Manuscript in press to appear early 2001
Taylor & Francis Publishers, UK

GIS for Group Decision Making

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This book has been written as an equal effort between the co-authors. It is a report of the research activities between 1995-2000. Although much of the research activity related to this topic has been published in journals in one form or another, this book contains eight original chapters as a synthesis of findings.

Preface

Groups are said to be basic building blocks of society. They mediate interests and help give voice to social, health, environmental, economic, and safety concerns to name but a few. Decision-making within both small and large groups is perhaps one of the more important activities of group behavior. Decision making establishes direction for action. Within the private sector over the past fifteen years, organizational development has followed a trend toward flatter structures. That means more participation in the direction of what and how things are accomplished in an organization. Within the public sector, citizen participation grows in significance as more citizens claim ineffective political representation on the part of elected officials about placed-based public decision problems. Within the link between the private and public sectors over the last several years there is a trend of private industry working more closely with public organizations, in so called private-public coalitions, to explore win-win situations for solving difficult community problems. In a similar manner, the rise of non-governmental organizations in a way is due to the ineffectiveness of governments to respond to the needs and call for action, and the short-comings of private industry in pursuing a narrow, capitalistic motivation called “profits” when coming to grips with various valued concerns. Stove-piping of decision activities, whereby only one perspective is given voice for a long time in the private and/or public sector, might have caused many of the problems facing communities throughout the world these days. The complexity of many public-private situations is thus brought about by “stove-pipe responsibility” hence lack of accountability for those who have or who have not acted. Communities, be they place-based or cyber-based, are ripe for political restructuring. The growth in group decision making activity in essence is a restructuring of the political scene at local, regional, national, and international scales. Of course, the fuel added to the fire of restructuring change depends on the particular situations from place to place and what kinds of information are available.

One of the fundamental freedoms in a democratic society is the right of a citizen to know and participate in a decision situation when decisions about valued-concerns are being made that affect the welfare (taken broadly) of those people and places they live in. This is particularly true when those situations involve public or public-private problems, and the impacts occur to community at local, state, regional, national, and global scales. It seems that representative democracy is being challenged in a way by modern communications technology. With direct access to information communication technology comes an impression that direct democracy is better due to closer ties to information. The Internet is at the core of a change in getting access to information in a timely manner. Getting access to wireless, Internet communications technology that is on the verge of a substantial expansion will likely fuel the frustration in decision situations. The continual lament is: Why isn’t more being done faster?

Getting access to information about valued-concerns in community and society is one of the reasons why geographic information systems are being put to use – but certainly not the only reason. Through broader access to GIS data it is expected that people can analyze and deliberate the pros and cons of values, goals, objectives, and criteria describing public and public-private problems at various scales. Whether this slows or improves any given decision situation, and decision situations in general, still remains to be seen. Nonetheless, more and more information is being made available for groups and citizens to consider if they so choose. Creating an environment to facilitate analysis and deliberation in a group decision setting is the purpose behind participatory GIS (PGIS). Developing a conceptual understanding of the use of PGIS, which in turn might add to a more effective deployment of PGIS, as one among many viable information technologies is the purpose behind this book.

This book has been written as an equal effort between the co-authors. It is a report of the research activities between 1995-2000. Although much of our research activity related to this topic has been published in journals in one form or another, this book contains eight original chapters as a synthesis of findings. Researching the dynamics of complex geographical decision situations, examining the influences of the use of participatory geographic information systems and its extension as a form of decision support capability, is the principle motivation for undertaking the investigations reported herein. We see the research as forming a foundation for what we call "participatory, geographic information science".

This book is meant to be an introduction to participatory, geographic information science as much as it is a report on our research agenda for the past few years. The foundation of this book is built from a concerted effort to balance among three research domains – theory, methodology, and substance - involved in studies of PGIS use. All three domains are (or rather should be) present in all research, but the difference in research is a matter of the difference in emphasis of the domains as used in a research study. We try to make this clearer by writing this book in order to open opportunities for research not stifle them.

