[DA-045] GIS&T in Business

Abstract

Geographic Information Systems and Technology are utilized extensively in the business sector and have become a strategic element for competition and partnering. Although the traditional digital map layers and tables remain at the core of business GIS, the spatial architecture in firms now includes location analytics, location intelligence, AI, machine learning, imagery, social media linkages. Cloud-based solutions provide platform flexibility, centralized data, and potential to roll out user-friendly webGIS across large segments of business users and customers. GIS is well suited to the digital transformations that are essential for firms, large and small. With these advances, GIS has become prominent and its function has moved upwards in companies' organizational hierarchies, with enterprise GIS even being recognized in the C-suite. UPS is an example in which GIS is now a critical corporate competitive factor. In spite of these successes, a gap remains in the supply of skilled spatial workforce for companies. Business schools can contribute by changing by school leadership "getting it" about spatial, bringing GIS into the mainstream curricula, developing training for business faculty in teaching, conducting research in location analytics, and populating student body and alumni base with knowledge and enthusiasm for spatial thinking and management.

Keywords: business, commercial, decision-making, enterprise GIS, GIS in business schools, location analytics, retail, spatial busineses, workforce

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Explanation

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1. Definitions

GIS in the contemporary business context: the scientific foundation of providing a spatial capability that brings spatial information, insight, analytics, and knowledge to the organization (Pick, 2008; Tomlinson, 2013; Pick et al., 2022).

Location Analytics: advanced analytics tools relating to space, such as spatial data

mining, machine learning (ML), advanced network analysis, and artificial intelligence (AI), which complement and expand on traditional techniques of visualization, elementary spatial analysis, and spatial statistics (Raad, 2019)

Location Intelligence: a broad concept that encompasses all the elements that support decision making, which include the outputs of location analytics, shared information and maps, and data, which together assist managers in making a spatial-informed decisions (Kantor, 2018).

2. GIS as a Growing Element in Busineses

Geographic information systems (GIS) is becoming a critical aspect for companies as it permeates more business applications and, at the same time, becomes very fast, server-based or cloud-based, more user-friendly, and less expensive per user. This article defines and introduces GIS in the business context, considers two of its key business functions of supporting operations and decision-making, looks at contemporary trends, and examines management and strategies for GIS infusion in business schools.

A starting point is to define GIS in the contemporary business context. GIS in this article is the scientific foundation of providing a spatial capability that brings spatial information, insight, analytics, and knowledge to the organization (Pick, 2008; Tomlinson, 2013; Pick et al., 2022).. In this sense, GIS is at the core of how a spatially-driven firm creates efficiencies, productivity, and value for the company and its customers. As GIS has become more powerful, more advanced analytics tools relating to space have been developed, such as spatial data mining, machine learning (ML), advanced network analysis, and artificial intelligence (AI), which complement and expand on traditional techniques of visualization, elementary spatial analysis, and spatial statistics (Raad, 2019). Location analytics refers to all these tools. In addition, location intelligence is defined as a broad concept that encompasses all the elements that support decision making, which include the outputs of location analytics, shared information and maps, and data, which together assist managers in making a spatial-informed decisions (Kantor, 2018). Sometimes, the location intelligence is summarized in a dashboard i.e. a multi-panel display, often in real time, that includes maps, tables, graphs, charts and text.

GIS has been growing at an estimated rate for the geospatial industry of 13.8 percent for year 2020 (Geospatial Media and Communications, 2010). The geospatial industry is estimated to be valued at $429.8 billion in 2020 (Geospatial Media and Communications, 2019).

2.1 GIS Software at the Core of Spatial Applications in the Business Setting

Although contemporary business spatial applications are diverse, ranging from mobile apps to spatial machine learning to enterprise integration, GIS software is at the core of the application. GIS software combines non-spatial data-bases with digital boundary layers to output analytical solutions (Pick, 2008; O'Sullivan and Unwin, 2014; Longley et al., 2015). This article does not address the details of how GIS software functions, but the reader is referred to other UCGIS articles and to GIS textbooks (Longley et al., 2015; Bolstad, 2019). Contemporary GIS software for business uses has become user-friendly and is transitioning from the desktop and local servers to cloud-based solution. Examples include Esri's ArcGIS

Pro, with connects to cloud-based data, ArcGIS Online, which is fully cloud-based and general purpose, and Business Analyst Online, which is simple to use, with limited features, but comes with a rich spatial database of business-related data for units of analysis ranging, in the US, from the national level down to the block-group level. QGIS, an open source software, is available in desktop, server, and web browser versions. It has linkages to other GIS commercial and public domain software and to cloud-based data.

