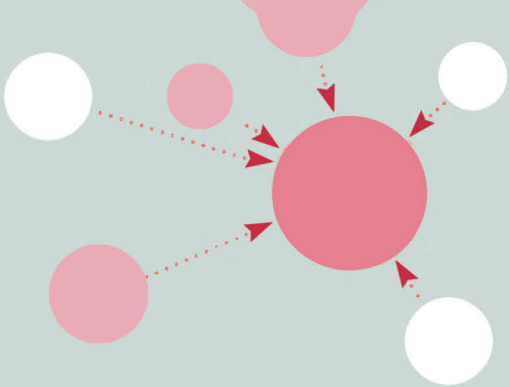

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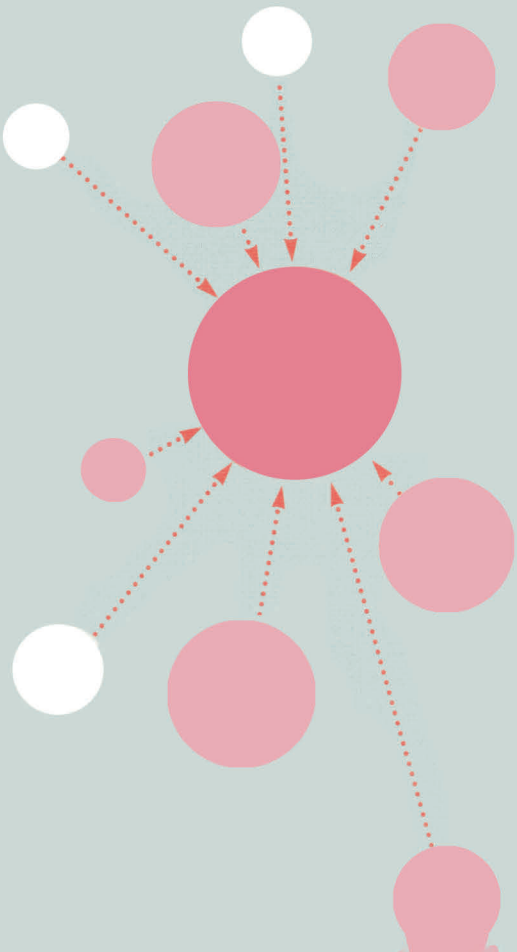

How effective are GIS in practice?

Heather Campbell
and Ian Masser

GIS and Organizations

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Contents

	List of figures and tables	vii
	Acknowledgements	ix
1	**Introduction**	**1**
	Technology: innovation or irrelevance?	1
	Diffusion	4
	Overview	8
2	**Technology and organizations**	**9**
	Introduction	9
	Technology	9
	Organizations	13
	Reinvention	23
	Conclusion	24
3	**Perspectives on implementation**	**25**
	Introduction	25
	Technological determinism	26
	Managerial rationalism	29
	Social interactionism	34
	Success and failure	49
	Conclusion	50
4	**Organizations and GIS: a case study of British local government**	**51**
	Introduction	51
	British local government	52

	Research strategy	61
	Overview of the research findings	64
5	**The diffusion of GIS in British local government**	**65**
	Introduction	65
	GIS adoption	65
	System development	68
	Choice of technology	72
	Benefits and problems associated with GIS	74
	Main changes since 1991	76
	Evaluation	79
	Conclusion	83
6	**Reinvention and utilization: GIS in practice**	**84**
	Introduction	84
	The case studies	85
	Why do organizations adopt GIS?	87
	Characteristics of the GIS technologies being implemented in the case study authorities	90
	Evaluation	108
7	**GIS implementation: a problematic process**	**113**
	Introduction	113
	Technological considerations	114
	Organizational considerations	118
	Information management strategies	118
	Commitment and participation	132
	Instability	144
	Conclusion	151
8	**GIS: innovation or irrelevance?**	**153**
	Introduction	153
	Implications of the research findings	154
	Implications for research	161
	Conclusion	162
	References	164
	Index	173

