GIS and logistics service providers

(Final Paper)

Abstract

A research aims to examine opportunities for GIS to add competitive advantage in marketing and planning for companies on the supply side of logistics. It goes deep to explore many operation and business aspects of logistics and how could GIS vendors provide clients with better solutions for their logistics problems

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Executive Summary

Geographical Information Systems (GIS) enable storage, manipulation, analysis and display of geographically referenced data. The rate of growth in the GIS industry has accelerated in the 1990s as businesses have adopted GIS to relate different sources of information to one another through a common geographical reference.

The value of GIS lies in enabling users to integrate different sets of data through a common geographical reference system such as latitude and longitude. Users can then question these data based on their geographical relationships and display the results on a map, in a table or on a chart.

Technical barriers to the widespread use of GIS in business have been eroded in the 1990s by five factors: reduced cost of computing power; increased availability of digital map data; availability of software component technology; integration with corporate databases; and growth in use of the Internet for sharing software and data.

Spatial data processing functions are now available under a wide range of different terms including ‘desktop mapping’, ‘spatial information’. ‘spatial resource planning’ and ‘spatial decision support’ as well as geographical information systems. These functions can be found as part of wider corporate decision support systems.

There are numerous opportunities to exploit geographical relationships in data within activities in the value chain and to support different levels of logistics decision-making.

Amongst companies providing logistics services the term ‘geographical information systems’ (GIS) is either not recognized or considered to include any software capable of displaying digital maps.

The greatest use of software packages with an element, or component, of GIS technology is at an operational level e.g. routing, scheduling, tracking, tracing or navigation. Lack of use of GIS packages to support higher-level logistics decision-making may be for a variety of reasons: a lack of involvement of contract distribution companies in these decisions; the availability of centralized resources for planning; difficulty in justifying the cost of buying and supporting a mapping package; the perception by software companies that logistics services is not a target market.

The greatest use of GIS packages appears in two areas: companies with large numbers of customers, large networks of facilities and a large geographical spread e.g. express parcels companies. Also logistics consultants involved in strategic levels of logistics decision making.

Because of the geographical nature of much of the analysis that supports logistics decision-making, I do expect that the use of these packages will grow within this sector in future.

Introduction

Information technology (IT) can play a major role in improving efficiency and effectiveness in logistics processes. Through these improvements IT can provide a competitive advantage to both users and providers of logistics services. Logistics is inherently concerned with geographical information: from board level decisions about the location of manufacturing and warehousing to operational level decisions about the best route for a vehicle. IT that is specifically designed to work with geographical data offers interesting possibilities for both users and providers of logistics services.

Geographical Information Systems (GIS) enable storage, manipulation, analysis and display of geographically referenced data. The GIS industry has developed over the past 30 years from specialist academic and government roots in cartography, photogrammetry and remote sensing into a $1.2 billion industry world-wide[1]. The rate of growth in the GIS industry has accelerated in the 1990s as businesses have adopted GIS to relate different sources of information to one another through a common geographical reference.

The aim of this paper is to examine opportunities for GIS to add competitive advantage in marketing and development for companies on the supply side of logistics i.e. the companies that provide logistics services such as contract distribution, freight forwarding, express parcels, international haulage, short sea and deep sea shipping and all cargo aircraft.

1 What are Geographical Information Systems?

1.1 Defining GIS

GIS are commonly defined by the processes that are carried out: "… computer system[s] for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface"[2]. The physical components required to carry out these processes are illustrated in figure 1. The software is divided into four parts: DBMS (database management system; graphics system; interface; and operating system). There is specialist hardware - scanner, plotter and digitizer – in addition to the computer and the graphics workstations. There are data, spatial (map) and attribute (company). Finally, the system may be linked through a communications network.