We proceed with the book as follows. In Chapter 1 we set a tone about how these three research domains can be combined to set the research orientation of a study. Understanding the balance of emphasis among domains leads one to understand the difference in research orientation as basic, method-driven, and applied research. Understanding the difference in emphasis as to which domain leads the emphasis, which domain supports, and which domain follows sets up a "pathway" as the basis of research strategies reported in the three empirical studies reported herein. Much of this book is about the conceptual underpinnings of participatory decision making. We treat these issues in Chapter 2 in the form of Enhanced Adaptive Structuration Theory 2 that relates the convening, process, and outcome aspects of decision situations to each other within the context of a human-computer-human interaction. In regards to methodology, we are not afraid of being labeled methodologists, both from a perspective of GIS decision support methods and social-behavioral methods as they are treated in Chapters 3 and 4, respectively. Chapter 3 highlights the methods and tools that underpin PGIS as an extended set of capabilities to standard GIS capabilities. In Chapter 4 we provide a comprehensive overview of how research strategies can be designed to investigate PGIS use in participatory decision making. Those chapters as part I set the stage to describe the chapters of part II. In Chapters 5, 6, and 7 of part II we present three studies that address substantive decision making concerns about public health, transportation, and habitat restoration, respectively. We made use of three rather different research strategies to develop empirical findings. Each of the findings stems from the emphasis of the three domains. Chapter 5 treats public health decision making as a problem in task analysis to elucidate the character of geographic decision support capabilities. Chapter 6 uses a case analysis approach to investigate a transportation improvement program decision process to uncover the influence among a variety of decision aspects and speculates about why GIS is not used more often in such situations. Chapter 7 reports on a group experiment concerning habitat restoration whereby the data that resulted from the experiment are analyzed using two different approaches, and the approaches are compared in terms of the amount of information gain each provides to the findings. In the conclusions of Chapter 8 we reflect on how the emphasis of the three domains was used, and what prospects there are for future research.

Given the trends involving growth of participation in public-private decision making and the trends in technology change, we see a tremendous opportunity for research in participatory geographic information systems development and use. Through a better understanding among three research domains, and how each supports and at the same time constrains each other, we hope that this book will motivate the reader to make a contribution in some manner toward a participatory, geographic information science.

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Chapter 1

An Introduction to Geographic Information Systems and Participatory Geographic Information Science

Abstract

Group decision making that deals with geographical problems has been around for quite some time. However, an interest in participatory decision making is growing in importance as more and more people with concerns about environmental, land use, natural resource, and transportation issues believe that those who are impacted by decisions should be a part of the process. Many geographical decision problems are viewed as unstructured and laden with locational conflict because their solutions are formed through the participation of multiple stakeholders with varying stakeholder values. In this introductory chapter we introduce the reader to what we call "participatory geographic information systems" and provide an overview of what we call "participatory geographic information science". Geographic information systems that are designed and used by groups with multiple stakeholder perspectives are described as "participatory geographic information systems. Participatory geographic information systems have all of the capabilities of GIS, with additional capabilities for group decision support. Social-behavioural studies about participatory geographic information systems use, as a process of human-computer-human interaction are a cornerstone of the empirical aspect of participatory geographic information science. Participatory geographic information science is a subfield of geographic information science that contributes to an understanding of PGIS use in society. We introduce the reader to our framework for this book that is based on balancing the emphasis among research domains - theory, method, and substance. That framework underpins our approach to research helping us build toward a participatory geographic information science.

Chapter 2

A Macro-Micro Framework for Participatory Decision Situations

Abstract

This chapter introduces the reader to a macro-micro approach to decision processes. It is a systematic yet flexible approach for characterizing complex geographical decision making, and one way of setting a foundation for understanding the complex character of decision support opportunities. We provide an example of a macro-micro decision strategy as a way of expressing the core issues in the macro-micro approach. Once the basic macro-approach has been presented, we then elaborate on the micro aspect of understanding complex decision situations in terms of a revised version of Enhanced Adaptive Structuration Theory (EAST) – what we now call EAST2. EAST2 is composed of twenty-five aspects collected into eight constructs. Relationships between the eight constructs are described in terms of seven premises. We show how the premises can motivate research questions to focus empirical studies about participatory geographic information systems use. We have used EAST2 to guide us in our empirical research investigations involving GIS-supported collaborative decision making as reported in Chapters 5-7.

Table 2.1 An Example Macro-Micro, Participatory Decision Strategy. A Strategy Organizes Group Process as one Approach to Task Management.

	Macro-Phases in a Decision Strategy		
Micro-Activities in a Decision Strategy	**1. Intelligence** about values, objectives, and criteria	**2. Design** of a set of feasible options	**3. Choice** about recommendations
A. Gather...	issues to develop & refine **value trees** as a basis for objectives	**primary criteria** as a basis for option generation	**values, criteria, and option list scenarios** for an evaluation
B. Organize...	**objectives** as a basis for criteria and constraints	and apply approach(es) for **option generation**	approaches to **priority and sensitivity analyses**
C. Select...	**criteria** to be used in analysis as a basis for generating options	the **feasible option list**	**Recommendation** as a prioritized list of options
D. Review...	criteria, **resources, constraints,** and **standards**	**option set(s)** in line with resources, constraints and standards	**recommendation(s)** in line with original **value(s), goal(s)** and **objectives**