Figures and tables

Figures

1.1	A conceptualization of diffusion	6
3.1	Underlying rationale of the corporate approach to GIS implementation	33
3.2	Limitations in the underlying rationale of the corporate approach to GIS implementation	42
4.1	District authorities in Great Britain in 1994	53
4.2	County and regional authorities in Great Britain in 1994	54

Tables

2.1	Key characteristics of a selection of theoretical approaches to decision-making in organizations	20
3.1	Main characteristics of technological determinism	26
3.2	Main characteristics of managerial rationalism	29
3.3	Arguments in favour of a corporate strategy towards GIS implementation	34
3.4	Main characteristics of social interactionism	37
3.5	Arguments that question the appropriateness of a corporate strategy towards GIS implementation	45
4.1	Average population of local authorities in Great Britain in 1991	55
5.1	Plans for GIS in local authorities in Great Britain	66
5.2	Authorities with GIS by type of local authority	66
5.3	Percentage of local authorities with GIS facilities by type and region	67

5.4	Level of GIS adoption by authorities and systems	68
5.5	Length of experience with GIS technologies	69
5.6	Approach to GIS implementation	69
5.7	Number of departments involved in multi-departmental GIS facilities	70
5.8	Departments involved in GIS facilities	70
5.9	Lead departments in multi-departmental facilities	71
5.10	Single department GIS	72
5.11	Software adopted for GIS work	73
5.12	Hardware adopted for GIS work	74
5.13	Most important benefits associated with GIS	75
5.14	Most important problems associated with GIS	75
5.15	Summary of main changes between 1991 and 1993 with respect to GIS adoption and system development	76
5.16	Summary of main changes between 1991 and 1993 with respect to GIS technology and perceived benefits and problems	78
6.1	Characteristics of the case studies	86
6.2	Technical characteristics of the GIS adopted by the case study authorities	91
6.3	Number of terminals able to access GIS technology	93
6.4	Types of departments with computer access to GIS facilities	94
6.5	Range of skills and number of staff employed in implementing GIS technology	96
6.6	Organizational structure for GIS implementation	99
6.7	Number of departments involved and with access to GIS facilities	100
6.8	Departments with attribute data on a GIS	103
6.9	Operational applications	105
6.10	Applications under development	105
6.11	Overview of the utilization of GIS in the case studies	107
7.1	Perspectives on the implementation process	114

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Introduction

Technology: innovation or irrelevance?

The ability to innovate is generally regarded as fundamental to organizational survival. Governments throughout the world are expending considerable resources searching for technological innovations and novel techniques which it is assumed will increase industrial as well as administrative competitiveness. However, many seemingly good ideas remain in the workshops of their inventors. Some innovations diffuse rapidly throughout society while other equally worthy developments progress little further than the laboratory. These observations question the extent to which diffusion is dependent upon the inherent technological characteristics of a particular innovation. At least as important appear to be the cultural, organizational and institutional contexts into which such a development is to be embedded (Bijker, Hughes and Pinch 1987; Dunlop and Kling 1991a; Goodman, Sproull and Associates 1990; Rogers 1983). It is, therefore, crucial that consideration is not only given to the elegance of the technology but the interrelationships between organizations and innovations if greater understanding is to be achieved of how a potentially good idea becomes a facility taken for granted. As a result, this study seeks to investigate how organizations respond to innovations and, more particularly, what processes influence the effective implementation of new technologies in real-world situations.

