

# VISUAL INTERACTIVE MODELLING OF BUSINESS GEOLOCALIZATION

Kaspars Cabs, Arnis Lektauers, Yuri Merkurjev  
Riga Technical University  
1 Kalku Street, Riga LV-1658, Latvia  
E-mail: [kaspars.cabs@gmail.com](mailto:kaspars.cabs@gmail.com), [arnis@itl.rtu.lv](mailto:arnis@itl.rtu.lv), [merkur@itl.rtu.lv](mailto:merkur@itl.rtu.lv)

## KEYWORDS

Visual interactive modelling, GIS, Business geolocalization

## ABSTRACT

The world economy is facing rapid changes, which can also be explicitly seen in Latvia. Decrease in the GDP of nearly 20% has had a serious impact on the overall business environment, and especially the businesses oriented on the internal consumption.

Aim of this research is creation of an internet-based multiuser methodology which would provide quick business environment analysis for small and medium-sized enterprises. The analysis is based both on GIS-based data, as well as on available data that come from other data bases. The main analysis tool is based on the possibility to display static information in the dynamic visual environment, thus assessing the possible impact on the business not only in the particular moment, but also showing its dynamics.

Research is also focusing on problems of dynamic representation of information in the internet environment, in particular with regards to the stability and speed of internet operation, and possibility to get the best possible dynamic representation in case of unstable access to the data.

Also visual representation of data is important. According to definition provided in Zhang (2008) visualization is the transformation process of data, information and knowledge into a graphical depiction with the goal being to provide data analysis, information exploration, information interpretation, trend forecasting, pattern recognition, etc. The dynamical visualization or animation enables the user to visually observe the dynamics of the business environment behavior and increases the effect of model credibility by giving a more complete review of the simulated system. In order for user not to lose the link to research environment during the visual modelling, aim of the system is to save basic information – the map, and to display on it additional information in a user-friendly way.

The geographic research area under consideration is the city of Riga, and the source of basic data for elaboration of the methodology is information from the Riga Development Plan, as well as information from available data bases on the transport flows, population density, density of road transportation, location of shopping malls, warehouses, office centres as well as enterprises-related data.

## INTRODUCTION

During the last two years Latvia has experienced dramatic changes in its economic development. Imbalanced development during the previous years has resulted into decrease of the GDP by more than 20% within two years time. The world economic crises has had an impact on these changes, but much more it is the result of growth which was not based on the real economic segments, i.e. it was possible due to the cheap loans, which were used for the real estate and not for the production. In order to plan their activities in the crisis situation, the enterprises need to use different tools of economic analyses, planning and prognosis. Location of the enterprise, connected infrastructure, location of the competitors, potential clientele - all these factors create a joint system, where the possible location of the enterprise promotes attraction of the clients to the particular location, which, in its turn, attracts new competitors to this particular territory. Examples of this are the shopping malls, where competing shops are located nearby.

Many enterprises choose their location based on their preferences, e.g. accessibility of the location, historical location, as they do not want to experience changes; the location can as well be based on the availability of the necessary workforce; and other options. However, if a big enterprise is able to leave an impact on the urban environment, agglomeration process; and similarly, small and micro enterprises in their turn have to use the opportunities created by the big enterprises and their impact on the environment. In order to assess this environment properly, elaboration of a specific methodology is proposed, which will enable evaluation of the existing situation and its comparison with the changes taken place in the past; it will enable forecasting

of the development scenarios both, for the overall business environment as well as for the particular industry or enterprise.

## BACKGROUND

Changes in the number of population in the concrete location during a certain period of time compared with the changes in the economic activities create a basis for the development perspective of the particular territory. For example, during 1997 – 2008 number of inhabitants in the centre of City of Riga has decreased by 40 - 50%, whereas number of inhabitants in the outskirts of Riga has increased by 10-20% (source: <http://www.apkaimes.lv>). At the same time the location of the municipal service providers has remained the same (e.g. location of the kindergartens). Thus, the possible support of the municipality should be directed towards the potentially advantageous territories for development of private enterprises taking over these functions. Analysis like this is very time consuming, and often not available for the small and micro enterprises, as it often requires significant financial and time resources, which due to the crisis situation are not available to these enterprises.

