploitation of digital acoustic maps of large and middle-sized cities for purposes of professional spatial planning and educational aims", co-financed by the Committee of Scientific Research (KBN). The basic methodological assumption of this project is development of the technology of a strategic acoustic map creation as an autonomous layer in the Spatial (Geographical) Information Systems (GIS), currently used for many purposes by Polish local governments. This article presents the progress of development of this project in its three basic aspects: map information processing aspect, acoustic aspect and an aspect of managing a complex research and application activity. In particular, there were emphasised specific steps, comprising scientific project schedule and conclusions from so far completed tasks. There was also presented the conception of managing the activities in municipal offices related to creation and exploitation of strategic acoustic maps with usage of business process mapping technique. This particular technique may both support the effective development of the practical part of the project, as well as the educational and implementation part, comprising training of local governments personnel and advisory relating to the creation of local programs for excessive noise counteraction.

Key words: EU Noise Mapping, GIS technology.

1. Introduction

For contemporary civilisation noise is a specific “pollutant” of human natural habitat. The reduction of exposure to noise, particularly of inhabitants of urban areas, is a significant element of many currently developed activities aiming at, so called, living space revitalisation. According to the recent indications by the European Commission, revitalisation is considered to be a process of living quality improvement in the revitalised areas. The requirements of, so called, European Noise Directive [4] oblige local authorities of the EU cities whose population exceeds 250,000 inhabitants to assess the acoustic threat in their areas by creation of strategic acoustic maps by 30 June 2007, and until 18 July 2008 to develop of action plans for noise issues management and, if necessary, for noise reduction in these areas. Polish legislation related to this directive (act “Environment Protection Law” [29]) obliges local authorities to introduce the conclusions and recommendations from the creation and exploitation of strategic acoustic maps to their spatial planning procedures. These maps are to be the base for taking proper administrative decisions.

The aforementioned preconditions were the base for preparation of a research project „Development of the national system of creation and exploitation of digital acoustic maps of large and middle-sized cities for purposes of professional spatial planning and educational aims.”. The application for co-financing of this research project was submitted by the consortium consisting of four institutions: Silesian University of Technology, AGH University of Technology and Science in Kraków, Wrocław University of Technology and the Central Mining Institute in Katowice. The formula of this project is unique in the way, that this consortium plays the roles of both developer and implementer. Having granted financing for this project, it was decided that the main developer is the Department of Fundamentals of Technical Systems on the Faculty of Organisation and Management of the Silesian University of Technology, and the other institutions of the consortium are subcontractors. Due to the necessity of proving by the developer of the project so called “own contribution”, upon the acceptance of the Ministry of Science and Information Technology, it was assumed that the amount of proven own contribution is related directly to the virtually performed tasks. The completion of the project is foreseen to the end of year 2006.

2. Basic assumptions for the research project

The basic objective of this project is development of technology of acoustic maps creation with the assumption that such a map will be an autonomous layer of the digital map of the city (precisely speaking in the Municipal Spatial Information System using the GIS technology). Above all, to create the acoustic layer, it makes it possible to use the existing data associated with digital map referring to objects, infrastructure and other elements on the map which may potentially influence the acoustic climate.

It was also assumed that the acoustic map will be developed with usage of calculation method (basing on aforementioned information) and consequently the calculation results will be verified in so called “reference points”. Because both during creation and exploitation process the key factor is the repeatability of spatial layout of these points, it was assumed that GPS-based system will be used for their location.

For the whole of the project there is a crucial assumption that along with the practical aspect (IT – acoustic) it also comprises the educational and training aspect. From this point of view, for the shape of the project, it is vital to define the end user and its outcome.

Due to legal conditions, the responsibility for creation and exploitation of acoustic maps lies in hands of local governments (self-government units – JST). The project development team assumed, that it would be crucial to involve local authorities in its realisation as well as ongoing results communication and simultaneous commencement of respective training process for the personnel which would eventually be responsible for map exploitation.

Therefore one of the first complementary tasks completed in this project was launching a website with continuously updated content (www.mapyakustyczne.pl), containing among others a free-access open discussion forum.

