Assessing integrated information systems as a strategic tool to support sustainable development in british local government: the geographic information systems (gis) case.

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'You have to know the battles you can win, and you have to know the battles that it is very unlikely that you would win, and therefore you take a much more clandestine and much more stealthy and much more pragmatic approach'. Case study 2.

ABSTRACT

Local authorities' engagement in local sustainable development initiatives has been focused in separate ways including just one or two out of the three dimensions of sustainable development – economic, social and environmental – but not all together.

The work reported here adopts a qualitative research approach and case study methodology. Four different case studies were selected according to their stage of development using GIS to support local government's functions. These case studies serve as a means of understanding the fundamental reasons for the GIS adoption at local level as well as the implications and impact of this technology at organisational level. While the study suggests that a formal policy or a GIS corporate strategy are the starting points, resources and GIS experience, continuity and expertise are crucial when evaluating success and failure, outcomes and results. The work reported here concludes that, to engage local authorities in GIS, middle and long-term partnership and networking initiatives appear to be critical, as well as the fundamental issue which considers not just (1) the adoption of a technological framework, (2) a planning framework and (3) a data provision framework but also (4) a periodic process of GIS measurement in the search for best practices as well as a cross-sector approach to local sustainable development.
Keywords: ágeographic information systemsñáintegrafed information systemsñ ásustainable developmentñ álocal governmentñácase studiesñ

RESUMEN

El compromiso de los gobiernos locales en iniciativas de desarrollo sustentable ha estado focalizado a cubrir sólo una o dos de las tres dimensiones que comprende el desarrollo sustentable, [dimensión económica, social y ambiental], pero no todas en su conjunto.

La investigación aquí reportada ha adoptado el enfoque cualitativo y la metodología de estudio de casos. Los cuatro diferentes estudios de caso fueron seleccionados de acuerdo al estado de avance logrado en el uso de la tecnología de los Sistemas de Información Geográficos SIG para apoyar las funciones del gobierno local. Los estudios de caso son un método para comprender las principales razones para la implementación de sistemas de información georeferenciados en los gobiernos locales británicos, así como también las implicancias y el impacto de esta tecnología a nivel organizacional. Mientras que el estudio sugiere que una política formal o una estrategia corporativa de uso de los sistemas de información georeferenciados son el punto de partida, recursos, experiencia, continuidad y expertise en el uso de los SIG; son factores cruciales al momento de evaluar impacto y resultados. La conclusión de esta investigación es que el compromiso de las autoridades locales en iniciativas de asociatividad y redes de colaboración de mediano y largo plazo son puntos críticos, así como también lo son, no sólo (1) la adopción de un soporte tecnológico, (2) la planificación de su arquitectura, (3) un plan y procedimientos para la provisión de datos, (4) y un proceso periódico de medición y evaluación de los SIG en busca de buenas prácticas, sino que también, (5) un a enfoque intersectorial hacia el desarrollo sustentable.

Palabras claves: ásistemas de información geográficasñ ádesarrollo sustentableñ ágobiernos localesñ áestudio de casosñ

1. RESEARCH CONTEXT

Local governments unlike any other public organisation are being challenged by the British Government in order to achieve the aims of modernisation; so community planning is increasingly being seen as the main way for planning in localities as well as strategic coordination with central government. According to Saunders (2002, p.14), this challenge has intensified since the publication of 'A better quality of life: the strategy for sustainable development for the UK' in 1999, where social, economic and environmental well-being areas were formally defined as a new duty for local government.

The promotion and improvement of these areas is a real challenge to local authorities in the UK because their achievement means that local governments need to focus attention on sustainable development. Although to manage sustainable development is crucial to local authorities, it is also a complex function because it requires clear foresight and an integrated planning process at three different levels – economic, social and environmental – where most of the time the balance between the degree of relevance and inclusion of these three dimensions appears contradictory.

Considering the economic dimension, the objectives associated with sustainability are growth, equity, and efficiency. Taking into consideration the social dimension, the objectives associated with sustainability are empowerment, participation, social mobility, social cohesion, and institutional development. Regarding the environmental or ecological dimension, the objectives associated with sustainability are ecosystem integrity, biodiversity, and global issues. Despite the conceptual power of sustainable development, the problem is that the concept has, according to McNeill (2000, p.9), 'an essential conflict at its core', which can be manifested (1) as 'the conflict between the interest of the present and the interest of future generations; (2) as the

conflict between human well-being and the protection of nature; (3) as the conflict between poor and rich; (4) as the conflict between local and global focus'. Besides, from an academic point of view, specialised literature generally shows separate debates about sustainable development emphasising just one or two dimensions, not integrating these three core elements.

In seeking solutions to achieve the challenge of sustainable development, local governments in the UK as well as elsewhere have increasingly embraced different approaches and models through design, planning, and implementing local policies and goals. Whereas local governments implement their initiatives, there is a tacit factor underpinning these approaches which is **how to manage strategic information**. In general terms it is possible to identify approaches focused on business models, on technological models, on organisational development, and on partnership or collaborative approaches between the state and non-state sectors.

In an area as diverse and complex as sustainable development, collaborative approaches have become an important means of governing and managing local programmes where according to Worthington, Patton and Lindley (2003, p.92), 'demands for cross-sector collaboration have become significant in the field of environmental policy and lie at the heart of the national and international debate over how to reconcile the demand for economic growth with the need to preserve and protect the natural environment'. The conclusions on partnership approach to achieving sustainable development evaluated for Worthington, Patton and Lindley (2003, p.92) indicate that 'partnership has been championed as the most appropriate approach to sustainable development where the focus has been trying to pursue a holistic and integrated response to social, environmental and economic problems'. Nevertheless, this approach is particularly complex in terms of continuity and the authors indicate that 'given the perceived need to address both short-term and long-term concerns and choices about future scenarios often when no single solution is apparent, the partnership models appears to offer a means of engendering a structured debate at local level amongst different stakeholder groups around these choices and their implementation'.

The technological approach to achieving sustainable development aims is also complex because in practical terms, local authorities are encouraged to foster value-added initiatives with budgetary constraints and organisational restrictions. To Halfawy, Vanier and Hubble (2004, p.375) 'the increasing requirements to maintain acceptable levels of performance in municipal infrastructure systems, combined with budgetary constraints, present a significant challenge to municipalities'. Despite these restrictions and constraints, the technological approach is strong. According to Gill (2000, p.1), 'one means of achieving these aims is to improve the use of the wide range of technologies available, moving towards a more electronic form of government, based on sound service delivery principles and good information management'.

