

DISPERSION OF KNOWLEDGE

A CASE STUDY ON THE EARLY 90'S GIS IMPLEMENTATION LITERATURE

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ABSTRACT

This paper addresses the effectiveness of literature in communicating the existing knowledge. Instead of analyzing the correctness or sufficiency of the existing knowledge, the aim is to evaluate how much dispersed over the literature is knowledge. Dispersion of knowledge is considered to be a hypothesis to be verified through two analytical procedures. We applied those analytical procedures in a case study on the early 90's literature on Geographic Information Systems – GIS – implementation. Results have shown that different publications tend to address different implementation issues, and that those publications addressing a same specific issue tend to propose alternative or competing approaches. The objectives of this paper are three fold: first, to show knowledge tend to be dispersed and how this may happen; second, to warn authors and researchers, inviting them to avoid dispersion of knowledge and, third, to present a brief framework to assist authors and researchers avoiding dispersion of knowledge.

INTRODUCTION

Tourism guides ease the mind of tourists because they pull information together: points of interest, maps, transportation, lodging and hotels, typical temperatures and emergency numbers. Tourists do can survive without a tourism guide. However, without a guide the tourists are far more likely to overlook points that they otherwise would have been very interested in considering. The attractions are still there, and all the information included in the guide is usually available in other sources. The difference is a matter of availability and systematic organization of the information that may be relevant. The guide eases and even stimulates tourism because it is effective in communicating information.

The outcomes of GIS implementation efforts – theme of our case study - do not depend only on the existence of adequate theories, strategies and methodologies. They also depend on the use of those theories and techniques by consultants, by course instructors and finally by those accomplishing the practical activities to implement a GIS. The use of appropriate theories and implementation approaches is strongly influenced by the effectiveness of the literature in transmitting such knowledge. Conveniently organized literature can ease and stimulate the use of appropriate theories and implementation approaches, enabling better results (like tourism guides do).

Research Objectives

Numerous articles and books have been written to provide guidance on GIS implementation. This paper reviews and analyses that literature. The focus is not on the correctness or sufficiency

of the existing knowledge (so, we selected papers from the early 90's). The goal is to analyze the effectiveness of the literature in communicating such knowledge.

Dispersion of knowledge is the major aspect to be explored. GIS implementation is a multidisciplinary theme. It can involve topics such as design methodologies, management of user resistance, staffing, data acquisition techniques, project management and strategic partnerships. In addition, there should be a vast number of contributions - competing, alternative or complementary approaches - on each of these topics. The way literature deals with such a variety of topics and approaches will be studied. How convenient is the literature if one seeks knowledge on the various implementation aspects? Is that knowledge systematically grouped and organized or is it dispersed over the literature?

Research Hypothesis

Dispersion of knowledge will be considered as a hypothesis to be tested. Assuming that there are several specific issues involved in the theme GIS implementation, and that there are several competing, alternative or complementary approaches on each of these issues, two specific tests were formulated:

1. Verify whether the knowledge on the various implementation issues is dispersed over the literature (different publications addressing different issues) or whether individual publications tend to address all the issues.
2. Verify whether the various implementation approaches on each specific issue are dispersed over the literature (different publications addressing different approaches) or whether individual publications tend to address all existing approaches.

To answer the questions above the literature will be submitted to two analytical procedures: Coverage Analysis and Theoretical Diversity Analysis.

GROUNDING DEFINITIONS

To analyze the effectiveness of literature in communicating the existing knowledge about GIS implementation it is essential to define first which literature should be considered. In the next two sections the set of literature to be focused on will be described.

Scope Selection: Defining Guiding Literature

One can identify findings about GIS implementation in all the literature related to GIS, as well as in the literature on information science, social and political sciences. However, the analysis reported in the next sections will focus on the Guiding Literature. We define Guiding Literature as the one the main purpose of which is to provide guidance for the process of GIS implementation. Only the literature possessing the following three characteristics will be included in the Guiding Literature:

- literature specific to the GIS field;
- literature the explicit purpose of which is to give directions for GIS implementation;
- the directions provided refer to the implementation process as a whole, not just to a part of the process.