The innovation that provides the focus for the study is geographic information systems (GIS) and the organizational context is British local government. GIS are essentially a set of computer-based technologies which are able to store, display, manipulate and analyse spatial data, most particularly map-based information. Arguably, manual forms of GIS have been available for many decades and computer-based systems since the 1960s. However, recent advances

in the data-handling capabilities of computers, most particularly the speed with which large data sets can be processed, led GIS to become commercially viable during the 1980s. As a result, the concepts on which GIS are based are by no means new, but the speed and flexibility with which it is now possible to exploit the geographical properties of information has produced an innovation that has prompted considerable interest as well as prophetic claims for the technology. It is not only vendors, manufacturers and researchers who have been enthusiastic about GIS technologies; developments in this field led the British government to commission an inquiry chaired by Lord Chorley to investigate the issues surrounding the handling of geographic information. The landmark report of this Commission was published in 1987 with the significance of the technological advances they had seen encapsulated in the following now legendary statement: 'Such a system is as significant to spatial analysis as the inventions of the microscope and telescope were to science, the computer to economics and the printing press to information dissemination. It is the biggest step forward in the handling of geographic information since the invention of the map' (Department of the Environment 1987, para.1.7).

The conceptually simple capacity to be able to unleash the power of computers to process spatial data and thereby to use geography as the main organizing principle for database design has an appeal which, in conjunction with the map-based outputs, started to capture the imagination in the 1980s. GIS technologies were promoted as offering opportunities to improve efficiency by reducing the duplication of spatial data sets and at the same time ensuring that all sections of an organization had access to the same up-to-date information. Furthermore, GIS were envisaged as contributing to organizational effectiveness through the provision of basic data as well as stimulating more complex analyses which would enhance decision-making capabilities at operational, managerial and strategic levels. Fundamental to such claims was the capacity of GIS to integrate data sets from a wide variety of sources. As a result, GIS were regarded as facilitating data sharing which in turn would lead to more informed decision-making and logically better decisions. Some went further, suggesting that the greater availability of information would result in a democratization of decision-making and improvements to the quality of life of the whole of society.

The optimism associated with the potential of GIS mirrors much that has been written in relation to information technology in general. Underlying such sentiments is a strong feeling that improvements in social and economic conditions are dependent upon technological innovations, most particularly developments in computing (Feigenbaum and McCorduck 1991; Naisbitt 1984; Toffler 1980). Implicit within the utopian views of technology is an assumption that society is entering, or perhaps has already entered, an information age, in which economic prosperity as well as harmony within society depends upon the ability to process vast reserves of information. Toffler (1980) terms this the 'Third Wave', a period in which successful market economies are distinguished by the rapid diffusion of computers. As a result, it is predicted that mechanical production methods will gradually be replaced by programmable technologies.

The increasing availability of information in association with the ability to exploit these resources to the full is not only envisaged as a vital contributor to economic success but also as liberating those who have traditionally felt excluded from the decisions that affect their lives. For example, in the workplace computerized technology has been conceptualized as 'informating' activities, thereby removing the tedium from many tasks and dispersing power more widely (Zuboff 1988).

Despite claims about the potential opportunities that will result from the introduction of new forms of computer-based systems such as GIS, very little is known about the actual impact that this technology is having in practice. As yet, attention has largely concentrated on enhancing technical know-how in relation to handling geographic information. Technological innovation is, however, of little value if the product of such developments proves problematic to implement or is regarded as an irrelevance by potential users. In contrast to the expectations of the utopian conceptions of technology, evidence suggests that technical elegance is no guarantor of widespread utilization. For example, studies investigating the introduction of computer-based systems, mainly within the private sector, have shown that marginal gains, unforeseen problems or even complete abandonment of the project are more common than success (Dunlop and Kling 1991c; Eason 1988; Lucas 1975; Lyytinen and Hirschheim 1987; Moore 1993; Mowshowitz 1976). The objective of this book, therefore, is to examine the relationship between an innovation and the organizational context in which it is to be embedded. Is the prime determinant of the widespread diffusion of a new technology its technical capabilities or are other factors responsible for the outcome of this process? Is the dawning of the information age, if that is what is taking place, about technological innovation or the capacity of organizations to absorb change?

GIS technologies provide an excellent case study for such an investigation. They exemplify the characteristics of the new generation of programmable technologies which some suggest will transform society. The potential of this technology has been eloquently outlined but how are users reacting in practice? It is this group, whose concerns have little to do with GIS and are therefore agnostic and perhaps even sceptical about the merits of changes to existing work practices, that will make the ultimate judgement as to its value. Will their verdict be innovation or irrelevance, and what processes will contribute to this assessment?