The potential of the technological approach however has limitations and Halfawy, Vanier and Hubble consider that (2004, p.378) 'the lack of interoperability and inefficient data exchange between legacy software tools has been a major impediment to communicating information in a timely, efficient fashion'. They (2004, p.375) also hold that 'most of these tools were developed for a single assets class lacking an integrated and

comprehensive view of the whole management processes'. As a consequence, 'the proliferation of these tools has created an "islands of information" phenomenon in most municipalities or local governments', so inefficiencies in the coordination of work processes have been commonplace. In conclusion, Halfawy, Vanier and Hubble (2004, p.375) recognise that 'a major challenge that needs to be addressed is how to integrate these tools to support their seamless interoperation and the efficient sharing and exchange of data'.

Other problems associated with the technological approach are mentioned by authors like Santos and Sarriegi (2004) and O'Callaghan (2000) who have noted that despite the fact that local authorities need to plan and develop appropriate information systems, 'misunderstanding about the concept of integration have given rise to thoughts that it was impossible to build a generic model applicable' to local government, even considering that they produce and share common functions and information. Similarly, criticism from the organisational approach has been indicated by Waring and Wainwright (2000, p.146). They consider that 'the reality of systems integration is far removed from the idealized concepts expounded by hardware and software vendors and integration consultants', but 'the models and definitions that they use are too simplistic and fail to address the potential issues that each organisation will face when implementing their own integrated solutions'. So when the organisations do not realize the benefits of integration, the normal consequence is that it leads to compromise, a partial use of the systems or even their complete abandonment. In addition, Wainwright and Waring (2004, p.330) hold that in many organisations, there is 'relatively little cumulative effort related to the implementation of integrated information systems and developing usable analytic methods and tools to predict the social and cultural impact of adopting new information technologies'.

The lack of integration and interoperability indicated by Halfawy, Vanier and Hubble could be overcome with the development of a methodology which reinforces the adoption of a common standard to manage information. Santos and Sarriegi (2004, p.495) hold that 'the methodology of integrated information systems covers this need'. Halfawy, Vanier and Hubble (2004, p.385) go beyond generalisations and directly recommend the implementation of a particular technology which is the Geographic Information Systems – GIS – approach. They hold that 'leveraging the use of Geographic Information Systems (GIS) improves the efficiency and effectiveness of the asset management work process, the most critical requirement of sustainable management of municipal assets'.

The majority of the information is associated with the attributes of location, and the data managed by Geographic Information Systems (GIS) is information that is geo-referenced. As a product developed from the field of computer science, geography and information systems, Heywood, Cornelius and Carver (2002, p.12) recognise that a Geographic Information System (GIS) is much more than a mere 'system for capturing, storing, checking, integrating, manipulating, analysing, retrieving and displaying data which are spatially referenced to the earth'. Authors such as Longley (2006), O'Callaghan (2000), Gill (2000), Halfawy, Vanier and Hubble (2004) agree on the potential of their tools if they are properly applied. Gill (2000, p.2) holds that a Geographic Information System 'is not simply a system for digital mapping or automating existing cartography tasks'; he considers that 'GIS packages also have enormous data integration powers and can

significantly improve data analysis and representation processes'. The enabling capacities of the GIS make possible their implementation in most other organisations, government agencies, utilities and other places.

The Geographic Information System, GIS – as an example of an integrated information system – is not novel technology. In fact, Gill (2000, p.2) estimates that 'the term GIS probably made its appearance in the UK in the mid 1970s; he recognises that 'GIS packages have enormous data integration powers and can significantly improve data analysis and representation processes'. On the other hand, the author underlines that GIS 'can accommodate over 80% of a local authority's existing data holdings in the UK'. At local level, a GIS seems to be a powerful tool for supporting the decision making process. Gill (2000, p.2) underlines that the 'GIS can make a great contribution to improving the effectiveness and efficiency of local government research, policy evaluation, strategic planning, and service delivery'. Within this context, a survey addressed by the Royal Town Planning Institute (2000, p.21) concludes that 'the evolution of GIS is far from complete, with 75% of authorities having plans for further development'. Nevertheless, despite this high level of adoption, Halfawy, Vanier and Hubble (2004, p.377) indicate that 'the value of GIS systems in supporting data management, query, and analysis, remains largely unused or underutilized'.

Within this context, the relevance of this research was that it allows the retention of the holistic and meaningful characteristics of the process related to GIS adoption in events related to real sustainable development practices. In particular this research was looking to gain an insight or a more in-depth description and understanding of what crucial factors should be considered in the adoption of this specific technology in complex organisations such as local governments; who, how and why they are working on the implementation of GIS at local level; how sustainable development is being considered and measured using this particular technology and how to assess the effect of implementing GIS in this field; what effects, consequences and outcomes the adoption of GIS has had, not only supporting processes, functions and procedures, but also how it has affected the decision making process at local level; and finally how these systems could improve the overall operations of local government.

2. RESEARCH OBJECTIVES

This study considered the development of a small-scale research project, which examined four case studies to observe in detail the characteristics of local governments which have implemented GIS as integrated information systems. So the aim of this research was to determine the impact of Geographic Information Systems, GIS, on sustainable development initiatives implemented by local government in the UK. Consequently, to meet this aim, the following specific objectives were set up:

1. To identify and evaluate the methodology, process, and resources involved in the adoption and implementation of Geographic Information Systems (GIS) to carry out sustainable development policies at local level.

2. To determine outcomes, experiences, and impact in the adoption of Geographic Information Systems, especially in the process of organisational development at local level.

3. To identify the main applications, functions and solutions provided by Geographic Information Systems; to reinforce and support economic, social and environmental decision making processes at local level.

4. To examine the understanding, acceptance, adoption, and users' satisfaction of Geographic Information Systems (GIS) to support strategic functions in local government.

5. To identify best practices in GIS initiatives related to delivering public services, cooperation, and partnership, communication, networking practices, and training facilities at local level.