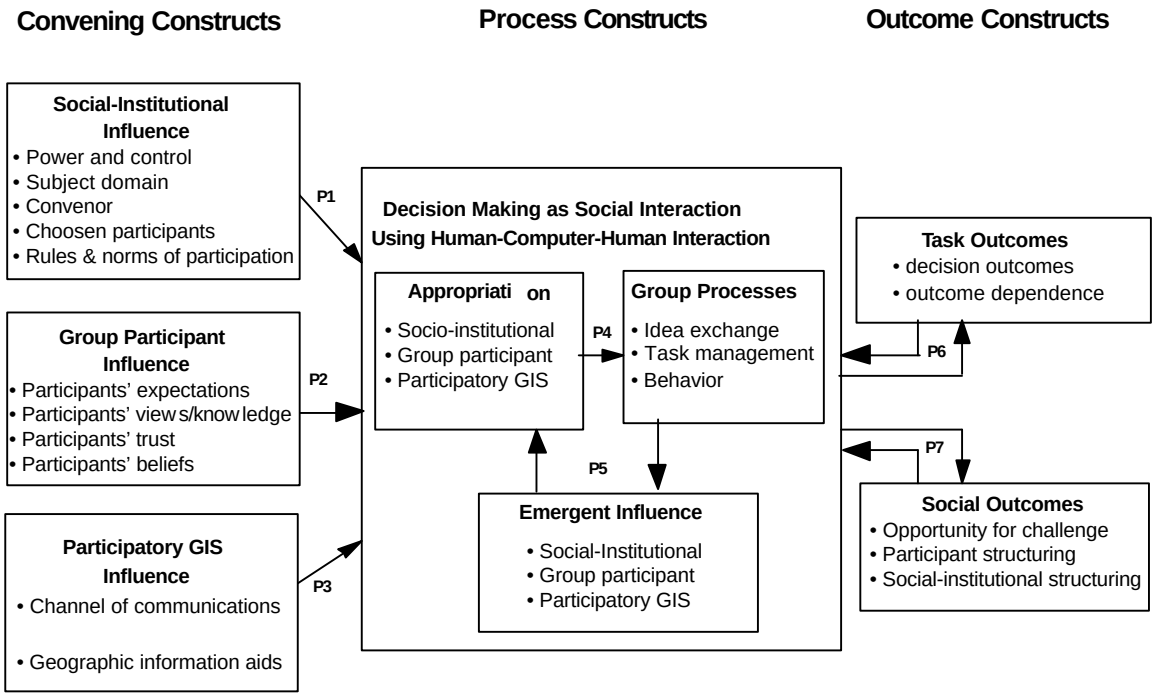

Figure 2.1 Enhanced Adaptive Structuration Theory 2 (EAST2) frames convening, process, and outcome constructs plus the respective premises to provide a conceptual map for understanding a group decision support situation.

Chapter 3

Methods and Tools for Participatory, Spatial Decision Support

Abstract

In Chapter 2 we introduced a general framework for understanding collaborative spatial decision making. The framework helps lay out a systematic way of conducting a task analysis as the basis of a user needs assessment for setting up collaborative decision making approaches to problem solving and decision making and for analysing collaborative decision making processes. Guided by that framework, we now present specific methods and tools for participatory spatial decision support and the hardware and software architectures to implement decision support. Methodologies and tools for participatory group decision making come from many sources. They include work on GIS extensions aimed at improving its decision support capabilities, work on group support systems technology as well as theoretical and empirical studies of its use. Other sources include work on capturing the dynamics of argumentation, research on the human dimensions of groupware and computer networking, and critiques of GIS as a construction of positivist thinking, constraining alternative views of reality that otherwise might broaden the decision making discourse. These sources bring various viewpoints of decision making that can be generalised as a decision analytical and collaborative approach. The analytical approach uses mathematical models to analyse structured parts of a decision problem leaving the unstructured parts for the decision makers' judgement. The collaborative approach views decision making as an evolutionary process that progresses from an unstructured discourse to a problem resolution using discussion, argumentation, and voting. We argue that both approaches are needed in a group decision support environment and that in order to effectively support group participation in decision making, collaboration and decision analysis tools must be integrated. We present a variety of methods and tools for participatory group decision support.

Table 3.1 Methods and Tools for CSDM derived from Macro-Micro Decision Strategy.