Due to the first criterion, all the literature on general implementation of information systems, for example, will be excluded. This literature is vast and, although consultants regularly draw from

it, most organizations contemplating corporate implementation of GIS will look just or foremost to the GIS literature for guidance in planning and managing the GIS implementation. The second criterion excludes the numerous implementation histories such as Douglas (1991), Jones (1993), Morrison (1993), Hobbs (1994) and Juhl (1994). Such histories do not have providing guidance as a main, explicit purpose as required by the second criterion. The main purpose of implementation histories is to report an implementation in a specific organization. The implementation approaches and methods used, the major problems encountered, the solutions adopted are the major aspects described in these papers. The third criterion excludes the literature that is limited to one specific issue of GIS implementation such as data conversion or acquisition (Montgomery & Schuch 1993, Cannistra & Gooden 1994), user needs assessment (Wiggins & French 1991), data modeling (Egenhofer & Frank 1992), data sharing (Jones & Slutzak 1994, Onsrud & Rushton 1995) and cost benefit analysis (Calkins & Obemeyer 1991). The main purpose in this case is not to guide the implementation process as a whole, but only part of the process.

The literature excluded of our definition may be valuable for understanding GIS implementation. However, for the goals of this research it has secondary importance. The analysis reported in the next sections will focus on the Guiding Literature: the literature that is directed at GIS, looks at the GIS implementation process as a whole and is explicitly intended to guide (all) the process.

Classes of Literature

After defining the scope of the literature to be analyzed, the Guiding Literature, a vast set of publications were reviewed and five classes of literature within the defined scope were identified. The classes were defined according to the issues usually addressed, style adopted for presentation of knowledge, type of publication and other factors. The analysis reported in the next sections will consider the five classes described below:

- **Implementation Methodologies.** Implementation Methodologies class includes the proposals to teach someone how to implement GIS through step-by-step directions. These proposals tend to address primarily the implementation of the technology itself, looking like an adaptation of a methodology for information systems design. The steps are usually phases of the information system design process (such as user needs analysis, database modeling, etc.). The discussions about topics not directly related to information system design (such as GIS staffing and system management) are typically inserted as additional considerations or steps of GIS technology implementation.
- **Implementation Strategies.** Implementation strategies are similar to implementation methodologies but they address GIS implementation in a more generic way. They usually propose general stages or phases for GIS implementation. Some of these stages can look like steps of the implementation methodologies class, but their focus is not on guiding the design of the information system itself. Instead, they focus on such activities as strategic planning of the implementation process, planning the implementation pace and scope, defining rules for prioritizing applications, managing user resistance and persuading managers to support the project.
- **Success Factors.** This class comprises the literature that has listed key determinants of implementation success. Success factors may be expressed as strategies or activities (such as getting top management support and involve users in design) that must be adopted or carried out in order to increase the possibilities of implementation success. Besides strategies and activities, success factors may also be stated as pre-existing conditions or conditions that may

be altered, and that will ease or hinder the implementation. Examples of such conditions are lack of data, lack of personal skills and resistance to change.

- **Research Findings.** The Research Findings class of literature includes the material that presents results of research projects on GIS implementation. The papers usually involve theoretical discussions, descriptions of field surveys or case studies and, finally, statements of research conclusions. The findings of this class of literature are often presented in formats and manners similar to those found in the Success Factors class.
- **Implementation Guides.** Implementation guides are books the primary goal of which is to guide GIS implementation. Directions to the readers are often in the same or similar presentation formats seen in the other literature classes (such as step-by-step directions and list of success factors).

COVERAGE ANALYSIS

GIS Implementation is a multidisciplinary theme. It can involve the choice of GIS software, data acquisition, project management, strategic partnerships and numerous long-term choices for embedding the information system in the organization. It is not surprising that individual papers in the Guiding Literature address or emphasize certain implementation issues more than others. Coverage Analysis is an analytical procedure designed to verify whether different publications tend to address different issues on GIS implementation or whether individual publications tend to address all the GIS implementation issues.

