Assessment of the Economic Value of the Geospatial Information Industry in Ireland

Submitted to

Ordnance Survey Ireland

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www.indecon.ie

12 February 2014

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Introduction and Background

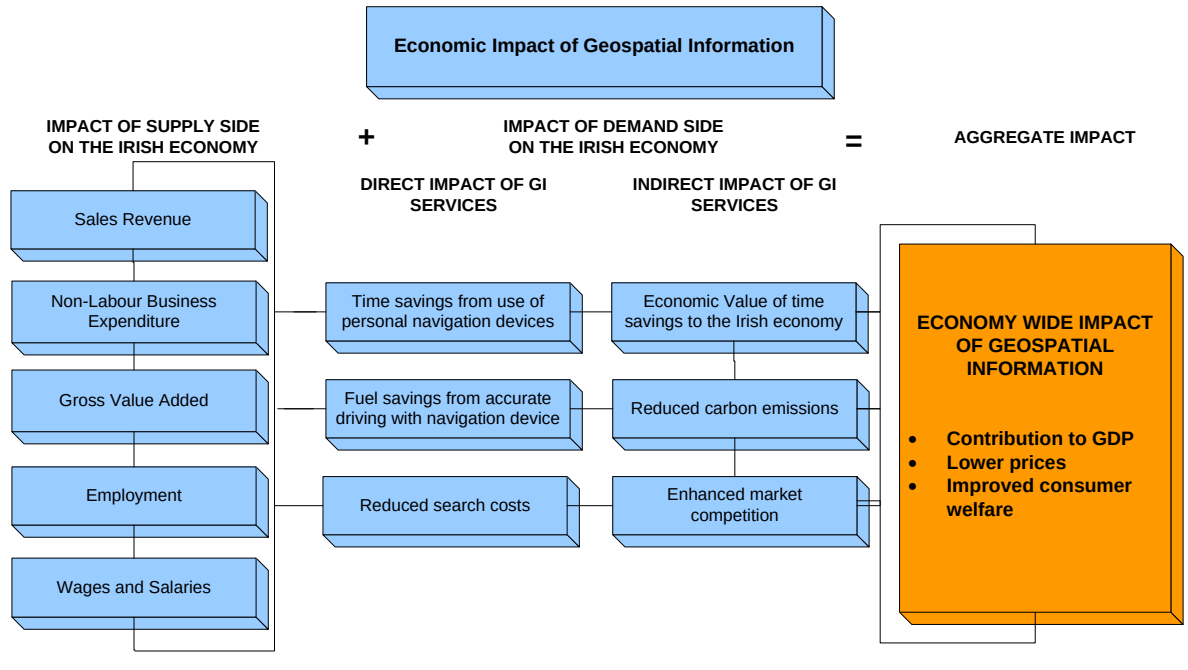
This report is submitted to Ordnance Survey Ireland (OSi) by Indecon International Economic Consultants. The report represents an independent assessment of the economic value of geospatial information ('GI') in Ireland. The background to this study is that an understanding of the direct and indirect impacts of the sector is important for decision makers in both the public and private sectors. Against this background the OSi on behalf of the geospatial industry in Ireland commissioned Indecon to independently establish the economic value of geospatial information to the Irish Economy.

Methodological approach

A feature of the geospatial information industry is that its economic impacts include externalities from the use of geospatial information as well as the impacts of the activities of industry suppliers. It is therefore useful to consider such horizontal or demand-side impacts related to the usage, as well as the vertical, supply-side impacts of the industry. A rigorous methodology has been applied in completing this assessment, which incorporates new primary research among suppliers as well as users of geospatial information.

The figure below presents an overview of the areas examined in assessing the economic impact of geospatial information on the Irish economy. The impact of the supply side of the industry is reflected in output or sales of geospatial information products and services, employment, wages and salaries, gross value added, and Irish economy expenditures. On the demand side, impacts affect a range of producers, consumers and government.

Overview of Approach to assessing the Economic Impacts of Geospatial Information



Source: Indecon analysis

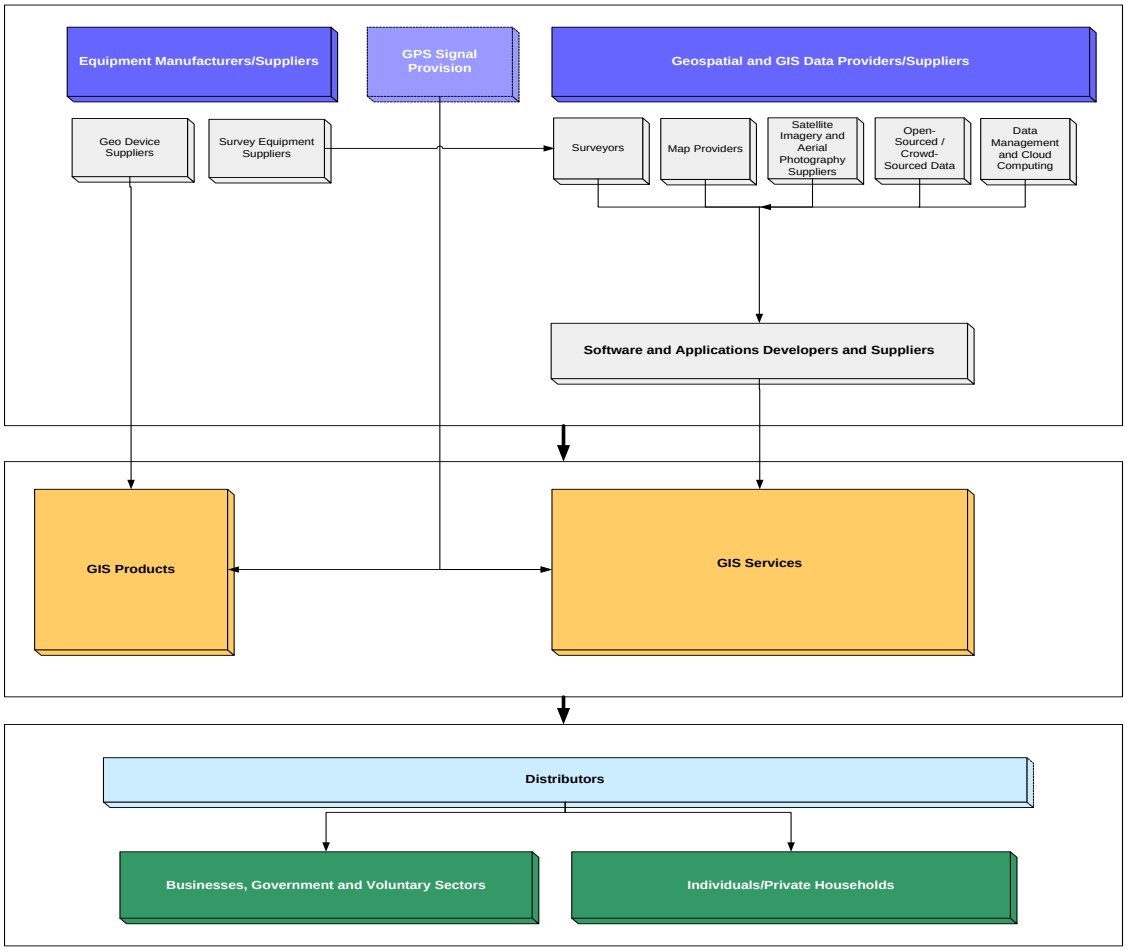
Description of Industry and Economic Value Chain

Geospatial information comprises data relating to the physical location and names of objects or businesses. Geographic Information Systems (GIS) use geospatial data to examine or demonstrate relationships or other characteristics. Services provided can range from basic maps, to sophisticated provision of geospatial data and software for use in the public and private sectors.

It is evident that there is a wide range of applications of geospatial information. In the business sector, applications relate to agriculture, transport, manufacturing, retail and utilities; in government, applications range from areas as diverse as planning to road maintenance and revenue collection to cost saving measures. Among consumers, geospatial information and Location Based Services (LBS) are utilised in interacting with education, social networking, hotel, restaurants, tourism, retail and other sectors.

In order to understand the economic impact of the industry in Ireland, it is useful to examine the economic value chain. The value chain of the geospatial information industry includes: data providers, manufacturers, services companies and distributors of GIS products. The development of geospatial information has changed substantially with the advent of digital information and the internet, allowing for rapid development and dissemination of GI. An illustration of the footprint and value chain of the industry is presented in the figure below.

Figure 1.1: Value Chain for Geospatial Information Industry



Source: Indecon analysis

Indecon's primary research for this study highlights the sectors which are significant users of geospatial information. This research indicates that the most important sectors in terms of GI use are likely to be central and local government, utilities, construction related services, agriculture, forestry and fishing and education and transport. A breakdown of the sectors is shown in the table below. The evidence presented later in this report also indicates that geospatial information is significantly used by final consumers.

Ranking of Significance of Government and Corporate users of Geospatial Information	
Users	**Percentage of Rating as significant or very significant user of GI**
Local Government/Local Authorities	84%
Utilities (Energy, Water, Telcos etc.)	81%
Central Government	79%
Architects, Engineers and Other Construction-related	64%
Agriculture, Forestry & Fishing Sector	50%
Education Sector	47%
Transport/Logistics Sector	42%
Multinational Companies	40%
Health Sector, incl. Hospitals and Emergency Services	35%
Defence Sector	27%
Other Businesses	25%
Retailers	23%
Other Services Companies	17%
Value Added Services Providers	13%
Source: Indecon Confidential Survey of GI user and supply companies	

Economic Impact of GI Industry in Ireland

A key element of the research project was to quantify the economic impacts and contribution of suppliers of geospatial information in Ireland in terms of output, expenditures, employment and contribution to value added. The key findings from our assessment in relation to the economic impact of GI suppliers in Ireland are summarised in the following table and highlight the fact it is an important sector within the Irish economy.

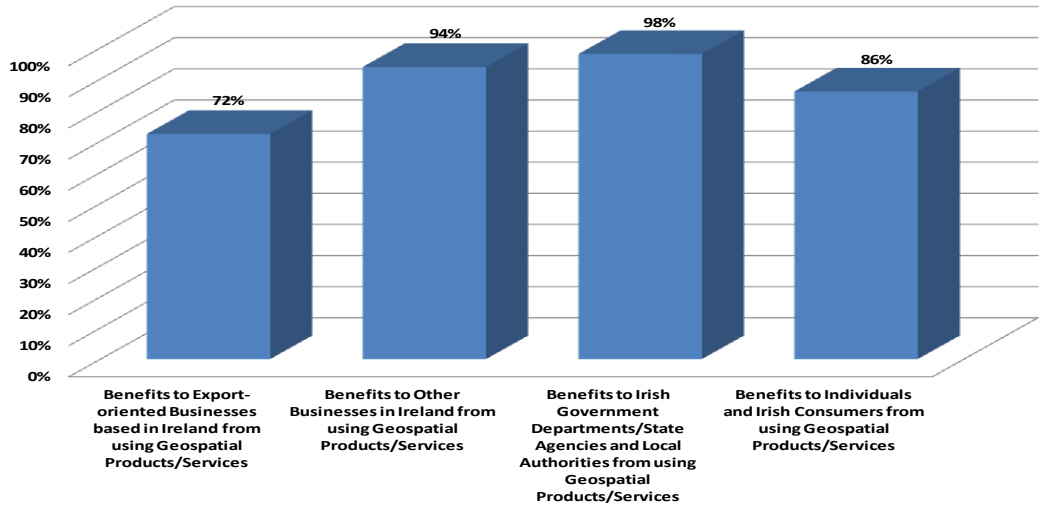
Economic Impact of Geospatial Information – Summary of Direct and Economy-Wide Impacts of GI Industry in Ireland		
Component of Impact	**Direct Impact – 2012**	**Total Economy-Wide Impact - 2012***
Employment – Full-Time Equivalent Persons	1,677	3,078
Output (Sales) - € Million	117.5	256.1
Wage/Salary Expenditures - € Million	84.4	142.7
Gross Value Added/GDP Contribution - € Million	69.3	126.4
Source: Indecon analysis and modelling * Economy-wide impact = direct impact + multiplier (indirect and induced) impacts in supply chain.		

The GI industry has expanded significantly in recent years with the growth in digitalisation and location-based services. The significance of the supply side of the industry can be seen from the fact that it directly employs an estimated 1,677 full-time equivalent persons and supports employment of over 3,000 persons when multiplier impacts are considered. The industry in Ireland generated sales or output valued at €117.5 million in 2012 and spent a total of €84.4 million on wages/salaries. It contributed over €69.3 million in terms of Gross Value Added (GVA) to Irish economy. The evidence suggests that the geospatial information sector in Ireland is larger than some previous estimates for other countries.

Economic Benefits from the Use of Geospatial Information

In addition to the economic impact of the industry there are wider economic externalities arising from the use of geospatial information. The figure below presents views of the benefits to users of geospatial information. The evidence shows that firms surveyed indicated their judgement that benefits from geospatial information accrue to users engaged in business and exporting activities, the government and final consumers. More than 98% of companies surveyed consider that there are significant or very significant benefits to the Irish government from using geospatial information. The majority (94%) perceive significant or very significant benefits are derived by businesses in Ireland from using geospatial information. Of those surveyed, 86% consider final consumers to benefit significantly or very significantly from using geospatial products and services.

Percentage of Survey respondents who indicated Significant or very Significant Potential User Benefits arising from the provision of Geospatial Products/Services in Ireland



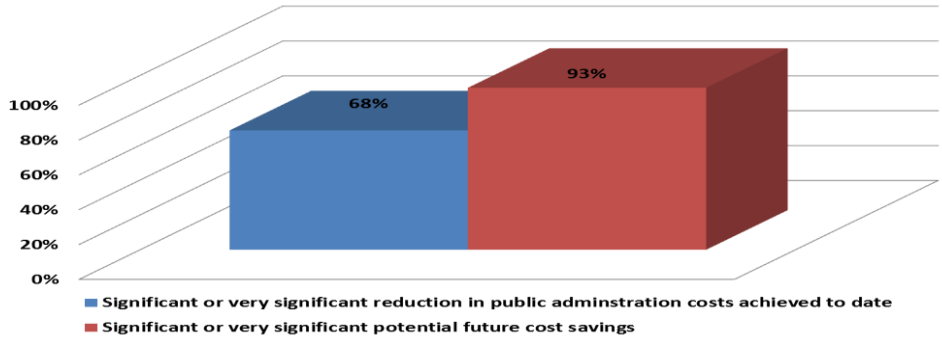
Source: Indecon Confidential Survey of GI users and suppliers

In order to test whether these perceptions are valid it is appropriate to examine the evidence on the economic benefits from the usage of geospatial information. These include the cost savings in the public and private sectors, the value of time savings and the impacts on competition and innovation. There are specific areas of impact in different sectors including for example the value of lives saved from faster emergency response times and reduced carbon emissions. A quantification of some of the key benefits is presented in this report. Such geospatial information could also potentially improve aspects of planning and decision making but these areas are not amenable to quantification.

Public Sector Cost Savings

One area of potential benefit from the use of geospatial information is cost savings within the public and local authority sectors. The figure below gives an indication of the potential significance of the reduction in administrative costs in public service provision. A majority (68%) of those surveyed believe that significant or very significant savings in administration costs of public services due to geospatial products/services have been achieved to date while more than 90% believe that there are potential further significant or very significant reductions in such administration costs to be achieved. Similar savings are likely to also accrue to businesses in the private sector where geospatial information is used. It is interesting to note that in the Irish Government's Public Service Reform Plan 2014-2015, it is intended to improve public services through more efficient usage of geospatial information.

Impact of Geospatial products/services in the achievement of reductions in Administrative Costs of providing Public Services and the future potential of such products/services to reduce such costs.



Source: Indecon Confidential Survey of GI users and suppliers

In examining the scale of such cost savings it is of note that previous international research estimated productivity savings in the public sector from the utilisation of geospatial information to range between 0.2 – 0.5%. Indecon has estimated that if even 0.2% savings were made in current public expenditures, excluding transfer payments, this would result in annual savings of €82m.

Impact of Geospatial Information Benefits in Reducing Public Sector Costs	
Estimated Annual Public Expenditure savings	€82m

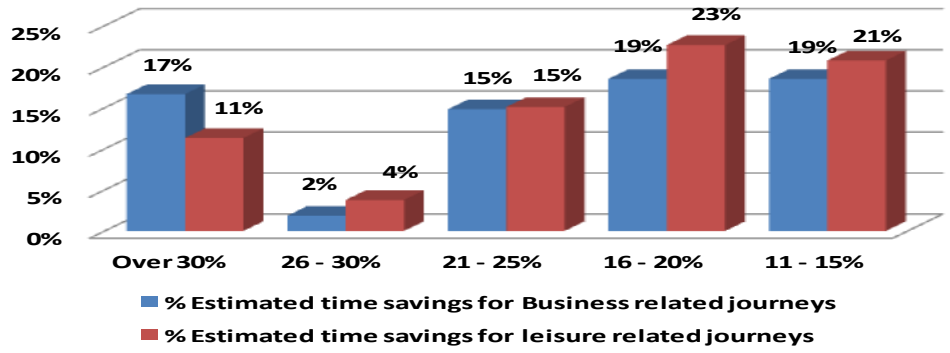
Source: Indecon analysis and modelling.

Economic Value of Time Savings

Another potential economic benefit of geospatial information is the time savings arising from the use of geospatial information. The next figure presents respondents' views on the estimated journey time savings which are generated through the use of geospatial navigation devices in guiding individuals to their location.

Just over half (53%) of the respondents believe that there are time savings of 16-20% or more for leisure related journeys and also significant savings in business related journeys.

Reduction in Average Journey Times for individuals in Ireland as a result of using Geospatial Navigation Devices/Software in guiding them to their destination



Source: Indecon Confidential Survey of GI users and suppliers

Indecon estimates of the significance of the economic value of time savings is presented in the table below and suggest annual savings of €279m. Of these, over €185m are estimated to accrue as a result of time savings on business related journeys.

Economic Value of Annual Time Savings Arising from Geospatial Information

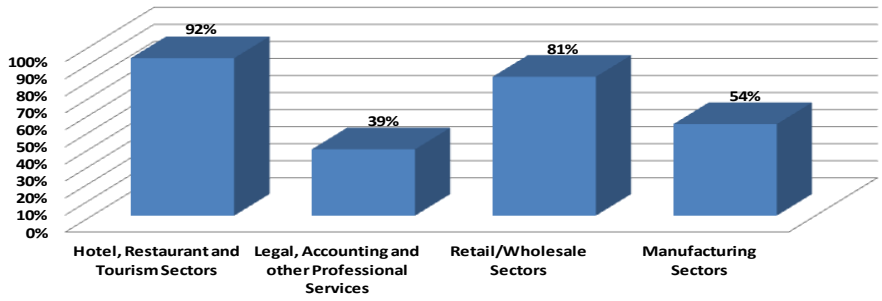
	€
Economic value of Time savings for Private Cars	94.26m
Economic Value of Time Savings for Commercial Vehicles	185.18m
Total Economic Value of Time Savings	279.44m

Source: Indecon Confidential Survey of GI users and suppliers

Impact on Competition

The consumer benefits of effective competition has been recognised in economic research. These include lower prices and improved services and quality and greater consumer choice. Of relevance to this study is that geospatial information has a potential role in intensifying competition by lowering search costs. Indecon's survey evidence suggests that geospatial information is judged to be significant or very significant in intensifying competition in certain sectors. As indicated below companies surveyed indicated their view that this factor would be particularly significant in hotel, restaurant and tourism sectors and also in retail and wholesale sectors. While quantification of the scale of such competition benefits is problematic some illustrative estimates completed by Indecon suggest these could be of the order of €78 - €130 million per annum.

Significance or otherwise of Geospatial products/services in intensifying competition by lowering search costs in each of the following broad sectors of the Irish economy

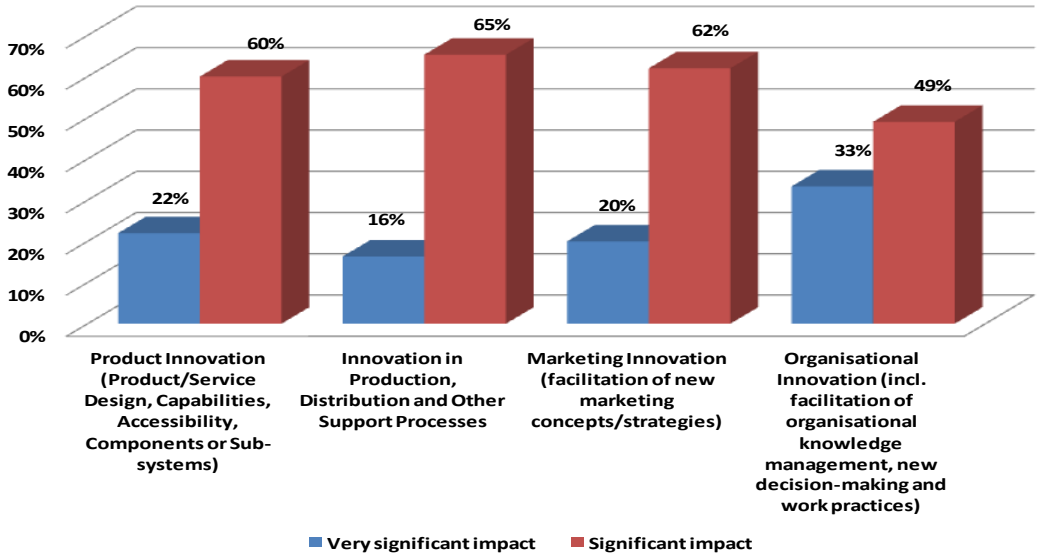


Source: Indecon Confidential Survey of GI users and suppliers.
Figures relate to percentage of those surveyed rating impacts on competition on sectors as very significant or significant.