To achieve its aims and objectives, the research developed a qualitative research approach, using a combination of methods such as questionnaire, interviews and analysis of documents. As case studies are valuable as preliminaries to major investigations, the results of this research would be used as raw material to develop a major project, applied to municipalities in Chile.

3. RESEARCH METHODS

3.1. Research Approach

It was considered that a research based on a qualitative paradigm would allow the development of an in-depth study or empirical reality, particularly focused on areas assumed relevant for achieving the aims and objectives of this research. Considering the advantages of qualitative analysis mentioned by Denscombe (2003, p.220) who states that 'the data and the analysis are grounded in the conditions of social existence; there is a richness and detail to the data; there is tolerance of ambiguity and contradictions of the social reality being investigated'; and also because there is the prospect of alternative explanations, this paper presents the development of a qualitative and small-scale research. Under this approach in the process of data generation and analysis the interpretative skills and abilities are considered fundamental.

Similarly the use of qualitative methods has allowed to reflect and to interpret the reality which the research was interested in studying – in this case all the complex factors involved in the adoption of integrated information systems, such as GIS to support sustainable development initiatives by local governments. Although the adoption of a qualitative analysis approach generally is used to generate new concepts or theories, in this particular research it was used to evaluate possibly different realities using the same methods to enrich the overall conclusions.

Among the available qualitative method approaches, this research adopted the case study methodology because it allows observation and analysis from an insider perspective, and also because it allows in-depth discovery to be achieved, getting exploratory and descriptive analysis, evaluating processes, and validating assumptions from the literature. This method also has a holistic sense which assumes case studies as a dynamic reality. The selection criteria of this approach were based on its underpinning principles and also on the diversity of issues which needed to be integrated into the research.

Since this is a qualitative and small-scale research, it was developed as providing an appropriate opportunity to explore complex issues in more detail. To investigate the

central research statement, three key issues were addressed: (1) local government, (2) sustainable development initiatives, and (3) geographic information systems. To add value to previous data and literature on these issues, the decision was taken to integrate these perspectives.

3.2. Methods Used: Case Studies

The case methodology was used to gain in-depth understanding, normally supplied with meaning for the subject under study, [in this case it was provided by the Gis managers] focusing on process rather than outcomes, on discovery rather than confirmations. In this particular research, the methodology to get in-depth exploration was focused on four examples or case studies reached as a result of negotiation access to key individuals in the local authorities in the UK, to determine the impact of Geographic Information Systems (GIS) on sustainable development initiatives implemented by them.

As a research strategy, the essence of a case study is that it tries to illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what results. So, considering the perspective and the implications of the aims and objectives, it was decided that as a research strategy, case studies were a suitable methodology to achieve them properly. Similarly, it was estimated that case studies provide anecdotal evidence which will be useful to illustrate decisions, practices, procedures and perceptions of people involved in programmes and activities related to the implementation of sustainable development initiatives at local level.

Using a range of multiple sources of information and data collection techniques, including interviews and questionnaires, all of them rich in content and context, it was possible to observe the characteristics, processes and relationships of the community under study, in this case, local government. Through this method it was feasible to look for approaches to the questions which were being asked concerning the conditions that appear essential for successful GIS implementation, as well as participation and involvement in sustainable development planning matters of local authorities. Due to the fact that GIS uses information technology which is still ongoing, the research was focused on the latest initiatives implemented.

3.3. Sampling Criteria

The qualitative research approach considers the adoption of a non-probability sampling technique and in a case study the usual form of non-probability sampling is termed purposive, purposeful or criterion-based sampling. In practical terms this means that there was no guarantee that every element had an equal chance of being included, or that the case studies were representative of some population. This decision was methodologically appropriate because the research was not focused in validating or generalising.

In qualitative research, sampling criteria should be flexible, as well as focused. According to Burns (2000, p.465) 'a case is selected because it serves the real purpose and objectives of the researcher of discovering, gaining understanding and insight into a particularly chosen phenomenon'. In this paper the cases were selected to provide a panel of varying experience to which similar questions might be addressed, so the sampling criteria was adopted considering the aims and objectives.

Besides there were other factors which had to be taken into consideration when making decisions on sampling criteria. So in this research the decision and criteria for selecting local authorities or case studies, was determined by:

(1) Stages of development or experience in the usage of Geographic Information Systems (GIS)
(2) Conditions and results of negotiating access to GIS managers and/or Officers.
(3) Geographical location.
(4) Feasibility in terms of the amount of time available.

3.4. Target Group

Considering recent surveys carried out by the Royal Town Planning Institute which have demonstrated a high level of adoption of Geographic Information Systems (GIS) technology – over 75% of local authorities having plans for further development – the case studies sampling was located within this population, so the target group was the local authority responsible for administrative units which are implementing local sustainable initiatives using GIS applications.

As a result of the specialised literature review process and following the guidelines given by an expert on Geographic Information Systems (GIS) six case studies were initially considered. Due to restrictions or limitation of access to the local government units, four out of six was the final number of case studies integrated into this research. The following basic data is presented to identify the case studies:

Profile Case Study 1: is a city comprising 36 local districts with a residential population of 247,817 (2001 Census), located on the south coast of England.

Profile Case Study 2: is a Metropolitan Borough, comprising 26 districts, with a residential population estimated as 305,500 in 2005, located in the West Midlands

Profile Case Study 3: is a district located in southern England, with a total population estimated in 2005 as 93,000 distributed in one larger and several smaller settlements.

Profile Case Study 4: is a County divided into five local government districts with 15 towns and one city. It is located in the South Midlands with a total population estimated in 2005 at 626,900 inhabitants.

3.5. Data Collection

Being aware and conscious of some limitations of qualitative methods indicated by Denscombe (2003, p. 221) in the sense that 'there is a danger of oversimplifying the explanation, producing inconsistencies and ambiguities', and also recognising that in terms of methodology, qualitative research has some difficulties in terms of data analysis, the data collection techniques adopted in this research as sources of evidence, were review and analysis of documents, questionnaire, and semi-structured interviews. Using these data collection techniques it was possible to achieve data and theory's triangulation.

3.5.1. Questionnaire

Considering the five specific objectives set in this research and as a result of the literature review process, a questionnaire was developed, checked and amended during June 2006. The survey has a brief introductory and explanatory part, a part to register the case study contact information, and four main sections with a total of 47 questions.