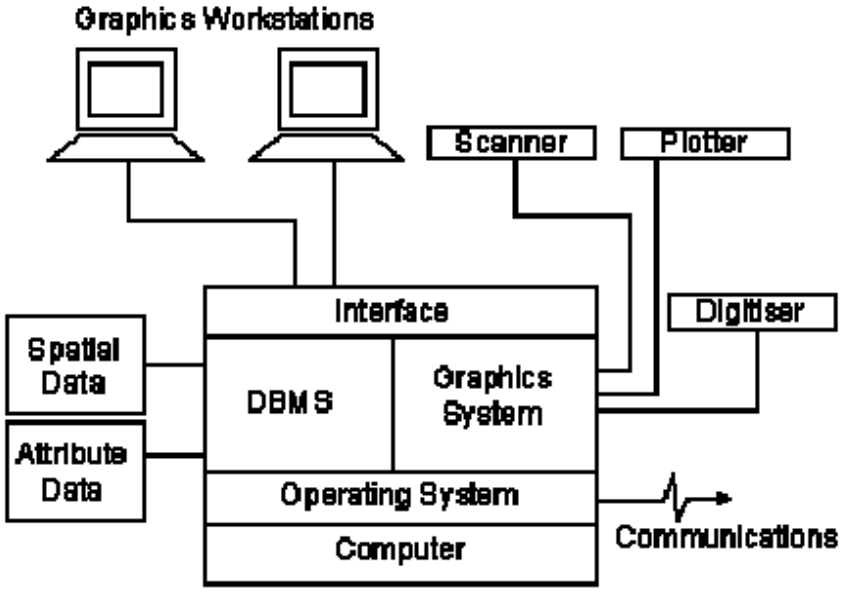

Figure 1. The physical components of a GIS. *Source: AGI*

In practice, the term GIS is often used to mean just the software product that contains the functions necessary to carry out some, or all, of these processes. Used in this sense, geographical information systems are primarily commercial products for producing maps. Their value lies in enabling users to integrate different sets of data through a common geographical reference system such as latitude and longitude. Users can then interrogate these data based on their geographical relationships and display the results on a map, in a table or on a chart. Well-known GIS products in the UK include ArcInfo™ and ArcView™ from ESRI, GeoMedia™ from Intergraph, MapInfo™ Professional from MapInfo Corp and GeoConcept™ from GeoConcept SA .

1.2 Functions of a GIS

The processes of integration and interrogation can be broken down into a number of general categories. Laurini and Thompson[3] have identified ten major tasks for spatial information systems listed below (figures 1-4 are derived from Laurini and Thompson).