The current stage of development of GIS technologies makes this an opportune time to examine the experiences of users. The initial purchase of any new product is usually associated with a great deal of enthusiasm and expectation. It is therefore important before embarking on an investigation of this type that sufficient time has passed to allow a realistic assessment to be made. In the case of GIS such circumstances now appear to have been fulfilled as early adopters introduced the technology into their organizations in the mid-1980s. Such organizations are by their very nature often viewed as atypical. However, it is now possible to draw on the experiences of what may be termed

the second generation of GIS adopters, without falling into the trap of being forced to focus on the very early stages of implementation in these organizations.

The organizational environment that provides the backcloth for the introduction of GIS, is British local government. If computer-based technologies are about facilitating information handling, where better to examine the input of one group of these innovations than in a set of organizations whose *raison d'être* is focused on consuming, processing, managing and manufacturing information. As Hoggett rather neatly puts it, 'what poultry is to Kentucky Fried Chicken, information is to local government' (Hoggett 1987, p. 226). Furthermore, not only does information appear to be the focus of the majority of activities of local government but also, according to the Chorley Report, at least 60 per cent has a geographical component (Department of the Environment 1987). Local government, therefore, seems to be an appropriate context in which to examine the potential of GIS and more particularly the interrelationships between innovations and organizations.

The process underlying much of the preceeding discussion has been the concept of diffusion. The remainder of this chapter will consider the nature of diffusion in relation to a technological innovation such as GIS. This will be followed by an overview of the structure of the book.

Diffusion

Diffusion is the fundamental process that is responsible for the transfer of innovations from the workshops of their inventors to becoming a daily part of the lives of a large section of society. There appears to be a great deal of ambiguity surrounding the precise meaning of diffusion. It is possible to identify two groups of researchers for which the concept of diffusion has provided a focus to their studies. First, geographers have shown some interest in the spatial aspects of diffusion. Their principal concern has been to investigate the effect of distance from the source of an innovation on the speed and extent of adoption (see, for example, Hägerstrand 1952 and 1967). It is, however, arguable that it is the second group of researchers based in the sociology discipline who have made the most significant contribution to our understanding of the process of diffusion (see, for example, Eveland, Klepper and Rogers 1977; Rogers 1983 and 1986).

Rogers in his overview of research in this field defines diffusion as 'the process by which an innovation is communicated through certain channels over time among members of a social system. It is a special type of communication, in that the messages are concerned with new ideas' (Rogers 1983, p. 5). This definition is important as it identifies a number of significant concepts in relation to diffusion. The first concerns the innovative nature of the product being diffused and therefore the uncertainty surrounding the consequences of adoption. The second important element of the definition is the stress placed on the whole

role of communication channels as the means of relaying information about the merits and deficiencies of an innovation. These channels include both the mass media and the opinions of peers, in particular what are termed 'opinion leaders'. Rogers also emphasizes the significance of time as well as the nature of the social system in which the process of diffusion is located. The concepts embedded within this overall conceptualization are important, as the speed and extent of the diffusion of an innovation is linked to social and political processes rather than simply the inherent technical worth of the product.