Describing the questionnaire structure, in section 1 it was requested respondents to provide information about the case study background. The section has a total of 5 questions and according to the type of response choice 1 is nominal and the rest are numerical. Section 2 was entitled *'GIS as a Strategic Tool to Support Sustainable Development in British Local Government'*. The section was elaborated to establish the extent to which local governments recognise the potential of GIS to support sustainable development initiatives at local level, and the questions were made to achieve the objectives 1 and 2 of the research. The section has 14 questions in total: 13 are open and 1 is a closed question. Following the type of response choice 11 are categorical or nominal questions and 3 are numerical. The questions in this section were created to measure the first and second objectives of the research.

Section 3, entitled *'GIS Architecture at Local Level and Access to Information'*, was elaborated to achieve the third objective. As the research was focused in identifying the main applications, functions and solutions provided by Geographic Information Systems to reinforce and support economic, social and environmental decision-making processes at local level, the main issues thus were concerned GIS hardware, software platform and professional networking. The section also included questions on interoperability standards or metadata schemas. The section has 11 questions in total, from which 2 are open-ended and 9 are closed questions. According to the type of response choice 1 is numerical and 8 are categorical or nominal.

Section 4 was devoted to the issue *'GIS Improvements, Performance and Management'*. Considering that local governments, unlike any other public organisation, are being challenged by the British Government in order to achieve the aims of modernization, and also that community planning is increasingly being seen as the main way for planning in localities as well as strategic coordination with central government, through this section the survey was looking to establish whether GIS are being used to improve efficiency indicators and how these improvements in efficiency and performance are demonstrated year on year. The section was formed to achieve the fourth and fifth objectives. The section has 11 questions in total, being 2 open-ended and 9 closed questions. Considering the measurement of responses 2 are numerical and 7 categorical.

The questionnaire has 83.78% of closed questions. They are mainly categorical or nominal questions. Within the closed questions, 12 have point scales to order the responses. The choice to elaborate closed questions was made taking into consideration Fowler's (2002, p.91) ideas that 'closed questions are usually a more satisfactory way of creating data; the respondents can perform more reliably the task of answering the question when response alternatives are given and the researcher can perform more reliably the task of interpreting the meaning of answers when alternatives are given to the respondents'. In the questionnaire's elaborating the research followed the Fowler (2002), Fink (2003), Flick (2002), Rea and Parker (2005) guidelines, thus it was avoiding formulating too many open-ended questions because 'although open questions sometimes result in quotable material that can be useful for the survey report, they are difficult to compare and interpret'.

3.5.2. Interviews

With the objective of making a more accurate interpretation of the meaning of the issues under study as well as to facilitate the case analysis, the research decided to complement the questionnaire with interviews to describe the case in detail and provide an analysis of issues that the case presents. Similarly some advantages of the in-person interviews mentioned by Rea and Parker (2005, p.18) applied to this research were: (a) flexibility: the interviewer can probe for more detail and explain unclear questions, (b) complexity: interviewers can administer complex questionnaires, (c) ability to contact hard-to-reach populations such as GIS managers, and (d) assurance that instructions are followed and questions are answered in the order intended so that the integrity of the questionnaire sequence is maintained.

Taking into consideration the types of semi-structured interviews it was decided to develop a focused interview. The received surveys were undertaken as a primary source of information to elaborate a more fine-grained semi-structured interview schedule or guide. So the research followed the three criteria during the design of the interview guide and during the conducting of the interview itself. The factors that the research followed were all those mentioned by Flick (2002, p.75): (1) 'the criterion of specificity to determine the impact or meaning of an event for the interviewee; (2) the criterion of range to ensure that all aspects and topics to the research questions are mentioned during the interview; and (3) the criterion of depth and personal context to observe how the stimulus material was experienced by the interviewee'.

4. DATA COLLECTING RESULTS

This point is devoted to showing the research findings, especially the numerical question results obtained from the questionnaire. Analysis relates to the evidence obtained from both the quantitative and qualitative data collected from the questionnaires and provided by interviews with local authorities responsible for Geographic Information Systems is shown in the following section.

Table 1: 'Gis Design to Improve the Quality of Strategic Planning and Decision Making Processes in Economic, Social And Environmental Areas'.

How well are your GIS designed to improve the quality of strategic planning and decision making processes in the following areas? Use scale of 1 to 5 where 1 is poorly and 5 is fully.	Case Study 1	Case Study 2	Case Study 3	Case Study 4	Average
Q12. Economic					
Customer relationship	1	4	3	2	2,5
Asset management	1	5	4	2	3,0
Council taxation payment and benefits	2	5	4	0	2,8
Fraud management	1	4	3	1	2,3
Audit budget programmes	1	3	3	1	2,0
Commercial property management	1	3	3	0	1,8
Concessionary fares/travel	1	1	2	0	1,0
Car park administration	1	4	2	2	2,3
Debt management and recovery	1	3	2	1	1,8

Licensing	2	3	4	1	2,5
E-payment	1	1	3	1	1,5
E-procurement	1	1	3	1	1,5
County purchasing	1	1	0	1	0,8
County council payroll	1	2	0	1	1,0
Total	**16**	**40**	**36**	**14**	
	22,86	**57,14**	**51,43**	**20,00**	

Q13. Social					
Delivering public policy	3	4	5	2	3,5
Housing services	3	5	3	0	2,8
Policy services	3	4	5	1	3,3
Health care services	3	3	3	0	2,3
Social welfare services	3	4	3	2	3,0
Public libraries	3	4	3	1	2,8
Museums	3	4	3	1	2,8
Leisure centres	2	4	3	0	2,3
State school administration	3	5	3	3	3,5
Theatre location and booking	2	4	3	0	2,3
Public parks	3	5	4	0	3,0
Citizenship relationship	3	5	2	2	3,0
Election management	2	5	2	2	2,8
Electoral registration	3	5	2	2	3,0
	39	**61**	**44**	**16**	
	55,71	**87,14**	**62,86**	**22,86**	

Q14. Environmental					
Public transport	4	3	3	4	3,5
Street mapping	4	5	5	4	4,5
Traffic control	4	5	3	3	3,8
Waste management	4	4	4	2	3,5
Building services/control	3	5	5	3	4,0
Urban planning	2	5	5	3	3,8
Land management	3	5	4	1	3,3
Tourism services	2	4	3	0	2,3
Refuse collection	2	5	4	0	2,8
Recycling	3	5	4	2	3,5
Street lighting	3	5	3	4	3,8
Street cleansing	3	4	4	0	2,8
Air pollution	3	4	4	0	2,8
Road opening reinstatements	2	5	4	3	3,5
Environmental indicators control (GRI)	2	5	3	2	3,0
Total	**44**	**69**	**58**	**31**	
	58,67	**92,00**	**77,33**	**41,33**	

Table 2: 'Ways to Adopt GIS at Local Level'.

