THE IMPACT OF SPATIAL DATA QUALITY ON COMPANY'S DECISION MAKING

J. M. Mäkelä

Helsinki University of Technology, Department of Surveying / Laboratory of Geoinformation and Positioning Technology
jaana.makela@tkk.fi

KEY WORDS: Spatial data, spatial information, business information, analysis, decision-making, benefit

ABSTRACT:

The impact of spatial data quality on decision-making depends on the role of the geographic information system (GIS) in the company. The requirements for data quality are different depending on whether GIS is used in the operational level, in the management level or in the executive level of the company. The objective of the research is to model, calculate and present the benefits of GIS to a company. The 'benefitmodel' is business goal-oriented. One essential parameter in the 'benefitmodel' is the spatial data quality. The background of the research, some parameters of the 'benefitmodel' and aspects of the significance of spatial data quality to the benefits are presented in this paper.

1. INTRODUCTION

Business environment is changing all the time. Business is more demanding and managers have to react fast to customers' and competitors' actions. They have to make choices and decisions in a complex and uncertain environment. The significance of information as a company's competition factor has been emphasized during the last ten years. Comprehensive and real time information is needed to develop the business.

The role of GIS and spatial information has extended from niche technical solutions to enterprise business solutions. GIS has traditionally been used to support daily operations and make operations more effective. Then users have mostly been GIS professionals or experienced GIS users. In the last years the role of GIS has extended in the companies. Spatial information is utilized in the management level to support decision-making. In decision support systems spatial information and business information are integrated and used in different business analysis like marketing analysis, site location analysis and risk analysis. The most advanced role GIS has in the executive level of a company. Spatial information is used to visualize analyses and plans and thus to support strategic decision-making.

Spatial information is nowadays more and more a key factor in the enterprise's decision support systems. New users are mostly non-GIS professionals. More demanding decisions with higher monetary risks are made based on location intelligence. Therefore GIS professional's responsibility is to understand the meaning of spatial data quality in different decision-making situations. Data vendors provide spatial data of different quality to varying user requirements.

The spatial data quality has impact on company's decision making and the amount of impact depends on the role of GIS in the decision making process, on the usability of spatial information and on eligible benefits.

The aim of this article is to clarify the background of the research. The focus is on the new GIS utilizing companies.

The information in this article is based on books, journals and partly on my work in the Finnish National Council for Geographic Information. The experiential knowledge comes from my work in different GIS companies.

2. SPATIAL DATA QUALITY

2.1 The viewpoint into spatial data quality

In the early years of digital spatial data production the spatial data producers were also the users. They understood the quality of spatial data well. These users were mainly public organisations like municipalities, national land survey, road administration etc. When technology to gather spatial data from aerial photographs and satellite images developed, consulting companies started to produce spatial data to customers to make planning more efficient. Customers were able to define and evaluate the quality standards for spatial data. The viewpoint into data quality was strongly usage-centred.

Nowadays the usage of spatial information products has increased enormously. Most user companies don't produce the spatial data products themselves but buy those from data vendors. Data vendors are both public organisations and private GIS companies. GIS companies add value to raw spatial data and produce spatial data products, which are ready to be used in spatial analysis and decision-making processes. These products are for multipurpose. The quality of the products depends on the quality of the source (raw) data and the value adding process. The viewpoint into data quality is production-centred.

2.2 Data quality elements

Quality is a function of accuracy, precision and uncertainty. The less errors, the more accurate is the data. The accuracy is divided into positional, attribute and temporal accuracy. The spatial data quality is also measured by correctness, completeness and integrity of data (Malczewski, 1999). Uncertainty is defined as the indeterminacy in spatial or temporal location or in attribute classification. Jakobsson (2006) says, that there is one clear difference in geographic

information compared to other information. It always contains errors or uncertainty.

The quality of spatial data is assessed according to the usability of the data. It depends on the purpose of the use which quality elements are most important and most critical. The impact of these quality elements is discussed in chapter 4.

2.3 Awareness of the spatial data quality

The awareness of the spatial data quality is important. Non-professional new users are often not familiar with the spatial data products and their quality. They need information about the usability of the data in their specific needs. Does the professionalism of the data vendor guarantee adequate data quality, reliability and fitness-for-use? It is still common for organisations to spend thousands of dollars purchasing geographic data without receiving any quality documentation (Hunter 1998). If no reliable information or documents about the quality of data are available, perhaps the new user doesn't take a risk to invest in spatial data products and get the benefits of GIS. Therefore quality documentation is needed.

Metadata services increase the potential user's awareness of spatial data quality. Metadata help users to search for and compare different spatial data products, acquire spatial data products, and evaluate the fitness-for-use.

3. DECISION-MAKING

3.1 Improve the business

Decisions are made to solve problems or to find new opportunities and thus improve the business. What is the shortest way to transport goods to our customer? Could we improve our sales performance? Should we close down our factory? Decisions are often complex and the situation on hand may embody uncertainty.

The decision-maker can use intuition to solve the problem or rationalize the problem. The more challenging the decision-making situation and the bigger the monetary value of consequences, the more rationale a decision-maker has to be. He needs all relevant information to support the decision-making.

