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Analysing Construction Trends in the European Union Using Geographic Information Systems

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Abstract: Geographic Information System (GIS) is a useful tool for storing and manipulating geographical information to analyse patterns, relationships, and trends in order to gain new insights to make better and more informed decisions. Using the power of spatial organisation to suggest causes, explanations and relationships is significantly more superior to other forms of data representation such as the table or graph. This paper examines the construction trends in the European Union (EU) by using GIS software as a computional and presentation tool. The performance trends of the construction market in EU countries relative to the Gross Domestic Product (GDP), population and other economic sectors such as agriculture and manufacturing for a 20-year period between 1985 and 2004 were evaluated using GIS. Many EU countries seem to have a relationship with construction among the variables considered. This suggests that GDP, population, agriculture, and manufacturing are important factors that affect the role and development of the construction industry within an economy. GIS representation also demonstrated that it is capable of highlighting unique trends and features for further detailed analysis to be carried out.

Keywords: Construction, Economic development, Geographic Information System (GIS), European Union

INTRODUCTION

Construction is a major industry throughout the world and usually accounts for a significant proportion of the Gross Domestic Product (GDP) in most countries (Bon and Crosthwaite, 2000). For this reason, factors that affect the global construction industry are a major concern for international contractors and government agencies who are involved in export marketing of construction services and the formulation and implementation of policies for the industries (Low, 1993). According to Low (1993), Bon and Crosthwaite (2000), and Mawhinney (2001), there is a dearth of studies in the area of international marketing research for construction at the macro level despite its signicifant contribution to both world development and the national economy. This results in a lack of available up-to-date construction market trend and performance analysis to reflect the global growth and direction of progress in the construction sector.

Current modes of presenting construction trend results provide only limited support in the analysis. The more common presentation formats are simple bar charts, pie charts, line diagrams and tables. These formats are useful for presenting time series information for temporal trend

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analysis but not for spatial trend analysis which is considerably more important in global analysis. An efficient Marketing Information Systems (MKIS) is required to handle and analyse large amount of information for effective decision making (Low, 1993). Advanced Information Technology (IT) applications such as Geographic Information Systems (GISs) are useful tools that can be employed as MKIS because of their capabilities in carrying out spatial analysis.

Given the last comprehensive review of the global construction market was completed some time ago (Low, 1993), it appears timely to examine and review the current state of the global construction industry through GIS using the EU market as a case study.

This study aims to examine and analyse the construction trends in the European Union (EU) by using GIS software as a computational and presentation tool. The performance trends of the construction market in the EU relative to the GDP, population and other economic sectors such as agriculture and manufacturing for a 20-year period between 1985 and 2004 will be evaluated using GIS. This is to establish the relationships between construction and other economic indicators such as GDP, population, agriculture and manufacturing.

Statistical data was collated from established world organisations such as the United Nations (UN), the Internatinal Monetary Fund (IMF) and the World Bank's (WB) CD-ROM resources. Publications and internet-based sources of national statistical offices and websites were also accessed to collate the latest country national account statistics of EU member states.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

GIS is a useful tool for storing and manipulating geographical information in order to analyse patterns, relationships, and trends so as to gain new insights to make better and more informed decisions. GIS greatly increases one's ability to view data from different perspectives and under different forms of data combinations and settings. Using the power of spatial organisation to suggest causes, explanations and relationships is more significantly superior to other forms of data representation such as the table or graph (Goodchild and Haining, 2004). In a way, GIS allows users to visualise the spatial distribution of data on maps prior to further statistical analysis. In presenting spatial data in various statistical graphs and diagrams, this yields more insights into the richness of the data presented.

There seems to be that no one agreed upon the definition of a GIS (DeMers, 1997). ESRI (2005) defines GIS as "a technology that manages, analyses, and disseminates geographic knowledge". Essentially, GIS is a computer based information system that is capable of capturing, storing, modeling, manipulating, retrieving, analysing, and presenting geographical or spatial reference information.

Besides geographical data, GIS is also capable of handling spatial data. Spatial data is different from other types of data as it has geographical positions, descriptive attributes, spatial (topography) and temporal relationships (Microgis Geomatics, 2004). It can be GIS layers such as towns, roads, buildings, and mass rail transport (MRT) network. When geographic information integrates with spatial analysis, geospatial is the term used to refer to applying spatial specificity to the Earth's surface or near its surface (Longley et al., 2001).

GIS comprises of three key components that include technology (hardware and software), database (geographical, spatial and related referenced data) and infrastructure (users, facilities and supporting organisational context). GIS not only analyse spatial but also non-spatial data (Wang, 2005). Non-spatial data (attributes) may consist of attribute information that includes borehole information with soil properties, statistical data such as GDP, value added of construction, etc.