1. Automated mapping: replicating paper maps on computer.

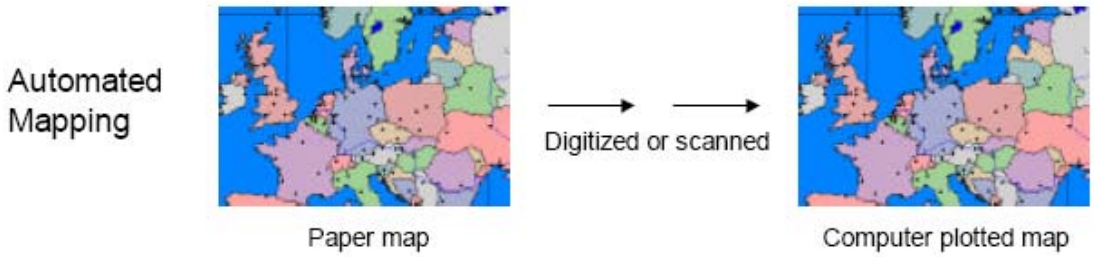

Figure 1 Automated Mapping

2. Thematic mapping: for instance using customer information and demographic data.

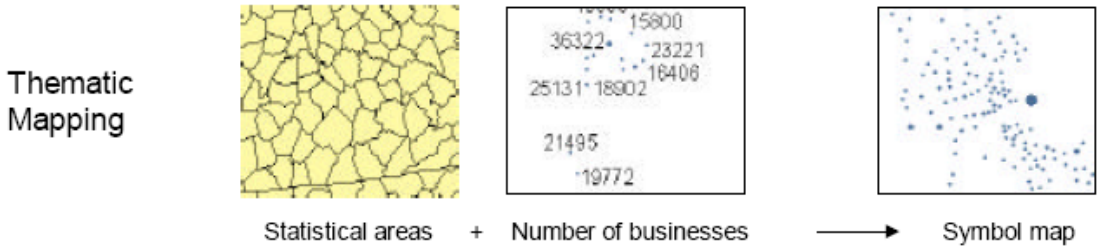

Figure 2 Thematic Mapping

3. Map overlay or composite mapping: producing a map from several layers of data.

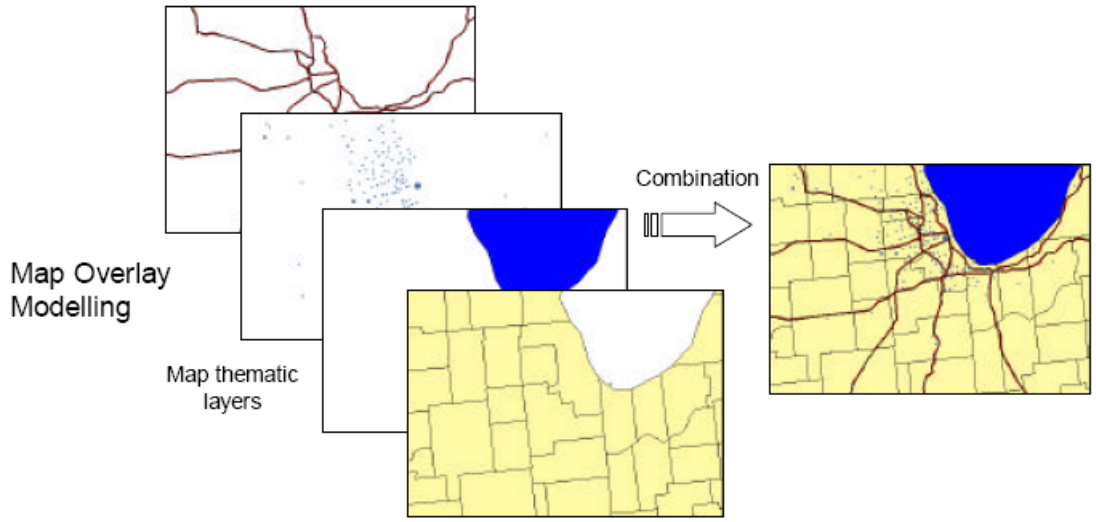

Figure 3 Map Overlay Modeling

4. Spatial querying: obtaining information from a database in response to identification of particular conditions.

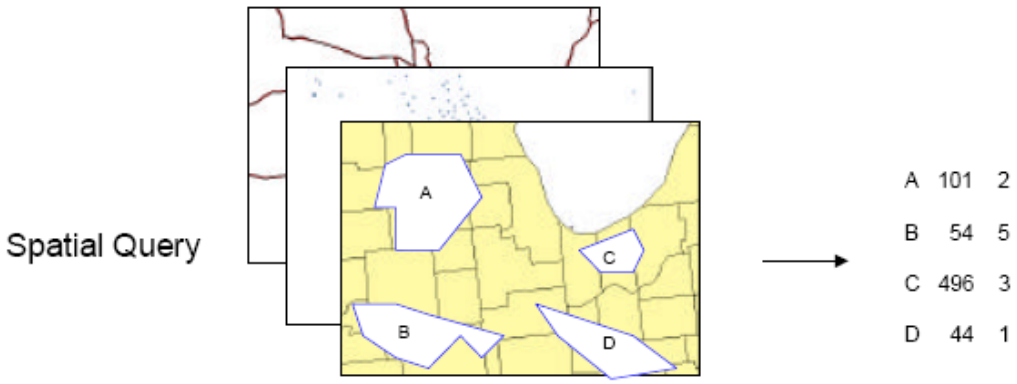

Figure 4 Spatial Query

5. Spatial browsing: exploring the contents of a database in response to identification of particular conditions.
6. Spatial problem solving: for example deducing inclusions of points in polygons, or for spatial decision making incorporating both spatial and logical deductive reasoning.
7. Analysis of spatial data: tasks which deal with the attributes of entities, like the average size of sales territories or the degree to which product sales are related to weather conditions.
8. Creating spatial statistics: tasks that require measurements of spatial properties of phenomena, like the total distance traveled by a vehicle on a road network.
9. Analysis of spatial statistics: tasks which treat spatial properties as attributes, for example the correlation between highway network connectivity and levels of economic development.
10. Spatial analysis: encompassing tasks, including simulation, which use a variety of tools of spatial statistics and location-based problem solving.

These tasks define ways in which users make use of spatial data. Tasks are carried out on spatial and attribute data sets held in a database.

Geographical or spatial digital data is generally in one of two forms: vector or raster (see figure 5). Vector data is made up of points, lines and polygons (on the right in figure 5). The location of customers for an express parcels operator could be stored as a set of points, the road network as a set of lines and the boundaries of depot service areas as a set of polygons. Raster data takes the form of a grid in which each cell stores a particular value (on the left in figure 5). Satellite and aerial photographs are in raster format, or paper maps that have been digitally scanned.