2.2 Integration with Other Technologies

Contemporary GIS builds on the core of traditional GIS software to support a variety of platforms and incorporate or link with a broad functionality. Modern GIS supports a variety of technology platforms, ranging from handheld mobile devices, to laptops, workstations, servers, portals and hubs. This has led to greater flexibility in business spatial solutions. For example, Walgreens implemented an enterprise spatial system that is centrally controlled and integrates (a) data from mobile devices, for consumers to gain information including shopping and mapping of Walgreens stores; (b) laptops and servers in regional offices, for regional managers to decide on store locations, understand competitors, and decide on competitiveness of stores; and (c) enterprise applications, centrally based for spatial analysis of pharmacy information, market structure, and economic data.

Contemporary GIS in business makes use of the cloud. Spatial data have always been large-sized due partly to the added storage of digital boundary information. Today spatial data are vast, for some firms, often at a size that stresses the firm's own server resources. Hence, the cloud has become prevalent in business GIS, with its ability to manage huge amounts of data, scale up or down, and save on maintenance cost. The cloud supports private, internal business libraries of spatial layers and non-spatial data. At the same time, the firm can access vast public cloud-based libraries of spatial layers, such as Esri's Living Atlas and Data.Gov, which has over 175,000 geospatial datasets. The challenge to business users is to develop the capability to discover and retrieve the appropriate, high-quality data they are seeking out of the massive libraries.

Business spatial portals are single dashboard-like entry websites that allow the user to select a GIS application for easy entry. Business hubs, an offshoot of governmental hubs, provide interactive access to numerous services and mapping. The internal hub user has access to numerous mapping solutions and can also contribute back spatial information and communicate responses on maps, while the external user has a more limited set of services and channels.

2.3 Imagery and Remote Sensing

Imagery and remote sensing from satellites and aircraft over-flights originally were utilized mainly for environmental, physical-geography, and geological applications. Increasingly, imagery can be effectively utilized for business purposes. For instance, companies such as Zonda can utilize imagery to determine business processes on the ground, such as the status of building construction from day-to-day, the hourly retail market activity based on images of number of cars in the parking lots of retail stores, and changes in seaport supply chains based on the loading and unloading of containers from ships and tractor-trailers.

3. GIS for Operations and Location Intelligence Decision Support

Two examples of business applications are for business operations and location intelligence for decision support.

3.1 GIS for Operations

For business operations, a GIS, driven by locational information, can operate the location-based activities of the company. The locational information can consist of point locations, such as franchise locations of a large, branded fast food company with multiple fast food franchises along with locations of neighboring competitor outlets, in order to better operate the supply to the franchises. In an alternative example, GIS supports the routing decisions to operate ground transportation. UPS is famous for operating its huge fleet economically and efficiently (Chiappinelli, 2017). It does this through the ORION spatial software that advises UPS delivery personnel on how to route trucks down to every stop and turn, in order to save on gasoline and maintain fast deliveries for a fleet of over 115,000 delivery trucks. This requires accurate data collection on street maps, traffic rules, truck capacities, customer locations, and engine consumption of gasoline (UPS, 2016).

3.2 Location Intelligene for Decision Support

In decision support, spatial analysis and mapping can help in the three steps of decision-making: (a) gather information, (b) examine the alternative solutions to the problem, and (c) select the best alternative. Gathering information can involve searching in digital map libraries for the spatial layers most relevant to a business problem. Information can also be gathered from imagery and remote sensing, from crowdsourced human providers in the field, or by digitizing points using mobile devices. Based on the digital map information as well as non-spatial data, alternative approaches to support the decision making can be explored. For example, choice of a new business site location might be recommended through a spatial economic model, or by mapping of social media content about location through machine learning (ML). For ML, a sample of desired business success/failure outcomes and input of business siting characteristics is given, which yields an algorithm to predict outcomes. Supervised ML can then be applied to a new set of business sites to predict success or failure, which can be a basis for siting choice.

Among the alternative solutions, the business specialist or team making the decision, selects the best alternative to support the site location decision. A business example is a large insurance firm, which utilizes GIS mapping to assist commercial underwriters in deciding on the costs of insurance. Decisions on pricing of flood insurance can be based on the insured’s home address, which is compared to a spatial flood analysis module to determine the probability of a nearby flood (Pick, 2008).

4. Trends in GIS for Business

GIS for business is not static but in recent years has been subject to long-term forces of change, that include spatial digital transformation, cloud-based architecture, imagery and remote sensing, analytics, rising organizational maturity levels of GIS, and enhanced return on investment. Together, they are contributing to strengthen GIS as an important and often critical component for business success.