Q16. What methodology actions has the Local Authority taken to adopt GIS technology in your Council? Indicate on a scale of 1 to 5 where 1 is no action and 5 is full action.	**Case Study 1**	**Case Study 2**	**Case Study 3**	**Case Study 4**	**Average**
Consulted citizens about what they want	1	1	1	1	1,0
Consulted staff about what they need	4	2	4	3	3,3
Consulted GIS providers	5	3	5	3	4,0
Consulted GIS consultants	1	1	3	4	2,3
Consulted other stakeholders (County Councils, business sector)	3	1	3	4	2,8

Table 3: 'Implementation Of GIS In British Local Government: fundamental reasons for the GIS adoption at local level'.

Q17 We are seeking the reasons why the GIS have been implemented in your organization. Indicate on a scale of 1 to 5 the position of your council on the importance of GIS where 1 represents less significant and 5 represents a high level of significance.	**Case Study 1**	**Case Study 2**	**Case Study 3**	**Case Study 4**	**Average**
Q12. Economic					
GIS was/were implemented following a strong political and management commitment based on the Agenda 21 to support the local plan or strategy	1	5	3	1	2,50
GIS required was/were installed to deliver e-government policy	2	5	5	2	3,50
GIS technology was/were implemented to support planning process, administrative functions process and decision-making process functions	5	5	5	3	4,50
GIS was/were installed to give access and support to the process of customer requests	1	4	3	3	2,75
GIS was/were implemented to support citizenship or civil society empowerment	1	3	3	1	2,00
GIS was/were implemented to achieve the challenges of modernisation, according to the Local Government White Paper 1998	3	4	4	1	3,00
GIS was/were installed to foster networking and partnership activities with other Councils	1	2	2	2	1,75
GIS was/were implemented by their popularity and to support a new style of Knowledge Management	2	5	2	3	3,00
	16 **40,00**	**33** **82,50**	**27** **67,50**	**16** **40,00**	

Table 4: 'Main GIS Applications Used in Supporting Sustainable Development'.

Q.19. Select the main applications of the GIS used in supporting sustainable development initiatives in your Council. Score each one on a scale of 1 to 7 where 7 indicate the major focus of the GIS.	**Case Study 1**	**Case Study 2**	**Case Study 3**	**Case Study 4**	**Average**
Environment monitoring, contaminated areas, environmental control plans	5	7	4	2	4,50
Land Use planning: green spaces, major transport lines, built-up areas, public facilities, traffic zones	5	6	5	5	5,25
Network topologies: to identify nodes, segments, blocks, census tracks, electoral districts	5	3	3	5	4,00
County Council Geography/ Land mapping: county council base maps, local topography, land cover, local boundaries, natural resources maps, land values	3	4	4	6	4,25
Utility cadastre/registry: sewer lines, electricity, gas, water, telecommunications	3	2	3	4	3,00
Building plans: building lines, zoning, types of building, local streets, parcels.	5	5	5	2	4,25
Total	**26**	**27**	**24**	**24**	
	61,90	**64,29**	**57,14**	**57,14**	

Table 5: 'Products and Information Services Provided to the Local Community Using the Available GIS Applications'.

Q20. What products and information services does your Council provide to the local community using the available GIS applications? Score each one on scale of 1 to 7 where 7 indicate the major contribution of the GIS	**Case Study 1**	**Case Study 2**	**Case Study 3**	**Case Study 4**	**Average**
Website design – web service application	1	0	1	1	0,75
E-Procurement: electronic forms management	5	5	1	1	3,00
New service planning: market modelling analysis	1	4	3	1	2,25
Direct marketing (online location finding)	1	6	1	1	2,25
Outsourcing services: example environmental assessment impact	1	0	1	1	0,75
Networking and Telecommunications services	1	0	1	1	0,75
Others (indicate)	0	7	6	2	3,75
	10	**22**	**14**	**8**	
	20,41	**44,90**	**28,57**	**16,33**	

Others: Case Study 2: Council's information portal; Case Study 3: Planning/building control services; Case Study 4: Consultations

Table 6: 'Problematic Factors in the GIS Implementation Process at Local Level'.

Q23. Using the 1 to 5 scale, weight the following factors which in your opinion have been problematic in the GIS implementation process in your organization, where 1 represents a small weakness and 5 a major weakness	**Case Study 1**	**Case Study 2**	**Case Study 3**	**Case Study 4**	**Average**
Lack of long term strategic planning in which includes user requirements, implementation plan, system and database design, system acquisition and installation, technical training, data conversion, etc.	5	2	2	4	**3,25**
Lack of adequate financing or funding programme	5	1	5	5	**4,00**
Lack of political and management support; lack of administrative support	4	1	5	4	**3,50**
Poor management and coordination within the County Council or lack of coordination among departments	3	2	2	4	**2,75**
Potential GIS champions are not in a strategic position with enough power to overcome barriers or to obtain political support from the local authority	3	2	5	2	**3,00**
Convergence with others national projects in GIS; lack of cooperation plan; absence of habits and routines for communication and data sharing within or among Councils	3	4	2	2	**2,75**
Lack of adequate GIS team or staff – higher-skilled workforce is required	3	1	2	5	**2,75**
Organisational resistance to innovation of staff and management	3	2	4	4	**3,25**
Ownership of the GIS initiative or intellectual property and copyright issues	1	1	4	2	**2,00**
Customer apathy	2	2	2	1	**1,75**
Security and confidentiality concerns about the database creation, conversion, maintenance, updating and vulnerability to failures	2	3	1	1	**1,75**
Increased reliance on computers, changes in software, upgrades to hardware or incompatibility of software and hardware within the organization and with the regional GIS		4	1	1	**1,50**
'Island of information phenomenon'. Technical problems related to dissimilar user interfaces or poor integration between internal systems and databases		4	3	3	**2,50**
Lack of national standard to manage the interoperability (metadata standards)		5	3	1	**2,25**
total	**34**	**34**	**41**	**39**	
%	**48,57**	**48,57**	**58,57**		**55,71**

Table 8: 'Metadata Schema and Modelling Languages'.