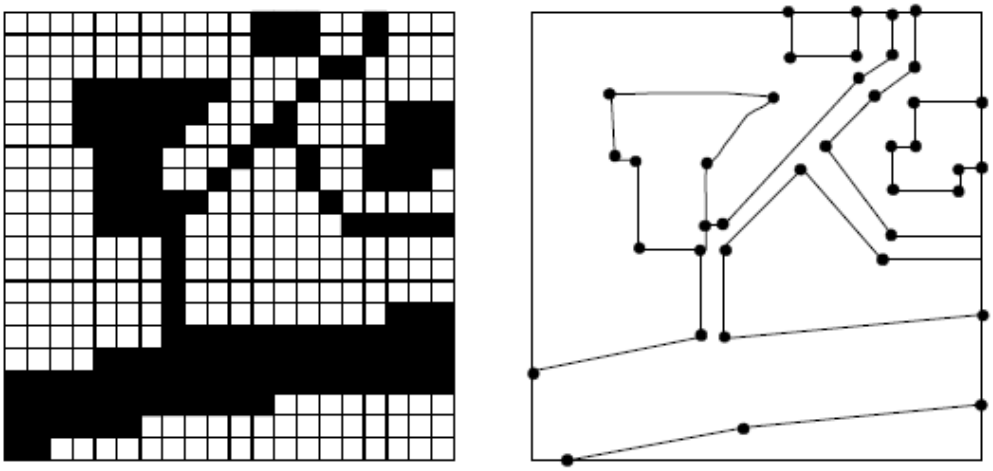

Figure 5 Raster and Vector Data *(after Worboys, 1995[4])*

Figure 5 shows that either format can be used to represent the same data. Both formats have advantages and disadvantages in terms of computer processing speed and storage space. Most GIS products are able to make use of data in both formats. The attributes of points, lines, polygons or cells are typically a mixture of numerical and textual data.

Typically users will buy, or license, standard geographical, boundary and attribute data sets and combine these with their own data in a GIS. There are many suppliers of digital map data in the world, for example, the Ordnance Survey, Bartholomews and the Automobile Association (AA).

There are also a number of companies offering specialist products such as Navigation Technologies which provide street level maps with navigational attributes or Cities Revealed which provide aerial photography. A typical set of vector data will include different layers for the motorway and trunk road network, for towns and cities of different populations, ports, airports rail way stations, etc. Boundary data sets are supplied from a number of sources. They can be in the form of hierarchies like electoral districts and wards or postcode areas, districts and sectors, or a single geography such as television boundary regions.

There is also a number of general and specialist point data sets available such as golf courses, billboards, retail outlets. The suppliers of these data sets generally distribute through one or more official re-sellers such as Geoplan, Kingswood, ESRI's DataStore or MapInfo's Data Products.

2 GIS in business

2.1 The development of the GIS market

Until the early 1990s geographical information systems were complex, they used proprietary database management systems and the components were expensive. The major commercial uses were to maintain land inventory records for local and national government departments and utility companies. While there were many proponents of the use of GIS in business cost and complexity were effective barriers to all but the largest companies. Since the early 1990s these barriers have been eroded by five major enabling factors resulting in the growing use of GIS, or GIS related software, in business.

First, reductions in the cost of computer hardware and networking technology have given any company the possibility to operate GIS software. Second, detailed digital map data have become available for most Western countries. These are complemented by a wide range of digital data sets available from national statistical organizations and commercial market research companies (although the cost of these data sets varies from country to country). Third, software component technology, in particular for Microsoft operating systems, has enabled the major GIS vendors to supply individual mapping functions in a form that can be easily incorporated with other packages increasing the number of people exposed to the potential of mapping software. At the same time the vendors have been able to integrate their products with established software products providing other functions. Fourth, companies producing the software used to manage large databases have introduced products that assist integration of existing corporate databases with GIS. Finally, this process of integration has been further facilitated by the growth in the use of the Internet as a common network for sharing software and data.

GIS products have also evolved and new companies have entered the market. GIS vendors have also recognized the need to reduce, or mask, the complexity of GIS software in order to appeal to a wide range of business users. This has led to the introduction of software packages with a limited set of functions, with guidance on how to complete standard tasks and often integrated with standard sets of map and attributes data[5]. Most recently Microsoft has entered the mapping market. Microsoft MapPoint™ is a part of the Microsoft Office™ suite. It provides users with the ability to combine their data with some commonly used geographical data sets and produce maps. Maps can be incorporated in document, spreadsheets and presentations. Microsoft are offering ease-of-use, key data sets and limited functionality at a price that is considerably lower than the major desktop mapping packages for the Microsoft Windows™ platform.