3.2 Decision-analysis process

Decision analysis provides structure and guidance for thinking systematically about decisions. The first step for the decision-maker is to identify the decision situation and to understand his objectives (Clemen, 1996). What are the objectives? Minimize costs, maximize profit or turnover or minimize risks?

The decision analysis process is divided into three phases: 1) intelligence, 2) design and 3) choice phase (Malczewski, 1999). In the intelligence phase information is obtained, processed and examined to identify opportunities or problems. Usefulness, timeliness, accuracy, reliability and flexibility of information must be considered. In the design phase the decision-maker invents, develops and analyses possible solutions of the problem. Alternatives are evaluated in the choice phase. The decision maker ranks the alternatives depending on decision maker's preferences with respect to the evaluation criteria. Finally the best alternative is chosen. The decision situation determines the need and the nature of the information required.

4. SPATIAL INFORMATION IN DECION MAKING

4.1 Multicriteria decision-making

Spatial data itself is of little value. Data must be transformed into information to be useful. When data is organized, presented, analyzed, interpreted and considered useful for the decision problem, it becomes information (Malczewski, 1999).

Spatial information has a role in different decision-making phases. The importance of the role and requirements for spatial data quality depend on the user's awareness of GIS potential in decision-making and on the usability of spatial information in the process.

Most spatial decision problems are multicriteria in nature (Malczewski, 1999). Spatial multicriteria decision analysis (MCDM) can be defined as a collection of techniques for analyzing geographic events where the results of the analysis depend on the spatial arrangement of the events. MCDM problems include six components: 1) *a goal* the decision-maker attempts to achieve, 2) *a decision-maker or group of decision-makers*, 3) a set of *evaluation criteria* (objectives or/and attributes), 4) *decision alternatives*, 5) *decision environment* (uncontrollable variables) and 6) *outcomes* of each alternative. The MCDM can be classified into multiobjective decision-making (MODM) or multiattribute decision-making (MADM) based on the classification of evaluation criteria into attributes and objectives.

4.2 Situation awareness

Spatial information is usually external information and acquired from data vendors. Business information is mainly company's own, internal information. A rule of thumb is, that 80 percent of all data, that is important to the company, is found inside the company (Pirttimäki, 2007).

Situation picture collects all information sources together. Spatial information acts as a link in the situation picture. It combines all information together, defines Kiviranta (2006). As spatial relations between different business information are revealed, a totally new awareness of the situation can open up to the decision-maker. In brief the benefit of spatial information is firstly the increased utilization of existing business information in the company and secondly provision of better information of the situation. Situation awareness is part of business intelligence.

The significance of spatial information in the intelligence phase of decision-analysis is correlated with the fact, how well business information is integrated with spatial information. Temporal accuracy and completeness of the spatial dataset support the integration and the identification of possible problems or intended opportunities. Positional accuracy of spatial data must be adequate to locate business information in space. Sometimes it is enough for the new users just to see the situation visualized on a map.

4.3 Design and choice of alternatives

The situation picture reveals the business problem or the business opportunity to the decision-maker. Firstly he has to understand the objectives before he starts to design the

alternatives. Secondly he must define the evaluation criteria of alternatives. The criteria are problem specific. How spatial analyses are used, or are they used, to develop and analyze solutions, depends on the benefits of GIS in the problem solution and on the GIS competence in the company.

If company's functions in general are spatially related, spatial analyses might be a fixed part in the decision support systems and business processes. In that case user specific spatial data are also fixed. The requirements for data accuracy, correctness, completeness and integrity alias usefulness must be defined carefully in advance when developing the decision support system. In very specific problems advanced GIS operations are needed. The more advanced and detailed GIS operations are, the higher requirements are set for the spatial data quality. Hence a GIS expert is needed to perform the analysis and both define and acquire spatial data needed in the case.

The alternatives are evaluated according the outcomes of alternatives and predefined criteria. Each alternative is evaluated and analyzed in relation to others in terms of a specific decision rule (Malczewski, 1999). The rule is used to rank the alternatives. The ranking depends on the decision-maker's preferences.

There is always uncertainty in spatial information. The user must decide whether the level of uncertainty is acceptable or not. The awareness of spatial data quality reduces the risk, which is related to the outcomes of alternatives and thus to the decision-making itself.

4.4 Benefitmodel

The aim of the research is to model, calculate and present the benefits of GIS to a company through a benefitmodel. How much can GIS support and benefit the decision making in a company? By means of the benefitmodel a company can calculate the monetary value of GIS benefits. The key question is, how to quantify the benefits. The parameters and variables of the model depend on the company's objectives and operations.

The components of geographic information system: spatial data, software, applications, user expertise and integrability of the system will be variables in the model. Spatial data has influence on the benefits and the significance of the quality factor is adjusted in the model by weighting.

5. CONCLUSIONS

Spatial information could be utilized more in companies' decision-making. The quality of spatial data products is often unknown, because information about the quality is missing. This can delay or prevent the utilization of spatial data in potential private companies. On the other hand one can ask if it is anyway better to use spatial data even with certain uncertainty than not to use it at all? Is the benefit of GIS in decision-making situation so valuable, that the decision-maker should take a risk?

The significance of spatial data quality for decision-making and company's benefits is still unknown. The research is in the beginning. The second phase is to collect data from case study companies, analyse the data and formulate the benefitmodel.

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