Selecting Issues on GIS Implementation

A set of specific issues on GIS implementation was selected and grouped under four themes, as shown in the heading row of Table 1. The theme Overall Strategy refers to the overall strategy recommended to conduct the GIS implementation process. The specific issues selected to represent this theme are Strategic Planning of the implementation process and planning the implementation Pace and Scope. The Information System Design theme consists of issues directly related to the technical design of the information system. Information System Design Method (sequence of activities), Implementation Plan and Pilot Projects are the issues selected within this theme. The issues included in the theme Strategies for Enabling the Implementation address the viability of the implementation process: how to get and sustain Top-Management Support, how to manage User Resistance, and alternative Funding Strategies. Project and System Management theme includes issues related to the management of the implementation process and the start up of management routines for the operational system. The issues selected to represent this theme are System Control (organizational location, coordination bodies), and GIS Staffing (positions needed) and Contracting (role of consultants and contractors).

The specific issues listed under each of the four themes, or groups of issues, should be viewed as key illustrative example issues rather than as the only issues that might be relevant under the theme. Selecting some standard, illustrative key issues under each theme allows the organized comparison of contributions from different authors, as will be shown in the next sections.

Themes on GIS implementation	Overall Strategy		Information System Design			Strategies for Enabling the Implementation			Project and System Management		Level of detail of the contributions
	Strategic Planning	Pace and Scope	IS Design Method	Implementation Plan	Pilot Projects	Top-Management Support	User Resistance	Funding Strategies	System Control	Staffing and Contracting	
Specific issues on GIS implementation											
Classes of literature											
Implementation Methodologies						C				L	Mention
A = Antenucci et al. (1991) C = Clarke (1991) L = Love (1991) V = Ventura (1991)					V	A,V	V				Broad Proposal
			A,C L,V	A,C L,V	A,C L				A	A	Detailed Proposal
Implementation Strategies											Mention
P = Peuquet & Bacastow (1991) F = Ferrari & Garcia (1994) H = Hedges (1994) S = Somers (1994)	F,H S							F			Broad Proposal
	F,H P,S					F,H S	P				Detailed Proposal
Success Factors					C						Mention
C = Croswell (1991) V = Ventura et al. (1992) K = Koller (1993) E = Engelken (1994)	C,E	C,E		C,K	E	C,E K,V	C,K V	V		C	Broad Proposal
				E					C,V	V	Detailed Proposal
Research Findings					O	A,B			O	O	Mention
A = Azad & Wiggins (1993) B = Budic (1993) O = Onsrud & Pinto (1993) M = Masser & Campbell (1994)			O	A			A,B				Broad Proposal
									M		Detailed Proposal
Implementation Guides						H,P					Mention
P = PTI & ICMA (1991) K = Korte (1992) H = Huxhold & Levinsohn (1995)		H,P	H	K	H,P	K					Broad Proposal
	H		K,P	H,P	K			H,P	H,P	H,K P	Detailed Proposal

Table 1: Summary of the Coverage Analysis applied to selected publications included in the Guiding Literature

Selecting a Sample of Publications

A small set of publications was selected to represent each of the classes of literature in the Coverage Analysis, as shown in the left-heading column of Table 1. Implementation Methodologies class of literature is represented by Antenucci et al. (1991), Clarke (1991), Love (1991) and Ventura (1991). To represent the Implementation Strategies class, Peuquet & Bacastow (1991), Ferrari & Garcia (1994), Hedges (1994), and Somers (1994) were selected. Croswell (1991), Ventura et al. (1992), Koller (1993), and Engelken (1994) will represent the Success Factors class. The publications chosen to represent the Research Findings class are Azad & Wiggins (1993), Budic (1993), Onsrud & Pinto (1993), and Masser & Campbell (1994).

Finally, PTI & ICMA (1991), Korte (1992), and Huxhold & Levinsohn (1995) will represent the Implementation Guides class of literature.

Selecting a small set of publications to represent each class of literature allows us to analyze a smaller volume of information, simplifying the processes. The selected publications should be viewed as representatives of the overall style and contents of the whole body of publications that form each class, rather than as more relevant than the non-selected ones.