As the commercial market has developed so vendors of GIS products have moved away from the original term, 'GIS', and created a range of alternative descriptions for software products, such as 'desktop mapping', 'spatial information'. 'spatial resource planning' and 'spatial decision support', in an attempt to differentiate their products from their competitors and to appeal to new markets. International Data Corporation (IDC), a U.S. market analysis company, tracks GIS products within what they refer to as the 'spatial information management' market[6].

The analytical tasks performed within GIS products involve non-spatial processes particularly statistical analysis, optimization, network routing and dynamic positioning. Software companies can attempt to address a particular business requirement from strength in spatial or non-spatial processing. They can either buy-in or write additional software to supplement their main area of expertise. Rather than trying to include all functions in one package software vendors offer modules, or add-ons, with extra functions or provide users with the ability to write their own functions in either proprietary or standard programming languages. There are many products that provide some of the tasks described in section 1.2 and so fall between the extremes of comprehensively featured GIS products and simple mapping packages. These products often share a common purpose: users need to provide information to support business decisions[7]. This shared purpose covers a broad range of applications such as Enterprise Resource Planning (ERP) or Decision Support Systems (DSS).

Generally these applications involve a number of software products linked together. Corporate data are held in database, or data warehouse, products such as Oracle, Informix or DB2. They are entered either through an interface to support a business process e.g. orders, or generated from processing within a package e.g. orders delivered on time. This interface could be a package designed for a particular database, for any database or a set of custom-built software routines written specially for a company in a particular programming language[8]. The interface may be linked to the database on the same physical machine, on a Local Area Network (LAN) or company intranet, or across the Internet.

A user at a workstation can retrieve data through software located on the workstation, served across a LAN, intranet, or the Internet. These data can be analyzed and the results presented in the form of a table, chart or map. The results can be printed in hard copy or disseminated across a LAN, intranet, or the Internet. The spatial processing tasks constitute a small part of this system. GIS vendors address the different permutations of system structure by offering a range of products. For instance MapInfo sell, in addition to their original product MapInfo Professional™ : MapX™ - a software component to integrate mapping in other products; SpatialWare™ - software to integrate with database products from Oracle, Informix and IBM; MapXtreme™ - a map server for the Internet; and MapXsite™ - software to provide 'Where's the Nearest' capabilities in company web sites.

A more practical approach to understanding the potential value of GIS technology is to look at how spatial data can support decision-making in different areas of business.

2.2 Opportunities for GIS in logistics

An often-cited statistic in promotional literature on GIS is that 80% of business data has a geographical element. The implication is that geographical information systems have relevance and can add value in almost any area of business. Hendriks[9] uses using Porter's concept of the value chain to examine where geographical, or spatial, information systems fit within the information strategy of organizations. He suggests that companies can identify opportunities within the five primary and four supporting activities of the value chain. His indication of likely opportunities is shown in table 3.

Table 1 GIS in the value chain. *Source: Hendriks, 1998*

ADMINISTRATION & INFRASTRUCTURE: GIS as a tool for strategic planning; as a spatial decision support tool for asset management HUMAN RESOURCES MANAGEMENT: Flexible workforce management based on project location PRODUCT / TECHNOLOGY DEVELOPMENT: Examination of effects of spatialization in process/product PROCUREMENT: fleet management, supply management				
INBOUND LOGISTICS: optimization of warehouse usage; logistics modelling	SALES & MARKETING: GIS as a market analysis tool; simulation of dispersion of new products; target marketing and advertising	SERVICES: route planning; dealer network maintenance; customer complaints; dispatch; maintenance forecasting	OPERATIONS: enhancing the spatial content of process or product	OUTBOUND LOGISTICS: route planning; fleet management; delivery assessment

There is a strong logistics focus including route planning, optimization, modeling, network maintenance, fleet management and delivery assessment. The 'spatialization' of process or product might be taken to mean the way in which demand varies geographically. Equally, enhancing the spatial content of process or product might refer to customization or postponement operations although this is not clear. It is possible to divide the potential logistics opportunities according to the level of decision-making that they support.