Impact on Innovation

The GI sector directly invests in R&D but of greater impact is the potential role of GI in stimulating innovation in the Irish economy. Indecon's research indicates that 80% of companies surveyed suggested that GI was likely to have very significant or significant impacts in areas such as product innovation, innovation in processes, marketing innovation and organisational innovation (see chart below). Through these channels, the use of GI has the potential to increase competitiveness and productivity of the Irish economy.

Impact of Geospatial Information in Facilitating Innovation in the Irish Economy – Views of GI Suppliers on Significance of Specific Aspects of Contribution of GI



Source: Indecon confidential survey of GI supplier companies

Future Opportunities

The use of geospatial information is expanding at a rapid pace in both the public and private sectors. There is a recognition amongst stakeholders in industry and in government that an understanding of location and place is a component of effective decision making. As part of our research, we assessed some emerging developments in the GI industry and the future opportunities which may arise. The main findings of our assessment were as follows:

- The geospatial information Industry is set to continue expanding with the emergence of new technologies and applications.
- The increased availability of open/free data will facilitate more innovative uses of GI.
- It is likely that product differentiation on the part of GI suppliers will be through adding layers of value to free data.

The developments in the sector will open new opportunities for productivity improvements and cost savings. The greater usage will result in the opportunity to increase journey time savings and to intensify competition.

There is potential for the GI supply industry in Ireland to expand and to develop enhanced export earnings. This is likely to involve both indigenous and foreign investors in capitalising on Ireland as a location for geospatial information provision.

Overall Conclusion

Indecon's independent assessment of the economic impact and contribution of the geospatial Industry to the Irish economy, indicates that the sector plays an important role in the Irish economy in terms of output, employment and value added. The sector directly employs over 1,600 people and supports employment of over 3,000. The direct value added of the sector is estimated to be over €69.3m and, when multiplier impacts are included, this is estimated to be over €120m.

Key Economic Impact of Geospatial Supply Industry	
Direct Employment	1,677
Economy-wide Employment	3,087
Gross Value Added	€126.4m
Source: Indecon Confidential Survey of GI users and suppliers	

Also of significance are the wider economic benefits from use of geospatial information, most notably the reduction in public sector costs, the economic value of time savings and the role of the GI sector in intensifying competition. Our analysis below highlights the quantified size of such externalities.

Estimated Economic Benefits of Use of GI	
Annual Public Sector Cost Saving	€82m
Economic Value of Annual Time Saving	€279m
Competition Benefits	€104m
Source: Indecon Confidential Survey of GI users and suppliers	

Acknowledgements and Disclaimer

Indecon would like to acknowledge the valuable assistance and inputs to this assessment provided by a number of individuals and organisations. We would particularly like to thank officials within OSi for their inputs and assistance throughout the process, including Colin Bray (CEO), Hugh Mangan and Tony Murphy. We would also like to thank individuals within the Irish Organisation for Geographic information (IRLOGI) for their valuable inputs and assistance in facilitating the industry workshop held in October 2013. Particular thanks are due to Rob Ovington, John Hawkins, Dara Keogh, Saeed Khan, Ben King, Eamonn Donnelly and Gearoid O' Rian who chaired Indecon sub-groups during workshops and to all organisations who inputted to the workshop discussions. Thanks are also due to the following organisations who inputted at the workshop, namely, DoECLG, CSO, ESRI, DAHG, PRAI, Marine Institute, Oracle, IMGS, Waterford Co. Co., Donegal Co. Co., Fingal Co. Co., Cork Co. Co., South Dublin Co. Co., DLRD Co. Co., Realsim, GeoDirectory, Irish Water, Bord Gáis, Eircom, Autodesk, RPS, ARUP, Mallon, Accenture, Topcon, SIS, Icon, ISpatial, RPA, NRA, IAA, GAMMA, TBC, DIT, QUB, UCC, Centroid, Mountainviews, Air Ambulance, Ambulance Service. Last but not least, we would like to express our gratitude to the companies and organisations who took the time to complete the surveys and who have provided other valuable inputs to the assessment.

1 Introduction and Background

1.1 Introduction

This report is submitted to Ordnance Survey Ireland (OSi) by Indecon International Economic Consultants. The OSi, on behalf of the geospatial industry, commissioned Indecon to complete this analysis following a competitive tender. The report represents an independent assessment of the economic value of geospatial information ('GI') in Ireland.

1.2 Background and Scope

The background to this study is that the use of GI is increasing rapidly. The ongoing expansion of the internet and mobile communication devices, as well as location-based services, are bringing individuals and organisations directly into contact with location information on a daily basis. As a result an understanding of location and place is part of effective decision making in both the public and private sectors.

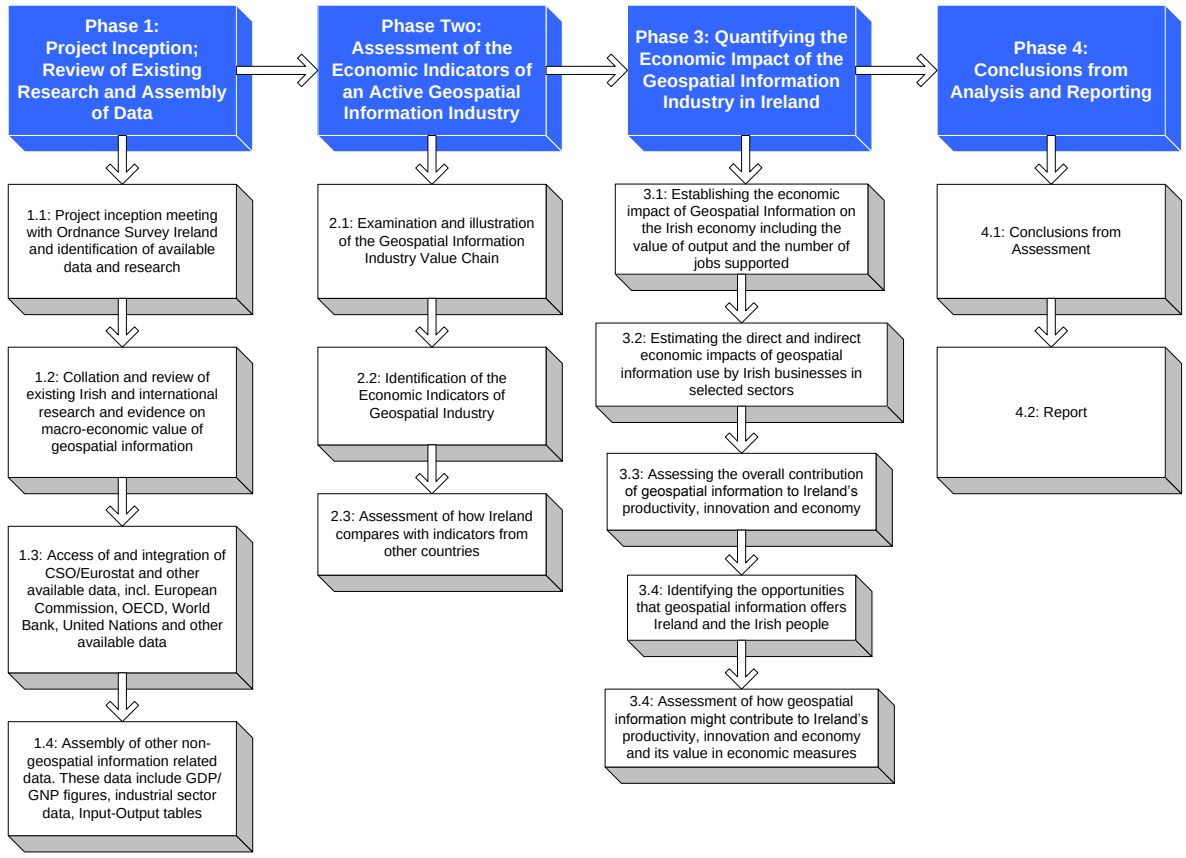
The overall objective of this report is to establish the economic value of geospatial information in the Irish Economy and to consider the wider contribution of the industry. This report addresses a number of aspects, including:

- Establishing the economic contribution of geospatial information sector to Ireland's economy; and
- Wider user benefits.

1.3 Methodological Approach

A feature of the geospatial information sector is that its impacts are not just limited to the activities of GI industry suppliers. It is therefore useful to take account of the horizontal, demand-side impacts related to the usage of GI, as well as the vertical, supply-side impacts of the industry which supplies GI-related goods and services. A rigorous methodology has been applied, which incorporates an impact measurement framework that is consistent with best practice internationally. A schematic summary of the overall methodology and work programme applied in completing this assessment is presented in Figure 1.1.

Figure 1.1: Schematic Summary of Methodological Approach and Work Programme



Source: Indecon Analysis

A number of previous studies have evaluated aspects of the value of geospatial information in other countries. Some of these studies have focussed on specific applications of geospatial information and the impact on productivity gains for business. Few studies have attempted to rigorously measure the overall economic impact of geospatial information and there is a disparity in the methodologies employed.

Table 1.1 provides a summary of the key findings of a number of previous studies and the various estimates of the economic significance of the GI sector in other countries. These show a range of estimates of the impact between 0.01% and 0.5% of GDP.

Table 1.1: Summary of Key Findings from Review of Existing International Research on Economic Value of Geospatial Information		
Country	**Sectors**	**% GDP**
UK[1]	Economy-wide	0.01%
England/Wales[2]	Local government service provision	0.02% higher than without GI
Australia[3]	Economy-wide	0.09%
New Zealand[4]	Economy-wide	0.06%
Netherlands[5]	Government, private and research sectors using GI	0.25%
Germany[6]	'Geobusiness sector': navigation and services, planning and marketing	0.04%
Switzerland[7]	Consulting/services, software development, data production/processing, marketing, cadastral surveying, cartography, navigation/logistics, planning	0.11%
United States[8]	GI related revenue	0.5% GDP
Source: Indecon analysis of international research		

The results suggest that in the United States[9], the economic value of the geospatial information industry was estimated at 0.5% of GDP. In Germany[10] and Switzerland,[11] the industry was estimated at 0.04% and 0.11% of GDP, respectively, while in the Netherlands[12] and Australia,[13] it was estimated at 0.25% and 0.09% of GDP. Other studies have attempted to estimate the productivity gains as a result of using geospatial information; for example, in the UK, GDP was estimated to be 0.02% be higher as a result of geospatial information. Further details on some of the previous research can be found in Annex 2. While these studies are of use as comparators, it is not appropriate to simply apply aggregate results to the Irish economy and caution should be exercised in considering any comparisons. However, the evidence presented later in this report suggests that the significance of the GI sector in Ireland is higher than the relative scale suggested by estimates in some previous studies.

[1] Oxera (1999)
[2] ACIL Tasman/ConsultingWhere (2010)
[3] ACIL Tasman (2008)
[4] ACIL Tasman (2009)
[5] GeoBusiness Nederland (2011)
[6] MICUS Consulting (2010) "European Legislation as a Driver for German Geobusiness"
[7] Infras (2008)
[8] Boston Consulting Group (2012) "Putting the U.S. Geospatial Services Industry on the map"
[9] Boston Consulting Group (2012) "Putting the U.S. Geospatial Services Industry on the map"
[10] MICUS Consulting (2010) "European Legislation as a Driver for German Geobusiness"
[11] Infras (2008)
[12] GeoBusiness Nederland (2011)
[13] ACIL Tasman (2008)

In assessing the economic impact of the geospatial information industry in Ireland, it is useful to consider both the demand side and the supply side of the industry. The demand side is made up of users of geospatial information – businesses, government and consumers.

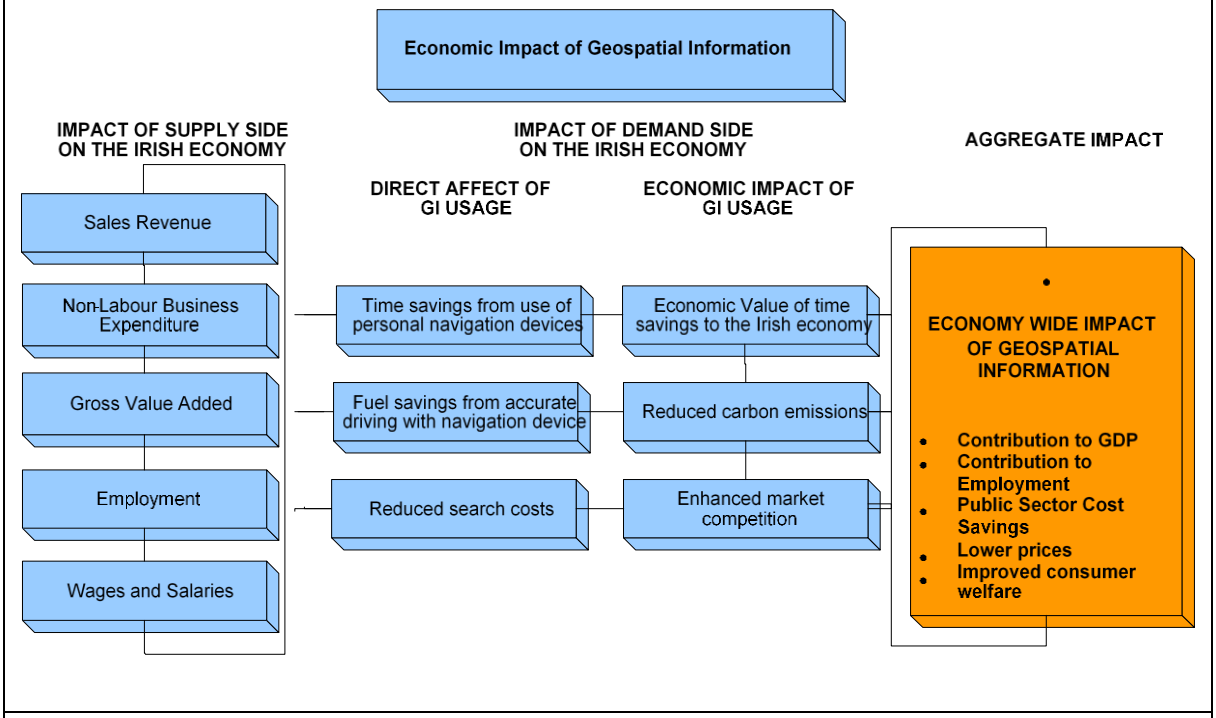
Key elements of the direct value of the supply side of geospatial information industry include:

- The Output, which measures the overall value of goods and services produced;
- The Value Added contribution of the sector to GDP at market prices; and
- The numbers of full time equivalent staff employed by the sector.

In measuring the impact of geospatial information from a supply-side perspective, we evaluate each of these elements to give an overall picture of its contribution to the economy. This takes into account sales revenues, expenditures and employment. We also evaluate the impact of including multiplier impacts. The results of our estimates of the economic value of the sector are presented in Section 2 of this report.

Figure 1.2 presents an overview of the areas examined in assessing the economic impact of geospatial information. This includes the impact of the supply side of the industry as well as the benefits from usage of geospatial information (see below). We discuss these user benefits in more detail in Section 3.

Figure 1.2: Overview of Approach to assessing the economic impact of Geospatial Information



Source: Indecon analysis

In evaluating the economic impact of the GI sector, it is necessary to integrate data from a wide range of Irish as well as international sources, in addition to undertaking new primary research (see below). The official data sources utilised in this assessment have included:

- Retail Sales Index;
- Census of Population;
- National Income and Expenditure Accounts;
- National Roads Authority – surveys on journey time and distances;
- EuroStat – international data on mobile internet usage; and
- EuroBarometer – international comparison data on use of SatNav devices.

As part of this study, we undertook detailed new primary research via a survey of GI data providers and a survey of organisations. A copy of the questionnaires used are included in Annex 4. In relation to the survey of providers 17 organisations were surveyed and a high response rate of 70% was secured. For organisations identified as users 115 were surveyed and 43% responded. The high response rates were achieved with the assistance of OSi and the sector and reflects the interest and co-operation amongst the industry regarding the value of GI to the Irish economy.

Indecon also participated in an important Industry workshop organised by OSi and the Irish organisation for Geographic information which was held in Dublin on the 16th October 2013. This brought together a range of users and suppliers of geospatial information in Ireland and provided a range of key insights into the industry. A list of industry participants is included in Annex 1. These insights were important in understanding the economic impact of geospatial information.

This report comes at a time when the appreciation of the importance of Geospatial Information is increasing greatly. In its Public Service Reform Plan 2014-2015, the Irish government has stated its intention to make broad use of open geospatial data, to increase data sharing across public sector bodies and to improve public service delivery through increased use of big data analytics for processing geospatial information.[14]

1.4 Description of Economic Value Chain

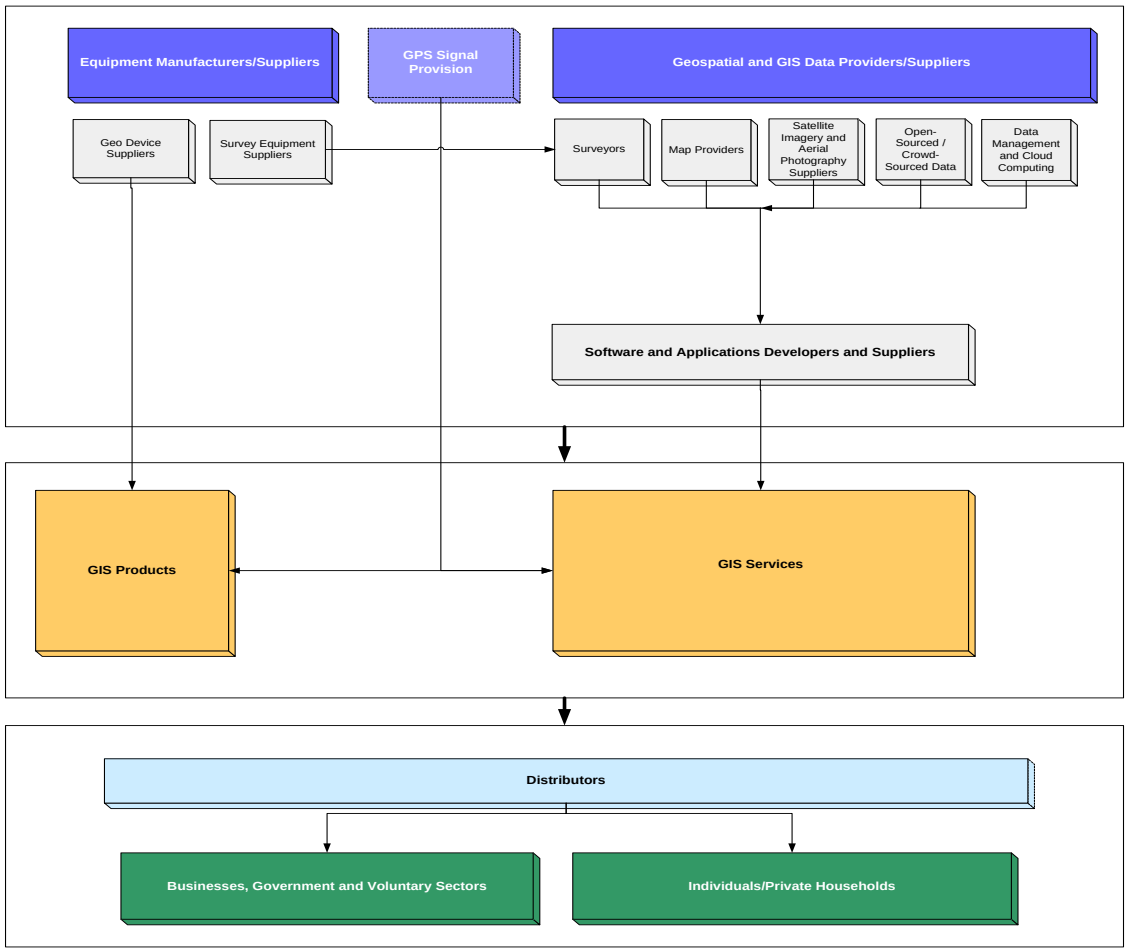
A value chain describes the flow of interactions between companies and how they contribute to the provision of services used by businesses and final consumers. The GI industry can be classified into three main subsectors:

- Provision of geospatial data and maps;
- Provision of GIS products and services; and
- Distribution of GIS related products and services.