The Apkaimes portal has tried to help in this situation providing information available in the Riga City Council; there are tools for analysis of statistics available, which enable assessment based on the concrete territory. However, this covers only a small part of the available information. In order to perform a complete analysis, it is important to assess also the location of businesses operation in another spheres (e.g. it is beneficial for a pharmacy to be located next to the grocery store, as it increases the number of customers). It is also important to pay due attention to the use of the territory and the situation with the crimes in the particular territory (e.g. the Latgale suburb of the city is facing bigger problems with the drug abuse compared to the other suburbs).

## TASK

The presented research is aimed at, based on the available information, a web-based system prototype, which is using the developed methodology that would enable not only the statistical analyses, but also showing its dynamics and prognosis. This paper reviews methodology which is based on the analyses of correlations between the existing statistical data using the interactive options (the user defines importance of the particular statistical information in relation to the other layer of statistical information), as well as defines the dynamics of the statistical information (correlation size-importance value dynamics). The result is characteristics of the GIS space cell. Taking into account the

dependence of the agent activity from the cell parameters, there can be several characteristics to the same cell.

Thus in order to prepare the cell characteristics, it is important that the results of all layers are comparable to each other. For example, it is necessary to compare the weight of the capacity of the public transport and number of population with the number of enterprises of a particular sector within one cell. In order to achieve this, all the cell level results are normalised.

In order to display information, the map is divided into cells, which is easy to perceive for the reader, and it is also a convenient format for the programming, as only location of the particular cell is to be defined, which can be performed as a data base function in the real time.

This way of displaying information is one of the most common and is used as an information carrier for different systems. For example, one of the display models is used in the V-DEVS framework (see Lektauers 2009), and in this case information in the cells is changed dynamically during operation of the model.

## DESCRIPTION OF MAPS ENGINE

Maps engine is created in the flash environment, the functional engine of the map consists of several functional blocks. Display of maps and other objects is ensured by the block "Maps, Objects display".

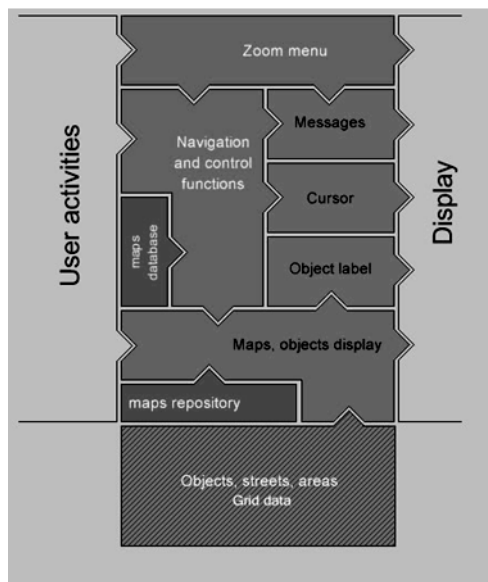


Figure 1. Flash interface.

Movement of the map, zooming in and out is ensured by the blocks „Navigation and control functions” and „Zoom menu”. Additional information (messages, cursors, labels) is displayed by the respective blocks - „Messages”, „Cursor” and „Object label”. All the maps are saved as map fragments in raster format in the „Maps repository”. Parts of the objects are displayed by the block „Objects, streets, areas, Grid data”. This block has two cooperation algorithms with the environment, (1) cooperation is ensured by the JavaScript requests; (2) the map sends requests to the web interfaces. In the current example the user defines in the web environment selection criteria for the layers, which are further transferred to the flash interface of the map, which, in its turn, requests grid data from the web interface and transfers this data and receives grid data which is further displayed by the flash interface.