The accessibility of desired class IT tools is prerequisite for implementability of results of the project concurrently with the initial assumptions. Therefore, one of the first tasks on the task-list of the project was located one referring to identification of status and scope of usage of GIS class systems in the public administration units – in municipal offices of the biggest Polish cities.

3. GIS systems in local administration units

This stage of research comprised performing the comparative analysis of GIS programs used in the units of the local government (JST). The analysis was carried out between 2001-2003 [10, 11, 18] basing on survey aiming at recognising the GIS software, used by municipal offices in activities done by these units. The poll conducted in two steps comprised 40 municipal offices of cities whose population exceeds 100,000 inhabitants. The first one “Usage of GIS programs in local government units” consisted of 21 detailed questions. There were 38 responses from the cities. In three cases there was indicated that there are no GIS tools implemented in the office, however, there are plans of implementing such in the nearest future. The other offices responded in a full, meritoriously satisfying way.

The GIS systems in municipal offices are used mainly for digital map creation purposes, in geodesy and cartography, property management, perpetual usufruct, rentals, communal property, state treasury property and anti-flooding measures.

Despite the fact that each office has and uses the GIS class software, the majority of them when performing their tasks, does not use its all features. It is particularly vivid in the table below where the planned usage is confronted with the real one. The table presents the results of polls conducted for the purposes of this project and compares them with the ones acquired two years earlier (Table 1).

Table 1. Types of activity of the municipal offices with usage of GIS-based systems – implemented and planned to implement.

Type of activity	Implemented		Planned	
	2001	2003	2001	2003
Spatial planning	14	27	6	5
Ecological catastrophe simulations	3	2	10	14
Land property register	15	29	5	3
Gas, sewage, water supply, electricity networks maintenance	5	12	12	13
Faults and glitches location	3	2	13	13
Location decision making	8	16	13	11
Real-estate management	11	21	8	12
Investment control	2	9	15	11
Education, healthcare regional assignment	4	8	12	7
Environment protection and threat identification	3	9	14	14
Catastrophe and crisis situations management	5	6	11	13
Building management	11	16	10	13

In the majority of cases the implemented GIS system is a networked one, in 9 cases there are both workstation and networked systems. The GIS network comprises the whole office in 31 cases. In 24 offices there are no dedicated units for exploitation and maintenance of GIS system. Simultaneously, in 22 offices the tasks related to GIS systems are done on their own and in 12 cases the offices look for assistance of other entities:

- geodetic organisations and enterprises (when creating new layers and completing the databases),
- branch companies: water supply, gas, power plants, electricity suppliers (data input and verification).

In 20 surveyed units there were introduced some measures aiming at usage of GIS systems in environment protection related tasks. The data referring to the conditions of the environment necessary for performing such tasks are acquired exclusively by the municipal offices through constant monitoring, periodic measurements and forecasting (in a very limited scope). The data are most often acquired from external sources, i.e. Regional Inspectorate of Environment Protection, Environment Protection Programme, property register, etc. The GPS (Global Positioning System) was used for environmental data acquisition in none of the cities which have performed environment protection related tasks so far.

The separate issue which was surveyed was the identification of share of particular GIS systems in the analysed market. It was discovered that the most frequently used GIS class software by Polish local governments is delivered by ArcInfo, MapInfo and Microstation.

4. Database preparation for purposes of acoustic environment simulation

The execution of the following tasks in the project was possible only in the co-operation with the selected municipal offices. This task comprised identification of a complementary data set in GIS systems, the accessibility of which determines the creation of the strategic acoustic map in accordance with the developed technology. The set of data necessary for creation of the acoustic map of the city using the GIS system comprised the following elements:

1. Terrain raster base in one of the following file formats *.bmp, *.jpg, *.tif, other, vector-calibrated in GIS system.
2. Topographic information layer, lay of the land (isolines, elevation above the sea level).
3. Objects (buildings) layer:
   a) graphical, with data determining the layout of the objects (contours of objects),
   b) table, with data determining the specific features of the objects.
4. Streets and roads layer:
   a) graphical, with data determining the layout of the road (axis of the road/street),
   b) table, with data determining the specific features of the section of the road/street.
5. Parking lots layer:
   a) graphical, with data determining the layout of the lot (contours of lots),
   b) table, with data determining the specific features referring to amount of parking places, manager/owner (e.g. shop, restaurant, supermarket, local government unit).
6. Rail transportation layer (trams, trains)
   a) graphical, with data determining the layout of the rail (axis of the rail),
   b) table, with data determining the specific features of the section of the rail.
7. Additional layers covering the following information: spatial development plan, greenery location (parks, etc.), recreation areas, water reservoirs, additional urban elements (acoustic screens, etc.), others.