Micro, Decision Strategy Activities	**Macro, Decision Strategy Phases**		
	1. Intelligence about values, objectives and criteria	**2. Design** of a feasible option set	**3. Choice** about decision options
A. Gather...	participant input on values, goal and objectives using **information management** and **structured-group process techniques**	**data and models** (GIS and spatial analysis, process models, optimisation, simulation) to generate options	values, criteria, and feasible decision options using **group collaboration support methods**
B. Organise...	goals and objectives using **representation aids** for criteria and constraints	an approach to decision option generation using **structured-group process techniques** and **models**	values, criteria, and feasible decision options using **choice models**
C. Select...	criteria to be used in decision process using **group collaboration support methods**	decision options from outcomes generated by **group process techniques** and **models**	goal- and consensus-achieving decision options using **choice models**
D. Review...	criteria, resources, constraints, and standards using **group collaboration support methods**	decision options and identify feasible options using **information management** and **choice models**	recommendation(s) of decision options using **judgement refinement techniques**

Table 3.4 Decision aiding methods and techniques for collaborative spatial decision support (adapted from Nyerges et al. 1998).

Level 1 : Basic Information Handling Support
(a) Information Management: storage, retrieval and organisation of spatial data and information (e.g., distributed database management system support).

(b) Visual aids: manipulation (analysis) and expression (visualisation) techniques for a specific part of decision problem (e.g., shared displays of charts, tables, maps, diagrams, matrix and/or other representational formats).

(c) Group collaboration support: techniques for idea generation, collection, and compilation; includes anonymous input of ideas, pooling and display of textual ideas, and search facilities to identify possible common ideas, (e.g., data and voice transmission, electronic voting, electronic white boards, computer conferencing, and large-screen displays).

Level 2: Decision Analysis Support

(d) Option modelling: methods of generating decision options. They include a variety of computational models from static spatial location models (e.g. suitability analysis in GIS) through optimisation models (e.g. location-allocation models) to dynamic models that predict the behaviour of real-world processes (e.g., hydrological models of river flow, or water pollution contribution based on effluent release).

(e) Choice models: integration of individual criteria across optional choices, (e.g., multiple criteria decision models using multiple attributes and multiple alternatives for systematically weighted rankings or preferences).

(f) Structured-group process techniques: methods for facilitating and structuring decision making, (e.g., brainstorming, Delphi, modified Delphi, and technology of participation).

Level 3: Group Reasoning Support
(g) Judgement refinement / amplification techniques: quantification of heuristic judgement processes (e.g., sensitivity/trade-off analysis for comparing project options, Bayesian analysis, or social judgement analysis for tracking each members judgements for feedback to the individual or group).

(h) Analytical reasoning methods: perform problem specific reasoning based on a representation of the decision problem, (e.g., using mathematical programming or expert systems guided by automatic mediation, parliamentary procedure, or Robert's Rules of Order, identifying patterns in a reasoning process).

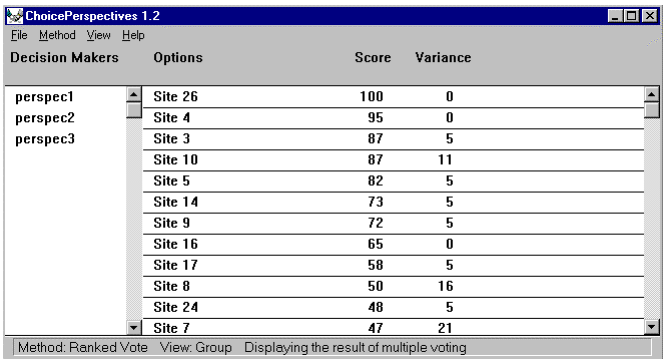

Figure 3.5 Consensus scores and variances for habitat site options

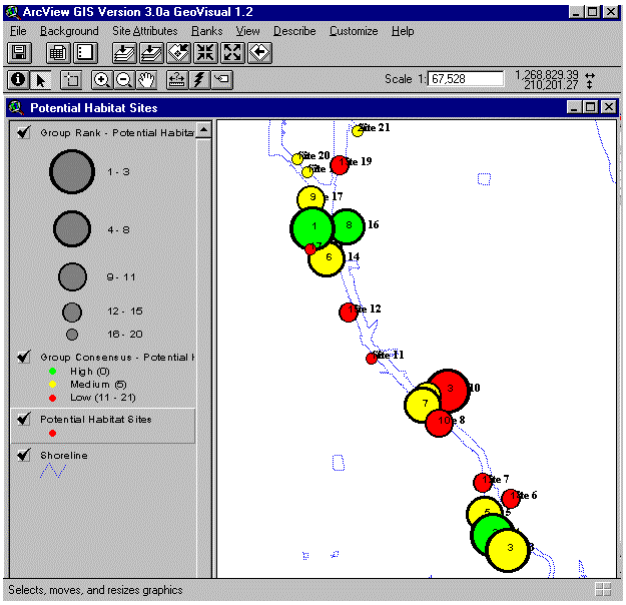

Figure 3.6 Consensus rank map of habitat site options

Chapter 4

Social-Behavioral Research Strategies for Investigating the Use of Participatory Geographic Information Systems