Figure 1.3 gives a snapshot of the GI industry in terms of production of raw geospatial data and subsequent value added by other suppliers in the industry.

[14] Public Service Reform Plan 2014-2016 available at: http://reformplan.per.gov.ie/downloads/files/Reform%20Plan%202014.pdf

Figure 1.3: Value Chain for Geospatial Information Industry



Source: Indecon analysis

Provision of geospatial data and maps

Geospatial data is combined with additional information for a range of services and applications. Signal provision (satellite manufacture/installation/operation) generates raw geospatial data, which is frequently combined with satellite imagery.[15] Much of this data is processed in the form of a GIS. GIS products or services include Personal Navigation Devices (PNDs), maps, aerial photography, geospatial software and surveying equipment.

[15] Signal provision can be state owned or privately run, and the manufacture of satellites involves private companies with certain expertise, as well as government led initiatives and state funding for R&D. A large proportion of investment in signal technology comes from the private sector, but certain aspects rely on public funding – e.g. EU's Galileo satellite radio navigation and positioning program received funding of €3.4 billion up to 2011, with an expectation of a further €1.9 million being required to complete the deployment phase.

Provision and Distribution of GIS products and services

Geographic information Systems use geospatial data to interpret and visualise geographical data in ways that demonstrate relationships or other characteristics. GIS products and services include land based, air and marine navigation software, Location Based Services (LBS), route planning, environmental services and a wide range of other applications. Software is designed specifically to clients' needs, or in other formats which facilitate the use of geospatial information. The final component of the GI value chain includes distributors of GI products and services to consumers.

1.5 Report Structure

The remainder of this report is structured as follows:

In Section 2 we examine the key issue of the economic impact and characteristics of the industry.

In Section 3 we evaluate consumer/user benefits of geospatial information.

In section 4 we discuss potential future opportunities and in the final Section we provide a summary of conclusions.

1.6 Acknowledgements and Disclaimer

Indecon would like to acknowledge the valuable assistance and inputs to this assessment provided by a number of individuals and organisations. We would particularly like to thank officials within OSi for their inputs and assistance throughout the process, including Colin Bray (CEO), Hugh Mangan and Tony Murphy. We would also like to thank individuals within the Irish Organisation for Geographic information (IRLOGI) for their valuable inputs and assistance in facilitating the industry workshop held in October 2013. Particular thanks are due to Rob Ovington, John Hawkins, Dara Keogh, Saeed Khan, Ben King, Eamonn Donnelly and Gearoid O' Rian who chaired Indecon sub-groups during workshops and to all organisations who inputted to the workshop discussions. Thanks are also due to the following organisations who inputted at the workshop, namely, DoECLG, CSO, ESRI, DAHG, PRAI, Marine Institute, Oracle, IMGS, Waterford Co. Co., Donegal Co. Co., Fingal Co. Co., Cork Co. Co., South Dublin Co. Co., DLRD Co. Co., Realsim, GeoDirectory, Irish Water, Bord Gáis, Eircom, Autodesk, RPS, ARUP, Mallon, Accenture, Topcon, SIS, Icon, ISpatial, RPA, NRA, IAA, GAMMA, TBC, DIT, QUB, UCC, Centroid, Mountainviews, Air Ambulance, Ambulance Service. Last but not least, we would like to express our gratitude to the companies and organisations who took the time to complete the surveys and who have provided other valuable inputs to the assessment.

The usual disclaimer applies and responsibility for the analysis and findings in this independent report remain the sole responsibility of Indecon.

2 Economic Impact and Characteristics of GI Industry in Ireland

2.1 Introduction

In this section we assess the economic impacts of geospatial information suppliers on the Irish economy and the characteristic of the supply sector. For most economic sectors this would constitute the economic impact of the industry. However, we believe there are economic benefits or externalities arising from the usage of geospatial information which should be considered and these are examined in Section 3 of the report.

2.2 Characteristics GI Industry in Ireland

The GI industry in Ireland is a sector which provides a complex range of services and which is characterised by high levels of R&D investment. The sector is a very labour intensive, high-skilled industry. It is useful to examine the services that the GI industry in Ireland are offering to clients. Table 2.1 below indicates that around 52% of Irish suppliers offer online or paper maps. Also significant is that a high proportion of companies offer GIS software and locally stored digital maps and Geo-apps. There is also a significant focus on the provision of GIS training services.

Table 2.1: Types of GI services offered by GI suppliers

Services demanded by users	**%**
On-line and Paper Maps	52%
Locally-stored Digital Maps	33%
Satellite Imagery	19%
Navigation and Other Satellite Positioning Services	19%
GIS Software	48%
Geo-apps	38%
Survey Equipment and Survey Services	24%
SatNav, Mobile and Other Devices	10%
Distributors/Agents for above or Other Location-enabled Equipment or Services	24%
Geo Training/Education Services	38%
Source: Indecon Confidential Survey of GI user companies	

It is also useful to consider the range of GI services used by clients in Ireland. This analysis is summarised in Table 2.2. Maps, satellite imagery, GIS software and navigation and satellite positioning services are areas extensively used.

Table 2.2: Types of GI services used by GI users	
Services demanded by users	**%**
On-line and Paper Maps	91%
Locally-stored Digital Maps	85%
Satellite Imagery	72%
Navigation and Other Satellite Positioning Services	70%
GIS Software	100%
Geo-apps	67%
Survey Equipment and Survey Services	70%
SatNav, Mobile and Other Devices	76%
Distributors/Agents for above or Other Location-enabled Equipment or Services	20%
Geo Training/Education Services	39%
Source: Indecon Confidential Survey of GI user companies	

An important aspect of the GI industry is the extent to which firms within the sector engage in R&D activities. This analysis is shown in Table 2.3 and indicates that around 45% of GI supplier companies have a dedicated R&D department. The high level of commitment to R&D reflects the rapidly evolving nature of the sector.

Table 2.3: R&D presence for GI supplier companies in Ireland	
Presence of a designated R&D department	**%**
Yes	45%
No	40%
N/A	15%
Source: Indecon Confidential Survey of GI supplier companies	

It is also useful to examine the levels of R&D expenditures in the GI sector. Suppliers of geospatial information surveyed by Indecon spend over €14.6 million on R&D activities in Ireland, as presented in Table 2.4, most of which is on in-house R&D. Also of note is that as part of our consultations we have been informed that these estimates may not capture all the levels of expenditures in universities on R&D in the geospatial area. There has been significant investment in universities funded from SFI, HEA and from European funding agencies such as SEUPB, InterReg and the European Research Council. These include expenditure in PhDs, Post Docs, Software/Equipment and buildings in research centres and in geography departments.

Table 2.4: Expenditure on R&D in 2012 – GI suppliers	
Expenditure on R&D	
Expenditure in 2012 on in-house R&D	€14.56 million
Expenditure during 2012 on R&D performed on your behalf by other parties	€0.12 million
Total	**€14.68 million**
Source: Indecon Confidential Survey of GI supplier companies	

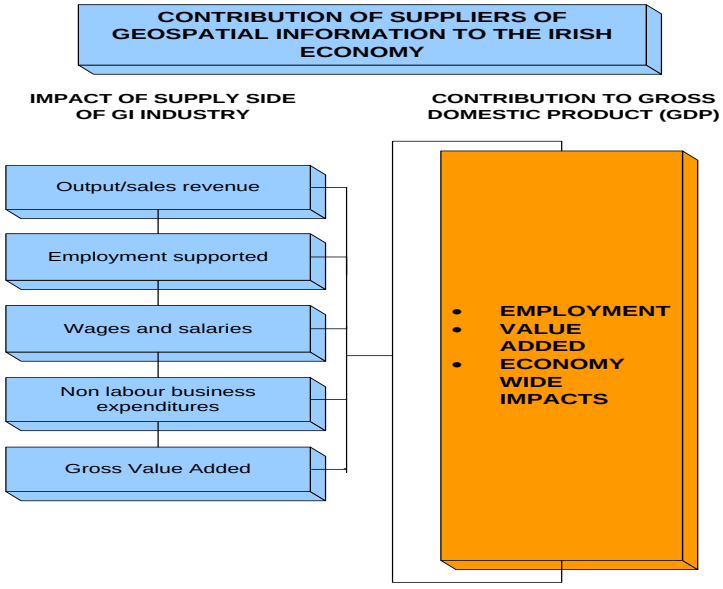
Our analysis also suggests high levels of innovation and new product development within the sector. Table 2.5 indicates that 95% of suppliers of geospatial information introduced new product or service innovations during the period 2010 - 2012.

Table 2.5: New product or service innovations	
New product or service innovations during 2010 – 2012	**%**
Yes	95%
No	5%
Source: Indecon Confidential Survey of GI supplier companies	

2.3 Assessment of Direct Economic Contribution

In assessing the direct economic contribution of the GI supply industry in Ireland, it is useful to examine a number of key metrics. Figure 2.1 illustrates the main components direct impact examined for the supplier sector including: Output/sales revenue; Employment supported; Wages and salaries; Non-Labour Business Expenditures; and Gross Value Added (GVA).

Figure 2.1: Contribution of suppliers of Geospatial Information Industry to the Irish economy



Source: Indecon analysis

In assessing the direct economic contribution of the supplier industry, Indecon has used survey results and some internal estimates to aggregate for firms not included in the survey. In the case of one large supplier however we only attribute a small part of their Irish operations as we are using a conservative definition of the GI sector. Overall, we believe that the results represent conservative estimates but that such an approach is prudent.

2.3.1 Output/Sales

Output or sales is a key aspect of overall economic impact. Table 2.6: presents annual sales of GI suppliers in Ireland. Based on the latest full year information pertaining to 2012, the overall sales of GI suppliers in Ireland is estimated to amount to €117.5 million. This number also includes a number of surveyors in Ireland which are heavily reliant upon geospatial information. This highlights the significance of the sector and it is important to note that this may underestimate the value as non-commercial public bodies produce geospatial data for public consumption not included in this estimate.

Table 2.6: Economic Impact of Geospatial Information - total revenue from sales of GI related products or services in 2012

Economic Impact of Geospatial Information	€ million - 2012
Total revenue from sales of geospatial products or services in Ireland	117.5
Source: Indecon Confidential Survey of GI supplier companies	

Table 2.7: presents total value of exports from GI related products or services in 2012. Total exports are estimated to amount to over €18.9 million. Indecon believes there may be potential for a significant expansion in this area and this represents an important area of potential opportunity for the Irish economy.

Table 2.7: Economic Impact of Geospatial Information - exports of GI products or services in 2012

Economic Impact of Geospatial Information	€ million - 2012
Export sales of geospatial products or services	18.9
Source: Indecon Confidential Survey of GI supplier companies	

2.3.2 Employment Supported

Table 2.8: presents the estimated numbers of full time equivalent (FTE) employees engaged in the supply of GI for the year 2013.[16] The figures suggest that the sector is a significant employer and direct employment amounts to around 1,600 full-time equivalent positions.

Table 2.8: Economic Impact of Geospatial Information - numbers of Full Time Equivalent (FTE) employees in the industry in 2013	
Numbers of FTE employees	**No. of FTEs**
FTE persons employed in Ireland	1,677
Source: Indecon Confidential Survey of GI industry	

2.3.3 Expenditures – Wages/Salaries

Direct expenditure in the Irish economy includes expenditures on wages and salaries and on domestically sourced materials and services. Table 2.9: presents estimates of payroll expenditures of the GI sector in Ireland. Based on the latest full year data, suppliers of geospatial information are estimated to contribute a total of €84.4 million to the Irish economy in the form of expenditures on wages and salaries.

Table 2.9: Economic Impact of Geospatial Information - expenditure on wages and salaries in 2012	
Economic Impact of Geospatial Information	**€ million - 2012**
Expenditure on wages and salaries in Ireland	84.4
Source: Indecon Confidential Survey of GI supplier companies	

2.3.4 Expenditures – Non-Labour Business Expenditures

Table 2.10 overleaf presents estimated expenditures by suppliers of geospatial information on non-labour inputs. Based on the latest full year data, this amounts to over €48.2 million.

Table 2.10: Economic Impact of Geospatial Information - overall expenditure in non-labour goods and business services inputs in 2012	
Economic Impact of Geospatial Information	**€ million - 2012**
Overall expenditure on Non Labour Goods and Business Services Inputs in Irish operations	48.2
Source: Indecon Confidential Survey of GI supplier companies	

[16] We have employment numbers for 2013 and 2012 – there is little difference between the two years.

2.3.5 GVA/GDP Contribution

The direct economic contribution of geospatial information suppliers can be seen in terms of value added. Our analysis indicates an estimated value added for the GI sector of over €69.3m.

Table 2.11: Economic Impact of Geospatial Information - Gross Value Added - contribution to GDP	
	€ million - 2012
Gross Value Added	69.3
Source: Indecon Confidential Survey of GI supplier companies	

2.4 Assessment of Indirect and Economy-wide Impacts

This section considers the important issue of the wider, economy-wide impacts arising from the direct economic impacts of the geospatial information industry considered in the previous section. In particular, the following aspects of economy-wide impact are quantified at a sectoral level:

- Economy-wide output contribution;
- Economy-wide employment contribution; and
- Economy-wide value added/GDP contribution.

The approach applied in arriving at the economy-wide impacts is based on the application of input-output analysis. Specifically, this section utilises the supply and use and input-output tables for the Irish economy developed by the CSO.[17] The analysis is undertaken through the development and application of *multipliers* for output and employment. There are two types of multiplier which are relevant in the context of assessing economic impact of GI sector, namely:

- Type I multipliers; and
- Type II multipliers.

Type I multipliers enable the estimation of the economy-wide impacts arising from the *direct plus indirect impacts* associated with changes in activity that occur in backward-linked industries due to an increase in demand from the geospatial industry.

Type II multipliers are an expansion of the Type I construct but include *direct, indirect and induced impacts*. Induced impacts arise through the additional consumption that takes place as a result of the additional employment incomes created through the indirect impacts. In other words, Type II multipliers include the household as an additional sector in the economic relationships that make up the input-output framework.

[17] CSO (2005), Op. Cit.

Input-output estimates for the Irish economy include output multipliers at a sectoral level based on the published Leontief inverse matrix. For the purposes of this study, Indecon has developed a framework of Type II output multipliers which permit the estimation of economy-wide impacts at sectoral level arising from the operations of GI suppliers. These multipliers have been developed based on inclusion of interactions with the household sector.[18]

Interpretation of multipliers

We would urge caution in the interpretation and usage of the output and employment multiplier estimates presented in this section, as multipliers reflect the structure of the economy at a particular point in time and are subject to change.

More significantly, it is important to note that the output multipliers capture the sum of all the gross products rather than of the net value added of each product.

It is therefore important to note that the output multiplier captures the sum of all the gross products rather than of the net value added of each product. Thus, for example, if product B is an intermediary product in product A, then the cost of product B is absorbed into the cost of product A, rather than added to the final value of A. As a result of this, the economy-wide output impact cannot be interpreted as a contribution to GDP, but is indicative of the scale of cumulative outputs resulting from the additional demand facilitated.

It must be noted that there are significant difficulties and challenges with using a multiplier approach in terms the overall impact of a sector on the Irish economy. These concerns were highlighted by Durkan (1994):

> *"It is commonplace that every sector contributes heavily to the economy - much more than its initial value added; that every sector is responsible for much greater employment than its own direct employment; that every sector is making a contribution to public revenue greater than the direct expenditure on the sector by the State, and so on. It is for these reasons that economic impact studies must be treated with caution. ……. Economic impact studies are concerned with estimating the linkages on the production side between a sector and other sectors in the economy. All sectors exhibit these linkages to one degree or another."*[19]

In selecting appropriate multipliers for the geospatial industry, we select the ones which most closely match the activities of that industry. In our analysis we use NACE sector code 71.

Table 2.12: Economic Impact of Geospatial Information - Type I & II multipliers

	Output Multiplier	Income Multiplier	Employment Multiplier	GVA Multiplier
(Type 1)	1.513	1.440	1.490	1.506
(Type 2)	2.185	1.690	1.835	1.822

Source: Indecon confidential Input-output Model of the Irish economy

[18] The derivation of Type II multipliers requires the re-calculation, through matrix operations, of the Leontief Inverse matrix to include the household sector.

[19] *The Economics of the Arts in Ireland*, Durkan, J., 1994.

2.4.1 Economy-wide Supplier Impacts

Table 2.13 presents the economy-wide impact of turnover/output produced by the geospatial information industry. Based on the data for 2012, the direct impact of revenue by GI suppliers is estimated to be €117 million, while the economy-wide output is estimated to exceed **€**256 million per annum.

Table 2.13: Economic Impact of Geospatial Information – Economy-wide Impact of Output		
	Direct Impact	**Total Economy-Wide Impact**
Turnover/output	€117.5 million	€256.9 million
Source: Indecon Analysis of Confidential Survey of GI supplier companies		

Table 2.14 presents the economy-wide impact of expenditures by GI suppliers on wages and salaries. The direct impact of expenditures on wages and salaries during 2012 was €84.4 million, while the economy-wide expenditure was estimated to be €142.7 million.

Table 2.14: Economic Impact of Geospatial Information – Economy-wide Impact of Salary Expenditure		
	Direct Impact	**Total Economy-Wide Impact**
Salary expenditure	€84.4 million	€142.7 million
Source: Indecon Analysis of Confidential Survey of GI supplier companies		

Table 2.15 presents the economy-wide impact of Gross Value Added (GVA). The direct impact of GVA during 2012 was €69.3 million, while the economy-wide impact was €126.4 million.

Table 2.15: Economic Impact of Geospatial Information - Economy-wide Impact of GVA		
	Direct Impact	**Total Economy-Wide Impact**
Gross Value Added	€69.3 million	€126.4 million
Source: Indecon Analysis of Confidential Survey of GI supplier companies		

Table 2.16 presents the economy-wide impact of employment generated by the GI industry. The direct impact of GI related employment during 2012 was 1,677 jobs (in Ireland). However, when account is taken of multiplier impacts, our estimates suggest the sector supports employment of 3,078.

Table 2.16: Economic Impact of Geospatial Information - Economy-wide Impact of Employment		
	Direct Impact	**Total Economy-Wide Impact**
Employment	1,677	3,078
Source: Indecon Confidential Survey of GI supplier companies		

2.5 Summary of Economic Impact of GI suppliers

An important objective of this research project was to quantify the direct as well as wider economy impacts and contribution of suppliers of geospatial information in Ireland, in terms of output, expenditures, employment and contribution to value added/GDP. The key findings from our assessment undertaken are summarised in the table below.

Table 2.17: Economic Impact of Geospatial Information – Summary of Direct and Economy-Wide Impacts of GI Industry in Ireland		
Component of Impact	**Direct Impact – 2012**	**Total Economy-Wide Impact - 2012***
Employment – Full-Time Equivalent Persons	1,677	3,078
Revenue - € Million	117.5	256.1
Wage/Salary Expenditures - € Million	84.4	142.7
Gross Value Added/GDP Contribution - € Million	69.3	126.4
Source: Indecon analysis and modelling * Economy-wide impact = direct impact + multiplier (indirect and induced) impacts in supply chain.		

The findings indicate that the GI sector is an important component of the Irish economy. Our estimates suggest that the industry directly employs an estimated 1,677 full-time equivalent persons and supports employment of over 3,000 persons when direct as well as multiplier impacts are considered. The industry in Ireland is estimated to have generated sales valued at €117.5 million in 2012 and spent a total of €84.4 million on wages/salaries. The estimates indicate that over €69.3 million in terms of Gross Value Added (GVA) to Irish economy was generated by the geospatial supply industry. In addition to the economic impact of the supply side of the GI sector there are potential wider user benefits of GI which are considered in Chapter 3.

3 Economic Benefits from the Use of Geospatial Information

3.1 Introduction

The use of geospatial information in Ireland has indirect economic benefits. In order to consider these benefits, it is useful to consider what sectors are users of such information. The table below presents views on what sectors are significant of users of geospatial information in Ireland. This suggests that most significant users include central or local government, utilities, agriculture, construction, forestry, fisheries and education. In addition consumers are also a major user of geographic information.