Mapping the Coverage of Each Publication

Each letter printed in the inner cells of Table 1 indicates that a publication addresses one specific issue on GIS implementation. The column on which the letter is placed indicates the issue (top-heading row) and the letter itself identifies the publication through its authors' initials. The left-heading column works as a subtitle. For example, the first three inner rows of Table 1 refer to the publications representing the Implementation Methodologies class. In these rows the letter A identifies Antenucci et al. (1991), the letter C identifies Croswell (1991), L identifies Love (1991) and V identifies Ventura (1991).

Rating the Specificity of the Contributions

For each class of literature there are three alternative rows rating the level of detail of the contribution expressed in the literature for addressing the corresponding implementation issue. The three alternative rates are: Mention, Broad (non-detailed) Proposal, and Detailed Proposal. The Mention level indicates that a publication mentions the importance of considering the specific issue during GIS implementation but does not present a proposal concerning how or when to treat the issue. For example, Mention would be rated if a publication states that it is very important to obtain top management support but does not suggest how to obtain such support. An example of the Broad Proposal level would be a recommendation to acquire top-management support through education of leaders, with no further details on the educational process. An example of the Detailed Proposal level would be one that lists specific suggestions or tasks within an overall strategy, such as a strategy of using quick and straightforward applications as a means for obtaining top-management support.

Although in some instances the boundaries among the three levels of detail described above may look somewhat unclear, discriminating the levels allows us to portray a more realistic picture of the contributions expressed in the Guiding Literature. Besides, rather than qualifying precisely the contributions of individual publications, the main purpose of the analysis reported here is to identify overall trends. The level of detail of an individual contribution will be considered only under this global context.

Coverage of the Classes

The papers that form the Implementation Methodologies class of literature address primarily Information System Design issues. They also address other issues, but prevalingly with Broad Proposals (Table 1). Their main focus is on the IS design method (the sequence of activities, or steps) and all suggestions on other issues are contained in this primary discussion.

Implementation Strategies publications address basically two groups of issues: Overall Strategy and Strategies for Enabling the Implementation (see Table 1). The enabling issues are presented as the main motivation for the proposed alternative strategies for GIS implementation. For example, all of the Implementation Strategies propose some sort of short-term results as a means to ease obtaining top-level support.

The Success Factors papers are not focused on any specific group of issues. Instead, the Broad Proposals in these papers are distributed over all four groups. The Research Findings papers have a similar coverage (Table 1). They usually present theoretical considerations and research results as a strong foundation of their proposals, and in this sense they differ from the Success Factors literature. But the conclusions of the Research Findings include recommendations the meaning of which is very similar to "success factors", such as "variables predictive of successful outcomes" (Azad & Wiggins 1993:1), "factors affecting GIS adoption" (Budic 1993:234) or "factors that are critical for successful system adoption after acquisition" (Onsrud & Pinto 1993:38). Because the academic community rarely makes recommendations beyond what can be substantiated by its observations, one would expect few explicitly recommended Detailed Proposals.

The Implementation Guides present a two-fold focus. They focus on the Information System Design group, like the Implementation Methodologies, but they also present a strong coverage on the issues of the Project and System Management group. The other issues received prevalingly Broad Proposals, as shown in Table 1.

Comparing Overall Coverage Trends. Sources of Knowledge

A visual analysis of Table 1 allows us to compare the focus of each class of literature (highlighted with ellipses). Implementation Methodologies papers concentrate on Information System Design. The Implementation Strategies class of literature focuses on both Overall Strategy and Strategies for Enabling the Implementation groups of issues. The Detailed Proposals provided by the Implementation Guides class of literature converge to Information System Design and to Project and System Management groups of issues.

In addition to trends of each class regarding themes prevalingly addressed, observation of the ellipses of Table 1 allows us to identify the sources of the more detailed knowledge on each group of issues. The main source of the more detailed knowledge on Overall Strategy and on Strategies for Enabling the Implementation is the Implementation Strategies class. The more detailed knowledge about Information System Design may be found in both classes of literature: Implementation Methodologies and Implementation Guides. The prevailing origin of knowledge about Project and System Management group is the literature included in the Implementation Guides class.