Abstract

Social-behavioral research about the use of participatory geographic information systems requires an informed balance among three research domains – substantive, theoretical, and methodological - if we are to make balanced progress in participatory geographic information science. In this chapter, material for discussing a substantive domain draws from the past few years of co-authors' research about GIS-supported collaborative decision making, and for the theoretical domain we draw from our development of Enhanced Adaptive Structuration Theory. Out of our research experience in the methodological domain, we develop a new framework for understanding choices among research strategies for social-behavioral studies of participatory geographic information systems use. A research strategy is comprised of several phases: research problem articulation, treatment mode selection, data gathering strategy, data analysis strategy, and reporting strategy. Planning a research study is a matter of making choices within those phases of a research strategy. Informed choices can be made based on criteria about the quality of findings we can anticipate. The criteria include strategic considerations for research finding outcomes, as well as validity and reliability. A re-interpretation of internal validity in terms of correspondences among relations with research domains is presented. Several research strategies and their respective phase choices are compared against each other. This systematic treatment of strategies helps researchers understand the advantages and disadvantages of choosing various strategies for studying group use of participatory geographic information systems.

Table 4.3 Stages of Research and Phases in a Research Strategy

Stage 1: Scoping/Planning the Research
Phase 1) Scope/Consider Research Questions
Phase 2) Scope/Consider Treatment Mode(s) Strategy
Phase 3) Scope/Consider Setting Strategy
Phase 4) Scope/Consider Data Collection Strategy
Phase 5) Scope/Consider Analysis Strategy
Phase 6) Scope/Consider Reporting Strategy

Devising Research Design
(Phases 2 - 5)

Stage 2: Doing/Implementing the Research Strategy
Phase 1) Articulate/Commit Research Questions
Phase 2) Specify/Commit Treatment Mode(s) Strategy
Phase 3) Specify/Commit Setting Strategy
Phase 4) Specify/Perform Data Collection Strategy
Phase 5) Specify/Perform Analysis Strategy
Phase 6) Perform Reporting Strategy

Implementing Research Design
(Phases 2 - 5)

Stage 3: Corroborating the Research Findings
Compare to other findings and compare/contrast the validities
take each phase 1-6 above and report connections to other findings in terms of similarities, differences, limitations, biases, etc.

Chapter 5

Collaborative Spatial Decision Making in Primary Health Care Management: A Task Analysis-Driven Approach

Abstract

An important problem in addressing the primary health care needs of underserved rural areas is the allocation of financial resources. In this chapter we report on the use of a spatial decision support system used by a group of health care decision makers within the Department of Health and Welfare of the State of Idaho. Distributing limited financial resources in an equitable, yet need-responsive way is an issue faced by health management agencies not only in Idaho but also across the USA. The funding allocation problem has a significant spatial component. The decision of which counties should receive funds is driven by the location of counties. Location determines to a large degree the distribution of available health care resources and consequently the coverage of health care needs. The decision problem can be characterized as multicriterion and evaluative since its closure requires most certainly the evaluation of health care needs in Idaho counties based on a number of attributes. Which of these attributes should be selected as effective evaluation criteria is a question that becomes part of the decision problem. A decision support tool called GeoChoicePerspectives was used to assist in the allocation of funds. A task analysis method was used to describe the system requirements needed by decision makers to carry out the geographical decision support. Capabilities that portray maps and decision tables are described. Other advanced decision support techniques are used to describe the potential for group decision support.

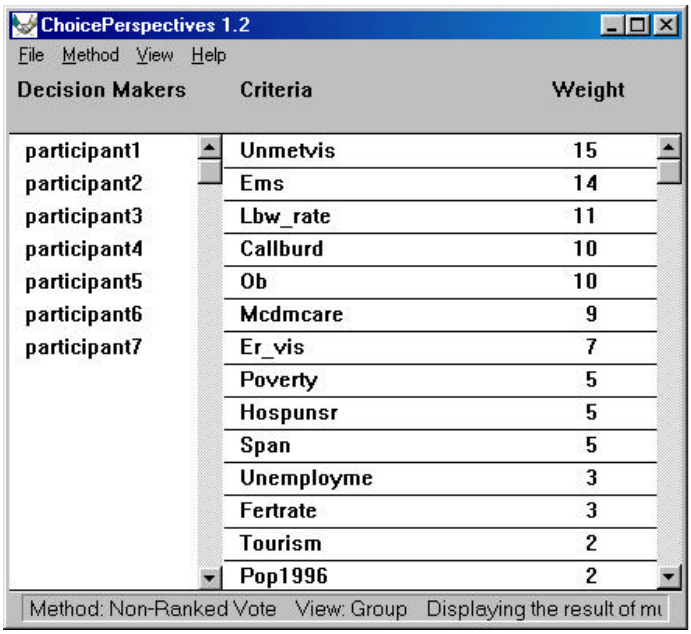

Figure 9. Mean criterion weight values computed from seven submitted votes.