McKinnon[10] provides taxonomy of logistics decision making consisting of four levels shown in table 2. This taxonomy was originally devised to help assess how logistics decisions affect the demand for road freight transport. Changing 'transport' to 'distribution' at the bottom level is sufficient to include other functions besides transport.

Table 2 A taxonomy of logistics decisions. *Source: McKinnon 1998*

Level	**Description**
Logistics structures	Numbers, locations and capacity of factories, warehouses and terminals
Pattern of trading links	Created by commercial decisions on sourcing, sub-contracting and distribution, and manifest as a freight network linking a company'' premises to those of its trading partners
Scheduling of product flow	The programming of production and distribution operations translate trading into discrete freight flows. Adherence to a just-in-time (JIT) regime, for example, usually requires frequent delivery of small orders
Management of transport resources	Within the framework defined by decisions at the previous three levels, transport managers still have discretion over the use of transport resources.

Table 3 places the opportunities that Hendriks sees for GIS in logistics at the level of decision-making that they support. In addition, alternative descriptions of opportunities, based on descriptions of existing software, have been added. The table is not intended to be definitive but to illustrate the fact that opportunities for GIS exist at all levels of decision making

Table 3 GIS opportunities to support logistics decisions.

Level	**Decision support software**
Logistics structures	Strategic planning, Distribution network planning, Asset management, Performance measurement
Pattern of trading links	Supply management, Demand analysis and measurement Dealer network maintenance
Scheduling of product flow	Logistics modelling Goods receipt and despatch Dispatch Delivery assessment
Management of transport resources	Routing and scheduling Driver and vehicle performance Fleet management, Maintenance forecasting, Optimization of warehouse usage Warehouse management

Articles in US trade journals suggest that companies are using GIS in logistics. Proctor and Gamble used MapInfo in combination with optimization software to re-design their facility location[11]. Federal Express used ArcInfo™ and GenaMap™ to measure service standard across the U.S.[12] and have built a warehouse location model using the Visual Basic programming language together with ESRI's Map Objects™ mapping components[13]. A recent special edition of the magazine Business Geographics discusses the role of GIS in supply chains[14]. Moreover, a recent article in Distribution Business hints at growing interest in GIS in logistics, suggesting that: "A quiet revolution is under way in the use of computer-based mapping and geographic information systems in the logistics world"[15]

3 Opportunities for GIS in Logistics Service Providers

3.1 The role of Logistics Service Providers in decision-making

Companies providing logistics services are operating as part their clients' logistics systems. In terms of the value chain shown in table 1 they are part of their clients' inbound and outbound logistics. From the perspective of a client's value-chain the opportunities for GIS to support inbound and outbound logistics depend on the involvement of the service provider in the clients' logistics decisions. From the perspective of the service provider's value-chain, administration, human resources, technology development, procurement, sales and marketing, services and operations are adding value to the inbound and outbound logistic services.

The role of logistics service providers has been limited to the lowest level of decision making, the management of distribution resources. De-regulation of freight transport, particularly by road, stimulated the market for outsourcing of freight transport and warehousing services. Companies that did not see transport as a core activity could remove the costs of transport assets and labor from their balance sheets. However, outsourcing also helped to stimulate the market for IT products to support these functions.

3.2 Management of Distribution Resources

Worldwide, there is now an extensive range of software, available for different hardware and operating systems to support anyone managing warehouses or transport operations. For example, in UK, one source lists over 100 different software packages that are able to provide routing and scheduling functions[16].While there may be some overlap there are clearly a large number of routing products that are not classified as GIS. Vendors of routing and scheduling packages have developed their products, and their geographical interfaces, independently of the main GIS vendors.

The ability to calculate drive times is a key element of much GIS analysis in business. The cost benefit analyses for routing and scheduling products should be straight forward to present in terms of savings in numbers of vehicles and reduced mileage. The cost savings in the area of operation addressed have to be greater than the cost of purchasing and using the system. A recent estimate suggests that computerized vehicle routing and scheduling packages can cut transport costs and distance traveled by between 5 and 10 percent[17].

Despite this, companies have been slow to accept the use of routing and scheduling Packages[18]. While much effort has been focused on the technical side of routing applications much less effort appears to have been spent in considering how people integrate these packages into existing business processes. The management implications and the impact on other areas of the business are often of greater concern than the use of the package[19]. Interviews with logistics service providers confirm that these are still important issues to be considered in the adoption of new software, particularly with tracking software.