Table 3.1: Significant users of Geospatial Information

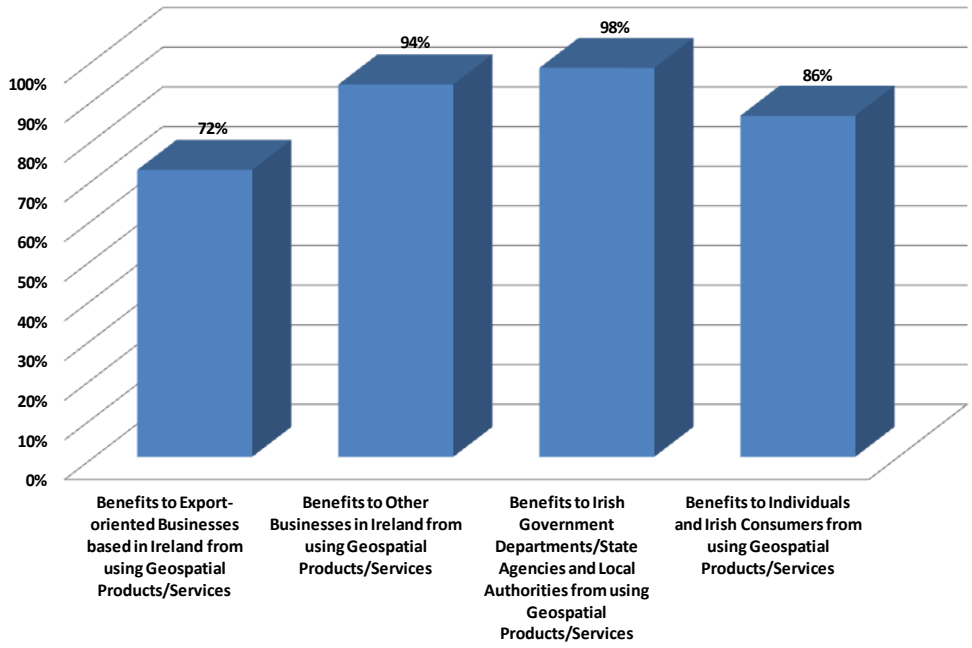
Users	Percentage of Rating as significant user of GI or very significant
Local Government/Local Authorities	84%
Utilities (Energy, Water, Telcos etc.)	81%
Central Government	79%
Architects, Engineers and Other Construction-related	64%
Agriculture, Forestry & Fishing Sector	50%
Education Sector	47%
Transport/Logistics Sector	42%
Multinational Companies	40%
Health Sector, incl. Hospitals and Emergency Services	35%
Defence Sector	27%
Other Businesses	25%
Retailers	23%
Other Services Companies	17%
Value Added Services Providers	13%
Source: Indecon Survey of GI user and supply companies	

In Annex 5 we outline some of the applications of GI in both the public and private sectors. In this chapter we consider a quantification of the scale of the externalities accruing to the Irish economy from the use of geospatial information.

3.2 Overview of Consumer/User Benefits of GI

There are a range of potential benefits from the use of geospatial information. (Figure 3.1) presents the views of firms surveyed on what areas in the Irish economy are likely to demonstrate significant or very significant benefits arising from using geospatial information. The evidence suggests that benefits from geospatial information are believed to accrue to users engaged in business and exporting activities, the government and to final consumers. More than 98% of companies surveyed consider that there are significant or very significant benefits to the Irish Government from using geospatial products and services. Most firms surveyed (94%) also judged that there were significant or very significant benefits to users in businesses and 86% estimated there were such benefits to final consumers.

Figure 3.1: Percentage of Survey respondents who indicated Significant or very Significant Potential User Benefits arising from the provision of Geospatial Products/Services in Ireland



Source: Indecon Confidential Survey of GI users and suppliers

Table 3.2 presents some examples of the views of survey respondents on specific impacts from the use of geospatial information on the Irish economy. These highlight the potential role of information and of additional supporting services in improving decision making and in reducing both capital and operating costs.

Table 3.2: Economic Impact of Geospatial Information – Selected Views of GI Suppliers and Users
"Geospatial data is of significant importance to the Irish industry as a whole. It can provide significant improvement to the formulation of evidence-based decision making and policy
"I feel that the geospatial industry can provide considerable operating and capital expenditure savings for utility, government and local government agencies through improved decision making by taking into account location information. Location information is key to efficient asset and resource management for organisations with large mobile workforces. It is proved both in Ireland and abroad that Location information greatly improves resource management by efficiently scheduling mobile works. Improved decisions on Asset management can be made by accounting for the location of assets in relation to faults and future demand and planning asset replacement and maintenance accordingly."
"The professional users like utilities enhance their view of business with the additional visual dimension provided by GIS. With powerful links to Databases they can generate a far more complete picture of scenarios that otherwise would be meaningless without GIS."
Source: Indecon Confidential Survey of GI supplier companies

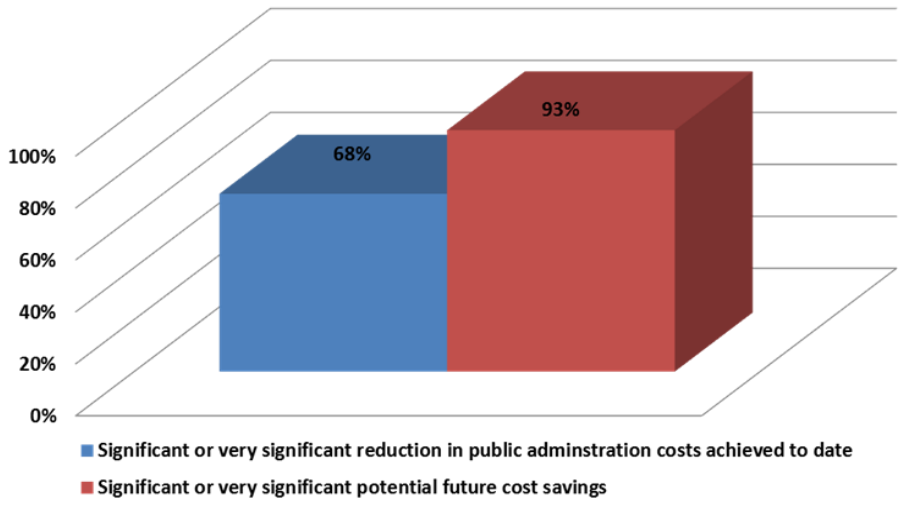
The main potential externalities from the use of geospatial information identified by Indecon are outlined in the table below. There are also benefits arising from the specific application of geospatial information in areas such as improved emergency response times.

Table 3.3: Potential user Benefits of Geospatial Information
• Public and Private Sector Cost Savings • Economic Value of Journey Time Savings • Benefits to Consumers of Intensifying Competition • Wider Impacts on Innovation
Source: Indecon Confidential Survey of GI supplier companies

3.3 Public and Private Sector Cost Savings

One area of potential economic benefits from the use of geospatial information is cost savings within the public and private sectors. In our analysis we focus on potential public sector cost savings but productivity gains from the use of geospatial information apply equally to the private sector. Figure 3.2 gives an indication of the views of companies surveyed on the significance or otherwise of reduction in administrative costs in public service provision. More than 90% of those surveyed believe that there are considerable potential future reductions in costs to be saved, while 68% believe that there have been significant or very significant reductions achieved to date.

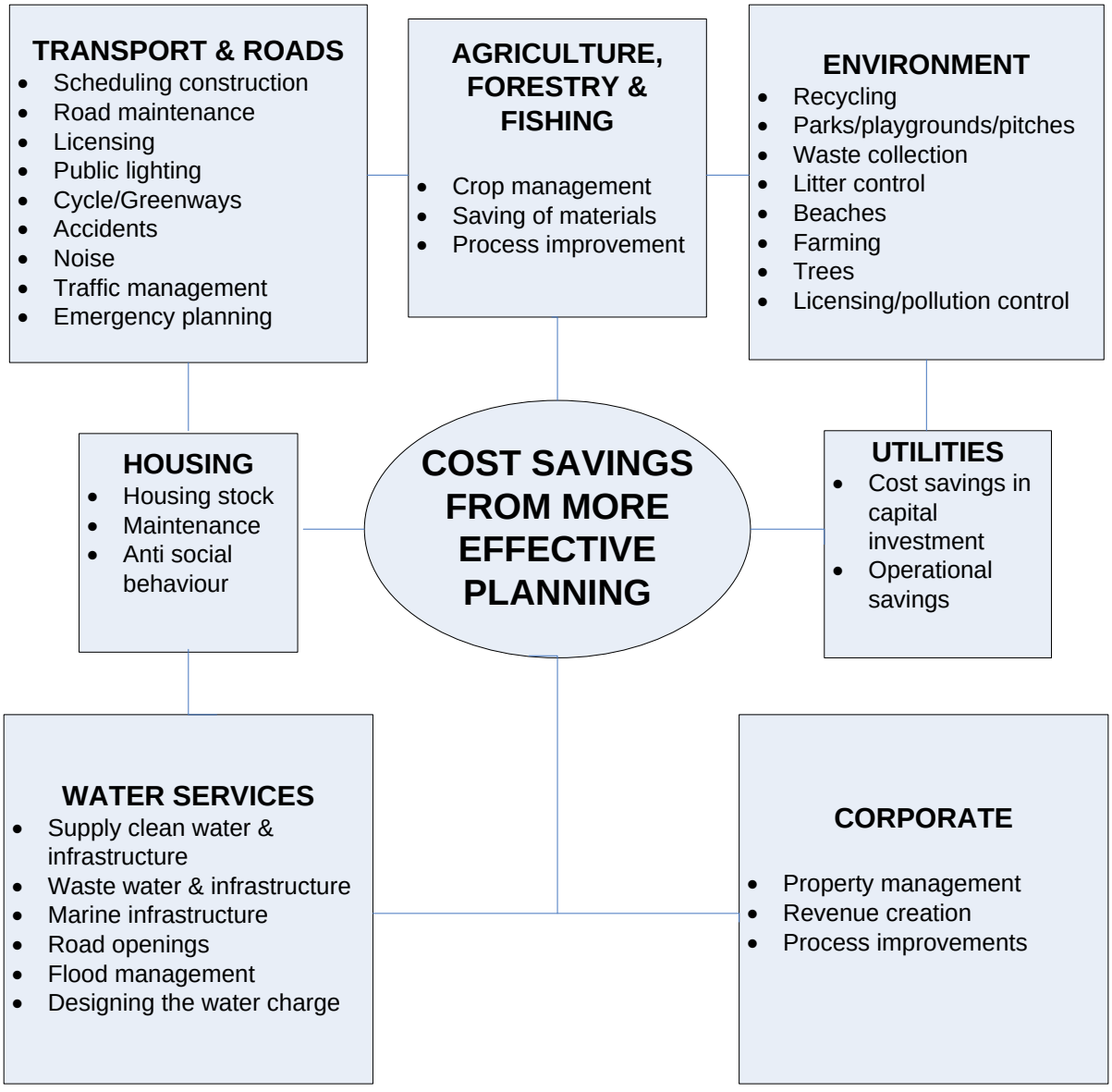
Figure 3.2: Impact of Geospatial products/services in the achievement of reductions in Administrative Costs of providing Public Services and the future potential of such products/services to reduce such costs.



Source: Indecon Confidential Survey of GI users and suppliers

The contribution of GI to planning can lead to increases in productivity and reductions in public sector costs – for example, access to data online leads to better decision making, less duplication of data, efficient meetings and mobile working. An illustration of the potential areas where more effective planning and cost savings can arise through the use of GI is presented in Figure 3.3.

Figure 3.3: Potential areas of productivity – cost savings from more effective planning through use of GI



Source: Indecon/OSi workshop

The impacts of more efficient planning as a result of GI can also be seen in individual organisations in terms of staff time and budget savings in expenditures. Also of importance is the potential impact on costs arising from reduced capital or operating costs due to more efficient decisions as a result of population profiling and demographic planning. One such application that has been developed to improve public services is the application which allows local authorities to locate and fix problems more efficiently. This and other case studies on applications of geospatial information are shown in Annex 3.

An indication of the scale of potential cost savings from the use of geospatial information can be seen by reviewing some previous international research. A 2010 Research paper[20] on the impact of a global navigation satellite system in the public service undertaken for a German Federal Ministry identified a range of potential savings in public service cost amounting to over €93.7m per annum. In a simulation modelling exercise undertaken in New Zealand for the Department of Economic Development[21] it was estimated that the direct impact of spatial information on total factor productivity in the Government services amounted to 0.52%. Another study[22] undertaken by ACIL Tasman and ConsultingWhere for the Local Government Association and Improvement and Development Agency in July 2010 suggested that geospatial information used by local public service delivery in England and Wales led to a 0.233% increase in productivity for local public service providers.

As indicated in Table 3.4 the international research referred to above suggest a range of estimates of productivity gains/cost savings in the public sector from the use of geographical information. If one assumes a conservative estimate of 0.2% and applies this to current public expenditures in Ireland, excluding transfer payments, this would suggest potential savings of €82m per annum. (Current gross expenditure in Ireland is in the region of €55 billion. When transfer payments are excluded, this figure is around €41 billion.)

It is interesting to note that in the Irish Government's Public Service Reform Plan 2014-2015, it is intended to improve public services through more efficiency usage of geospatial information.[23]

Table 3.4: Public Sector Cost Savings Arising from GI

	Euro
International Estimates of productivity savings in the public sector	0.2- 0.5%
Indecon estimates used for Ireland	0.2%
Indecon's estimate of public sector savings	€82m
Source: Indecon	

[20] The Impact of a Global Navigation Satellite System on the Public Sector, Marcus, Fornefeld, M, Beckman, G and Leibritz, U, Marcus, Dusseldorf 2010.

[21] Spatial Information in the New Zealand Economy, Prepared for the Ministry of Economic Development, SKM and ACIL Tasman, August 2009

[22] ConsultingWhere and ACIL Tasman, The Value of Geospatial information to Local Public Service Delivery in England and Wales, July 2010

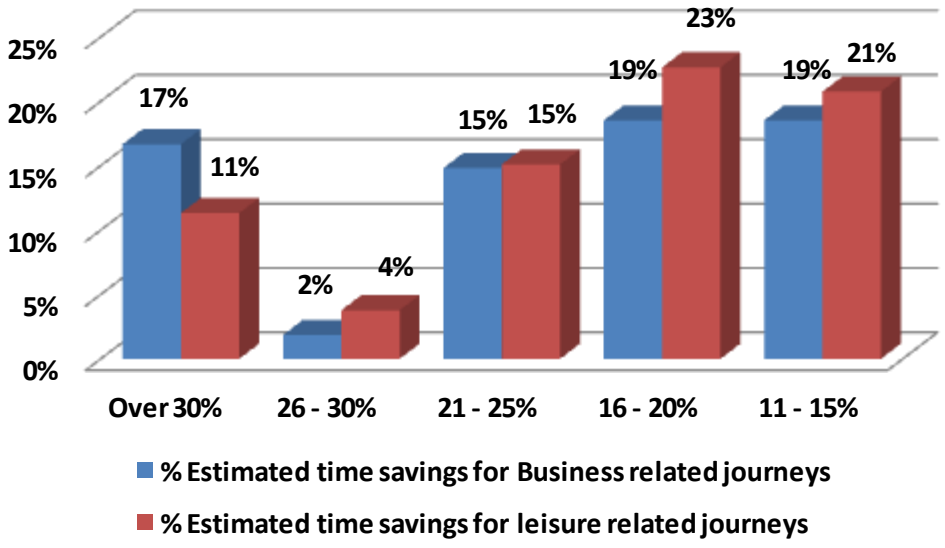
[23] Public Service Reform Plan 2014-2016 available at: http://reformplan.per.gov.ie/downloads/files/Reform%20Plan%202014.pdf

3.4 Economic Value of Time Savings

A key benefit of increased geospatial information usage in the Irish economy is a reduction in journey times. This has measurable economic benefit in terms of value of time savings. Such savings also have potential wider benefits in terms of productivity/competitiveness enhancement as well as sector specific impacts.

Figure 3.4 presents respondents' views on the estimated journey time savings which are generated through the use of geospatial navigation devices in guiding users to their location. The largest proportion (23%) of the respondents believe that there are time savings of around 16-20% for leisure related journeys while a further 30% suggested time savings in excess of this level.

Figure 3.4: Reduction in Average Journey Times for individuals in Ireland as a result of using Geospatial Navigation Devices/Software in guiding them to their destination



Source: Indecon Confidential Survey of GI users and suppliers

In order to quantify the reduction in journey time attributable to a navigation system, it is necessary to make some reasonable assumptions of the number of cars which utilise a Personal Navigation Devices (PND). We use the results from the European Commission survey which indicated that around 43% of individuals had some type of navigational device in their car. For commercial and government vehicles, we use a higher assumption which is based on previous research[24] which indicates that 60% of commercial vehicles use a navigational device.

However, in order to ensure our analysis does not overestimate the benefits it is important to note that even if individuals have a navigation device, it is unlikely that they will use them on every

[24] A Dutch study in 2010 indicated that approximately 20% of passenger vehicles have navigation devices, while 60% of goods vehicles have these devices. Institute for Road Safety Research (2010) 'SWOV Fact Sheet: Safety effects of navigation systems' Netherlands, December.

journey - we would expect most individuals generally to use a device on unfamiliar journeys. A study on the frequency of usage estimated that about 35% of drivers use them on 20% of their trips, 15% use them on 80% of their trips and 50% of drivers use them on 5% of their trips.[25] We take account of this in our estimates.

Our estimates of the journey savings are based on a number of assumptions and data as outlined below:

- Data on the number of private and commercial vehicles comes from the CSO database on transport statistics in Ireland[26] and we use the number of vehicles in Ireland for 2012;
- Data on the average number of journeys per year comes from the National Transport Authority Household Survey, where the number of trips greater than two kilometres per day is aggregated to the number per year;[27]
- The average number of minutes per journey is based on an estimate of 21 minutes;[28]
- The reduction in journey time is assumed to be 16%, which is based on our survey evidence;
- It is assumed that the average car travels at a speed of 20 kilometres per hour;[29]
- Average fuel efficiency of the Irish Car Stock of 7.7 litres/100 km;[30]
- A value of time of €16.70 per hour (for private vehicles) comes from the National Roads Authority Project Appraisal Guidelines (2011), where we take the average of working time (€27.81), commuting time (€10.98) and non-working time (€9.98) and convert 2011 prices to 2012 prices; and
- A value of €28.50 is used to estimate the user benefits to commercial vehicles (working time).

Table 3.5 presents our estimation of the economic impact of geospatial information on journey time savings in private cars. The value of time is an economic value that is used to place a monetary value on the non-monetary time saving. Fuel saved in litres is calculated by multiplying the number of kilometres saved by the average fuel consumption per kilometre which is assumed to be 0.077 litres per kilometre.

[25] Institute for Road Safety Research (2010) – this study also showed that individuals with navigation devices tend to drive more per year.
[26] http://cso.ie/Quicktables/GetQuickTables.aspx?FileName=TEA01.asp&TableName=Motor+Vehicles+Licensed+for+the+First+Time&StatisticalProduct=DB_TE
+http://6311664e1a241bd4b58f-3999d26af054d711e4557be72bd8ff23.r3.cf3.rackcdn.com/wp-content/uploads/2011/12/Household-Survey-Greater-Dublin-Area-2006.pdf
28 National Transport Authority (2013) – National Household Travel Survey (2012)
[29] This is based on the recent NTA National Travel Survey which indicates the average time of a trip is 21 minutes and the average distance travelled is 7 km. Thus, we have derived an estimate of 20km/h as the average speed from these figures.
[30] Hennessy and Tol (2011) "The Impact of Government Policy on Private Car Ownership in Ireland" The Economic and Social Review, Vol 42 No.2, Summer 2011, p135-157

Table 3.5: Economic Value of time savings due to GI - private cars , 2012	
Number of private cars	1.88 million
Annual journeys using GI	89.33 million
Number of hours saved	4.94 million
Annual Value of time savings €	**82.37 million**
Fuel saved (litres)	7.60 million
Value of fuel savings €	11.89 million
Total economic value €	**94.26 million**
Source: Indecon analysis	

The economic benefits of time savings include environmental benefits through reduced fuel expenditure and carbon emissions. Adding fuel savings to the value of time savings gives an overall picture of the economy-wide benefit of using satellite navigation devices in private cars on the Irish economy. We estimate the combined fuel savings and time savings to be in the region of €94.3m per year.

Other benefits arising from the use of geospatial information include less congestion and fewer road accidents. One study also indicated that 65% of drivers in a sample of six countries considered GPS systems to increase driver alertness and awareness, leading to fewer road incidents.[31] (We have not attempted to place an economic value on either the reduced congestion or on accident savings).

In our estimates it is assumed that 60% of commercial vehicles use satellite navigation devices. Further, taxi drivers use navigation devices to pick up and drop off passengers in a timely manner, as additional time trying to find a location incurs a cost in the form of foregone revenue from another passenger – particularly during peak times. It is assumed that a PND reduces travel time for commercial vehicles by 17% based on our survey evidence.