Upon the performed research it can be judged that the acquisition of the aforementioned set of high quality and up-to-date data was one of the most serious difficulties which may be encountered during the project implementation. Currently existing information resources are often fragmented, come from various sources, are not time-cohesive, and their structure and quality is determined by priorities and legal regulations referring to the usage of map data which have been in power so far. For instance, the information concerning heights of buildings on the map is mainly described through number of floors, which is determined by geodetic requirements. Due to this fact both a supermarket and a neo-gothic church are considered to be the same class one-storey-building. As the pilot research indicates, the basic digital maps acquired according to the Environment Protection Law from the national geodetic resource, in the majority of cases cannot be used in applications for acoustic calculations and require re-processing.

To the main drawbacks of these maps one can include the layout of objects on many layers, open edges of the polygonal contours of buildings which disable the possibility of creating 3D models and the overabundance of detailed information.

The quality of data which may be made accessible to the map creator by its end user (operator, office), influences significantly the total scope of the task, as well as the quality of outcome. Therefore, in this project the accessible simulation tools were also analysed, as well as the influence of their quality on the feasibility of tasks resulting form the Environment Protection Law.

5. Review of calculation methods used for the Digital Acoustic Maps purposes

Strategic Noise Maps (SNM) should be prepared for the most significant noise sources in urban agglomerations, that is: traffic, trams, railways and aviation, as well as for industrial plants and other significant sources of noise emitted to the environment, e.g. large parking lots, transportation bases, tram and bus depots, distribution stations, objects and places of events.

The calculation methods, recommended to use when creating SNM were determined in the Noise Directive [4]:

- traffic noise – French national method (NMPB) according to XPS 31-133 standard,
- rail noise – Dutch method “Standaard-Rekenmethode II” (SRM II),
- industrial noise and other sources – calculation method based on noise spreading model according to the norm PN ISO 9613-2 (assuming that substitute models and acoustic power levels L_{WA} for particular, significant noise sources are known),
- aviation noise – ECAC.CEAC Doc. 29 “Report on Standard Method of Computing Noise Contours around Civil Airports” method.

For rail and traffic noise, within the framework of Harmonoise and Imagine program, there were developed reference calculation methods, based on above mentioned national methods [7, 27] and the methodology of measuring and specifying empirical parameters for rail noise calculation method [6, 29]. For tramway noise there is no reference calculation method. Within the project two possibilities were analysed:

1) usage of German calculation method Schall 03 for rail noise, where the *tramway* option is possible,
2) application of a model of linear source with declared level of acoustic power per longitude unit L_{WAo} in association with a noise spreading model according to PN ISO 9613-2/.

In both cases empirical evaluation of L_{WAo} for typical railways and tramways and trains is necessary.

According to the legal regulations which are in power in Poland [29], during the process of creation of SNM for urban agglomerations, the calculations will be made particularly for traffic and tramway noise, accessorily for railway noise. Noise maps for airports, main railways and data referring to industrial plants and other objects which may significantly influence the environment, should be granted access to for map creation purposes by appropriate authorities and inspections, e.g. Environment Departments in municipal offices and Voivodeship offices (on regional level). In such case the owner of the object is obliged to prepare appropriate documents. One important problem occurring when adapting this data to the needs of SNM, which may even make it impossible to use them in environmental impact assessment reports, is the use of many various noise indicators used for purposes of noise maps and likewise for environment inspection (article 112 Environment Protection Law [29]).

Noise maps developed with use of calculation methods, are created with bounded precision resulting both from simplifications of even the best models, and also from uncertainty of initial data for calculations and formal and empirical parameters of the models. The problem of setting appropriate acoustic parameters for the calculation model is particularly vivid in tramway and railway noise calculations due to significant technical and exploitation-related differences regarding to domestic and western networks. Formal parameters which may significantly influence the precision and timing of calculations comprise, among others, the amount of reflections taken into consideration during calculations as well as the resolution of calculation raster.