Practitioners in this field acknowledge, however, that there are a number of limitations to the scope of much of the existing empirical research in this field (Rogers 1993). For instance, implicit within much of this work is a pro-innovation bias, that is to say an underlying assumption that the adoption of the particular development under consideration will necessarily benefit all concerned. Perhaps, more importantly in relation to a technology such as GIS, there has been a tendency to concentrate on relatively simple forms of diffusion involving decisions based solely on individual adopters. Ryan and Gross's (1943) landmark study, for instance, concentrates on the adoption of hybrid seed corn by farmers in two Iowa communities. Even in relation to the recent developments in computing and telecommunications capabilities, diffusion studies have tended to concentrate on products designed to meet the needs of the personal end of this market. For example, Dutton, Rogers and Suk-ho Jun (1987) have examined trends in home computing. Technologies such as GIS, however, present a more complicated situation, for rather than being adopted by one individual, the unit of analysis is usually an organization. Decisions in this type of context are therefore the result of the interaction between complex sets of personal, organizational and even cultural interests. Furthermore the purchase of the innovation is not the culmination of this process as there is no guarantee that the equipment that has been acquired will actually be utilized within the host organization. Consequently, it would appear that diffusion should be conceptualized as consisting of, first, a set of processes associated with the propensity of individuals or organizations to adopt a particular technology, and second, a set of processes that influence the effective utilization of an innovation. While the processes involved in both are likely to be closely related and mutually dependent, a useful conceptual device would be to view the former as essentially external to the organization while the latter is concerned with diffusion within the organization.

A further complication in devising an operational conceptualization of diffusion is that there is a tendency for it to be synonymous with terms such as adoption, implementation, routinization and utilization without any clear distinction as to the relationship between these concepts. Given that the innovation providing the focus for this study is GIS, it seems to be appropriate to regard diffusion as an umbrella concept: a term that encapsulates the processes of awareness raising, adoption, implementation, routinization and utilization and an assessment of the consequences of the entire exercise for the individuals and organizations concerned (see Figure 1.1). It is important, however, that while all

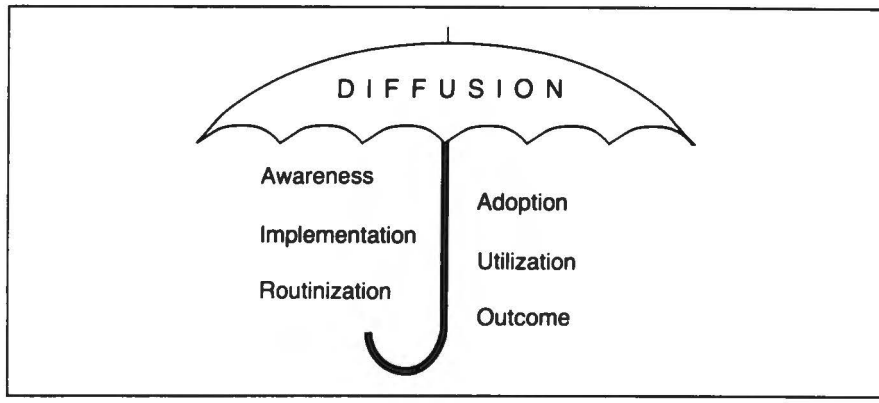

Figure 1.1 A conceptualization of diffusion

these elements are regarded as an inherent part of diffusion, the overall process is not considered to be linear in nature. It is a complex and problematic process in which aspects of implementation may well precede adoption: while one section of an organization may be routinely utilizing a technology, another may be unaware of its existence. Furthermore, in the case of a programmable technology such as GIS it is probable that there will be repeated cycles of development, learning and use as circumstances change or users become more demanding. Diffusion is not therefore a once-and-for-all process.

In contrast to much of the existing research on the diffusion of innovations, this study not only examines the speed and extent of GIS adoption within one organizational grouping but more particularly concentrates on the processes that influence whether effective utilization is achieved. Leonard-Barton (1988) notes that there has been a tendency for research to focus on the initial decision to adopt a new form of technology, ignoring the critical phase of implementation which underpins the transition from untested expectations to a taken-for-granted technology. This emphasis on exploring the relationship between organizations and innovations complements and supplements work on GIS which is currently under way, focusing on the traditional concerns of diffusion studies, most particularly the external communications channels through which knowledge about an innovation diffuses (see Assimakopoulos 1995). An increasing number of high-profile and often extremely expensive cases of information systems that have had to be abandoned point to the problematic nature of implementation (South West Thames Regional Health Authority 1993). The Audit Commission (1994) in a recent report has highlighted the poor return that many public organizations such as health and local authorities have made on their investments. It is also noticeable that the private sector is not immune from such experiences, as the now infamous events surrounding the introduction of the London Stock Exchange's TAURUS system testifies (McRae 1993). Examples

such as these emphasize the importance of extending the scope of research on the diffusion of innovations beyond the point of adoption. The centrality of implementation to this research makes it worth outlining briefly the concepts that will be developed more fully in the second part of the book.