Research in GIS places routing applications under the umbrella of GIS-T meaning GIS for transportation. Waters[20] provides a detailed description of what a GIS-T software package might include in addition to 'standard' GIS functions: matrix handling; shortest path analysis; spatial interaction and gravity models; trip generation-trip attraction. While he suggests that there are GIS-T software packages that include some, or all, of these functions (in particular he mentions the TransCad™ package produced by Caliper Corporation) he also points out that the package is a combination of GIS and other software. He also refers to the links between GIS-T and automatic vehicle location systems (AVLS). AVLS covers a range of related applications that use some form of communications technology, such as the Global Positioning System (GPS), to track the location of a vehicle. According to articles in the logistics trade press these systems are growing in popularity as they offer opportunities for dynamic re-scheduling of vehicles to take advantage of additional loading opportunities or to avoid areas of congestion[21].

They also offer management greater visibility over how their assets are being used. GIS can provide a visual display of the location of the vehicle. In the UK Isotrak offers a range of business services to fleet managers based on a combination of technologies that includes uses the GeoConcept™ GIS package. Several of the major GIS vendors market modules or add-ons for their products that provide tracking functionality. However, GIS rarely forms a part of the marketing literature for tracking products themselves. The mapping functions are 'embedded' in the package and the visual interface is taken for granted[22].

Where logistics appears in GIS vendor marketing it is generally in combination with a routing and scheduling package or a tracking and tracing system. MapInfo produced a promotional white paper on Desktop Mapping and Transportation in the U.S[23].

More recently ESRI have launched a product in the U.S. called ArcLogistics™ which appears to be a combination of routing and mapping functions. According to their publicity material it is derived from work that they carried out with the Sears Group in the US which included the use of GIS to assist in warehouse operations. The extent to which new entrants to the routing software market can succeed may depend on their ability to tap into the accumulated experience of existing software providers in the practical problems of applying routing and scheduling software in a business environment and of integrating their products with other business software.

3.3 Involvement in higher level decision-making

Service providers do become involved in higher level decision-making in their clients in certain circumstances. First, in some cases the logistics service provider may build, or lease, a new facility for a client in which case they will have been involved in decisions at the logistics structures level. Second, the large contract distribution companies have created internal consultancy departments to respond to invitations for tender and to support ongoing contracts. Third, there is a trend for clients to use one service provider, a 'lead' company, to manage relationships with other service providers[24].

This may mean that the main service provider becomes involved in decisions affecting scheduling of product flow and the pattern of trading links. In these cases the logistics service provider is becoming involved in distribution network planning.

The nature of decisions at this level is that they involve assessing multiple criteria and multiple scenarios. Issues of site location are good examples in which senior management wants to assess the performance of the existing distribution network, simulate the performance of new configurations of the network and consider the impact of new configurations on their operations.

Different logistics service markets have different requirements. The national freight transport companies, including express parcels, couriers and freight forwarders, need to run a network of offices to supply their market. The contract distributors need to understand how their operations fit into the distribution networks of their clients to produce competitive responses to tenders and to manage change during the course of a contract. Again, there are over 100 packages already available to help companies with these tasks[25]. However, at the level of strategic site analysis there is a close link to the use of GIS in the business-to-consumer sector.

These are only a few simple examples of the processes that a company might go through in using a GIS to support a decision to open a new site close an existing site. In practice, these simple tasks are repeated many times using a mixture of commercial and company data. A number of modeling techniques, such as gravity modeling and location allocation can be used to derive new data that can be mapped. The procedures can be automated so that a number of simulations can be run perhaps to suggest a number of new locations, or examine the effects of changing key criteria such as floor space or product range.

Target marketing activities such as planning direct mail or leaflet drop campaign focus on the individual rather than the site. However, at the heart of target marketing is the need to profile and segment both existing and potential customers. Companies carry out these activities using a mixture of demographics, geodemographics and company data.

For the logistics service industry there is little reason to use geodemographics. There have been attempts to try and create geodemographic classifications for the business-to-business sector but the characteristics of businesses are not directly related to geographical location in the same way that they are for consumers. Companies that are possible exceptions to this are those involved in home delivery operations or house moving. These companies can assess likely demand for their services through the customer profiling.

In summary, the value of GIS lies in the ability to integrate disparate sets of data, visualize them in the form of a map and link to software that provides non-spatial functions, such as optimization routines. This value is enhanced by the availability of commercial data sets that enhance internal company data and provide information about potential consumers. The greater the numbers of customers sites or service staff the greater the potential value of using GIS to support business functions. A recent article in Distribution Business alludes to the value of using a mapping package to help visualize the results of logistics analysis[26]. However, it is hard for companies to put a value on the ability to map corporate data.