Within the project some local and simulation research was done during which the influence of input data and computational parameters on the concurrence between calculation results and real noise measurements was analysed but also the precision of setting the global indicators, e.g. human population exposed to noise. The research was done for five chosen residential areas, having different features and characteristics of development, typical for large cities in Poland: detached houses, semi-detached houses, low buildings in the streets, tall blocks of flats laid parallel to the streets and dual-sided tall continuous buildings [19–23]. The results show that even if the same noise calculation models are used, the final results are different, depending on given model calculation parameters [21].

The results prove that empirical calculation models calibration and map verification is one of the most important and necessary steps in SNMs development which will be crucial for their reliability. Map verification is a multi-stage process comprising calibration and verification of noise emission model, calibration and verification of propagation model and final verification of the map. Calibration focuses on adjusting input data which are roughly estimated and have a significant level of uncertainty (e.g. road surface status, rail track status) in order to gain the best concurrence between results and measurements in checkpoints.

During the verification process the main problem is formulating a measurement strategy appropriately to assumed objective of verification and selection of representative observation points, but also precision and credibility of measurement data. The proposed methodology of long-term indicators setting for day and night may be found in [4].

6. Quality of acoustic map as a quality function of input data and used calculation methods

In the legal regulations [4, 29] acoustic maps are defined using a set of qualitative and quantitive factors. Therefore, only an object having all the demanded features can be considered as the acoustic map. According to these regulations, then, binary assessment scale is sufficient for estimating whether the map has the required features and in this way may be considered as an acoustic map, or not. On the other hand, the requirements given in the legal regulations are imprecise and grant a relative freedom of choice in map development process. In such situation one of key factors is the acoustic maps quality management through development process control. In Polish conditions, the most probable models of map management (by local governments) are:

a) development and exploitation of the map with own resources,
b) development outsourcing, exploitation with own resources,
c) development and exploitation outsourcing.

It was concluded, basing upon the co-operation with local governments, that the most probable solution will be the (b) model. Its implementation in the part referring to map development should be divided into two stages:

1) assessment of accessibility and quality of input data with the qualitative requirements description,
2) creation of the acoustic map.

Omission of the first step and single-step implementation of the project in current conditions in the country may lead to the cost control loss or quality deterioration. In Poland there is no stable service market for acoustic maps creation, neither the prices were set, nor the quality standards. Both the authorities and the developers have no requires experience in organisational and economic decisions optimisation. The basic problem with maps creation process refers to accessibility, quality and cost of data preparation assessment. The dual-stage option makes it possible to assess the standard of the map and cost of the development on given area.

Taking into consideration the fact that the process of ordering a map development should be carried out under the regulations of public procurement law, where the factor determining the choice of particular developer is the offered price, quality control is only possible using appropriate and thorough descriptions in tender documentation where the results from (1) should be included.

Due to the lack of precise formulations referring to acoustic maps resulting in serious interpretational or implementation-related difficulties (mainly because of shortage in essential input data), the EU Working Group on the Assessment of Environmental Noise (WG-AEN) developed a Good Practice Guide (GPG) for SNM creation and development of accompanying information referring to noise exposure threat [5].

The application of GPG helps solve many problems resulting from the shortage of input data referring to noise sources and its propagation, but also the population of people under threat of excessive noise exposure. Taking into account the level of advance of calculation methods (Sec. 5), market verification of the noise calculation software (Sec. 7), and a common practice of sharing the procedures devised in frameworks of EU research programs, e.g. Harmonoise and Imagine [6, 7], with software developers, the problem of calculation tools does not cause so much concerns as the problem of input data.

Analysing the acoustic map definitions given in regulations [4, 29] it may be observed that the term *acoustic map* refers to the set of information (database) about the acoustic environment with a visual form of data presentation. The traditional understanding of acoustic map as a set of set of data in a graphic form was transformed onto a modern system of geographical information. Acoustic maps are developed by various calculation methods, using collected input data acquired through calculations and measurements but also from verification and validation measurements. From the contemporary point of view, the creation of the acoustic map is a measurement. Along with the measurement results, there is also the measurement uncertainty given [5].