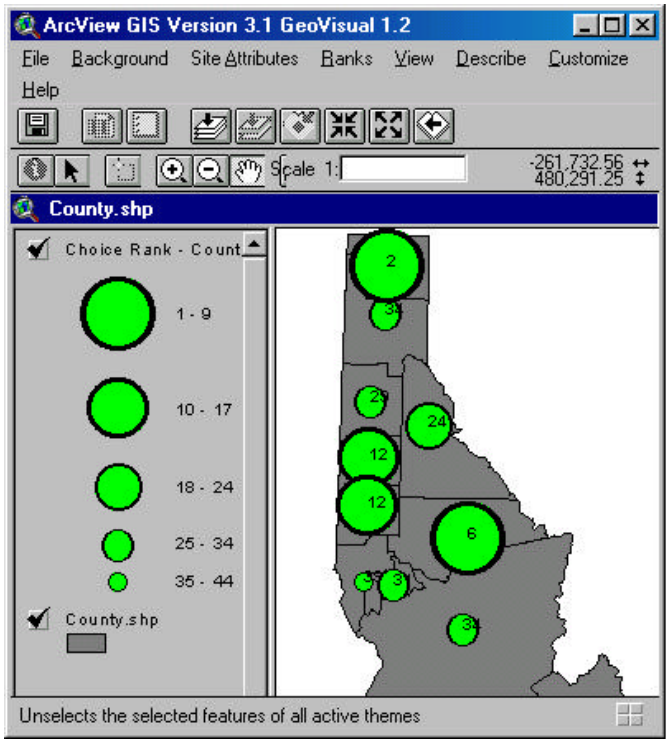

Figure 10. Option rank map presenting ranking results for Northern Idaho counties.

Chapter 6

Transportation Improvement Program Decision Making: Using Proposition Analysis in a Case Study

Abstract

The Transportation Equity Act for the 21st Century mandates that Metropolitan Planning Organizations coordinate plans, programs and projects within a region. Such coordination is required to be able to receive federal transportation funds for transportation improvement programs. A transportation improvement program is a three-year program of transportation projects that must be created (or updated as the case may be) every two years. The Puget Sound Regional Council prepares the regional transportation improvement prrogram for a four-county area in the central Puget Sound region. In this study we interviewed staff members of the Puget Sound Regional Council to discuss the challenges and opportunities for GIS use as pertains to the regional transportation improvement program. Early on in this study it became readily apparent that there is very limited use of GIS for decision support, i.e., relative to the proposed technology reported by the authors in a previous study related to this topic. Thus, this study thus became a social-behavioral search about why there has been so little use of geographic information technology when the task is so inherently geographic in character, and GIS technology is readily available. It is not that we suggest that technology should be used, but rather a curiosity of the constraints and/or lack of use. Thus, in this chapter we make use of social-behavioral science methodology (outlined in Chapter 4) to explore the character of group decision making, while using Enhanced Adaptive structuration Theory 2 as the framework. As such, we perform a proposition analysis – as a step beyond construct analysis as was presented in Chapter 5. A construct analysis, based on constructs from Enhanced Adpative Structuratin Theory 2 (presented in Chapter 2), followed by a proposition analysis based on premises is what we call “case analysis”. In a case analysis we are in search of explanations about information use and the relationship to decision groups. A construct analysis helps us answer questions about “what”, whereas a proposition analysis helps us answer questions about “why”. As a report on this case analysis, we perform a construct analysis of the 1999 regional transportation improvement program process. We report on the findings from proposition analysis that takes advantage of the results of a construct analysis. We provide a discussion of those findings – providing an interpretation of our findings. A conclusion provides a broader context for what we found.

Table 6.1. Puget Sound Regional Council 1999 TIP Decision Process

Task 1. PSRC Adopts TIP Policy Framework and Approves Funding Allocations for Regional & County-wide Processes
Task 1.1 Create TIP Policy Framework
Task 1.2 Adopt TIP Policy Framework
Task 1.3 Approve Funding Allocations

Task 2. Regional TIP Project Evaluation Process
Task 2.1 – Create and Approve Regional Evaluation Process
Task 2.2 – Project Option Generation
Task 2.3 – Score Projects
Task 2.4 – Initial Evaluation

Task 3. Review and Recommend Draft Regional Priorties

Task 4. Conformity analysis on ALL projects and Assemble Draft TIP
Task 4.1 Conformity Analysis
Task 4.2 Assemble Draft TIP