For commercial vehicles we use the estimate of the value of time that relates directly to working time. In 2012 terms, this figure is estimated to be €28.51 per hour which is taken from the National Roads Authority Project Appraisal Guidelines (2011). The average kilometres per hour and average fuel efficiency are the same as in Table 3.5. Using the different assumption on the value of time and the likely higher number of trips leads to higher estimates of economic benefit for commercial vehicles.

Table 3.6 presents our estimation of time and fuel savings for commercial and public service vehicles. The method used to estimate these time savings is the same as per private vehicles.

We estimate the combined fuel savings and time savings to be in the region of €185.2m per year.

[31] TomTom (2008) 'Independent research proves the positive influence of satellite navigation devices on driving and traffic safety' June - https://www.tno.nl/downloads%5cKey%20Findings%20document%20June%202008%20FINAL.pdf

Table 3.6: Economic Value of time savings due to GI - commercial vehicles, 2012	
Number of commercial vehicles	0.34 million
Annual Journeys using GI	78.30 million
Number of hours saved	6.07 million
Annual Value of time savings €	**172.91 million**
Fuel saved (litres)	7.84 million
Value of fuel savings €	12.27 million
Total economic value €	**185.18 million**
Source: Indecon analysis	

Another impact of the journey time savings is the impact on carbon emissions. For private car users, our estimates of the CO_2 savings are estimated to be approximately €2.45 million per annum.

In addition to the quantified value of time savings there may also be enhancements to productivity in the private sector and to competitiveness for example as a result of factors such as reduced time to deliver goods, more accurate production of delivery times and more effective fleet and logistics management. Faster delivery of goods means that more goods can be delivered, particularly resulting in an expansion of output or a reduction in input costs. A study on the benefits of Geo services in the US commercial service transportation sector found that savings of up $10.3 billion per year could be made, assuming 67.9% usage of GPS devices and average costs of labour and fuel of 11-13%.[32]

A specific example of the wider benefits of journey time savings can be seen by considering the impact on emergency response times. Emergency services such as fire, ambulance and police services use geospatial data to locate the scene of the emergency. Many emergency response units use automatic vehicle location (AVL)[33] and arriving at the scene more quickly could ultimately mean the difference between life and death. Indeed, at Indecon's workshop with GI professionals, many participants pointed out that a future innovation for GI will be in more effective emergency planning – be it from targets for ambulance response times to overcoming major accidents such as rail collisions or natural disasters. Response times depend on many factors – the urgency of the call out, the location, the efficiency of the support team, road traffic, the availability of an ambulance etc. Based on cardiac science statistics, we assume that the response time for a typical case is nine minutes. A navigation device is likely to enhance the response time by 17%. A number of studies have estimated the impact of improved response times on survival rates, and in our analysis we use the estimate given by O'Keefe et al (2010),[34] which estimates that cutting one minute off the response time increases the survival rate by around 7-10%. Recent Irish statistics indicate that the survival rate of out-of-hospital cardiac arrest is around 5%.[35] This evidence suggests that the use of geospatial information has important societal benefits in improving emergency response times.

[32] NDP consulting (2011) "The Economic Benefits of Commercial GPS Use in the US and the Costs of Potential Disruption" http://www.saveourgps.org/pdf/GPS-Report-June-22-2011.pdf

[33] For example, GPSTrackit, a global company, uses GI to offer custom tracking software to many emergency services, as well as logistics/delivery service providers - www.gpstrackit.com.

[34] http://emj.bmj.com/content/early/2010/08/25/emj.2009.086363.abstract;

[35] http://www.phecit.ie/PHECC/Publications_and_Resources/Newsletters/Newsletter_Itmes/Spring_2012/Out_of_Hospital_Cardiac.aspx

Table 3.7: Impact of Geospatial Information on Emergency Response Times	
Survival rate with GI	5%
Survival rate without GI	4.40%
Source: Indecon analysis	

The box below presents a case study which outlines a method of route optimisation currently being employed by the Northern Ireland Ambulance Service. It is estimated that geospatial information could optimise routes in emergency situations in order to improve its patient to performance indicator from 50% to 74%.

Box 1: Case Study – Route Optimisation in Emergency Services

One of the key targets set down in 2010 by the Northern Ireland Ambulance Service (NIAS) was to try to reduce its response time to Category A emergency calls. The target set was to reach the patient within eight minutes of the call in 75% of the calls. Previously, the service achieved this call out time for approximately 50% of Category A calls. One of the reasons this target was set down was due to extreme cases of patients waiting over 46 minutes for an ambulance to arrive on the scene.

The NIAS prepared a report for the Department of Health, Social Services and Public Safety on what is needed to enable them to reach this target. Various examinations and investigations were carried out including an assessment of the best positions to put the 60 existing ambulances to allow more rapid responses. Upon using geospatial applications such as desktop software, census data, NIAS data, 11 possible deployment options were discussed with the best option being 60 locations, many of which would be dynamic (i.e., moving during the day).

These initiatives were estimated to improve performance from 50% to about 70%. An ambulance or rapid response vehicle arrived within eight minutes for 71% of the 88,865 Category A calls made during 2010-2011. However, in 12 of 80 postcode districts, only 10% or less of all Category A calls made in each district were responded to within the target of eight minutes.

This provides a specific example of how the application of geospatial information could result in time savings and the impact of this on emergency response rates.

Source: Indecon Analysis of http://www.thedetail.tv/issues/72/ambulance-response-times/how-quickly-did-help-arrive-where-you-live

3.5 Increase in Competition in Irish Economy

A potential impact of GI is its impact on search costs and as a result on the level of competition in different sectors of the Irish economy. Search costs are the costs involved in finding a product or service. GI can reduce these search costs. Reducing these search costs may have the impact of intensifying competition in certain sectors of the economy which increases economic welfare.

Figure 3.5 presents survey participants' views of the effect of geospatial information in intensifying competition in different sectors as result of lowering search costs. One of the benefits of geospatial information products and services to final consumers is a reduction in search costs. For example, by

using their smartphones, consumers can locate a retail outlet which sells what they are looking for and the relevant comparative prices more quickly compared to searching for the product or service.

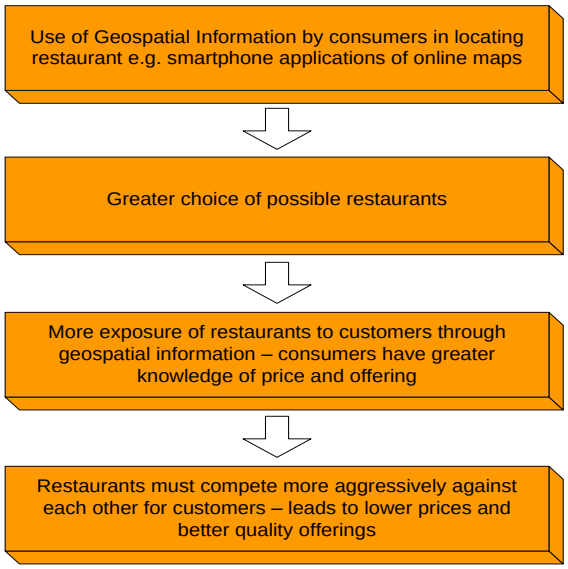
Indecon's survey evidence suggests that 92% of companies surveyed believe that geospatial products/services would have a very significant/significant impact in intensifying competition in the hotel, restaurant and tourism sectors and 81% indicated this was likely to be the case in the retail and wholesale sectors. This would arise as a result of the role of geospatial products/services in facilitating consumer search and in facilitating a comparison of alternative suppliers.

Figure 3.5: Significance or otherwise of Geospatial products/services in intensifying competition by lowering search costs in each of the following broad sectors of the Irish economy

**Percentage of those surveyed ranking impacts on competition in sectors very significant or significant*
Source: Indecon Confidential Survey of GI users and suppliers

Geospatial information allows consumers to locate businesses more effectively and to benefit from a wider choice when making purchases. Finding the location of a business more quickly involves time savings, while the existence of geospatial information provides access to a wider range of possible choices. This process is illustrated graphically in Figure 3.6 and this shows how reduced search ultimately may lead to lower prices and increase economic welfare. Economic welfare is increased as firms move towards their marginal cost of production and improved consumer search can assist in this.

Figure 3.6: Example of Impacts on Search Costs in Hospitality Sector and Market Competition



Source: Indecon analysis

Economic analysis suggests that greater choice benefits the consumer in four ways:

- It allows consumers to find products which are in line with their preferences;
- It imposes fewer constraints on decision making;
- It enables consumers to re-optimise their time and budget constraints – for example by trading off price against other costs, quality and convenience; and
- Greater competition amongst firms creates many benefits for the economy – including lower prices, greater efficiency, increased consumer choice, and innovative new services.

While there has been very little, if any, quantified research on the impact of search costs on competition as a result of the use of geospatial information, a number of economic models have been developed which examine the effect of transport costs on consumer behaviour, and the model of Salop (1979) is a simple one which could be applied to consider quantify the benefits of greater price competition as a result of a reduction in search costs. The model examines a market in which firms sell a standardised product to consumers who incur different transport costs in travelling to the firm, depending on their location.

We can apply this framework to consider the likely impact of reduced search due to geospatial information. The model used to derive a firm's can be examined using the following equation:[36]

$$Price = marginal\ cost + \frac{transport\ cost}{number\ of\ firms}$$

To highlight the potential impact on the intensification of competition it is useful to consider an assumption whereby the change in transport cost due to GI usage is reduced by 1.46% as per our

[36] This comes from Salop (1979) 'Monopolistic Competition and Outside Goods' (The Bell Journal of Economics Volume 10:1) which analyses the impact of location on market competition. A similar approach is reported in Oxera (2013).

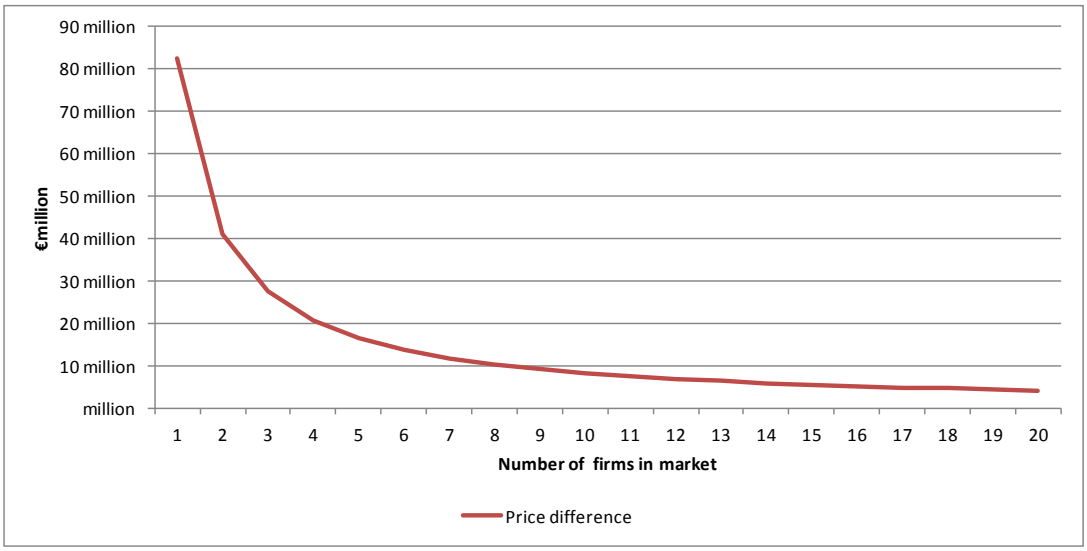
previous analysis of the reduction in journey time savings. In this sample model if one considers three alternative assumptions for the number of firms in the market one can consider the potential impact on prices as a result of the reduction in search costs. The analysis in the table below suggests that in the simplified model prices are lower with GI than without GI. However, price differences may be greater than those which would be reflected in an analysis simply due to transport cost differences.

Table 3.8: Effect of search costs on prices and competition

Price = (marginal cost) + (transport cost)/(number of firms)	
TRANSPORT COST	
Change in Transport Cost due to GI usage	1.46%
Price difference: 3 firms %	0.0134%
Price difference: 6 firms %	0.0067%
Source: Indecon analysis	

The price differences are higher in markets with a smaller number of firms. When this price difference is assumed across the economy, this leads to significant economic benefits. In Figure 3.7 we show how the economic impact on competition and prices change as the number of firms within the local market increases.

Figure 3.7: Likely range of impacts of reduced search costs on competition and prices



Source: Indecon analysis

We can also examine the likely economic value of using GI in terms of reduced search costs and the benefits to consumers. Our survey evidence indicates that 84.9% of companies surveyed believe the use of GI is likely to have significant or very significant benefits for consumers.

Table 3.9: Benefits to Individuals and Irish Consumers from using Geospatial Products/Services			
Very Significant	**Significant**	**Neither significant or insignificant**	**Not Significant**
28.3%	56.6%	11.3%	3.8%
Source: Indecon Confidential Survey of GI supplier companies			

If one assumes that a very significant response indicates a price decrease of say 1.46% (similar to the assumed transport cost reduction) and a significant rating represents half of this, namely 0.73%, this would allow us to construct a weighted estimate of the likely impact of GI on prices. This suggests that the likely impact of GI would be to reduce prices by around 0.8%. In our estimates we have, however, used a more conservative estimate of a price reduction of 0.5% as we believe the 0.8% may overestimate the impacts. The wider impact of such a price reduction will in turn be influenced by the price elasticity of demand. As noted in Pollack et al. (2008)[37] there is a wide variation in the estimation of the price elasticity of demand for public data and this report notes that an assumption is unity is acceptable in the absence of exact estimates.

Some illustrative estimates of the potential economic benefit to consumers associated with price reductions due to geospatial information are shown in Table 3.10. Assuming that the provision of geospatial information leads to price reductions of say 0.5% this implies that the overall consumer benefit may be around €104 million. If one looks at a range of between 75% and 125% of this point estimate this suggests benefits of the order of €78m - €130m. While such estimates are dependent on the underlying assumptions and are problematic, they are illustrative of the potential long term impacts from the intensification of competition. In considering the impact of intensifying competition it is of note that the National Consumer Agency has estimated that the cost of passive consumers and bad service was €840 million per year. [38]

Table 3.10: Estimate of Potential Economic Value from reduced search costs			
Sector	**Turnover**	**Price Reduction**	**Estimate of Consumer Surplus (€ million)**
Retail trade	€33.6 billion	0.5%	€84.0 million
Hotels and similar accommodation	€2.49 billion	0.5%	€6.2 million
Food and beverage service activities	€5.45 billion	0.5%	€13.6 million
Total Benefits			€103.9 million
Note: We apply "the rule of a half" in the estimation of the consumer surplus in this regard. We assume that the price elasticity is equal to unity. **Source: Indecon analysis**			

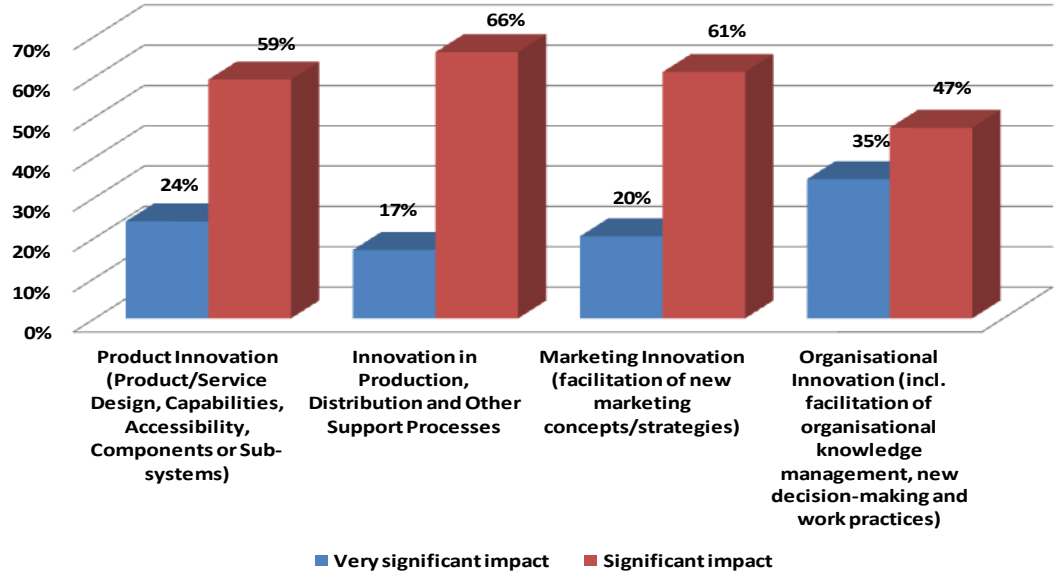
[37] Pollack, Newbery and Bentley (2008) "Models of Public Search Information Provision via Trading Funds" Study commissioned by the Department of Business, Enterprise and Regulatory Reform (BERR) and HM Treasury

[38] Source: Interview with Karen O'Leary, Chief Executive, NCA by Conor Pope, Irish Times, Monday January 6th, 2014, p 12.

3.5.1 Impact of geospatial industry on innovation in the Irish economy

Apart from specific efficiency savings and improved decision making, geospatial information can input to innovation policy in Ireland. Figure 3.8 presents the views of respondents to Indecon's survey of GI suppliers and users on the impact of geospatial information in facilitating innovation in the Irish economy.

Figure 3.8: Impact of Geospatial Information in facilitating innovation in the Irish economy



Source: Indecon confidential survey of GI supplier companies

The results of this analysis are shown in tabular form in Table 3.11. It is clear that the respondents consider that the industry can contribute to innovation across several sectors in the economy. Such innovations are likely to include for example organisational innovation – more efficient logistics and fleet management, or market innovations or product innovations.

Table 3.11: Wider impact of Geospatial products/services in facilitating different forms of innovation in the Irish economy

Innovation in the Irish economy	Very significant impact	Significant impact	Neither Significant nor Insignificant impact	Insignificant and No impact
Product Innovation (Product/Service Design, Capabilities, Accessibility, Components or Sub-systems)	24%	59%	17%	0%
Innovation in Production, Distribution and Other Support Processes	17%	66%	13%	4%
Marketing Innovation (facilitation of new marketing concepts/strategies)	20%	61%	15%	4%
Organisational Innovation (incl. facilitation of organisational knowledge management, new decision-making and work practices)	35%	47%	16%	2%

Source: Indecon Confidential Survey of GI user companies

Our survey results indicate that the geospatial is likely to be associated with 'organisational innovation'. Most (82%) respondents indicated that GI was likely to have very significant or a significant impact in this area. Over 80% of companies surveyed also anticipated that geospatial products/services would facilitate product innovation, innovation in processes and marketing innovation.

3.6 Summary of Key Findings

This section has outlined a number of potential economic impacts on the Irish economy arising from the use of geospatial information. In particular, we have quantified the economic benefits of time savings, reduced public sector costs and enhanced market competition. The key findings of this section can be summarised as follows:

- Our analysis indicates that the value of time savings due to the use of GI be in the region of €94m per year for private car users and €185m for commercial vehicle users;
- There are also significant savings associated in public and private sector costs. Indecon estimates suggest that these are likely to amount to over €82m per annum;
- While quantification of these impacts on competition is problematic, some illustrative estimates suggest benefits of the order of €78m - €130m per annum. Geospatial information allows consumers to locate businesses more effectively and to benefit from reduced search costs and a wider choice when making a purchase.