## GEOLOCALIZATION

Before starting business every businessman tries to find the best location for his company. Ray Kroc, founder of McDonald says that there are three main factors for the business – place, place and place. Geolocalization of the enterprise means linking its administration, production facilities or other premises of the certain location depending on the sector in which the enterprise operates.

In order to find the best location the managers of companies are making researches, elaborating business plans etc., which allow to analyze the existing situation and to make forecasts. Usually decision making process takes a lot of time and money and consists of several steps: analyses of many indicators, elements and their correlation.

To find the potential business location in the easiest and quickest way, a model is created, which performs analysis according to selected criteria.

## METHODOLOGY

Calculation for the main layer data is performed according to the following formula

$$L_{ij} = Norm(\sum_i \sum_j P(pl)),$$

where  $P(pl)$  – layer point count in cell  $ij$ ;  
 $Norm()$  – Normalization function – each cell data for layer should be normalized, it means that  $\sum_i \sum_j L_{ij} = 100$  ;

$L_{ij}$  - resulted normalized value for layer for cell  $ij$ .

Any layer data should be represented in the same way. To get the resulted data, the following formula is used

$$R_{ij} = GridColouring(\sum_i \sum_j \sum_k L_{ijk} Coef_k),$$

where  $L_{ijk}$  - normalized value for layer  $k$  of cell  $ij$ ;

$Coef_k$  - user defined coefficient for layer  $k$ ;

$GridColouring()$  – according to the normalized data, the function discretizes the resulted data to ensure better visualization.

## EXAMPLE

The existing model includes several data layers, as well as methodology for obtaining this data. One of the data layers is location of the enterprise based on their coordinates. They are displayed as coordinates of the enterprise and sector in which the enterprise operates, which is one of the data sub-layers.

Another information source is the intensity of the public transportation flows in the concrete cell, which are based on the data from the JSC „Rīgas Satiksme”, and it is – number of the transport stops in the concrete cell and number of public transport units stopping there.

The biggest concentration of the public transport is in the vicinity of the Riga Railway Station (see Figure 2) as the result the biggest shopping centres are already concentrating there (e.g. Origo, Stockman, Galerija „Centrs” u.t.t).

7121	89	82	Rīga	2	Public Transport	0.02
7122	90	783	Rīga	2	Public Transport	0.16
7123	91	10477	Rīga	2	Public Transport	2.20
7124	92	32332	Rīga	2	Public Transport	6.78
7125	93	10626	Rīga	2	Public Transport	2.23
7126	94	12118	Rīga	2	Public Transport	2.54

Figure 2. Concentration of the public transportation in the Centre of Riga and its display in the data base.

As seen in Figure 2, the number of the public transport units in the transport stops in the Centre of Riga is close to 32,000, which is 6.8% of all the stops for the transport units in Riga (the total number of stops for all transport units is equal 100%).

However, analyses of data shows that in the new suburbs of Riga the number of shopping centres per number of inhabitants is low, e.g. there are numerous new apartment houses built in the Plavnieki suburb, whereas the number of shopping centres is comparatively low.

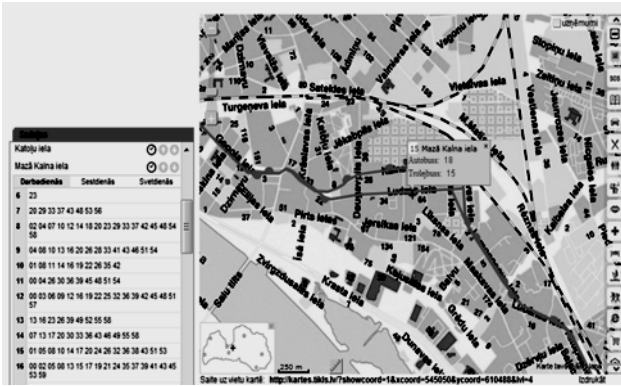


Figure 3. Public transport representation.

Another additional data layers are generated from the statistical module of the Apkaimes portal [www.apkaimes.lv](http://www.apkaimes.lv) (see Figure 4), which includes different statistical information in different periods of time (e.g. number of population, employment, number of kindergarten and similar). In this case additional processing of the data is necessary, as the division into districts (“apkaimes”) does not coincide with the cells. In this case the cell located in the particular district gets the weight based on the proportional size of the cell.