Task 5. Public Review and Comment on Draft TIP

Task 6 TPB Recommends TIP Action

Task 7 PSRC Executive Board Takes Final Action

Table 6.2. An Example of Construct Coding for Subtask 1.1

Task 1.1 Create TIP Policy Framework	1999 PSRC Transportation Implementation Program Policy framework creation has geographic implications, but no specific locational differentiation until implemented
Convening constructs	
construct 1: Mandates, objectives, rules, and guidelines	Criteria established by the Transportation Equity Act for the 21st Century (TEA-21) – Public Law 105-178 105th Congress, PSRC charter used for interpretation of law to specify criteria; Previous policy used as a guideline for improvement
construct 2: Participants involved	PSRC Transportation Implementation Program personnel.
construct 3: Information Tools	- hardcopy documents shared - email exchanged - manual document management
Process constructs	
Construct 4: Appropriation of structures	reports of meetings
Construct 5: Task management	- document reviews - face to face meetings
Construct 6: Emerging information	suggestions from various responsible parties Appendix I of the PSRC (1999) Call for Regional TEA-21 Projects establish the "regional project evaluation process and criteria". Indeed, this appendix details the construct 2 information that controls what information is emphasized in the decision situation. The appendix material that describes process provides material for detailing constructs 4, 5 and 6.
Outcome constructs	
Construct 7: Decision outcomes	- draft policy including criteria associated with policy objectives
Construct 8: Social outcomes	systematic overview of organizational processes

Chapter 7

Collaborative Decision Making about Habitat Restoration:
A Comparative Assessment of Social-Behavioral Data Analysis Strategies

Abstract

This chapter addresses research questions about the socio-behavioral dynamics of using geographic information system decision aids during collaborative decision making in small, inter-organizational groups. Using an experimental design of a conference room setting, a study of human-computer-human interaction was conducted with 109 volunteer participants formed into 22 groups, each group representing multiple (organizational) stakeholder perspectives. The experiment involved the use of GIS maps integrated with multiple criteria decision models to support group-based decision making. The objective of the decision making activity was the selection of habitat restoration sites in the Duwamish Waterway of Seattle, Washington. Video-taped data were coded using three coding systems, decision functions coding, decision aid coding, and group working relations coding. Although a single set of research questions was used to guide the investigation and hence collect the data, two different types of data analysis strategies were used to process the same data set. We analyzed data from this experiment using traditional statistical inference techniques and exploratory sequential analysis techniques, specifically lag sequential analysis for the latter. We show how different analysis strategies and respective techniques allow researchers to gain information about social-behavioral relationships about human-computer-human interaction from a different perspective. That is, the same research questions, motivated by the conceptual domain, and guided by the substantive issues, are associated with somewhat different relationships in the methodological domain, because the analysis techniques are different. A comparative assessment of the analysis strategies (techniques) shows a difference in information gain. We end the chapter with an evaluation of the appropriateness of different research strategies as suggested in Chapter 4.

Table 7.1 Premises about Collaborative Decision Making and Respective Research Questions Focusing on Use of Geographic Decision Aids for Selection of Habitat Redevelopment Sites

Premises	Research question motivated by respective premise
Convening Premises	
Premise 1. Social-institutional influences affect the appropriation of group participant influences and/or social-technical influences.	1.1 How does decision task complexity influence the types of geographic information structures (e.g., maps, tables, diagrams) appropriated by the participants? 1.2 How does decision task complexity influence group work?
Premise 2. Group participant influences affect the appropriation of social-institutional influences and/or social-technical influences.	2.1 Does prior knowledge/experience with decision aids promote more use of maps and decision models? 2.2 Does knowledge acquired through group decision making participation promote more effective use of decision models?
Premise 3. Social-technical influences can affect the appropriation of social-institutional influences and/or group participant influences.	3.1 What is the relationship between map appropriation and decision model appropriation? 3.2 What kinds of decision models are appropriated in relation to maps? 3.3 Does technology setting have any influence on the type of decision aid use?
Process Premises	
Premise 4. Appropriation of influences affect the dynamics of social interaction described in terms of group processes.	4.1 What is the relationship between map usage and decision functions, and decision table usage and decision functions? 4.2 Are there differences in the level of group conflict associated with different decision phases? 4.3 Does task complexity influence group conflict? 4.4 Does task complexity influence appropriation during a given phase? 4.5 Does group conflict have any influence on appropriation of decision aids?
Premise 5. Group processes have an affect on the types of influences that emerge during those processes, and emergent influences affect the appropriation of influences.	5.1 Does group work without conflict when examined by task complexity has any influence on decision aid appropriation? 5.2 Does group work without conflict when examined by session sequence has any influence on decision aid appropriation?