4 Future Opportunities and Economic Contribution

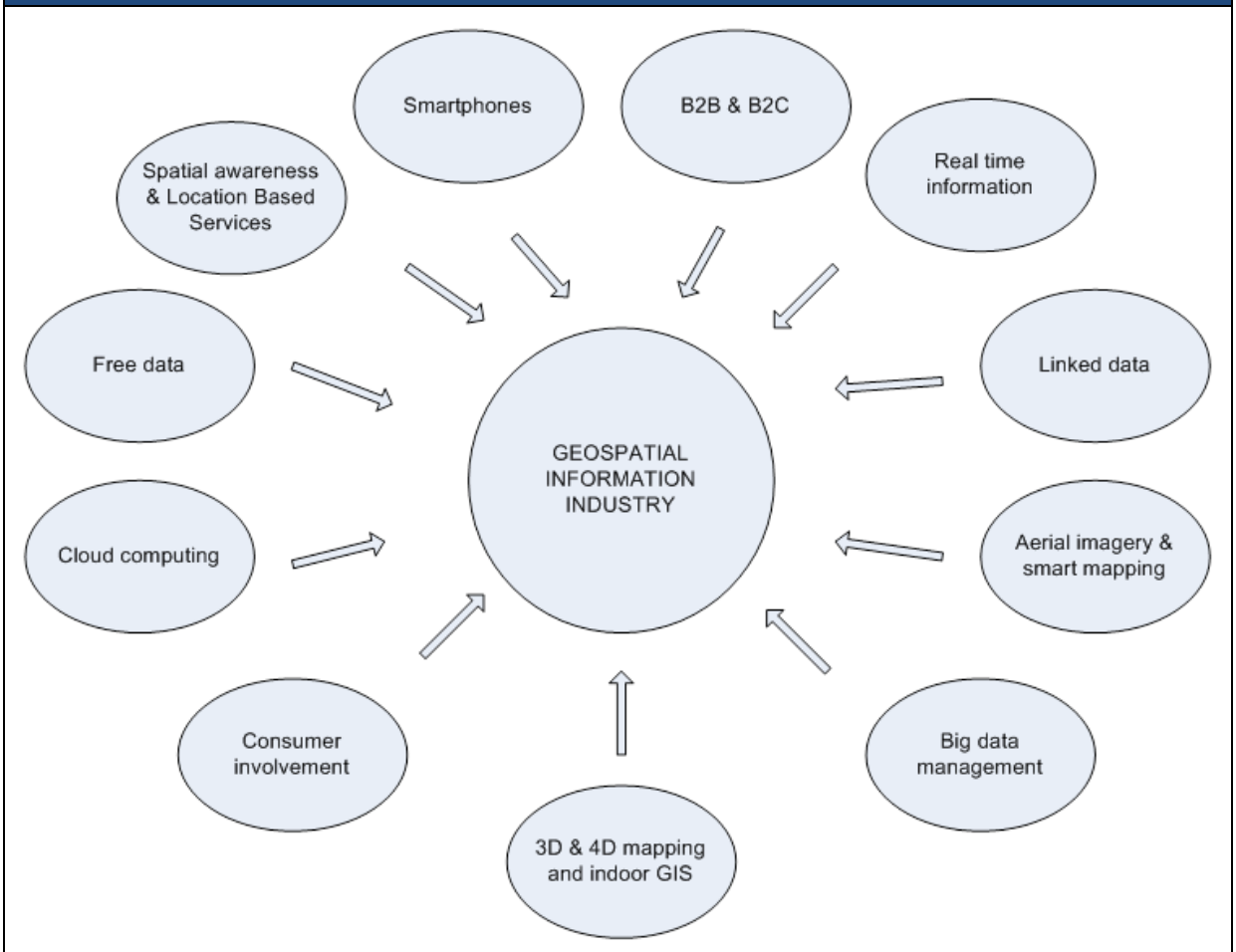
4.1 Introduction

The use of geospatial information is expanding at a rapid pace in a number of areas of economic activity. There is also growing recognition amongst stakeholders in industry and in government that an understanding of location and place is a component of effective decision making. In this section, we discuss some trends and developments in the GI industry, as well as projections of future growth and the economic benefits from open data.

4.2 Emerging Trends and Developments

Figure 4.1 presents a summary of some of the developments occurring in the geospatial information industry. Key developments include the role which smartphones play in disseminating geospatial data, the importance of location and spatial analysis, the effects of open source data, the move toward 3D and 4D mapping technology and the growing prominence of real-time information.

Figure 4.1: Developments in the Geospatial Information Industry



Source: Indecon analysis

Smartphones

Smartphones, tablets and internet devices facilitate the use of Location Based Services (LBS) in many areas including planning trips, finding shops and restaurants and in social networking. There has been a strong growth in the usage and development of mobile applications. An estimated 40% of smartphone applications use location information, and over 775,000 applications with LBS are in the Apple App Store as of 2013, with more than 700,000 in Android Apps, the latter having only 88,000 in 2011.[39] Developments include more mainstream usage of Augmented Reality (AR) – "an information overlay in mobile devices on top of the physical world" and the introduction of indoor positioning.[40]

Some estimates suggest that tablet usage is expected to grow at an annual growth rate of 35%, while smartphone penetration will grow by 18%.[41] Other estimates suggest that by 2020, mobile users will be downloading one gigabyte of content per day.[42] While the precise forecasts are inevitably subject to uncertainty, we believe that the geospatial information sector is likely to benefit from this growth in adoption of smart technology.

Spatial awareness and location based services (LBS)

Spatial awareness has increased as a result of greater accessibility to geospatial information. For example, it is estimated that there are around one billion users of Google maps every month. Some projections of future revenue suggest that by 2015, $13.5 billion will be generated by consumer location based services.[43] This includes location based advertising and marketing. Participants at Indecon's geospatial information Workshop highlighted the need for the accuracy of location information to improve to maintain its value. For example, many advertisements and marketing campaigns are targeted at consumers based on inferred locations as obtained through analysis of their past behaviour.[44]

"Business to business" (B2B) and "Business to consumer" (B2C) markets

The geospatial industry includes specialist providers of geospatial data for input into other businesses, and applications geared towards final consumers. The industry operates in a vertical "business to business" (B2B) market and a horizontal "business to consumer" (B2C) market.[45] This means that traditional GI suppliers are now competing with other major technology firms who have introduced sophisticated location technology to the market.

[39] http://www.gsa.europa.eu/sites/default/files/GNSS_Market%20Report_2013_web.pdf

[40] Ibid

[41] http://www.canalys.com/newsroom/mobile-device-market-reach-26-billion-units-2016

[42] http://www.opengeospatial.org/blog/1826

[43] IE Market Research (2010) Global and Regional GPs Navigation and Location Based Services Forecast, Quarter 3, July 2010

[44] http://www.opengeospatial.org/blog/1817

[45] Association for Geographic Information 'AGI Foresight Study: The UK Geospatial Industry in 2015" May 2010

Real-time information

Demand for real-time information and real time modelling capabilities means that technologies such as graphical processing units (GPUs), parallel processing and NoSQL databases are becoming increasingly available.[46] These technologies process data rapidly and eliminate data which users deem irrelevant, contributing to more informed decision making. Improvements in real-time information could enable greater productivity gains and enhanced competition. More accurate and readily available real-time information will contribute to the quality of customer service across many sectors.

Given that applications will require increasingly accurate and detailed information, it is likely that the quality of geospatial data (including real-time data) will become a strategic factor upon which suppliers may differentiate themselves.[47]

Linked data

Linked data offers "the ability to connect data to other information, contextualising and adding value to information that already exists."[48] With increased volumes of data, it is believed that data will become more valuable when it is combined with other data sources. UN analysis suggests that an expansion of data and censors "will produce a hyperconnected environment or 'internet of things' with estimates of over 50 billion things connected by 2020."[49] Geospatial information will play a key role in linking diverse sources of data.

The connection of a vast range of data sources is significantly reliant on the internet. Most internet devices – be it smartphone, tablet, or laptop come with a built in location transmitter, and this will extend to precise indoor positioning in future years. CISCO observes that "in 2008, the number of devices connected to the Internet exceeded the number of people on Earth. By 2020, there will be 50 billion devices connected."[50]

Aerial imaging and smart mapping

Aerial imaging and smart mapping is likely to be an important development for the GI industry. For example, information is vital to the management of cities and urban centres. Many major cities, including Dublin, are expanding information databases to meet the needs of residents, in what has become known as 'Smart cities.'[51] A 'Smart city' is one which produces sustainable economic development and high living standards through investments in efficient transport systems, ICT infrastructures and effective management of resources. Some of the decisions with regard to these factors are based on analysis of geospatial data. Smart cities observe the environment and activities

[46] http://www.agi.org.uk/storage/foresight/markets/Current%20and%20future%20use%20of%20geospatial%20information%20in%20the%20transport%20sector.pdf

[47] Indecon Geospatial Information Workshop

[48] Ibid

[49] United Nations Initiative on Global Geospatial Information Management, Future Trends in Geospatial Information Management, the Five to Ten Year Vision, January 2013.

[50] http://blogs.cisco.com/news/the-internet-of-things-infographic/

[51] Indecon Geospatial Information Workshop

of citizens in order to provide improved services. One example of this is the SmartSantander[52] project which has installed 12,000 censors to model and monitor urban life in Santander, and to inform optimal architectural planning and evaluation of building proposals in the city. Mobile devices can serve as useful platforms for censors in cities - research by AT&T shows how data from mobile phones can assist urban planners in understanding the dynamics of a city.[53]

At present, IBM Ireland has a Smarter Cities Technology Centre in Dublin where research is undertaken into water, energy, transportation, risk, and maritime technology. The research programme "focuses on advancing science and technology for intelligent urban and environmental systems, with a focus on creating systems for sustainable energy, water management, and transportation infrastructure."[54]

Big data management

With more than 2.5 quintillion bytes of data being created every day,[55] effective data management and distribution will be important for the future. Managing large volumes of geospatial data will require "big data" analytics to allow users to analyse such volumes of data and to decipher and model patterns from the data. Cloud computing (see below) has accelerated big data management and several initiatives have been taken to increase capabilities to process geospatial data – these include the European Commission's Big Data Public Private Forum and the US Office of Science and Technology Policy's (OSTP) Big Earth Data Initiative (BEDI).[56]

It is also likely that suppliers of big data solutions will emerge, many of which may offer custom business-specific software and applications. Thus, while the cost and availability of data is falling, specialised usage and demands from the data will generate revenues in a range of related areas.

During 2013, OSi developed a spatial data storage model known as Prime2. This spatial reference framework combines many OSi datasets into one source and allows users to select mapping features which they desire. The model ensures consistent and unique referencing of mapping information, both in terms of location referencing and object specific ID referencing.

3D and 4D mapping technology and indoor GIS

The ability to generate 3D maps in web browsers combined with the increased interest in urban planning is giving rise to a range of new applications. Moving from 2D to 3D and 4D mapping is driven both by users and suppliers. On the user side, there is increased demand for more complex and realistic 3D models, of cities for example, to enable effective planning and management of urban design.[57] 3D modelling also permits more accurate modelling of architectural developments. For example, 3D technology is used in analysis of wind farms, where their construction is likely to affect scenic areas and areas of high public worth.

[52] http://www.smartsantander.eu/downloads/Presentations/fia_book_2011_smartcities.pdf

[53] http://www2.research.att.com/~varshavsky/papers/becker11onecity.pdf

[54] http://www.research.ibm.com/labs/ireland/

[55] http://www-01.ibm.com/software/data/bigdata

[56] http://www.opengeospatial.org/blog/1866

[57] For example, as of November 2013, ESRI have signed an agreement with Singapore's Urban Development Authority (UDA) to develop a 3D smart city model which will aid urban planning and design. The model will visualize how the city will look before and after urban development.

Most GPS and location based services do not offer precise indoor location services, e.g. exact location within a building. Future advancements in GI technology will offer accurate indoor positioning as well as widespread availability of indoor maps.[58]

Consumer Involvement

Consumer involvement in geospatial information is expected to increase. This will include direct consumer involvement in data collection - for example, OpenStreetMap evolved from consumer contributions of geospatial information.[59] Large quantities of data can also be obtained from consumer's usage of social media applications such as Twitter and Facebook. This is likely to contribute to greater layering of data, or what is called 'modelled geospatial actor data' whereby "information generated by individuals using websites and social media is overlaid on top of spatially-accurate geospatial information."[60]

Cloud computing

Managing, hosting and serving vast amounts of data will require significant investment in computer infrastructure. Use of the 'cloud' offers a means of hosting and serving significant volumes of data without the investment costs of owning the technologies necessary for hosting and serving that information. For example, firms can rent 'cloud space' for file storage instead of investing in a standalone server and paying the associated maintenance costs. Use of the cloud is likely to become more prominent within the GI industry as demand for real-time data continues to grow.[61] Alongside the demand for instant access to data, it is also likely that users will demand the desired information to the platform of their choice – smartphone, tablet, personal computer etc. – such that data will need to be readily compatible with many different platforms.

Free data

The availability of free and open source data is likely to expand as governments take initiatives to remove barriers to wider adoption and the value of data will grow as more users adopt and respond to changes in its availability.[62] Global initiatives such as EU INSPIRE are in place to free up access to public sector geospatial information, and in Ireland the Public Service Reform Plan 2014-2016 aims to improve access to geo-spatial information for public services, businesses and citizens by developing a National Spatial Data Strategy and National Mapping Agreement" as well as "improve the outcomes of existing and new public services through the increased exploitation of emerging big data analytics."[63]

The availability of open source data will likely facilitate more innovative uses of geospatial information such as expansion of indoor GIS, emergency planning responses and postcodes, as funds can be reallocated away from paying for raw data and towards processing of the data for applications.[64]

[58] http://www.economist.com/news/technology-quarterly/21567197-navigation-technology-using-satellites-determine-your-position-only-works

[59] http://www.openstreetmap.org/#map=5/51.500/-0.100

[60] United Nations Initiative on Global Geospatial Information Management, Future Trends in Geospatial Information Management, the Five to Ten Year Vision, January 2013.

[61] Indecon Geospatial Information Workshop

[62] United Nations Initiative on Global Geospatial Information Management, Future Trends in Geospatial Information Management, the Five to Ten Year Vision, January 2013.

[63] Public Service Reform Plan 2014-2016 available at: http://reformplan.per.gov.ie/downloads/files/Reform%20Plan%202014.pdf

[64] Indecon Geospatial Information Workshop

While data is free at some point along the value chain, it is not free at source e.g., collection, so that the challenge is to develop an appropriate other funding model.[65] A challenge for the future will be finding the funding models required to maintain accurate GI, whilst growing demand for high quality geospatial information.

With a greater proportion of geospatial information being available free both in the B2B and B2C markets, GI providers are likely to try to differentiate by adding layers or features to the data which are demanded by clients. Providers may charge for premium services which they offer to customers already using their free services (e.g., advertising, applications, platforms).[66]

In considering the potential opportunities of open data, it is helpful to consider what type of open data services are most in demand. A recent Spanish study[67] has identified that the most popular open data areas include geographic/cartographic information, business and financial information, socio-demographic/statistical information and legal information as illustrated in the table below.

Table 4.1: Areas of Greatest Demand for Open Data

Data type	% demand
Geographic/Cartographic Info	51.1%
Business/Financial info	46.78%
Socio-Demographic/Statistical Info	29.8%
Legal Info	27.7%

Source: Spanish Open Data Portal Annual Report 'Characterisation Study of the Infomediary Sector,' July 2012
***Data refers to most popular Open Data domains – the percentage of companies working with specific type of Open Data, based on a survey of 150 companies.**

4.3 Projections of Future Growth

There are a wide range of growth assessments and projections of the future size of the geospatial industry. It is, however, likely that the industry will see considerable growth over the next decade, fuelled by innovations in the B2C market and in technological advances. Some of the projections for future growth are highlighted below.

- A study by Juniper Research forecast the market for Location Based Services to exceed $12.7 billion worldwide by 2014 with the largest share of revenues coming from Europe.[68]
- The European Commission noted that "the navigation infrastructure and services market in products and services has been forecast to reach €400b by 2025."[69]

[65] Association for Geographic Information 'AGI Foresight Study: The UK Geospatial Industry in 2015" May 2010
[66] Ibid
[67] 'Characterisation Study of the Infomediary Sector,' Spanish Open Data Portal Annual Report, July 2012
[68] https://www.juniperresearch.com/press-releases.php/viewpressrelease.php?pr=182
[69] European Commission (2006) Green Paper on Satellite Navigation Systems - http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0769en01.pdf

- Position One Consulting forecast the global value of GPS networks and services would rise from $263m in 2009 to $504m by 2013.[70]
- Pyramid Research forecast total revenue of the industry to reach $10.3b by 2015.[71]
- Strategy Analytics – estimated consumer/advertiser expenditure reach $10b by 2016 because of high demand for LBS services, driven by increased use of smartphones and other supportive devices.[72]
- IE Market Research (2010) forecasts the global market for GPS and LBS to reach $13.4b in revenue by 2014 – their analysis is based on continual increases in the take up of navigation devices and smartphone applications.[73]
- European GNSS Agency expects that worldwide revenues of the GI industry will grow at 9% per annum until 2016.[74]

Over the next decade, the number of Global Navigation Satellite Service (GNSS)[75] devices installed is projected to increase four-fold. [76] A key future development in geospatial information will be the move toward open data. Improved access to data and the lower cost of acquiring such data will inform better decision making, open up new business opportunities and intensifying competition. These developments will open new opportunities for increased productivity improvements and cost savings.

There is potential for the geospatial supply industry in Ireland to expand and to develop enhanced export earnings. This is likely to involve both indigenous and foreign investors in capitalising on Ireland as a location for geospatial information provision.

4.4 Summary of Key Findings

The main findings of our assessment were as follows:

- The geospatial information Industry is set to continue expanding with the emergence of new technology.
- The industry is driven by the growth in spatial awareness, widespread use of the internet and 'linked data.'
- The geospatial industry includes services offered to other businesses and services offered to consumers or "B2B" and "B2C", respectively.
- The proliferation of smartphones has been instrumental in bringing geospatial information into the consumer mainstream.

[70] http://www.egps.net/PDF/GPSServicesAbstractMar09.pdf

[71] http://bostinno.streetwise.co/2011/06/27/location-based-services-to-hit-10-3-billion-in-2015/

[72] Strategy Analytics (2011) 'The $10 Billion Rule: Location, Location, Location' http://www.strategyanalytics.com/default.aspx?mod=reportabstractviewer&a0=6355

[73] IE Market Research (2010) Global and Regional GPs Navigation and Location Based Services Forecast, Quarter 3, July 2010

[74] http://www.gsa.europa.eu/sites/default/files/GNSS_Market%20Report_2013_web.pdf

[75] This term encompasses any device using a GPS – i.e. SatNavs, smartphones etc.

[76] United Nations Initiative on Global Geospatial Information Management, Future Trends in Geospatial Information Management, the Five to Ten Year Vision, January 2013.

- The increased availability of free data will facilitate more innovative uses of GI, but also put downward pressure on pricing. It is likely that product differentiation on the part of GI suppliers will be through adding layers of value to free data.
- Real-time geospatial information will be important as will the move from 3D to 4D mapping.
- The developments in the sector will open new opportunities for productivity improvements and cost savings. The greater usage will result an increase in journey time savings and will intensify competition.
- There is potential for the geospatial supply industry in Ireland to expand and to develop enhanced export earnings. This is likely to involve both indigenous and foreign investors in capitalising on Ireland as a location for geospatial information provision.

5 Summary of Key Conclusions

5.1 Economic Impact of GI Industry in Ireland

The key findings from our assessment in relation to the economic impact of GI suppliers in Ireland are summarised in the following table and highlight the fact it is an important sector within the Irish economy.

Table 5.1: Economic Impact of Geospatial Information – Summary of Direct and Economy-Wide Impacts of GI Industry in Ireland

Component of Impact	Direct Impact – 2012	Total Economy-Wide Impact - 2012*
Employment – Full-Time Equivalent Persons	1,677	3,078
Output (Sales) - € Million	117.5	256.1
Wage/Salary Expenditures - € Million	84.4	142.7
Gross Value Added/GDP Contribution - € Million	69.3	126.4

Source: Indecon analysis and modelling
* Economy-wide impact = direct impact + multiplier (indirect and induced) impacts in supply chain.

The GI industry has expanded significantly in recent years with the growth in digitalisation and location-based services. The significance of the supply side of the industry can be seen from the fact that it directly employs an estimated 1,677 full-time equivalent persons and supports employment of over 3,000 persons when direct as well as multiplier impacts are considered. The industry in Ireland generated sales or output valued at €117.5 million in 2012 and spent a total of €84.4 million on wages/salaries. It contributed over €69.3 million in terms of Gross Value Added (GVA) to the Irish economy.

5.2 Economic Benefits from Use of Geospatial Information

In addition to the economic impact of the industry there are wider economic externalities arising from the use of geospatial information. The evidence shows that firms surveyed indicated their judgement that benefits from geospatial information accrue to users engaged in business and exporting activities, the government and final consumers.

Public Sector Cost Savings

One area of potential benefit from the use of geospatial information is cost savings within the public and local authority sectors. Indecon has estimated that if even 0.2% savings were made in current public expenditures, excluding transfer payments, this would result in annual savings of €82m.

Table 5.2: Impact of Geospatial Information Benefits in Reducing Public Sector Costs	
Estimated Annual Public Expenditure savings	€82m
Source: Indecon analysis and modelling.	

Economic Value of Time Savings

Another potential economic benefit of geospatial information related to consumer usage is the time savings arising from the use of geospatial information. Indecon estimates of the significance of the economic value of time savings is presented in the table below and suggest annual savings of €279m. Of these, over €185m are estimated to accrue as a result of time savings on business related journeys.