Coverage Analysis - Preliminary Findings

Results discussed above show that publications included in different classes of literature tend to address or emphasize different groups of issues. If we consider a reasonable amount of Detailed Proposals as a reasonable amount of knowledge on a specific group of issues, we may conclude that there is a reasonable body of knowledge on each of all four groups of issues. Each group of issues is highlighted by at least one ellipse, as shown in Table 1. Such conclusion is not a surprise at all, since the themes on GIS implementation were selected from this same body of literature. However, one may also conclude that it is not possible to access knowledge on all four groups by consulting literature included in one single class. A reader must consult different classes of literature, and naturally different publications, to access the more Detailed Proposals on all the four groups of issues.

ANALYSIS OF THEORETICAL DIVERSITY

Let's suppose that two publications address a specific subject and that the knowledge transmitted by one of them is essentially the same as the knowledge transmitted by the other one. Considering that the whole body of knowledge on that subject is the sum of these two contributions (and that such contributions are essentially equal), one may affirm that each one of the two contributions transmits the whole body of knowledge on that subject. In this case, if one wants to access that whole body of knowledge, one may consult just one of the two publications.

Defining Theoretical Component

In a second hypothetical situation, there are also two publications addressing a specific subject but now with competing, alternative or complementary theories. Such competing, alternative or complementary theories are *theoretical components* of the body of knowledge on that subject and, in this case, if one wants to access the whole body of knowledge, one must consult both publications.

Defining Analysis of Theoretical Diversity

In the Coverage Analysis we observed which (classes of) publications cover a specific subject. In the Analysis of Theoretical Diversity we complemented the Coverage Analysis by observing which (classes of) publications address all the theoretical components of the body of knowledge on a specific subject.

Selecting Theoretical Components

For each of the selected issues on GIS implementation we identified and selected some of the main theoretical components. For example, we selected two approaches (and, therefore, two theoretical components) to deal with user resistance: financial or career incentives (Koller 1993) and interactive prototyping (Peuquet & Bacastow 1991). See Table 2 for a summary of the selected theoretical components and references to literature on each issue.

It is important to remember, at this point, that analyzing the adequacy or usefulness of the approaches discussed in the literature is beyond the scope of this paper. Therefore, the purpose of identifying theoretical components is not to discriminate precisely and comprehensively competing, alternative or complementary approaches. Instead, it is to investigate whether or not there are different approaches on a specific subject, so that one may be able to verify which (classes of) publications address all the theoretical components of the body of knowledge on that specific subject. For such purposes, we have considered the subjectivity inherent to this process acceptable.

Groups of issues	Issues	Selected theoretical components
Overall Strategy	Strategic Planning	<ul style="list-style-type: none"> Developing a vision for the new system (Huxhold & Levinsohn 1995) Identifying strategic areas and prior applications (Hedges 1994) Assessing the readiness of organization to accept the new system (Crowell 1991, Hedges 1994)
	Pace and Scope	<ul style="list-style-type: none"> Dual-track implementation strategy (Somers 1994) Interactive prototyping implementation strategy (Peuquet & Bacastow 1991) Three-phased implementation strategy (Ferrari & Garcia 1994)
Information System Design	IS Design Method	<ul style="list-style-type: none"> Definition of goals and scope during design, through a comprehensive user needs analysis (Antenucci et al. 1991, PTI & ICMA 1991, Korte 1992) Definitions of goals and scope previous to design. User needs analysis applied only to selected areas (Clarke 1991, Ventura 1991, Huxhold & Levinsohn 1995)
	Implementation Plan	<ul style="list-style-type: none"> After user needs analysis, before system design (Antenucci et al. 1991, PTI & ICMA 1991) After system design (Clarke 1991, Ventura 1991) At startup and during the design process (Huxhold & Levinsohn 1995)
	Pilot Projects	<ul style="list-style-type: none"> As a test for design (Antenucci et al. 1991, Clarke 1991, Korte 1992) As a training tool (Antenucci et al. 1991, Huxhold & Levinsohn 1995) As a tool to ease communication between users and designers (Love 1991)
Strategies for Enabling the Implementation	Top-management Support	<ul style="list-style-type: none"> Through a favorable cost-benefit analysis (Antenucci et al. 1991, Ventura 1991, Ventura et al. 1992) Through education of leaders (Antenucci et al. 1991, Korte 1992, Koller 1993, Engelken 1994) Through lobby (Antenucci et al. 1991, Crowell 1991) Through a strategy with short-term results (Ferrari & Garcia 1994, Somers 1994)
	User Resistance	<ul style="list-style-type: none"> Offering financial or career incentives (Azad & Wiggins 1993, Koller 1993) Using interactive prototyping (Peuquet & Bacastow 1991)
	Funding Strategies	<ul style="list-style-type: none"> Cost sharing (PTI & ICMA 1991, Ventura et al. 1992) Public taxes, loans, partnerships between private and public sectors (PTI & ICMA 1991)
Project and System Management	System Control	<ul style="list-style-type: none"> Project teams (Crowell 1991, PTI & ICMA 1991, Ventura et al. 1992) Alternative strategies for system location and control (Antenucci et al. 1991, PTI & ICMA 1991, Huxhold & Levinsohn 1995)
	Staffing and Contracting	<ul style="list-style-type: none"> Staff positions needed (Antenucci et al. 1991, Crowell 1991, Korte 1992, Ventura et al. 1992, Huxhold & Levinsohn 1995) Activities that may be outsourced (PTI & ICMA 1991, Korte 1992, Huxhold & Levinsohn 1995)