Implementation

Innovations depend on the process of implementation to become absorbed into the organizational context in which they have been introduced. As a result, if the extent of adoption provides a benchmark as to whether users accept a new product to have potential, implementation determines whether it is utilized. Traditionally, implementation has been envisaged as one phase within a linear progression from initial awareness about an innovation through to routine use. In common with the more general process of diffusion, such an approach increasingly appears to be an oversimplification. For instance, the implementation may take place repeatedly in different sections of an organization, or in some cases even within the same organizational unit. However, the critical feature of this whole process is the difficult task of managing change.

The introduction of an innovation into an organization necessarily implies change. Implementation is a means through which such adaptations are transmitted to the often wary members of the organization. Interpretations as to the significance and complexity of this process vary. Overall, there appear to be three main groups of perspectives. First, *technological determinism* is based on the premise that the benefits of the innovation are so transparent to all concerned that securing utilization is inevitable and largely unproblematic. The second perspective, *managerial rationalism*, is similarly optimistic about the probability of realizing considerable benefits from the introduction of an innovation but instead of relating this solely to the technical characteristics of the new development, the rational application of appropriate management techniques is regarded as making a significant contribution. In contrast, the *social interactionist* perspective suggests that the chances of achieving utilization are far more problematic, with the outcome resulting from the interrelationships between the innovation and the context in which it is located. As a result, objective evaluations of the changes made necessary by the introduction of the new technology or the scope of the benefits are regarded as largely irrelevant to the likelihood of securing satisfactory implementation. Much more important is each individual's assessment of the potential threat or opportunities posed by the new development. In most cases such an appraisal is based on short term personal considerations.

It is increasingly evident that, whether or not the information age has arrived, great significance is being attached to the importance of innovativeness and more particularly the introduction of innovations. Innovations cannot, however, diffuse in isolation and it is therefore vital that consideration is given to improving understanding of the interrelationships between new technological

developments and the organizational contexts that they are intended to benefit. The subsequent study will therefore develop and explore the concepts outlined above in relation to the diffusion and most particularly the implementation of geographic information systems in British local government.

Overview

The subsequent discussion is structured around three further parts. Chapters 2, 3 and 4 develop the theoretical framework upon which the study is based. Chapter 2 explores the nature of innovations and their relationship to technological developments such as GIS, and reviews current thinking about the nature of organizations. The impact of the interrelationships between innovations and organizations on implementation provides the focus of Chapter 3. The discussion develops and extends the three perspectives that highlight the varying significance and complexity of this interaction. Having established the theoretical framework for the investigation, Chapter 4 provides a link between the conceptual and empirical parts of the discussion. The underlying research methodology is outlined and key features of British local government described.

Against this background Chapters 5, 6, and 7 present the findings of the investigations examining the diffusion of GIS in local government. Chapter 5 focuses on the extent of GIS adoption. The organizational and technical characteristics of the systems being introduced are also reviewed in Chapter 5, with a threefold typology developed of the styles of implementation that are being applied in the authorities. This typology provides a framework against which the detailed case study findings are presented in Chapters 6 and 7. The central themes of the study are explored in these chapters. Chapter 6 examines the reasons underlying the decisions to invest in the technology and the extent to which the basic form of an innovation is influenced by the organizational context and assesses the levels of GIS utilization taking place. The striking feature of these findings is the limited impact that GIS appear to be having. It is the search for an explanation of the problematic nature of the implementation process that provides the focus of Chapter 7. The implications of these findings have both theoretical and practical dimensions. Chapter 8 draws these issues together, highlighting that the effective implementation of an innovation is highly dependent on the organizational context in which it is located.