	Case Study 1	Case Study 2	Case Study 3	Case Study 4	Total
Dublin Core Metadata Element Set		1		1	2
MARC21 standard Machine-Readable Cataloguing					0
IEEE-LOM Learning Object Metadata standards					0
JPEG-2000 Government Information Locator Service		1			1
MPEG-21 Moving Picture Expert Group					0
MPEG-7 Moving Picture Expert Group					0
XML schema	1	1	1	1	4
ONIX Online Information Exchange					0
ODRL Open Digital Rights Language					0
XrML Extensible Rights Metadata Language					0
eGMS E-Government Metadata Standard		1	1	1	3
Australian Government Locator Service					0
ISAD. International Standard Archival Description					0
EDRM systems Electronic document and record management	1				1
OAIS information model for digital archives					0
Other standards (indicate)					0

Table 9: 'Expected GIS Benefits to Offer Efficiently Sustainable Development Initiatives Delivering in the Councils'.

Q43. Indicate on a scale of 1 to 7 what benefits is the GIS is expected to offer in efficiently delivering your Council's sustainable development initiatives, where 1 is a small role and 7 is a major role.	Case Study 1	Case Study 2	Case Study 3	Case Study 4	Average
The GIS role in better quality decisions and measuring improvement in sustainable development indicators, GRI	7	6	5	4	**5,50**
The GIS contribution to delivering efficiency, greater transparency in the relationship with customers, cost saving and staff saving	6	5	7	5	**5,75**
The GIS contribution to ensure traceability in market chain	2	4	2	1	**2,25**
The GIS role in terms of providing greater access to data	7	7	7	6	**6,75**
The GIS role in improvement of data processing, analysis, visualization and integration of strategic information	7	7	7	6	**6,75**
Unable to say	0	0	0	0	**0,00**
	29	**29**	**28**	**22**	
	82,86	**82,86**	**80,00**	**62,86**	

Table 10: 'Factors considered to be improved in the short term Council's GIS strategy'.

Q.45. GIS technology is still ongoing. Score on a scale of 1 to 7 the following factors that you consider might be improved in your Council's GIS strategy over the next few years, where 7 represents a major factor	**Case Study 1**	**Case Study 2**	**Case Study 3**	**Case Study 4**	**Average**
Change in the ways to support the planning processes	7	5	7	6	**6,3**
More advances in database integration	7	7	7	6	**6,8**
More exploration and exploitation of geographic information	7	7	7	6	**6,8**
Updating of GIS technology	7	4	7	4	**5,5**
Networking and partnership at international level	1	1	3	2	**1,8**
Reinforcement of GIS policy	7	3	6	3	**4,8**
Outsourcing services provision to other Local Government (GIS as a new business unit)	1	5	7	1	**3,5**
	37	**32**	**44**	**28**	
	75,51	**65,31**	**89,80**	**57,14**	

5. DISCUSSION AND CONCLUSIONS

The work reported here has met the overall aims of the research. This section examines in turn the five key research issues referred to in the specific objectives, indicating the experiences, attitudes and perceptions of local authorities involved in the adoption of Geographic Information Systems technology. Concerning the first objective of the study which was to *identify and evaluate the methodology, process, and resources involved in the adoption and implementation of Geographic Information Systems (GIS) to carry out sustainable development policies at local level*, the following conclusions were reached:

5.1.1. As far as sustainable development is concerned, considering three complex dimensions – economic, social and environmental – as well as from the literature where normally the concept is focused on one or two dimensions, local authorities tend to have the same segmented vision of sustainable development and thus normally the implications result in problems such as lack of integration when they design their policies or initiatives.

5.1.2. Under the Local Government Act 2000, local authorities have the power and responsibility to prepare and implement comprehensive community strategies. This document confers on local councils a leader role in promoting and improving local economic, social and environmental well-being. Within this context and concerning the methodology, process, and resources involved in the adoption and implementation of Geographic Information Systems (GIS) to carry out sustainable development policies at local level, the findings indicate that in all the case studies GIS were mainly implemented to support functions related to planning and decision-making processes, and to deliver e-government policy more than to implement sustainable development policies at local level.

5.1.3. It is clear the mandate that UK local authorities have to follow in establishing and supporting sustainable development initiatives, but given the variety of local political cultures, progressive advances in the GIS technology and the wide range of organisational interest, no single model exists to assist local government in this key role. No single methodology to adopt the GIS was taken in the case studies under study. Although to consult GIS providers was mentioned by all of them, there was a critical evaluation when local authorities followed this strategy without considering the experiences of other councils – benchmarking – or without consultation regarding staff needs.

5.1.4. To assess the progress in sustainable development initiatives supported by GIS was considered as other GIS capability through which it is possible to bring all those multi factors together, aggregating or adding value to the local authorities' functions. Nevertheless none of the case studies was currently measuring the impact of the GIS in sustainable development, despite there are models available for that; such as the Global Reporting Initiative (GRI) and 'The Bellagio Principles'.

5.1.5. Likewise fundamental is the issue of when, who and what organisational structure was responsible for the GIS implementation. When GIS has kept going continuously at Corporate Level and led by GIS staff, the impact in the organisation has been complex but significant compared with the approach to locate GIS at departmental level. Although the interviewees were in favour of the first approach, to change the emphasis is critical and requires strong commitment in terms of 'selling' GIS and also around GIS ownership.

5.1.6. The Councils have adopted a business model or a project management approach as guidance on how to prepare and implement the GIS technology in their organisations. In the process of GIS adoption the key resources involved were capital investment, GIS technology, GIS staff and acquisition of spatial data sets. With reference to the budget allocation to GIS technology there was no major criticism in the sense that they were not fully equipped. Nevertheless one of the critical issues mentioned by the interviewees was the imbalance between the total numbers of staff employed in their Councils with the total number of staff employed working in GIS. Except in one case study where there is a high GIS staff ratio, the lack of GIS staff contracted full-time was mentioned as a weakness.