Table 2: Selected theoretical components on each issue

Mapping the theoretical diversity of the classes

After identifying and selecting theoretical components on each issue we verified which publications and classes address all those components. A summary of the results is shown in Table 3.

Groups of issues	Issues	Publications that cover all the selected theoretical components	Classes of publications that cover all the selected theoretical components
Overall Strategy	Strategic Planning		
	Pace and Scope		Implementation Strategies
Information System Design	IS Design Method		Implementation Methodologies Implementation Guides
	Implementation Plan		
	Pilot Projects		Implementation Methodologies
Strategies for Enabling the Implementation	Top-management Support		
	User Resistance		
	Funding Strategies	PTI & ICMA (1991)	Implementation Guides
Project and System Management	System Control		Implementation Guides
	Staffing and Contracting		Implementation Guides

Table 3: Coverage of all the selected theoretical components on each issue

The Implementation Strategies class addresses all the theoretical components of the issue Pace and Scope because all the components of that issue were addressed by at least one publication included in the Implementation Strategies class. It is useful to check Table 2 for details. All the theoretical components of the issue IS Design Method were addressed by at least one publication included in both Implementation Strategies and Implementation Guides classes. Therefore, both classes cover all the components on that issue (compare with Table 2). In addition, the Implementation Methodologies class covered all the selected components on the Pilot Projects issue, and the Implementation Guides class covered the issues Funding Strategies, System Control, and Staffing and Contracting. Only on the issue Funding Strategies the selected components were totally covered by an individual publication.

Overall Trends on Theoretical Diversity

Results of the Coverage Analysis allowed us to identify the main sources of knowledge on each group of issues. If we compare these main sources of knowledge with results of the Theoretical Diversity Analysis, we will be able to find out how diverse (comprehensive) are such sources. Table 4 shows the main sources of knowledge for each group of issues (check with Table 1). The ellipse highlights the fact that the group Project and System Management has all the theoretical components (of all issues) covered by an individual class - Implementation Guides (check with Table 3).

Analysis of Theoretical Diversity - Preliminary Findings

Results show that for only one issue it is possible to access all the theoretical components by consulting an individual publication (Funding Strategies, check Table 3). For the other issues one must consult more than one publication to learn and compare the competing, alternative or complementary approaches. Results also show that for most issues there is an individual class covering all the theoretical components. This means that for such issues it is possible to access all the competing, alternative or complementary approaches by consulting (several) publications of an individual class of literature.

Groups of issues	Overall Strategy	Information System Design	Strategies for Enabling the Implementation	Project and System Management
Classes of Literature				
Implementation Methodologies		Main source		
Implementation Strategies	Main source		Main source	
Success Factors				
Research Findings				
Implementation Guides		Main source		Main source

Table 4: Theoretical diversity of the main sources of knowledge. The ellipse indicates that an individual class covered all the theoretical components (of all issues) of a group.