Table 5.3: Economic Value of Annual Time Savings Arising from Geospatial Information	
	€
Economic value of Time savings for Private Cars	94.26m
Economic Value of Time Savings for Commercial Vehicles	185.18m
Total Economic Value of Time Savings	279.44m
Source: Indecon Confidential Survey of GI users and suppliers	

Impact on Competition

The consumer benefits of effective competition have been recognised in economic research. These include lower prices and improved services and quality, and greater consumer choice. Of relevance to this study is that geospatial information has a potential role in intensifying competition by lowering search costs. While quantification of the scale of such competition benefits is problematic, some illustrative estimates suggest these could be of the order of €78m - €130m per annum.

Impact on Innovation

The GI sector directly invests in R&D but of greater impact is the potential role of GI in stimulating innovation in the Irish economy. Indecon's research indicates that 80% of companies surveyed suggested that GI was likely to have very significant or significant impacts in areas such as product innovation, innovation in processes, marketing innovation and organisational innovation. Through these channels, the use of GI has the potential to increase competitiveness and productivity of the Irish economy.

5.3 Future Opportunities

The use of geospatial information is expanding at a rapid pace in both the public and private sectors. Stakeholders in industry and in government recognise that an understanding of location and place is a component of effective decision making.

The geospatial information Industry is set to continue expanding in future years with the emergence of new technology and trends which will create vast amounts of data.

The developments in the sector will open new opportunities for productivity improvements and cost savings. The greater usage will result in increased journey time savings and will intensify competition.

There is potential for the geospatial supply industry in Ireland to expand and to develop enhanced export earnings. This is likely to involve both indigenous and foreign investors in capitalising on Ireland as a location for geospatial information provision.

5.4 Overall Conclusion

The evidence indicates that geospatial information plays an important role in the Irish economy in terms of output, employment and value added. Also of significance are the wider user benefits, most notably the reduction in public sector costs, the economic value of time savings and the role of GI sector in identifying competition. The sector directly employs over 1,600 people and supports employment of over 3,000. The direct value added of the sector is estimated to be over €69.3m and, when multiplier impacts are included, this is estimated to be over €120m.

In terms of the economic benefits of the use of geospatial information, our analysis highlights the potential scale of such benefits. These include potential public sector cost savings of over €82m per annum and time savings with an economic value of €279m.

Annex 1 List of Participants at Industry Workshop

Central Government Sub Groups	Names of Participants	Organisation
Chairperson	Rob Ovington	DoECLG
Secretary	Gerry Walker	CSO
	Paul Synott	ESRI (Supplier)
	Gareth John	DAHG
	Greg McDermott	PRAI
	Tom Brosnahan	PRAI
	Trevor Alcorn	Marine Institute
	Susan Mortimer	Marine Institute
	Hans Viehmann	Oracle

Local Government Sub Group	Names of Participants	Organisation
Chairperson	John Hawkins	Waterford Co Co
Secretary	Ciaran Kirk	IMGS (Supplier)
	Dara McDonagh	Donegal Co Co
	Clare McIntyre	Fingal Co Co
	Judith Vonhof	Cork Co Co
	Stephen McLoughlin	South Dublin Co Co
	Malachy Hevehan	DLRD Co Co
	Eamonn Doyle	ESRI (Supplier)
	Gavin Duffy	Realsim

Utilities Sub Group	Names of Participants	Organisation
Chairperson	Dara Keogh	GeoDirectory (Supplier)
Secretary	Simon Smullen	Bord Gais
	Paul Ahern	Irish Water
	Andy Day	Irish Water
	Christina Savien	Autodesk
	Column Hickey	Bord Gais
	Danny Mcdaid	Bord Gais
	Amanda Donnegan	IMGS (Supplier)
	Martin Colbert	Eircom

Architects, Engineers, Construction Sub Group	Names of Participants	Organisation
Chairperson	Saeed Khan	RPS Group
Secretary	Cormac Smyth	ARUP
	Jacinta Green	Mallon
	Keiran Tovey	Accenture
	Mark Green	Amicus
	David Bennett	Topcon
	John Caffery	SIS
	Tom McHugh	ICON
	Nicolas Rinaud	1Spatial (Supplier)

Transport Sub Group	Names of Participants	Organisation
Chairperson	Ben King	Railway Procurement Authority
Secretary	Brendan Kennedy	National Roads Authority
	Jamesie O' Sullivan	Irish Aviation Authority
	Richard Garry	GAMMA (Supplier)
	Mick Byrne	ESRI (Supplier)
	Chris Garde	TBC
	Howard Johnson	Air Ambulance
	Roy Cuthbert	Ambulance service

Cross-Sectoral Sub Group	Names of Participants	Organisation
Chairperson	Eamonn Donnelly	DIT
Secretary	Maria Byrne	IRLOGI committee (from OSi)
	Helen Murray O' Connor	DIT
	Hayley Walker-Smith	1Spatial
	Aidan Gallagher	Centroid
	Jenny McKinley	QUB
	Helen Bradley	UCC
	Simon Stewart	Mountainviews

Cross-Sectoral Sub Group 2	Names of Participants	Organisation
Chairperson	Gearoid O' Rian	Compass
Secretary	Richard Cantwell	GAMMA
	John O' Flaherty	MAC
	Aoife Shinners	IRLOGI committee (from OSi)
	Darius Bartlett	UCC
	Leslie Brown	
	Ronan O' Connor	AutoAddress
	Paddy Prendergast	DIT

Annex 2 Selected Research on Economic Significance of GI in other Countries

The Economic Contribution of Ordnance Survey GB – Oxera (1999)

A study by OXERA in 1999 evaluated the economic contribution of OS (i) as a purchaser of raw materials from suppliers, (ii) as a producer of final goods and services, and (iii) as a producer of intermediate goods and services which are then used in a variety of sectors.

OXERA focused on ten primary users of OS products – utilities, local government, real estate, transport, farming and forestry, central government, architects/engineers/survey/construction, legal and environmental consultancy, computer and related activities, mining, drilling, quarrying. In an information request to entities within these sectors, OXERA asked how dependent they are upon OS products, on a scale of A to E, A being 80-100% dependent on OS for producing their output.

Following this, they calculate the gross value added of each sector and multiply this by that sector's overall dependency ranking to give an estimate of what they assume as the value added which is OS dependent. Their estimates based on the above methodology suggested that Ordnance Survey in the UK, along with its suppliers and distributors, plus those parts of the economy which utilise OS contribute 12-20% of gross value added. The GI market in the UK was valued at over £200m for 1997. This equates to approximately 0.01% of GDP.

OS related GVA in 1996		
Sector	**Dependency ranking**	**GVA (£m)**
Utilities	A	22,979 - 28,724
Central government	E for policy	4,760 - 6,539
	B for operations	
Local government	B	28,045 - 37,394
Architects, engineers, construction and surveyors	D	9,068 - 18, 137
Real estate	E	0 - 14,139
Solicitors and environmental consultancy	E	0 - 1,580
Transport	C	14,151 - 21,226
Computer and related activities	E	0 - 1,872
Farming and Fishing	E	0 - 2,326
Mining, drilling and quarrying	E	0 - 3,889
Total		**79,003 - 135, 826**
Source: OXERA (1999)		

Value of Geospatial Information to Local Public Service Delivery in England and Wales – ConsultingWhere (2010)

This study focuses on the impact of GI on public service provision and in this way provides good insights into the productivity related benefits which GI contributes to the economy.

It is estimated that GDP is about £323m higher in between 2008 and 2009 than without GI. With more rapid introduction of policies to free up data, it is estimated that this could rise to £600m by 2015. Key findings show that construction, transport and business services are positively impacted, while greenhouse gas emissions are lower than they would otherwise be to achieve the improved

level of output. The approach included primary and secondary research including interviews and workshops with key stakeholders and industry experts.

Reported productivity improvements include:

- Improved transport efficiency through wide application of route optimisation and better congestion management;
- Improved decision making through using geospatially local information systems; and
- Reduced data duplication – using master datasets such as the National Land and Property Gazeteer (NLPG).

Overall, it was found that across the seven areas of public service provision analysed, the use of GI led to an accumulated 0.233% increase in productivity between 2008 and 2009. Included in this is a 0.06% improvement in the productivity of the construction centre. Further, the use of GI improves labour productivity equivalent to 1,500 full-time staff across England and Wales, i.e., 1,500 fewer staff are required as a result of GI application.

For 2009, it is estimated that adoption of GI in *local public service delivery* meant that GDP for England and Wales was £323m higher than otherwise - around 0.02% GDP.

Modelling in this study suggested that the introduction of GI in local public sector service delivery resulted in the emissions intensity of the economies of England and Wales being around 0.013% lower in 2009 than it would otherwise have been – this is mainly attributable to fewer vehicle journeys.

Under business as usual, the modelling predicted that emission intensity of these economies will be 0.020% lower in 2015 than it would have otherwise been. This percentage increases to 0.021% with ideal policies.

An Analysis of Benefits from use of Geographic Information Systems by King County Washington – Richard Zerbe and Associates (2012)

This analysis focuses on a small region in the state of Washington, USA with a population of 1.9m.

In the analysis, 175 GIS professionals and users were surveyed and five major agencies constituted more than 80% of the responses. Initially, 30 qualitative interviews with employees and managers in government agencies using GIS were conducted. This helped to develop a conceptual framework of how GIS is applied, its usage patterns and its output types. This suggested that much of the impact of GIS usage is felt in terms of time savings and increased output. Information from interviews was used to develop an online survey which included questions on the output of the organisation, its pre and post GIS output level, and its pre and post GIS resource inputs.

The main aim of the survey was to gauge the productivity improvements associated with GIS. Respondents identified tasks which GIS is used for, estimates of the current output, and time spent producing the output.

Managers asked to provide how many units of output per time (day, week, month or year) they produce and the numbers of full time employees who were working on producing the output pre and post GIS, as well as their annual average salaries. These figures were used to estimate the cost of staff (number of full-time employees multiplied by their salaries) and the total cost of producing the yearly output (both pre GIS and post GIS). Comparing total cost pre and post GIS gives an estimate of the $ per unit change in the cost of production from using GIS.

$$Total\ cost\ of\ annual\ output\ pre\ GIS: \frac{TC\ of\ staff}{output\ produced\ per\ year\ pre\ \ GIS}$$

$$Total\ cost\ of\ annual\ output\ post\ GIS: \frac{TC\ of\ staff}{output\ produced\ per\ year\ post\ \ GIS}$$

A key assumption is that the value of GIS produced output is as valuable as the lower quantity of output produced prior to GIS implementation – this may not be true as we are assuming that GIS based output yields higher demand due to being of higher quality and usefulness. If the assumption is not true, the benefits are lower. Two estimates of cost savings are made:

- Estimate one is calculated on assumption new reports are as valuable as older ones; and
- Estimate two assumes the additional post GIS output worth approximately one half of the pre GIS output.

The report is limited only to activities that were undertaken pre and post GIS, (i.e., it excludes activities that are not reliant upon GIS), and upon determining pre and post GIS labour costs, a cost benefit analysis was undertaken to determine if the cost of GIS equalled or exceeded the benefits of GIS.

Some of the key benefits reported were cost savings due to more efficient production of original output and benefits generated increased productivity beyond the original production level. Some respondents reported decreases in the price of their output by increased production efficiency facilitated by GIS technology.

A lower-bound estimate of net benefits of $87 million per year were reported based on the assumption of decreased value of post GIS output. The various government departments were reported to benefit substantially from having GIS technology:

- Department of Natural Resources and Parks - $87.44m per year;
- Wastewater Treatment Division and $54.25m; and
- Department of Transport - $18.76m.

The Value of Spatial Information: The impact of modern spatial information technologies on the Australian economy – ACIL Tasman (2008)

The results of this study suggest a contribution to GDP of between 0.6 and 1.2% of GDP.

Similar to other studies, it is recognised that consumer surplus and willingness to pay methods for valuing GI are redundant given difficulties of valuing GI and the fact that GI delivers public goods and intangible benefits that are either un-priced or which may be intangible for which there is no monetary value.

The analysis proceeds examined case studies in each major sector to:

- identify productivity improvements or resource increases attributable to spatial information;
- assess levels of adoption and impacts of spatial information in each sector; and
- estimate differences in productivity with and without GI.

It is suggested that firm level/case study analysis show greater potential for productivity gains or cost savings than are observed/confirmed at economy-wide level. This is because intra firm resource shifting often occurs where new technologies free up resources (e.g., labour), which partly explains the shrouding of impact at the aggregate level.

Technologies have generic as well as specific impacts; some technologies are platform or enabling, e.g., GIS-based asset monitoring package can be used by almost any firm (generic), but a robotic total station with real-time GPS may only have impact in surveying industry. New technology often builds on existing technologies and care must be taken to isolate the marginal impacts of new technology. Impacts tend to emerge incrementally over time as the technology diffuses throughout the economy.

The steps involved in the analysis of GI by ACIL Tasman were:

1. Identification of sectors – case studies, reviewing evidence on productivity growth in each sector.
2. Literature surveys, discussions with stakeholders on costs and benefits of adopting specific spatial information technology.
3. Identify stage of adoption and verify through discussions with experts.
4. Recognition of possible generic productivity impacts.
5. Synthesis of specific and generic impacts to arrive at reasonable minimum 'orders of magnitude'. Sector wide annualised impacts at the level of disaggregation suitable data modelling.
6. Compare scenarios with and without spatial information.

"Spatial information in the New Zealand economy" ACIL Tasman (2008)

This report focuses on modeling scenarios 'with and without' GI, providing the capability to compare changes in productivity with and without GI on economic aggregates such as GDP, consumption, employment and investment. In collecting data, telephone and face to face interviews were conducted, as well as a workshop and various information requests.

For the year 2008, it was reported that geospatial information contributed $1.2 billion in productivity related benefits to New Zealand economy. This was a result of increased adoption of modern spatial information technologies over the period 1995-2008, and is equivalent to slightly more than 0.6% of GDP or GNP in 2008.

Oxera (2013) "What is the economic impact of Geoservices" – prepared for Google

The study aims to quantify the impact of geospatial services on the world economy and consumer welfare. It classifies geospatial information into direct benefits from the industry, i.e., revenue/employment/GVA generated by firms developing and providing geospatial data products and services; consumer effects i.e. benefits that consumers, business and government obtain from using geospatial services; and wider economic effects such as productivity and efficiency improvements in terms of cost savings brought about by geospatial services.

- **Direct effects** (revenue of suppliers and providers of GI) were estimated to be between $150 and $270 billion globally, with an estimated Gross Value Added of $113 billion, approximately 0.2% of global GDP.
- **Consumer effects** were measured in terms of journey time savings, fuel savings and educational benefits. In this way, GI is treated as an intermediate good which facilitates other activities. Journey time savings and fuel savings were estimated at $22 billion per year, the educational benefit is estimated at $12 billion per year, and prices are expected to be about 0.002% lower due to greater competition amongst firms – the total yearly benefit is in region of $0.3 - $1 billion, and globally impact could be in range of $0.5 - $2 billion.
- **Wider economic effects** are benefits that stem from GI improving efficiency elsewhere in the economy, by creating new products and services and creating cost savings.

An alternative approach employed used was to scale up estimates available for specific countries. Boston Consulting Group (see below) estimated GI revenues in the US at $73 billion,[77] and Oxera took the ratio of this estimate to US GDP as a proxy for GI revenues in other countries. Countries unlikely to have a high tech industry such as GI (based on their not reporting or having very low R&D expenditure) were excluded. An estimate of between 0.5% of GDP (0.12 for US revenue of the satellite industry and 0.38 for other GI activities) was applied.

In estimating the total number of individuals employed in the GI sector, Oxera takes Boston Consulting Group's estimate for the US and applies it to other countries. The median wage rate associated with the GI sector in the US is applied to average wages in other countries as the ratio of US GI wages and average wages in each country. This gives an estimate of 4 million employed in the GI sector and $73 billion total remuneration associated with the GI sector.

Boston Consulting Group (2012) "Putting the US Geospatial Services industry on the map"

This study values the US geospatial industry at $73 billion annually, which equates to about 0.5% of GDP. This is based primarily on the revenues and labour remuneration related to the supply and provision of geospatial information products and services. There were an estimated approximately 500,000 high wage jobs associated with the sector. These include geo-data providers, location enabled device manufacturers, geo-app developers and a growing network of geospatial experts and educators.

[77] Boston Consulting Group (2012) "Putting the U.S. Geospatial Services Industry on the map"

Annex 3 Case Studies on Usage of GI

Box 2: Case Study – Map Alerter	
Website/app name	**Map Alerter**
Background	In a similar vein to *Fix My Street*, Map Alerter enhances communication between local councils and local citizens. Developed in 2011 by Pin Point Alerts Ltd, Map Alerter is a smartphone application which makes extensive use of geospatial information by allowing local councils to alert local citizens of events and service disruptions. Alerts could include flooding, severe weather impacts, road closures and diversions, winter service planning, local events, winter precautions – gritting. The app was initially launched with only Wexford County Council, but other councils quickly availed of the service. In 2012, Wexford County Council was awarded for its use of Map Alerter when it won Best Local Government Service that year.
Impact of the website/app	An example of the suggested benefits from the application can be illustrated by local water cut off: it is more cost effective to target only the housing estates that are affected rather than the whole region. The app is believed especially useful in rural areas, where local councils can issue service alerts by text message. Other alerts could include road work alerts, severe weather warnings, community alerts, flood alerts and local planning alerts. The app makes extensive use of population and demographic information. Pint Point Services also provide a number of other alert services such as an Irish crime prevention service called "Community Text Alert" which alerts local citizens to crime and suspicious activity.
Awareness of Company/Usage statistics	We understand the app currently extends to six county councils including: Waterford, Wexford, Carlow, Cork, Roscommon and Limerick.
Note: www.mapalerter.com	

Box 3: Case Study – MyPP	
Website/app name	**My PP**
Background	My PP is an online planning application website which allows users to submit a planning application online. The website overcomes some of the difficulty of accessing planning data within Local Authorities, and makes it easy for users to access planning files of interest to them. More than 70% of Ireland's planning applications to local authorities are now available to view online. Large scale maps make extensive use of geospatial information and present planning application data by town, city and county. Maps include icons which are colour coded in accordance with their planning status for each application, and each icon contains information on the local authority, planning reference, location, description and a link which directs the users to relevant drawings and documentation. All applications which have been granted are then archived on the website. The website also provides users with extensive information for making applications in general. Much of this information is not readily accessible online and having all the information in one user friendly location offers convenience to customers.
Impact of the website/app	The website obviates the need for making a paper application and improves the turnaround time of applications. The website features an interactive planning map, instant notification for planning applications being made near users, details on planning regulations for private properties (including a 3D house guide), a comprehensive directory, and lists of planning applications. At present, we understand 22 local authorities across Ireland are signed up and processing applications.
Note: www.mypp.ie	

Box 4: Case Study – 'Fix My Street' Website	
Background	Fix My Street is an Irish based website which allows users to report issues in their local area such as broken street lights, pot holes, street problems, eyesores etc. and have them addressed in a prompt manner by the council. The website makes extensive use of geospatial information by allowing the user to locate their street on the map and to see what reports have already been submitted in this area and the response rate. Users set up an online account and take a photo to accompany their application. Reports range from litter, to dangerous public paths, unsafe manholes, drainage problems, etc.
Key benefits	The key suggested benefit of the system is the efficiency with which local councils can respond to these applications. Where in the past individuals would have to endure an eyesore such as a burnt out vehicle for a long period while awaiting a response from their local council, *fixmystreet.ie* allows more prompt resolution of such dis-amenities. The website eliminates the need for phoning one's local council and facing long phone queues, as well as the difficulty of trying to explain the situation without the use of graphics. Councils aim to address reports within two working days.
Impact of the website/app	As well as easing the consumer experience with local councils, it may improve efficiency within councils as more issues are seen to with the same resources. Cost savings are generated as fewer phone calls must be answered and official documentation must be filled out.
Awareness of Company/Usage statistics	We understand that approximately 30 reports are submitted per week and over 100 per month. Approximately 44% of issues are resolved per month.
Note: www.fixmystreet.ie	