The measurement uncertainty reflects the lack of precise knowledge of the measured physical quantity. Thorough knowledge of the measured physical quantity demands infinite amount of information, which is practically inaccessible. In this way the results are given as a range of values, not as a single figure. The uncertainty may be treated as a quality measure of the acoustic map. Among many typical sources of uncertainty [30] one can list (without the need of thorough justification within the context of acoustic maps creation process) the following: non-representative sample selection for calculations verifying measurements, bounded knowledge about influence of particular environmental conditions or simplifying approximations and assumptions used in calculation and measurement procedures and methods.

7. Selection of IT-tools for acoustic map creation

The analysis of results of the poll described in Sec. 3 indicated which GIS-class software was most frequently used by Polish local governments. Because the base of the project execution was the assumption that the GIS-based environment management system should be a part of acoustic maps creation and exploitation system and the noise map should be one of the layers, the following step in the process was preparation of dedicated IT tools enabling the creation of implementable and applicable GIS acoustic layers. Creation of acoustic maps of huge spaces exposed to joint industrial, traffic and aviation noise should be aided with IT simulation tools using advanced computational techniques. Such tools should have the following features: ease of use, intuitive interface and control, comprehensible help, unintentional users' errors resistance, etc. Computer software for noise mapping used in GIS-class systems should then be described by the following parameters:

a) possibility of geographical, demographic and acoustic data acquisition straight from the GIS system,
b) calculations performed basing on various international norms (computational algorithms),
c) possibility of faultless acoustic data import/export from/to GIS system.

During project execution there were identified some professional software bundles for urban areas acoustic map creation. In particular there were bundles: CadnaA, SoundPlan, MITRA, LIMA, Predictor and IMMI. In the report covering this stage of the project [17] the detailed characteristics of these applications were described.

The evaluation of above listed tools brought the researchers to conclusion that the most suitable tool, according to the assumed criteria, would be CadnaA [2]. Therefore, the decisions were made to use this software in further works. On the one hand, such decision results in taking specific assumptions referring to demanded formats and types of data integrated with the digital area map, enabling to build simulation models of acoustic climate. On the other hand, because testing of the developed technology in the project was initially assumed (basing on the co-operation with executors of maps of large cities), such a decision made it possible to confront and assess the databases from digital maps which were currently at their disposal with the ones which had to be completed in order to create the acoustic layer.

8. Project management concept

Due to the unique character of the project, during its realisation emerged a few unique project management solutions in scientific manner.

For instance, particular tasks are meritoriously reported on meetings of the project team (according to the project schedule), afterwards the task is accepted through a common decision making and the final protocol is signed by the project manager. Financial reports are prepared by the leader of the project, however, basing on the Rector's decision, the leading institution does not charge extra the others for this activity. In other words, the costs are thoroughly reported in the place they are produced.

For the final shape of the project it was crucial to define clearly the end user (beneficiary) of its results. Project preparation team assumed that its inevitable element would be involvement of local authorities in this process. The support of the application when it was submitted was verbalized by a few mayors of the cities and by regional authority (marshal). Simultaneously, after the financing was granted, the co-operation of project partners with local governments turned into new shape – in financial aspect as well. In the project description it was stated that the developed technology would be tested in the cities in which the institutions lead their didactic activity. After positive financial decision, the consortium participants applied to their appropriate local authorities for extra financing, according to the agreement prepared by the leader. Concurrently with these agreements which were signed with 4 cities (Tychy, Zabrze, Gliwice, Rybnik), local authorities have kept co-financing this project from their municipal budgets. There was prepared a uniform financing system, using the possibility of scientific research donation from the Municipal Fund for Environmental Protection and Water Management.

Within the granted donation, the cities are entitled to indicate the areas where they would like to have the acoustic map prepared using the proposed technology. Simultaneously, the necessary conditions of GIS data preparation needed for the noise map creation are agreed with the GIS system implemented in a particular municipal office, the personnel may use trainings and workshops free of charge and the information collected during the pilot research and implementation is the exclusive property of the city. The resources acquired from municipal budgets are reported as "own contribution" and according to the agreement statements they are kept one a separate bank account and reported independently to the donating city.