Despite being interesting observations, one must consider that the purpose of our investigation is not to qualify individual publications or to analyze the coverage and diversity on individual issues. Instead, we should search for overall trends by analyzing the coverage and theoretical diversity of classes (instead of individual publications) and groups of issues (rather than individual issues).

In the context of overall trends, results show that the classes of literature found to be the main sources of knowledge on a specific group of issues do not tend to address all the theoretical components (of all issues) of such group. This means that if one wants to access all the competing, alternative or complimentary approaches on a specific theme (group of issues) one have to consult publications included in the main source and also in other classes of literature.

CONCLUSIONS

The purpose of this case study was to analyze the effectiveness of the literature in communicating the existing knowledge on GIS implementation. Dispersion of knowledge, the main aspect under observation, was considered as a hypothesis to be verified through two specific tests.

In the first test we would verify whether the knowledge on the various implementation issues is dispersed over the literature (different publications addressing different issues) or whether individual publications tend to address all the issues. Results of the Coverage Analysis have shown that publications included in different classes of literature tend to address different groups of issues. Such results lead us to conclude that it is not possible for a reader to access knowledge on the several aspects of GIS implementation by consulting literature included in one single class. One must consult several publications, included in different classes of literature.

In the second test we would verify whether the various implementation approaches on each specific issue are dispersed over the literature (different publications addressing different approaches) or whether individual publications tend to address all existing approaches. Results of the Theoretical Diversity Analysis have shown that individual publications do not tend to address all the approaches on a specific issue. In some cases, classes of literature (the selected

publications) have covered all the theoretical components (approaches) on a specific issue. But the classes of literature found to be the main sources of knowledge on a specific group of issues do not tend to address all the theoretical components of all issues included in such group. Based on such results one may conclude that if one wants to access all the competing, alternative or complimentary approaches on a specific issue, one have to consult several publications. And if one wants to access all the approaches on a specific theme (group of issues) one have to consult several publications included in different classes of literature.

Implications

Transmission of knowledge enables comprehension and subsequent use of such knowledge. The easier the access, the easier the comprehension and use. Dispersion of knowledge, as demonstrated in the previous sections, causes apprehension because it inhibits transmission, comprehension and use of such knowledge. Dispersion of knowledge may cause one to access knowledge on only part of the issues that should be considered while implementing a GIS. It may also cause one to access only part of the approaches on a specific issue, maybe preventing the adoption of those that are the most appropriate to the circumstances.

To gather up information from several sources may be an agreeable task for researchers and authors, maybe an acceptable task for consultants but probably an uncomfortable and sometimes exhaustive task for practitioners. The need of a user to consult information provided by several sources, as well as the possibility of a user to consult just the most ready-to-use literature cause apprehension because just a part of the desirable knowledge on the subject is reached.

Recommendations

Based on the results and conclusions exposed above we invite authors and researches to balance their efforts among production of new knowledge, insertion of new knowledge into a global context, organization of knowledge, and careful design of new literature. To assist authors and researchers in such challenging tasks, a summary of the framework adopted in this and other research efforts (Ferrari 1996, 1997) is presented below:

- Identify standard issues within an overall theme and review literature identifying and organizing the proposals on each of the standard issues.
- Compare all the proposals on each of the standard issues, identifying possible gaps and inconsistencies.
- Insert new knowledge into the global context, by comparing it with competing approaches and by making it compatible with theories on other issues.
- If you are addressing a specific issue, try to comment and compare all the approaches on that issue.
- If you are designing new literature, when possible and appropriate try to address all the issues of the overall theme.

We introduced this paper comparing GIS literature with tourism guides. We have argued that tourism guides ease and even stimulate tourism because they are effective in communicating information. After pointing out dispersion of knowledge as a shortcoming of GIS literature we want to reemphasize that, like tourism guides, comprehensive and systematically organized

literature can ease and stimulate the use of appropriate theories and implementation approaches, enabling better results in implementation efforts.

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