5.1.7. Particular GIS initiatives are normally reported using the case studies approach, but concerning the GIS technology adoption process itself, the evidence suggests that reporting the process is not a common pattern within the case studies. When the process is reported there are organisational restrictions on allowing access to the information. One of the implications is that the GIS know-how involved through this development is not shared and thus important learning lessons remain hidden for others who need to have access to strategic information. Another

implication is that if local authorities decide to evaluate or measure the GIS performance the lack of a reporting mechanism would affect the analysis and parameters by which GIS is put in perspective. In this context, local authorities have an important role to play in developing a feeling of mutual benefits, trust and sharing practices among the Councils as well as in creating an environment in which all the local authorities feel commitment to contributing GIS know-how. This vision could evolve if local authorities have the vision that they are facilitators rather than controllers within a collaborative framework.

Concerning the second objective of the research which was to determine outcomes, experiences, and impact in the adoption of Geographic Information Systems, especially in the process of organisational development at local level, the following conclusions were got:

5.2.1. With respect to the questions on outcomes, experiences, and impact of the adoption of Geographic Information Systems, especially on the process of organisational development at local level, there was not enough evidence from local authorities. It is possible to establish a correlation with the questions related to the satisfaction level with the current GIS initiatives implemented by the Councils, but considering that in all the case studies the Councils do not measure GIS performance in terms of GIS functions and in terms of the GIS contribution to organisational improvements, the impact was clearly not feasible to verify. Within this context the conclusion is that it is too early to give an unequivocal answer. As an indication GIS managers should consider that when local governments request residents to evaluate their local plans it could be a good moment to introduce some GIS measurement indicators in order to obtain feedback from the users. It is also possible to conclude that further research on GIS measurement should be developed, following the Global Reporting Initiative (GRI) model.

5.2.2. Considering the above observation, it was possible to establish that the degree of impact of the adoption of Geographic Information Systems is correlated with four main factors which were:

(1) Leadership attitude and involvement of the GIS staff within the organisation and their peers: one of the interviewees mentioned that 'you have to know the battles you can win, and you have to know the battles that it is very unlikely that you would win'.

(2) Local authority commitment and support in terms of a formal policy establishment, as well as availability of resources for the GIS strategy or for the GIS applications when there is no formal GIS strategy.

(3) Strategic vision and strategic thinking to assume GIS as an enabling technology and project their implementation continuously at least throughout middle-term initiatives to evaluate outcomes. To one of the GIS managers when 'planning professionals have woken up to the technology, the role of GIS, rather than just a nice publishing mechanism, they've realised the spatial tools actually help them in defining the areas

much more effectively because they can ask spatial questions and then they draw lines on maps'.

(4) The necessity to set off a continuous and widespread GIS learning process which promotes inclusiveness with other organisational structures in order to create the link between the user needs and the GIS applications. To one of the case studies the GIS learning process takes four years until the social services management realise how critical that is. So 'try and get round obstacles, and try to think medium to long term, and be flexible in the short term' seems to be a feasible GIS strategy in this case.

5.2.3. There was no distinction as to whether the engagement and discussions in 'economic', 'social' or 'environmental' issues were more or less complex but all our interviewees suggested that whilst the process to engage GIS is possible, it requires time. The value of the GIS learning experience is critical according to the time to establish business continuity plans for this technology.

5.2.4. In a political environment where local governments play a fundamental role as local decision- makers, GIS staff is challenged to create GIS skills and innovate within the traditional methods of working. Usually GIS staff has more technical than political skills and considering that in local councils GIS is developed and driven by central government targets, the outcomes, experiences, and impact of the adoption of Geographic Information Systems, all the case studies have had these kinds of organisational restrictions.

5.2.5. Although none of the case studies mentioned deficient outcomes in implementing GIS technology, the following 7 factors in descendent order were considered as problematic between a list of 14 choices given. The majority of them are organisational issues:

(1) lack of adequate financing or funding programme;
(2) lack of political, management and administrative support;
(3) lack of long term strategic planning which includes user requirements, implementation plan, system and database design, system acquisition and installation, technical training, data conversion, etc.;
(4) organisational resistance to innovation of staff and management;
(5) Potential GIS champions are not in a strategic position with enough power to overcome barriers or to obtain political support from the local authority;
(6) poor coordination among the Council departments;
(7) convergence with other GIS national projects and lack of cooperation plan data sharing among the Councils.

5.2.6. All the interviewees agreed on the idea that considering GIS is an ongoing technology, it is feasible to obtain better outcomes if the technology adoption is thought of as a long-term project, but for specific initiatives the best approach is middle and short-term initiatives, which means 5 years to 1 year planning. It is interesting to observe that it was verified that all the GIS successful initiatives were classified as long-term initiatives.

Concerning the third objective which was to *identify the main applications, functions and solutions provided by Geographic Information Systems; to reinforce and support economic, social and environmental decision making processes at local level,* the following conclusions were reach:

5.3.1. There was a tendency to have a more integrated GIS applications when GIS has been implemented at corporate level. When GIS has been implemented at departmental level, GIS applications tend to be focused on supporting certain functions, resulting in another segment within the local authority information system.

5.3.2. From the list that was elaborated on the basis of the literature review on GIS and sustainable development at local level, the research concluded that GIS is considered as providing best performance in supporting, reinforcing and enhancing the environmental dimension of sustainable development, so in descendent order of importance the GIS functions best evaluated to support local government were the following:

Street mapping	4.5
Building services/control	4.0
Street lighting	3.8
Urban planning	3.8
Traffic control	3.8
Public transport	3.5
Waste management	3.5
Recycling	3.5
Road opening reinstatements	3.5
Delivering public policy	3.5
State school administration	3.5
Land management	3.3
Policy services	3.3
Environmental indicators control	3.0
Social welfare services	3.0
Public parks	3.0
Citizenship relationship	3.0
Electoral registration	3.0
Asset management	3.0
Council taxation payment and benefits	2.8
Customer relationship	2.5
Licensing	2.5

5.3.3. Correlating with the above conclusion, when it was requested interviewees to select the main GIS applications used in supporting sustainable development initiatives in the Councils, the major focus of GIS was oriented to select environmental initiatives such as land use planning, green spaces, major transport lines, public facilities, traffic zones, environmental monitoring of contaminated areas, environmental control plans, land mapping, council base maps, local topography, land cover, local boundaries, natural resources maps, land values, building plans, building lines, zoning, types of building, local streets, parcels.