So far there were organised two seminars, during which, apart from a detailed presentation of works progress, various aspects of final development of the technology were discussed with the local governments' representatives. The third seminar is currently under preparation. Its schedule comprises both presentation of final results of the project, as well as identification of needs and possibilities of local governments referring to actions being consequences of creation (according to the law) of strategic noise maps.

Particular attention will be paid to knowledge formation process, abilities and competencies of this personnel which will be involved in the above mentioned activities. Therefore, within the project there was devised a conception of business process mapping [8] which may be used as a support for both the practical objective of the project, but also for the training and educational part comprising local government personnel training and consulting in preparation of local noise protection programs.

9. Business process maps as a tool for research project implementation

The chosen method is widely used in management sciences as a convenient tool combining features of structural analysis [32] with ways and aids of information system engineering [1]. The starting point for using this concept was the assumption that development of an effective technology of maps creation and exploitation could be considered as a particular example of information system design. Such a system describes full set of activities related to map creation and takes into consideration both data transformation relations and the network of relations between participants of the process.

Business process mapping method is based upon the assumption that:

- any sequence of activities realised in a given structure/organisation may be considered as an information flow system/process,
- process designing is cohesive with the information system design task,
- complex designing of the information system should use the multilevel approach.

The process map includes the following levels of the described process:

a) **organisation** level (where the process is designer),
b) **process** level (description of particular functions of the organisation),
c) **workplace** level (modelling and description of particular components of the organisation focusing on the workplaces involved in process realisation).

By using the above described method of process, system or model designing, it is possible to get a more complete description of the process than as a result of information flow modelling and survey.

Process mapping usually begins with identification of the participants (organisations) of the process. The list of these entities (process elements) may be treated as a description of a superior type of organization (*metaorganisation*). In many cases the base for creating a business process man is identification of a leading organisation (dominating). The other participants may be treated then as external elements of this process.

The defined elements of the process create the theme for splitting the analysed organisation into separate levels. In this way we get a general scheme of structure of the surveyed object (**organisation level**). Subsequently, starting from the organisational structure, one makes the analysis of tasks and activities realised in the organisation (**process scheme**).

Spreading particular tasks onto particular elements of the organisational structure makes it possible to prepare the description of process of transforming particular input streams in the following activities realised by these elements up to getting to the final result of the process. The business process map shows then the involvement of particular structure elements in the task realisation and enables the decision makers to assess this commitment both in the final result aspect (process output) but also in aspects of prerequisite inputs and own resources.

Such a presentation of a process makes it possible to find main relations occurring in it, determine time necessary for completing particular tasks and identify all non-continuities in the process (illogical, missing or unneeded activities).

Upon the analysis of separated objects in the surveyed structure and data flows between them, there was created a general description of informational input – output, information flows between these objects and specification of documents and tasks.

All the above listed elements of the discussed method were the base for creating the initial process (sub-process) map describing the creation of the strategic acoustic map for the need of local governments as determined in the law [29]. It was particularly assumed that the business process map would be built in a 4-element setting of the organisation level which would include:

1. Acoustic map authorised operator (local government),
2. GIS system operator,
3. GIS data collecting institution (incl. acoustic data),
4. Map creator.

Due to the necessary identification of mutual relations between participants of aforementioned process, it was assumed that the GIS system operator functions within the structure of the local government office but the data collector and map creator are external entities. It describes for instance the need of including on the business process map pre-defined processes which exemplarily are public tenders. The excerpt from the process map is presented in Fig. 1.

Business process map analysis may consider a base for:

- precise defining and describing particular tasks which create all the actions focusing on strategic acoustic map creation in local government as well as accompanying tasks, e.g. acceptance of noise preventing action plan and map exploitation (in spatial planning aspect),
- setting the requirements relating to key competencies of persons/teams executing particular tasks (with special attention to local government personnel competencies),
- indicating the conditions of decision making, of which the described process consists,
- identification of training needs of the process participants (staff),
- process-related actions scheduling.

The intention of the research project realising team is the development – basing on business process mapping technique – of a practical guide for local governments which are, according to the legal regulations, obliged to introduce strategic acoustic maps by certain date.