In cases, when parts of the cell cover several districts, the weight is based on the proportional size of the cell in each district and these values are summed up. In addition to this there is an option of attaching the user’s own data layer with its own values. In this case the layer is composed using one of the GIS basic values, like dot, line, polygon and calculation value. In case of a dot it is the value of the particular dot, in case of the line it is the value of the particular line, in case of the polygon – value of the polygon area.

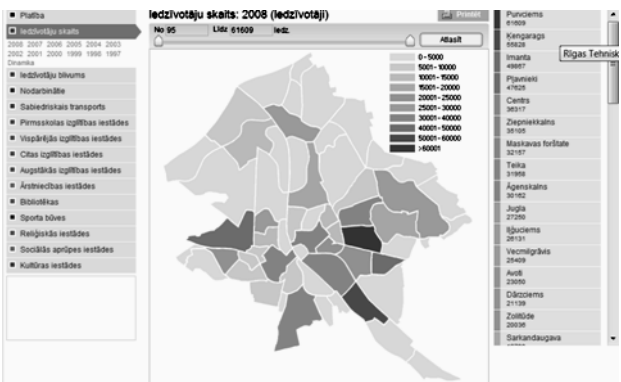


Figure 4. Apkaimes portal statistical part.

Thus task number one is selection of the data layers needed in order to carry out the analyses. For example, if the aim is creation of a car wash, it would be preferable to locate it in the close proximity to the existing car repair workshops and parking lots, as well as auto

showrooms. The data layer with information on the car repair workshops is selected, and its weight is defined (e.g. 30%); then the data layer with the information on the parking lots is added with its defined weight (e.g. 50%) and the data layer with the information on the auto showrooms with its weight (of 20%). The result is a grid with highlighted cells which is displayed on the map (see Figure 5).

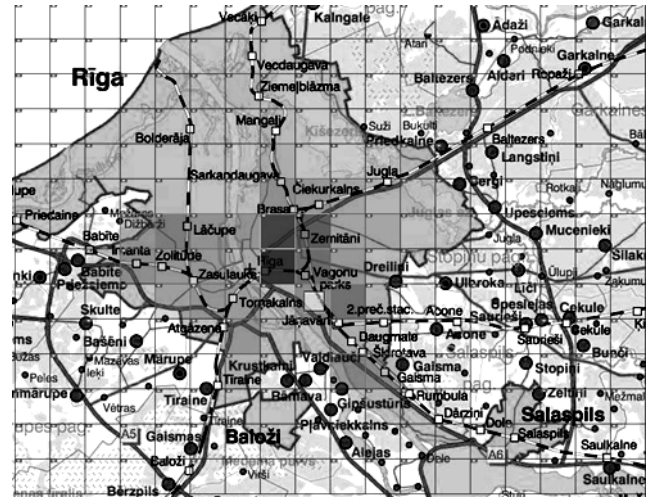


Figure 5. Example – visualised result.

Let us analyze data in one particular cell, which is highlighted blue in the example above. In this case the cell contains the following values (see Figure 6).

id_cellbusiness	cell	business...	businessen	a...	cellpely	cellypename	prc
5105	121	1068	...	Motocar, sale	8	1 Business	6.67
4928	121	1076	...	Motor vehicle service	5	1 Business	1.44
4931	121	1080	...	Parking places and garages	4	1 Business	2.23

Figure 6. Example – database projection.

In case of the parking lots the value of the cell expressed in per cent is 2.23%, and as the ratio of this value was 50%, the value results into  $2.23 * 50\% = 1.547$ . Likewise the other values are calculated, and the result is displayed on the map as colours of different intensity, thus visualizing information on the particular criteria.

## CONCLUSIONS

The presented research is devoted to exploitation of the visual interactive modelling to business localization. The developed methodology is aimed at comparison of different statistical values by modelling the possible business locations according to the targets defined by the user.