In the case of software used to support strategic level logistics decisions the cost-benefit is difficult to calculate. The cost of making a bad decision must be weighed against the price of the software and data, and the labor cost in training and use of a piece of software.

Such a calculation may be made harder because the process is likely to involve other software as well as the GIS. In the case of site location it is easy to suggest that the cost of a bad decision may run into millions of pounds compared to the cost of a software package costing thousands of pounds. However, the cost of a bad decision is only a potential loss not an actual cost as in the case of running 10 trucks when only nine are needed. Choosing to use a GIS package requires a belief in the overall benefits that may accrue rather than a straightforward cost benefit analysis.

3.4 Logistics service providers and marketing decision-making

Logistics service providers need to market and sell their services. The way in which they go about this depends on the nature of the service that they are offering. Peters *et a*l[27] offer an interesting insight into the sales and marketing process in third party logistics, or contract distribution, companies. They provide a ranking of the most effective ways of finding new clients based on responses from the CEOs of major European third party logistics companies to a survey. Direct mail, the form of marketing most commonly associated with GIS, is ranked only eighth.

The top three most effective ways to find new clients are: reference from a customer; presentation at a professional meeting; and sales call by a representative. In the same survey 75% of the CEOs reported that they had fewer than 100 customers. It is hard to see the need for GIS to support for the marketing function in contract distribution companies. Where the number of customers is large the potential is greater. Domestic and international express parcels companies, freight forwarders and large hauliers all tend to have large customer bases. It has been suggested that the largest express operators have gained market share through branding of services and the effective marketing of these brands[31]. Companies such as Federal Express, DHL and TNT have almost become generic terms for express parcels, mail and courier services.

3.5 Availability of staff and training

Although mapping packages are becoming easier to use they are still by no means simple software. The arrival of Microsoft MapPoint™ may change this in the medium to long term. However, where GIS or desktop mapping packages are used as analysis tools within logistics service companies or consultancies, it is by ‘experts’ who have had an opportunity to learn to use the product and make regular use of it in their work. In one case it was suggested that it can take up to three months for a user to become familiar with a package and effective in its use.

The packages may be broadly aimed at a particular function but they also require creative thought. Users need to understand the concepts behind mapping packages to be able to use them effectively. It would also be helpful if they understand some of the basic design issues in the creation of maps.

At least as important, users need to understand the corporate data that is used in the analysis. Understanding what criteria to use in an analysis of site profitability or performance comparison is critical to providing meaningful support. The software vendors run their own training programs to support particular products. There are also a growing number of courses in GIS at both undergraduate and postgraduate level at universities worldwide

4 Conclusions

Geographical information systems are available in a variety of forms, generally designed to appeal to particular industrial markets and for particular functions. The term ‘GIS’ is used in a loose fashion to refer to the market for mapping software products and also to a particular sub-set of this market, complex, high-specification and expensive mapping software.

Amongst companies providing logistics services the term ‘geographical information systems’ (GIS) is either not recognized or considered to include any software capable of displaying digital maps. The greatest use of software packages with an element, or component, of GIS technology is at an operational level e.g. routing, scheduling, tracking, tracing or navigation. Lack of use of GIS packages to support higher-level logistics decision-making may be for a variety of reasons:

- A lack of involvement of contract distribution companies in these decisions;
- The availability of centralized resources for planning;
- Difficulty in justifying the cost of buying and supporting a mapping package;
- The perception by software companies that logistics services is not a target market.

Companies may make greater use of GIS tools as: they take on more responsibility for clients e.g. by becoming ‘lead’ logistics companies; or are exposed to consultants using these tools. The greatest use of GIS packages appears in two areas: companies with large numbers of customers, large networks of facilities and a large geographical spread e.g. express parcels companies (these companies may have marketing strategies which encourage the use of GIS for analysis). Also logistics consultants involved in strategic levels of logistics decision-making.

The ability to map data held in corporate databases assists decision-making but is hard to value. The cost of software and data is outweighed by importance of proficient users. However, logistics service providers will become increasingly exposed to GIS technologies in a variety of forms. Given the inherently geographical nature of much of the analysis that supports logistics decision-making it is likely that the use of these packages will grow within this sector.

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