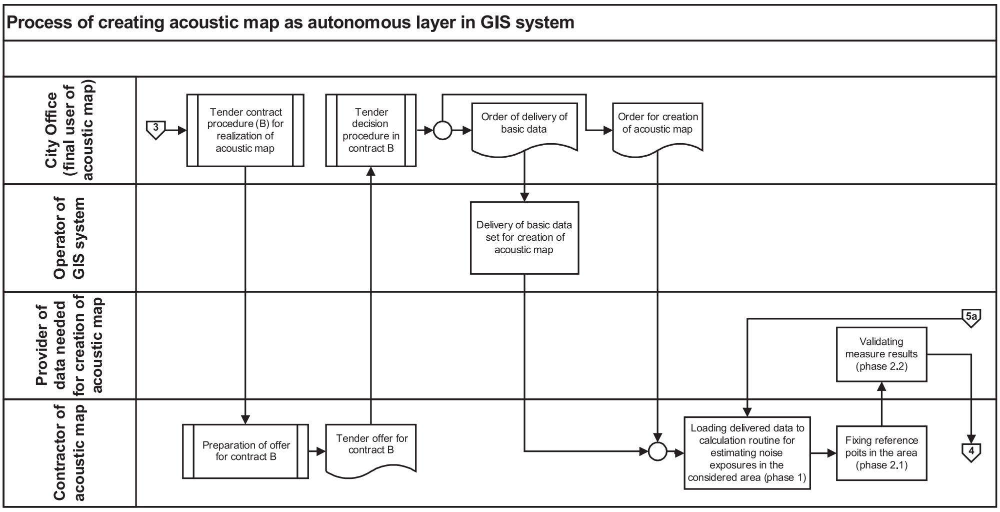

Fig. 1. Excerpt from the acoustic map creation business process map.

10. Conclusions

The completion of the aforementioned project, according to the schedule, is foreseen to take place in November 2006. The results, particularly the ones arising from the co-operation with local governments, allow us to state that realisation of legal requirements referring to strategic acoustic maps may encounter significant and serious difficulties relating to the level of knowledge and competencies of the personnel responsible for map creation and, consequently, exploitation. Therefore, the research team has been preparing assumptions for next project the aim of which will be effective training and education of the personnel in the area of the subject.

References

[1] BEYNON-DAVIES P., *Inżynieria systemów informacyjnych*, WNT, Warszawa 1999.

[2] CADNA/A, Demo User manual.

[3] *Determination of Lden and Lnight using measurements*, Imagine, IMA32TR-040510-SP08.

[4] Dyrektywa 2002/49/WE Parlamentu Europejskiego i Rady Europejskiej z dnia 25 czerwca 2002 r. odnosząca się do oceny i zarządzania poziomem hałasu w środowisku http://europa.eu.int/eur-lex/pl/dd/docs/2002/32002L0049-PL.doc

[5] *Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure*, Version 2, 13 January 2006.

[6] http://www.harmonoise.org/

[7] http://www.imagine-project.org/

[8] KAŹMIERCZAK J., *Zastosowanie map procesów w projektowaniu systemów wspomagania zarządzania zadaniami inżynierskimi*, Referat zaproszony na V Szkołę "Komputerowe wspomaganie projektowania, wytwarzania i eksploatacji", Żegiestów, maj 2001.

[9] KAŹMIERCZAK J., LIPOWCZAN A., SĄSIEDZKI P., *Network-based system for acoustic mapping of urban areas*, Proceedings of 42-nd Congress of European Regional Science Association, Dortmund/Germany, August 2002.

[10] KAŹMIERCZAK J., *Zarządzanie środowiskiem akustycznym w terenach zurbanizowanych z zastosowaniem systemów GIS*, [in:] *Nowoczesność przemysłu i usług. Nowe wyzwania*, J. PYKA [Ed.], TNOiK, Katowice 2004.

[11] KAŹMIERCZAK J., *Cyfrowe mapy akustyczne: uwagi o zarządzaniu celowym projektem badawczym*, Materiały VIII Konferencji "Komputerowo Zintegrowane Zarządzanie", Zakopane, styczeń 2005.