The described procedure concerns processing and visualisation of static information, during which the primary appraisal of the existing situation is made. On

the basis of this information it is already possible to perform the function of choice of the location. However, in order to get a precise evaluation, it is necessary not only to fix the existing static situation, but also to make its evaluation in dynamics.

Thus, the next task of the research will be using the existing data for creation of a dynamic simulation model. In that case the cell has to perform a certain function. In the discussed example this would be possibility either to sell a new car, or to perform its repair works, or to park it. And the car in that case could be moved from one cell to another.

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## REFERENCES

Tomlin CD (1990) Geographic Information Systems and Cartographic modeling. Engelwood Cliffs. New Jersey. USA

Rīgas domes Pilsētas attīstības departamenta Pilsētplānošanas pārvalde. Otra Rīga (2004) 95.lpp. (In Latvian)

Portāls "apkaimes.lv". Rīgas domes Pilsētas attīstības departaments, 2010, <http://www.apkaimes.lv>. (In Latvian)

Cekule M, Zīra M, Čabs K (2007) Interactive business geolocalization. XXIII International Cartographic Conference proceedings. Moscow.

Lektauers A., 2009. Multi-agent geosimulation of urban dynamics within the V-DEVS framework. In *Scientific Journal of RTU*. 5. series, Computer Science, 40. vol., Riga: RTU Publishing House, 2009, pp. 52-58.

Cekule M, Zira M, Cabs K, Baltmane I. (2008) GIS based Interactive Business Geolocalization, XXIV International Cartographic Conference proceedings. Chile, [http://icaci.org/documents/ICC\\_proceedings/ICC2009/html/nonref/5\\_5.pdf](http://icaci.org/documents/ICC_proceedings/ICC2009/html/nonref/5_5.pdf)

Zhang J., 2008. *Visualization for Information Retrieval*. The Informational Retrieval Series. Springer-Verlag, Berlin Heidelberg, 292 p.

## BIOGRAPHY

**Kaspars Čabs** is PhD student at the Faculty of Computer Science and Information Technology of the Riga Technical University since 2009. During the studies he has participated in the scientific, methodological and research work in close cooperation with the Institute of Geodesy and Geoinformatics of the University of Latvia. He has participated in the SMF/UPIMap2006 conference in Seoul with the presentation „GIS based interactive ecotourism and environmental IS in Internet”, as well as in the International Workshop at the German Airspace centre (DLR) in Neustrelitz.

In 2007 at the XXIII International Cartographic Conference in Moscow, Russia, he had a presentation on “Interactive business geolocalization”. Since December 2009 Kaspars Čabs is employed as a research assistant at the RTU Department of Modelling and Simulation.

**Arnis Lektauers** received the Dr.sc.ing. degree (2008) from the Riga Technical University (RTU), Riga, Latvia. His research interests include interactive hybrid modelling and simulation, and their application to complex systems design, as well as industrial, economic, ecological and sustainable development problems.

A. Lektauers worked for the development of software applications at private companies from 1996 to 2009. Currently he is Assistant Professor at the Department of Modelling and Simulation Senior Researcher at the Spatial and Regional Development Research Centre, both at Riga Technical University..

Arnis Lektauers is a member of Latvian Simulation Society, System Dynamics Society and IEEE Computer Society.

**Yuri Merkuryev** is professor, head of the department of Modelling and Simulation of Riga Technical University. He earned the Dr.sc.ing. degree in 1984 in systems identification, and Dr.habil.sc.ing. degree in 1997 in systems simulation, both from Riga Technical University, Latvia. His professional interests include methodology of discrete-event simulation, supply chain simulation and management, as well as education in the areas of simulation and logistics management.

Professor Merkuryev is a corresponding member of the Latvian Academy of Sciences, president of Latvian Simulation Society, Board member of the Federation of European Simulation Societies (EUROSIM), senior member of the Society for Modelling and Simulation International (SCS), and Chartered Fellow of British Computer Society.