Box 5: Case Study – Hailo App	
Background	The Hailo smartphone application allows users to "hail" a taxi wherever they are using their mobile phone. The ultimate impact of the application is to clear the market more quickly, i.e. match a taxi driver with a passenger instantaneously. It employs geospatial information to enable the user to find a taxi on the road nearest their current location by selecting that taxi on a map. The taxi is given the details of the driver and travels to the user.
Key benefits	The suggested benefits are a faster service for the user and more business for the taxi – e.g., when a taxi moves from an urban area out to a suburban area, the Hailo application will allow the taxi to pick up a customer out in that area, as a customer can select that taxi on their smartphone map. For example, if a taxi leaves the city centre to drop off one passenger, it may pick up another passenger near where they dropped off the initial passenger. While this has always been available through the use of phone operators and the chance of picking up people along the road, the new smartphone application increases this likelihood. The application is free to download, online accounts allow users to add their credit card, and it offers real-time information to alert the user to delays or unforeseen circumstances which may cause delay. We understand Hailo charge around 10% of each taxi fare. The application is an example of the productivity benefits which geospatial information. Increased business for taxi drivers expands their output and hence boosts economic activity and overall GDP. Consumers benefit through a more efficient taxi service and less time spent trying to hail a taxi, while more efficient matching of passenger with driver reduces the time the driver spends looking for a passenger, which in this case means lost revenue and more fuel consumed. Therefore, an indirect benefit of the app is to reduce fuel costs and carbon emissions, as well as increase drive revenues.
Impact of the website/app	We understand that out of 10,000 taxi drivers in Dublin, more than 6,000 have signed up, with over 50% penetration (users and taxi drivers) in other cities in Ireland. It is believed that 1 in 10 Irish customers have used Hailo to call a taxi at some point. The app has been downloaded more than 325,000 times in Ireland to date, and is growing at a rate of 5,000 to 6,000 per week. Since launching in Dublin in 2012, the service has been expanded to Cork, Limerick and Galway.
Note: "Capital proves to be a fare city for the fast-accelerating taxi app Hailo" Irish Independent 31/10/13[78]	

[78] http://www.independent.ie/business/irish/capital-proves-to-be-a-fare-city-for-the-fastaccelerating-taxi-app-hailo-29712728.html

Box 6: Case Study – VoucherCloud App	
Background	VoucherCloud is a smartphone application which makes extensive use of geospatial information to offer discounts and coupons to users within their local area. Based on a user's geographic location, offers by nearby establishments are advertised on the website. App users can use their smartphone's GPS system to locate shops, restaurants, cinemas, retail outlets etc. and download the voucher on their phone. Vouchers vary from percentage discounts, free extras, and quantity discounts. Vouchers also range from drinks promotions, meals, driving lessons, furniture, apparel and holidays.
Key benefits	It is a form of marketing and improves the link between consumer and producer. Furthermore, competition may be intensified among firms given that consumers have a range of options and prices to choose from. This is an example of how geospatial information could reduce search costs because this application sums up a range of choices in any given locale. The continued link between mobile internet and geospatial information is likely to be particularly important for these types of smartphone applications.
Impact of App	VoucherCloud operates across Europe and in the UK, and more than 4,500 businesses offer discounts and coupons.
Note: www.vouchercloud.ie	

Annex 4 Copy of Questionnaire for Survey of Suppliers and Users of GI

Confidential Information Request to GI sector

1. **Name of Company or Organisation:** _____

Geospatial Products/Services Provided

2. Are you a primarily a Provider/Supplier or User of geospatial products/services?
Primarily a Provider/Supplier ❒ Primarily a User ❒

3. Please indicate whether your company or organisation provides/supplies or uses any of the following geospatial products/services:

	Organisation Provides/Supplies the Following Products/Services	Organisation Uses the Following Products/Services
On-line and Paper Maps	❒	❒
Locally stored Digital Maps	❒	❒
Satellite Imagery	❒	❒
Navigation and Other Satellite Positioning Services	❒	❒
GIS Software Development and Supply	❒	❒
Geo-app Developers	❒	❒
Survey Equipment and Survey Services	❒	❒
SatNav, Mobile and Other Device Vendors	❒	❒
Distributors/Agents for above or other location-enabled equipment or services	❒	❒
Geo Training/Education Services	❒	❒
Other, please specify	_____	_____

Employment

4. Please indicate the approximate annual numbers employed in terms of full time equivalent (FTEs) numbers in Ireland and internationally.

FTE Numbers Employed		
	2012	2013
In Ireland		
Worldwide		

Customers

5. Please indicate the significance or otherwise of the following categories of customers/users of your company's products/services:

	Very Significant	Significant	Neither Significant nor Insignificant	Insignificant	None
Central Government	❒	❒	❒	❒	❒
Local Government/Local Authorities	❒	❒	❒	❒	❒
Utilities (Energy, Water, Telcos etc.)	❒	❒	❒	❒	❒
Retailers	❒	❒	❒	❒	❒
Agriculture, Forestry & Fishing Sector	❒	❒	❒	❒	❒
Transport/Logistics Sector	❒	❒	❒	❒	❒
Value Added Services Providers	❒	❒	❒	❒	❒
Education Sector	❒	❒	❒	❒	❒
Architects, Engineers and Other Construction-related	❒	❒	❒	❒	❒
Health Sector, incl. Hospitals and Emergency Services	❒	❒	❒	❒	❒
Multinational Companies	❒	❒	❒	❒	❒
Defence Sector	❒	❒	❒	❒	❒
Other Services Companies	❒	❒	❒	❒	❒
Other Businesses	❒	❒	❒	❒	❒

Sales and Exports

6. Please indicate the total Sales Revenues of your Irish operations in 2012: Total Sales Revenues – Irish Operations: 2012 - € Million: _____

7. If your business engages in exporting from Ireland, please indicate your total Export Sales of Irish-produced goods and services in 2012: Irish Export Sales – 2012 - € Million: _____

Wages and Salaries

8. Please indicate your overall Expenditure on Wages and Salaries in Ireland in 2012: Expenditures on Wages and Salaries in Ireland - 2012 - € Million: _____

Expenditure on Goods and Services

9. Please indicate your overall Expenditure on Goods and Services Business Inputs in your Irish operations (excluding wages and salaries) in 2012: 2012 - € Million: _____

10. Please indicate what percentage of your overall expenditures on goods and services business inputs in your Irish operations are:

(a) Imported	_____ %
(b) Irish Suppliers	_____ %
	100%

Taxation

11. Please indicate approximate annual taxes paid by your company in 2012:

Payroll-related taxes including PAYE, PRSI, USC Levies etc.	€ _____
Net VAT	€ _____
Corporation Tax	€ _____

12. Please indicate your views on the significance or otherwise of a range of potential user benefits arising from the provision of geospatial services in Ireland.

User Benefits from using Geospatial Services (as they relate to the services provided in Q 2)	**Very Significant Economic Benefits**	**Significant Economic Benefits**	**Neither Significant nor Insignificant Economic Benefits**	**Insignificant Economic Benefits**	**None**
Benefits to export oriented businesses based in Ireland from using Geo Services	❒	❒	❒	❒	❒
Benefits to other businesses in Ireland from using Geo Services	❒	❒	❒	❒	❒
Benefits to Irish Government Departments/State Agencies and Local Authorities from using Geo Services	❒	❒	❒	❒	❒
Benefits to individuals and Irish consumers	❒	❒	❒	❒	❒

Impact on Intensity of Competition in Irish Market

13. By facilitating consumer search of location, products and services, and comparison of prices of alternative suppliers, geospatial services can potentially increase the intensity of competition in Irish market by lowering search costs. Please indicate your views on the significance or otherwise of geospatial services in intensifying competition in each of the following broad sectors.

Impact of Geospatial Services on Competition in the Irish Market	**Very Significant Impact**	**Significant Impact**	**Neither Significant nor Insignificant Impact**	**Insignificant Impact**	**No Impact**
Hotel, Restaurant and Tourism Sectors	❒	❒	❒	❒	❒
Legal, Accounting and other Professional Services	❒	❒	❒	❒	❒
Retail/Wholesale Sectors	❒	❒	❒	❒	❒
Manufacturing Sectors	❒	❒	❒	❒	❒

Impact on Cost of Public Services

14. Please indicate your views on whether geospatial services have resulted in the achievement of reductions in administrative costs of public services and your views on future potential of such services to reduce such costs.

Impact of Geospatial services on administrative costs of public service provision	Very Significant Reductions	Significant Reductions	Neither Significant nor Insignificant Reductions	Insignificant Reductions	None
Impacts achieved to date	❒	❒	❒	❒	❒
Potential future impacts	❒	❒	❒	❒	❒

Impact on R&D and New Product Development and Innovation in the Irish Economy

15. During the years 2010 to 2012, did your company or organisation introduce any product or service innovations?
Yes ❒ No ❒ Not Applicable ❒

16. Please indicate below your views on the impact of geospatial services in facilitating different forms of Innovation in the Irish economy:

Impact of Geospatial Services in Facilitating Innovation	Very Significant Impact	Significant Impact	Neither Significant nor Insignificant Impact	Insignificant Impact	No Impact
Impact on Product Innovation (Product/Service Design, Capabilities, Accessibility, Components or Sub-systems)	❒	❒	❒	❒	❒
Impact on Innovation in Production, Distribution and Other Support Processes	❒	❒	❒	❒	❒
Marketing Innovation (facilitation of new marketing concepts/strategies)	❒	❒	❒	❒	❒
Organisational Innovation (incl. facilitation of organisational knowledge management, new decision-making and work practices	❒	❒	❒	❒	❒

17. Does your company or organisation have a dedicated R&D/department? Yes ❒ No ❒ Not applicable ❒

18. Please specify your estimated expenditure during 2012 on in-house R&D: 2012 - € '000s: _____

19. Please specify your estimated expenditure during 2012 on R&D performed on your behalf by other parties:
2012 - € '000s: _____

Estimation of Journey Time Savings from Geospatial Navigation Devices

20. Please indicate your approximate estimate of what percentage of businesses and individuals in Ireland use geospatial navigation devices/software:

	Commercial/Business/Government Users	Personal Users
Over 30%	❒	❒
21 – 30%	❒	❒
11 – 20%	❒	❒
6 – 10%	❒	❒
2 – 5%	❒	❒
<2%	❒	❒

21. Please indicate your approximate estimate of what percentage of average journey times for individuals in Ireland who use geospatial navigation devices/software is achieved in terms of reduction in journey times as a result of using geospatial services in guiding them to their destination.

Potential Journey Time Savings from Geospatial Services		
	% Time Savings for Leisure Journeys	% Time Savings for Business-related Journeys
Over 30%	❒	❒
26 – 30%	❒	❒
21 - 25%	❒	❒
16 - 20%	❒	❒
11 - 15%	❒	❒
6 - 10	❒	❒
<5%	❒	❒

Other Comments

22. Please provide below any other views or evidence which you may have on the economic impact of the GI sector in Ireland:

Thank you very much for taking the time to complete this important confidential information request. All data and responses will be treated as strictly confidential and aggregated with other responses. If you have any queries re this information request, please contact William H. Batt at Indecon (E-mail: whbatt@indecon.ie).

Annex 5 Applications of GI in Different Sectors

GI plays a role across a range of public and private sector activities. In this section, we present some examples of the applications of geospatial information in different sectors. Some of these have been documented in previous studies while others were identified at the Geospatial Information Workshop organized by IROLGI and OSI. This is not meant to be a comprehensive list of applications but is designed to highlight potential uses of geospatial information.

Agriculture/Forestry/Fishing

Some examples of applications of geospatial information include:

- Land and crop management – harvesting, tillage, monitoring livestock
- Monitoring crop growth – identifying soil best suited to growth
- Compliance with EU directives and regulation, e.g. the Nitrates Directive or the Water Framework Directive
- Risk management – bad weather, pests, diseases, pollution
- Managing pests – mapping specific areas where soil could be infected
- Planning current and future operations
- Precision Agriculture – the use of GeoData to monitor crop development and respond to specific areas of land where crops may require greater attention than others[79]
- Use of real-time positioning for hands free steering with resultant reduction of overlaps in planting, spraying and harvesting. Maintenance of soil information for Ireland which has applications for improved farm management, encompassing considerations for biodiversity, soil carbon, ecology, monitoring. [80]
- Land Parcel Identification System (LPIS) which is used to capture and manage spatial information relating to agricultural land parcels, including boundary position, parcel area and land usage. [81]

Some of the potential applications of GeoData in the fishing industry are as follows:

- Locating key catchment areas – reduce search costs such as time and fuel
- Monitoring fish stocks
- Fleet management
- Scheduling and planning
- Compliance with fish quotas
- Identifying areas with protected species

[79] ACIL Tasman (2008) "The Value of Spatial Information: The impact of modern spatial information technologies on the Australian economy?"

[80] Ibid

[81] Ibid

Transportation

One of sectors which there is extensive use of geospatial inputs is in the transport sector. Some of the applications include:

- Transportation of individuals and freight between locations
- Navigating – roads, air, sea, outer space
- Organisation and planning of routes by transport operators – airlines, trains, buses, taxis, ferries
- In car personal navigation device usage by consumers
- Managing traffic flows and congestion in urban areas
- Constructing roadways, waterways and railway lines
- Reducing the possibility of goods being misplaced, lost or delayed

Retail activities

There are a large number of applications of GI in the retail sector. Some of these include:

- Identifying optimal location of business
- Estimating consumer demand based on location
- Identifying products ranges and sourcing raw materials
- Constructing business model and strategy based on spatial analysis of competitors
- Estimating catchment area and potential size of the market
- Marketing activities based on incomes and demographics in the area
- Delivery management – e.g., online retailing
- Identifying the availability of skilled workers in a given location
- Estimating commercial rates levied by government
- Environmental considerations – e.g., where production activities may pose environmental impacts

Construction/Engineering/Surveying

A range of applications of GI are evident within the construction/engineering/survey sector. Some of these include:

- Planning a construction operation
- Engineering activities - road and pipeline construction
- Environmental considerations – local areas, natural habitats
- Architectural planning and design
- Coordination of construction activity
- Preparation of land for construction
- Machine guidance
- Feasibility studies and Investment Appraisals – Cost-Benefit Analysis
- Identifying the optimal location for a roadway or pipeline

- Developing aerial photography and satellite imagery
- Hydrology – planning water systems
- Analysis of ecosystems
- Energy generation – planning wind farms, power stations
- Machine guidance in road cutters etc.
- Surveyor, surveillance of sites
- Route and site selection (corridor mapping)
- Development of survey planning
- Online systems for lodging planning applications.

Communications

Another sector where there are clear potential uses of GI is the Communications sector. Some potential benefits include:

- Postal services – locating addresses and sorting mail and the development of postcodes
- Telecommunications – phone, internet, TV, radio
- Location Based Services in marketing and advertising
- Call centres – customer care
- The development of broadband and IT infrastructure, including identifying the best location for a base station[82]

Utilities – electricity, gas, water, telecoms

The utilities sector is an extensive user of geospatial information. Applications of GI within the utilities sector include:

- Asset management of networks of power lines, pipelines and channels – for example the introduction of smart metering in Ireland made extensive use of GI.
- Monitoring and maintenance of infrastructure.
- Mapping high energy zones using demographic data and forecasting energy consumption by location.
- Pricing of utilities – estimating demand and supply, both of which are based data with a geospatial dimension.[83]
- Planning the location of new pipelines, generators, power lines or dams – taking into account externalities and local conditions.
- Cost Benefit Analysis of new infrastructural projects - inform decisions of economic, environmental and social impact.

[82] ACIL Tasman (2008) "The Value of Spatial Information: The impact of modern spatial information technologies on the Australian economy?"

[83] Ibid

Central and Local government

Key areas of spatial information systems application in local and central government include:

- Asset mapping and management – footpath repairs, road maintenance
- Improvement in service delivery – bin collection, cleaning, etc.
- Setting rates and taxes, e.g., the recent property taxes in Ireland
- Management of local emergency responses
- Road works and traffic management
- Public schools
- Improved land use zoning and spatially based policy decisions affecting issues such as designated activity centres, green wedges and pedestrian routes
- Other planning involving layered data, e.g., future needs assessment such as linking demographic changes to school planning, urban growth boundaries and future transport infrastructure
- Organising local and national elections
- Rental Accommodation Scheme
- Scheduling construction
- Road maintenance and upgrades
- Licensing
- Public lighting
- Cycle/Greenways
- Accidents
- Traffic management
- Emergency planning
- National Census of Population
- Waste management
- Water metering
- Universal Social Charge
- Property tax[84]
- User reports of defects in roads/streets/lighting etc. [85]
- Winter Maintenance[86]
- Emergency response times

[84] GI was used in identifying houses potentially exempt from the local property tax and household charge: http://www.rte.ie/news/2013/0321/377661-property-tax/

[85] http://www.fixyourstreet.ie/main

[86]http://www.enviroteam-ireland.com/index.htm

Environment/Water Services

Applications of environmental organisation include:

- Recycling
- Parks/playgrounds/pitches
- Waste collection
- Litter control
- Beaches, bathing water, blue flag
- Trees
- Sampling
- Licensing/pollution control
- Farming
- Heritage
- Cultural reservation
- Waste water & infrastructure
- Flood management
- Hydrant checking

Consumer applications

Some of the applications of geospatial information by consumers include:

- Travelling – driving, walking, cycling
- Locating shops, restaurants, amenities
- Social networking – updating location information on social websites
- Holidaymaking
- Education – research and studying

Annex 6 Glossary of Terms and Abbreviations

All else equal: 'Ceteris paribus' - a prediction or causal interpretation between variables assumes that all other factors which may affect the variable stay constant. For example, if researchers predict that smartphone usage will increase in coming years, it is assumed that there will not be a supply shortage; that is, factors affecting supply of smartphones will stay constant.

Business to Business (B2B): refers to commercial transactions between producers of goods and services, for example between a manufacturer and a wholesaler.

Business to Consumer (B2C): refers to transactions between businesses and consumers, where consumers are the final end users of the product.

Consumer's surplus: the value consumers receive over and above what they actually have to pay.

Economic analysis: analysis that is undertaken using economic values, reflecting the values that society would be willing to pay for a good or service. In general, economic analysis values all items at their value in use or their opportunity cost to society. It has the same meaning as social cost-benefit analysis.

Economic impact analysis: the analysis of the total effects on the level of economic activity (output, income, employment) associated with the intervention. This kind of analysis focuses on macroeconomic indicators and forecasts the influence of the project on these indicators.

Externality: an externality is said to exist when the production or consumption of a good in one market affects the welfare of a third party without any payment or compensation being made. In project analysis, an externality is an effect of a project not reflected in its financial accounts and consequently not included in the valuation. Externalities may be positive or negative.

EU INSPIRE: 'Infrastructure for Spatial Information in the European Community' (INSPIRE) is an EU initiative which aims to create a European Union Spatial Data Infrastructure. It will facilitate sharing of spatial information and enable greater access to public sector data.

Global Navigation Satellite System (GNSS): a system of satellites which provide geospatial positioning and allow users to determine their exact location using a signal receiver. To date, the two main operational GNSSs are the US NAVSTAR Global Positioning System (GPS) and the Russian GLONASS.

Global Positioning System (GPS): A system of satellites and signal receivers which determine the exact location of a device anywhere on or near the Earth's surface. GPS can calculate the longitude and latitude of locations and transmit this information to a receiver, which allows the user to locate their exact location and other destinations they may wish to travel to.

Gross Domestic Product (GDP): the total value of all goods and services produced within the borders of a country. It is usually calculated on an annual basis.

Gross National Product (GNP): Gross Domestic Product plus income earned abroad by residents, less any income earned domestically by foreigners.

Gross Valued Added (GVA): refers to the difference between the value of output produced (i.e. sales revenues) and the cost of producing that output in terms of raw materials which are directly attributable to that output. GVA is the main component of Gross Domestic Product (GDP), the others components being taxes and subsidies.

Information and Communications Technology (ICT): an umbrella term which refers to the range of computing and communications applications which transmit many types of information. This includes internet, smartphones, satellites systems, and computer hardware and software.

Location Based Services (LBS): information services which provide the exact location of an object or place name. Most mobile devices are equipped with a location transmitter such as a Global Positioning System (GPS) which determines its exact location in real-time. Information services also include location of specific place names within a radius of one's current location.

Marginal Cost: the change in total cost from producing an additional unit of output. The point at which marginal cost is lowest means that firms are producing at the lowest cost of production.

Multiplier: A coefficient which, when applied to a direct economic impact (such as output or employment contribution), enables the estimation of economy-wide impacts. Multipliers are derived through input-output analysis of the relationships between sectors in an economy. Type I multipliers take into account the direct plus indirect impacts of economic activity, while Type II also account for the induced impacts arising from the re-spending of additional employment incomes generated through the indirect impacts.

Multiplier impact: Multiplier impacts relate to the indirect impacts of a given change in final demand or output of a good or service on the demand for intermediate inputs in the supply chain. For example, an increase in the output of Product A will also require an increase in the outputs of Products B and C that are used to produce Product A, such that the outputs of all three products combined amount to greater than the increase in the final output of Product A.

Public good: A good which is available to everyone in society and whose consumption (usage) does not reduce its availability to others, e.g. public parks, street lighting.

Value chain: A value chain describes the flow of interactions between companies and how they contribute to the provision of services used by businesses and final consumers. The value chain is about how and where value is added at different stages in the supply chain, beginning with providers of raw materials through to distributors of the final product.

Value of Time: The value of time is an economic value that is used to place a monetary value on the non-monetary time saving.

Value of Statistical Life: This is the economic value placed on infrastructure projects which reduce accidents or fatalities.