[12] KAŹMIERCZAK J., *Processes of creation and exploitation of strategic acoustic maps of urban areas*, Proceedings of EURONOISE 2006, Tampere/Finlandia, May 2006.

[13] LIMA 4.0, Product Data.

[14] LIPOWCZAN A., *Mapy akustyczne miast w świetle Prawa Ochrony Środowiska oraz Dyrektyw Unii Europejskiej*, Materiały 50-tego Otwartego Seminarium z Akustyki, Gliwice – Szczyrk 20003.

[15] Raport z badań własnych BW-462/ROZ-5/2000: *Rozpoznanie środków i sposobów zagrożenia hałasem w obszarach zurbanizowanych*, Materiały Katedry PST Pol. Śl., Zabrze 2000.

[16] Raport z badań własnych BW-502/ROZ-5/2001: *Analiza porównawcza programów GIS w zakresie identyfikacji oddziaływań środowiska*, Materiały KPST Pol. Śl., Zabrze 2001.

[17] Raport z realizacji badań BW-503/ROZ-5/2003: *Zastosowanie narzędzi GIS w zadaniach z zakresu zarządzania środowiskiem*, Materiały KPST Pol. Śl., Zabrze 2003.

[18] Raport z realizacji PC7/ROZ-5/2003 (zadanie 2): *Opracowanie ankiety i przeprowadzenie inwentaryzacji programów GIS w miastach powyżej 100 000 mieszkańców*, www.mapyakustyczne.pl.

[19] RUDNO-RUDZIŃSKA B., RUDNO-RUDZIŃSKI K., HABRAT T., *Analiza wpływu danych wyjściowych i parametrów modeli obliczeniowych na błąd mapy akustycznej*, Materiały OSA'2004.

[20] RUDNO–RUDZIŃSKA B., HABRAT T., *Cyfrowe mapy akustyczne – wyznaczanie wskaźników globalnych*, Materiały XXXIII Szkoły Zwalczania Zagrożeń Wibroakustycznych, Ustroń 2005.

[21] RUDNO–RUDZIŃSKA B., HABRAT T., *Comparative analysis of measurements and calculation results for road noise in built-up area*, Proc. ICSV12, Lisbon 2005.

[22] RUDNO–RUDZIŃSKA B., HABRAT T., *Influence of calculation parameters on time and accuracy of city road noise computations*, Proc. Forum Acusticum, Budapest 2005.

[23] RUDNO–RUDZIŃSKA B., HABRAT T., *Experimental validation of city road noise computations*, Archives of Acoustics, **30**, 4 (Supplement), 231–234 (2005).

[24] RUDNO–RUDZIŃSKI K., RUDNO–RUDZIŃSKA B., *Zarządzanie jakością map akustycznych*, [in:] Zarządzanie środowiskiem akustycznym. Konferencja Ochrony Środowiska, Urząd Miejski Wrocławia, Przedsiębiorstwo Techniczne "Energopiast", Wrocław, 38–42, April 26–27, 2006.

[25] RUDNO–RUDZIŃSKI K., RUDNO–RUDZIŃSKA B., *Opracowanie wariantowych programów szkoleniowych z zakresu technik i procedur opracowywania map akustycznych miast*, Raporty Inst. Telekomun. Teleinform. Akust. PWroc. Ser. SPR nr 21, 2006.

[26] SoundPlan.6.1, User manual.

[27] TECHNICAL REPORT HAR32TR-040922-DGMR20. Harmonoise WP3 "Engineering method for road traffic and railway noise after validation and fine-tuning", January 2005.

[28] TECHNICAL REPORT IMA6TR-050912-TNO01. Improved Methods for the Assessment of the General Impact of Noise in the Environment. IMAGINE railway noise source model, default source data and measurement protocol, September 2005.

[29] Ustawa z dnia 27 kwietnia 2001 r. Prawo ochrony środowiska [Dz. U. Nr 62, poz. 627 z dnia 20 czerwca 2001 r.]

[30] *Wyrażanie niepewności pomiaru*, Przewodnik, GUM 1999.

[31] YOURDON E., *Współczesna analiza strukturalna*, WNT, Warszawa 1996.