5.3.4. Similarly, with regard to the question of what products and information services the Council provides for the local community using the available GIS applications, the common vision is that it is important to determine what specific requirements of us are being requested, and then it is possible to use GIS to direct that service delivery towards them and finally to use GIS to monitor it and to see whether they are making a difference. Within this context the best evaluated GIS choices were particular initiatives that the councils are currently delivering in development control, planning policy, green space,

housing renewal, council's information portal, Intranet mapping, planning and control building services, consultations, real time bus information, and Council Data Forum.

5.3.5. The implementation of GIS sustainable development applications requires economic, social and environmental data sets in spatial format. All of the case studies have developed this kind of data set, so to have this information available for the public to use on the internet, the common tendency is to implement internet mapping. Similarly and in order to foster the implementation of sustainable development initiatives using the potential of GIS, there are two beneficial recommendations: firstly 'better communication between the different parts of the Council who seem to be doing a similar job', and secondly 'there could be a much better sharing of data, so, better communication is there and better understanding of what people are asking for just to make sure you are not re-inventing what has gone before'. Although to one of the case studies the implementation of sustainable development 'is something that in my experience is in its embryonic phase', in the cases where sustainable development initiatives are carried out through other departments, the recommendation is that the first time, the GIS staff should do work with them and provide the sort of infrastructure to help them with the data that they need to do their work, but once the partnership relationship has been created, the recommendation is to use the potential of GIS to go beyond creating the synergy that sustainable development requires.

Concerning the fourth and fifth objective, which were to examine the understanding, acceptance, adoption, and users' satisfaction of Geographic Information Systems (GIS) to support strategic functions in local government and to identify best practices in GIS initiatives related to delivering public services, cooperation, and partnership, communication, networking practices, and training facilities at local level, the following conclusions were got:

5.4.1. Although the sustainable development issue occupied the last position from the list of reasons to implement GIS at local level, there is a high level of understanding on the importance of GIS to support strategic functions; in fact, the best ranked reason to implement GIS was precisely to support functions related to planning and decision-making processes. There is also an interesting finding which indicates that among the GIS staff consulted – more than 80% in three of them and 62.86% in the other case study – there is a clear understanding about the potential of GIS in delivering sustainable development initiatives at local level The satisfaction with the GIS technology in terms of their role is in providing greater access to data, in delivering information efficiently, in improvement of data processing, analysis, visualization and integration of strategic information and in supporting better quality decisions and in measuring improvement and indicators in sustainable development.

5.4.2. Nevertheless in the opinion of nearly all those GIS local authorities consulted, over a scale of 1 to 7, there were at least three factors that they considered might be improved

through a GIS strategy over the next few years. The fist of them was 'more advances in database integration (6.8); in second place they mentioned 'more exploration and exploitation of geographic information' (6.8) and in third place the choice selected was 'change in the ways to support the planning processes (6.3). Issues on updating of GIS technology were considered less critical with 5.5. GIS networking and partnership at international level were the best evaluated in the case studies. In technical terms over a scale if 1 to 5 compatibility (4.5) and reliability (4.2) were the most satisfactory capabilities mentioned for the GIS software.

5.4.3. Although the case studies Nº1 and Nº3 are using the client-server configuration, the level of satisfaction with this approach is poor. One of the interviewees considered that GIS would be 'far more efficient to have it all centralised and fed out to an intranet so that everyone can access it from wherever, or whatever desktop'. According to the interviewees the problem with changing the GIS architecture is lack of financial resources; 'unfortunately there's no money to implement a more enterprise-based, web-based GIS. When the GIS architecture uses both desktop and client-server GIS configuration, the decision was evaluated as efficient especially to carry out the data transference functions that the council need. When GIS was implemented at corporate level, the decision to build a customised GIS was also evaluated as correct.

5.4.4. From the previous conclusion it was possible to find out that for Councils which have legacy systems it is much more difficult to migrate, and 'the problem with the GIS vendors is that once you commit to them, it's very difficult to extract yourself from that relationship because you keep investing and getting more and more entrenched in that relationship. So each application you buy or each additional piece of software makes a decision to walk away from that so much more difficult'. On the contrary, for Councils which have built their own GIS architecture and connected the database for spatial relationships, they 'can plug in any piece of GIS software and it means that for the first time you've taken your geographic information, you've put it into a database that you own; therefore you own your assets'.

5.4.5. There was a positive correlation between the reasons for which Geographical Information Systems were implemented in local governments with the level of satisfaction of the GIS managers because they evaluated as 'good' the adoption of GIS in terms of modernising processes at local level and as 'satisfactory' the adoption of GIS in terms of impact on the process of organisational development'. There was a critical vision in the case studies because none of the choices given was evaluated as 'excellent', but this outcome is logical if we put into perspective those factors that they considered as weaknesses.

5.4.6. With regards to the best GIS initiatives in delivering public services, all the case studies were selected by their best practices. Similarly, although the GIS networking was evaluated as good, the interviewees indicated that

although there is willingness to improve it, this kind of activity should exhibit a clear direction, have stated objectives, identifiable benefits, defined roles for individual participants, resources, time horizons, and feasible action plans orientated towards tangible outcomes instead of discursive good intentions.

Naturally this research have constrains related to aspects of the methodology. Within this context and critically evaluating the appraisal of the project and its extension it is possible to mention that triangulation could be used more extensively in order to corroborate facts, data and analysis. Using more than two methods to collect data probably the research will not become constrained by the nature and limitations of the employed methods in this research – questionnaire and interviews– and probably the conclusions would gather other insights.

Nevertheless it is important to appreciate that different methods might point in a similar direction but are unlikely to meet at some precise, unequivocal point of the issues under study. So it is important to avoid the presumption that use of methodological triangulation can prove that the data or analyses are absolutely correct. The research was not designed to achieve a perfect symmetry between different methodological approaches; it was planned to shown sense, significance, divergences and convergences using the GIS technology.

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