1. **4.1 Spatial digital transformation**

2. Spatial business transformation is part of the overall business trend towards digital transformation. Digital transformation is more than just dropping older technology and moving to digital, cloud-based solutions, but it inevitably implies alterations to the organization, including its services, business processes and culture (Tabrizi et al., 2019). When spatial digital transformation occurs, the GIS solution becomes more accessible across the organization, with larger digital data sets, advanced location analytics, location intelligence and greater scalability across platforms. The business will need to make adjustments to a larger user base; decentralized, skilled support staff; and job loss of traditional GIS professionals, trained on the desktop software. GIS and IT leaders can foster these changes through joint planning and strategies that include re-training and support for end-user application development. In particular, in a large rollout of cloud-based GIS across a company, users are more easily able to develop their own applications, rather than being dependent on specialists with professional training to do so. If done successfully, the spatial transformation can lead to a more GIS-enriched environment, which is powerful, flexible, and conducive to software sharing (Pick et al., 2022). An example is Rapid SOS Inc. Its business plan is to input large real-time data from major social media providers, which is leveraged along with location analytics to provide enriched, real-time spatial information for often tradition-bound 911 emergency response teams around the country.
3.
4. **4.2 Rising maturity levels of GIS in businesses**
5. Twenty years ago, the GIS departments in companies were located in lower- to mid-level parts of the organization, for example in a sub-department under IT or reporting to the functional department that was the initial locus of GIS, such as marketing, transportation, or real estate. GIS served this unit with local maps and description, which can be referred to as Maturity Stage 1. In Stage 2, spatial analytics was added to a still localized set of users. A recent survey of businesses revealed that GIS moved up in the organization to serve a broader portion of the company, often with the starting sponsorship of an executive at Stage 3 (SBI, 2018). Some businesses have advanced to Stage 4, in which the senior executives are responsible for GIS serving the entire company. Finally, in Stage 5, GIS is even more centered in the C-suite and has become an important competitive force (SBI, 2018). The 5 stages are seen in Table 1. A survey in 2018 indicated that the percentage of businesses sampled were: Stage 1 (14%), Stage 2 (27%), Stage 3 (39%), and Stages 4 and 4 (39%) (SBI, 2018). The maturation process implies the broad and often strategic use of location intelligence throughout the firm.

Table 1. Stages of Spatial Maturity in Organizations

Stage	Application Level and Scope	Spatial Data
Stage 1	GIS and Location Analytics are local, weak, and ad hoc	Limited to local needs. Often of low quality.
Stage 2	GIS and Location Analytics are present in a local department and locally managed	Data quality improved. Data may be shared with other departments
Stage 3	Initial enterprise-wide GIS and Location Analytics are present. Strong GIS middle management often across several departments.	Data is beginning to attract attention across the organization
Stage 4	Enterprise GIS and Location Analytics are available throughout the organization. Senior management is aware and supportive.	Centralized spatial data-base established for the whole organization

Stage	Application Level and Scope	Spatial Data
Stage 5	Enterprise GIS and Location Analytics has become a competitive force for the organization. Senior management prioritizes GIS and Location Analytics as a competitive force	The centralized data-base is expanded to support strong competition with competitors

5. Challenge of Workforce Supply in Spatial Business: GIS in Business School

With the growing role in business of geospatial technologies, the education and training of qualified employees becomes critical (DeBiase et al., 2010). A gap of skilled spatial staff was noted by 15 years ago (Marble, 2006) and remains a deficit today. Part of the challenge and opportunity is to augment GIS and location analytics in business school planning and curricula. Other avenues of education and training, not covered in this article, include corporate training programs, online education, and management and GIS certificates.

Although business schools arguably should be the primary source of spatial business education and training, studies have shown that business schools have a low infusion of GIS courses and materials (Sarkar and Pick, 2012). It is important to distinguish between (a) stand-alone GIS courses in the business school, which have the objective to understand spatial theories and techniques and (b) how GIS impacts business from GIS infusion in disciplinary courses, such as Marketing, Operations Management, Real Estate, and Analytics.

For business schools with a stated goal to emphasize GIS and spatial, this paper recommends a standalone course. It could be a core required course for a school with a strongly-stated goal or at least an elective course to substantiate a moderately-stated school goal. If GIS is not stated as a business school goal, this paper supports at least the b) option. GIS and location analytics constitute a long-term and growing force in the business sector, rising to the level of necessary inclusion as part of one or several relevant business courses in the sub-disciplines such as in marketing, operations, information technology or others. For such a course, one of the course goals needs to be GIS in the context of the sub-discipline. Hopefully the host department will view it as a part of the sub-discipline, not as a secondary goal.