Table 7.2 Two Types of Analyses for the Same Research Questions

Premise	Research question addressed	Traditional analysis	Sequential analysis
Premise 1. Social-institutional influences	1.1 How does decision task complexity influence the types of geographic information structures (e.g., maps, tables, diagrams) appropriated by the participants?	General Linear Model	Lag Sequential Analysis of DFCS -> DSCS, aggregated over DFCS codes What's the meaning of -> here?
	1.2 How does decision task complexity influence group work?	no analysis	Lag Sequential Analysis
Premise 2. Participant influences	2.1 Does prior knowledge/experience with decision aids promote more use of maps and decision models?	Analysis of Variance	no analysis
	2.2 Does knowledge acquired through group decision making participation promote more effective use of decision models?	Analysis of Variance	no analysis
Premise 3. Information technology influences	3.1 What is the relationship between map appropriation and decision model appropriation?	Pearson Correlation	Lag Sequential Analysis of DFCS -> DSCS by session sequence What's the meaning of -> ?
	3.2 What kinds of decision models are appropriated in relation to maps?	Pearson Correlation; General Linear Model	no analysis
	3.3 Does technology setting have any influence on the type of decision aid use?	no analysis	no analysis
Premise 4. Appropriation influences	4.1 What is the relationship between map usage and decision functions, and decision table usage and decision functions?	- Analysis of Variance - Difference in means (T test)	Lag Sequential Analysis of DFCS -> Decision aids by task sequence
	4.2 Are there differences in the level of group conflict associated with different decision phases?	Analysis of Variance	no analysis
	4.3 Does task complexity influence group conflict?	Analysis of Variance	Lag Sequential Analysis of GWRCS, collapsing by DSCS
	4.4 Does task complexity influence appropriation during a given phase?	no analysis	Lag Sequential Analysis of DFCS -> DSCS by phase by task complexity
	4.5 Does group conflict have any influence on appropriation of decision aids?	no analysis	Lag Sequential Analysis of DSCS by GWRCS
Premise 5. Emergent influences	5.1 Does group work with? conflict when examined by task complexity has any influence on decision aid appropriation?	no analysis	Lag Sequential Analysis of DSCS by GWRCS by task complexity
	5.2 Does group work without conflict when examined by session sequence has any influence on decision aid appropriation?	no analysis	Lag Sequential Analysis of DSCS by GWRCS by session sequence

Chapter 8

Conclusions and Prospects for Future Research

Abstract

In this final chapter we summarise our conclusions about research findings concerning participatory geographic information use that we made in each of the separate chapters. We interpret the implications of the findings as contributions toward a participatory geographic information science. We discuss prospects for future research about a participatory, spatial decision making that makes use of geographic information systems by reflecting on the research framework we have utilised throughout the book. As a foundation of the framework used in this book, we emphasise a balance among theory, methods and substance in our studies about the use of participatory geographic information systems. We contend that the proposed framework and the studies constitute the basis of a participatory geographic information science. In this approach the theory guides the use of methods, which are applied to solve substantive decision problems involving locational (spatial) characteristics. The approach serves both the development of group decision support technology as in participatory GIS and research about the use of participatory GIS. The theory – Enhanced Adaptive Structuration Theory 2 (EAST2) - provides a conceptual map for understanding a group decision support situation, thus providing the basis for selecting appropriate methods and decision support tools for a participatory task at hand. EAST2 further provides the guidelines for empirical research investigations involving participatory GIS. The empirical investigations about the use of participatory, geographic decision support tools and methods in substantive decision situations, allow us to verify EAST2, enhance our understanding of the tools and methods, and in turn lead us to develop better methods of participatory GIS. The chapter concludes with a discussion of prospects for future research about participatory GIS use that can broaden and deepen the knowledge base associated with the yet fledging subfield of participatory geographic information science.

Table 8.1 Research Studies About PGIS Use – Current Work and Future Prospects

Current Studies	**Research orientation**	**Main path**	**Domain pathway***	**Data strategy product**	**Analysis strategy product**
Chapter 5	applied	empirical	SMC	situation driven observations	interpreted observations about participatory decision support capabilities useful for a decision situation involving funding allocation for primary health
Chapter 6	applied	theoretical	SCM	situation driven propositions	tested propositions about aspects of participatory decision support within a transportation improvement decision making process
Chapter 7	basic	experimental	CMS	concept-driven design	tested hypotheses about human-computer-human interaction during a habitat restoration decision experiment
Future prospects					
Study X	basic	theoretical	CSM	concept-driven hypotheses	tested propositions describing different conceptual interpretations of a participatory decision support situation
Study Y	method	experimental	MCS	method-driven design	tested hypotheses about different approaches to gathering human-computer interaction data in experiments about participatory decision support
Study Z	method	empirical	MSC	method-driven observations	interpreted observations about the usefulness of task analysis in needs assessment for decision support.

Adapted from Brinberg and McGrath (1985) Table 3.1