If the school's choice is a standalone course, another issue arises on whether the course should emphasize spatial thinking and strategies for business or be a software-only GIS course. This paper recommends a standalone business course with disciplinary thinking as the driver, along with practice of some GIS software skills applied to relevant business cases. If a software-only GIS course is sought, the school would be better to teach it as a non-credit workshop or delegate the software-only course to another department such as geography, planning, or civil engineering.

5.1 GIS in the mainstream business curricula (Bachelor level, MBA, Master in Analytics)

GIS is scarce as a required course in the mainstream curricula of accredited business schools. Among the reasons are: (1) the core curriculum for business school accreditation must include a large set of required courses from the basic business disciplines of marketing, finance, accounting, management, organizational studies, information

technology, business ethics, operations, and management science. That leaves relatively little “wiggle room” for electives or core courses not required for accreditation. However, a little more flexibility is available through “concentrations” in undergraduate or graduate business programs; (2) there is relatively low level of interest in GIS currently in business schools; (3) even with interest, there is scarcity of experienced and trained faculty to teach spatial business courses, as well as paucity of teaching materials geared to GIS in business; and (4) although cloud-based GIS has grown considerably in the business sector relative to installed platform-based GIS, teaching in business schools has not yet shifted significantly to cloud-based GIS, a slowness that may stem from insufficient training, software pricing, the rapid change cycles for cloud-based GIS software, or other reasons.

What can break this log jam and enable GIS and location analytics to flourish in a mainstream role in business schools? Here are some suggestions on how business schools can recognize and support spatial courses, curricula, and programs.

- Recruit deans who recognize spatial thinking, or motivate/incentivize them to learn about GIS’s widespread adoption in the business sector.
- Encourage support for a current faculty member or recruit a new faculty member who has the knowledge and motivation to be a “champion” of GIS and location analytics in a business school. This faculty member may not have pioneered in building GIS in a different school previously, but is preferably highly motivated to introduce and build it in the recruiting school. The potential champion arguably can benefit by networking with peers from other business schools who lead established spatial initiatives. Further support could include funding for pedagogical and technical training, infrastructure, course relief, and recognition for service and leadership.
- Offer a continual program of faculty spatial workshops, tutorials, and research opportunities, and GIS research centers.
- Encourage faculty and administrators to promote in academic and professional associations and conferences that GIS is a needed addition to business-school curricula and programs.
- Engage with the spatial business community through outreach and joint task forces and programs at the town-gown border.
- Insert an initial required core GIS course in one of the largest school programs such as B.S. in Business/management or the MBA. Consequently, a benefit is that a body of spatially-trained students and alumni will grow and build the school’s momentum of spatial interest.
- Infuse GIS into portions of many of the core courses such as ethics and corporate social responsibility, strategy, operations, and accounting.
- Consider offering a graduate certificate program in GIS for business. This can be an alternative start-up route for students and corporate managers to gain significant knowledge and skills.

5.2 University of Redlands School of Business and Society mini-case of GIS infusion

The University of Redlands School of Business (SBS) taught its first elective course in GIS in 1992. In 2004, it pioneered in offering the first GIS concentration in an MBA program worldwide, and by 2008, it added a required course in GIS in Business in its B.S.in Business program. The curriculum was initially supported by one tenured professor and 10 academically or professional qualified part-time faculty. A critical success factor was the

establishment of annual faculty training workshops in GIS teaching in 2013. The workshops comprise presentations and discussions on spatial curricula, individual GIS courses, and new developments in GIS, open discussion of problems, and offer hands-on practice on use of technology and software, often with an industry guest speaker. The workshops have kept the teaching faculty “ahead of the curve” in spatial technology and practices.

SBS in 2011 opened the Center for Spatial Business that supports spatial research, teaching, and community outreach. The Center provides a speaker series on business GIS, helps school faculty with course or curricular questions, offers mini-grants to faculty to stimulate interest and expertise in GIS, and is the locus of extensive spatial research by 6 or 7 full-time faculty.

Recently, GIS components have been added to the MS in Business Analytics (MSBA) program, introduced in 2021. Not only is GIS infused the MSBA’s courses in visualization and storytelling and in the course on data mining, but also students can select an elective course on GIS in Marketing or Location Analytics. Furthermore, GIS also is included in some of the group projects in the program’s capstone course.

6. Summary

GIS is expanding rapidly as an integral and even critical success factor for businesses across many industries in the US and elsewhere. As GIS moves up in companies to become strategic, pro-active management becomes essential to retain a spatial edge versus the competition, while at other times cooperating with firms and governments. GIS has diverse platforms, applications, and maturity levels. It requires not only technology and software, but business planning and purpose, and skilled spatial managers and staff to lead and guide the path to success. Essential also is training and education, in which business schools have trailed but have the opportunity to catch up and fuel the next generation of spatial managers and innovators.

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