The primary function of a GIS is to transform data into meaningful information for users. The information is attached with a variety of qualities and characteristics to geographical locations and the qualities and characteristics can vary from ground elevation, atmospheric temperature and landslides, to zoning and land ownership. The key functions demonstrate the technological capabilities of most GIS applications that have been employed in marketing research (Li et al., 2005; Hess et al., 2004).

Thematic map overlay is one of the most important functions of GIS. GIS originates partly from the work of cartographers who produce general-purpose maps (containing many different themes) and thematic maps (focusing on a single theme such as soil, vegetation, population density or roads). Such thematic maps are transparent and overlay on top of another to form one map. This allows simultaneous viewing of several thematic maps of a single geographical area. This simple yet versatile technique of map overlays formed the backbone of GIS (see Figure 1) resulting in the creation of digital map layers. The multiple layers are integrated to create new data set and the resultant layers thus contain new spatial objects with different attribute and topological information (Microgis Geomatics, 2004).

To illustrate spatial patterns and trends, thematic maps can be represented as graduated symbol maps (see Figure 2), proportional symbol maps (pie chart and bar/column chart) (see Figure 3), dot density maps (see Figure 4) and choropleth maps (see Figure 5).

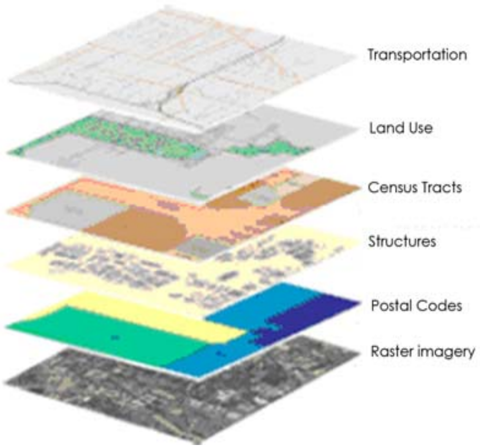

Figure 1. Thematic Overlays
Source: ESRI, 2006
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

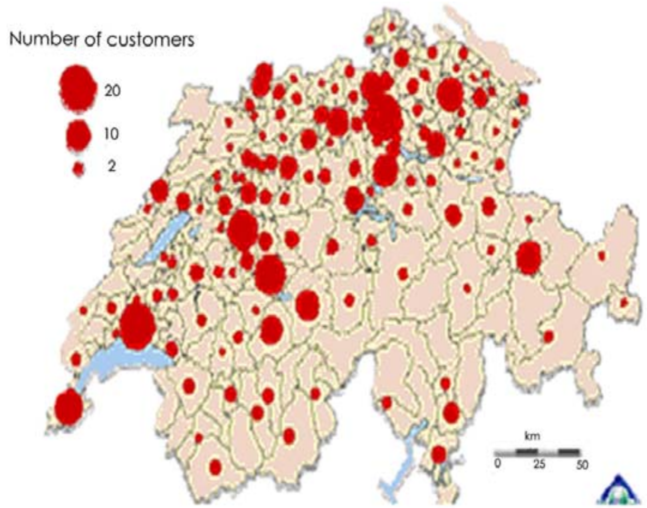

Figure 2. Graduated Symbol Map
Source: Microgis Geomatics, 2004
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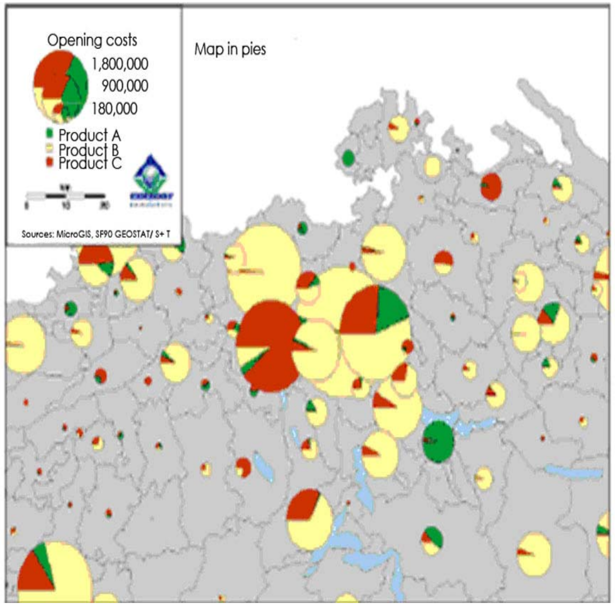

Figure 3. Map in Pies
Source: Microgis Geomatics, 2004
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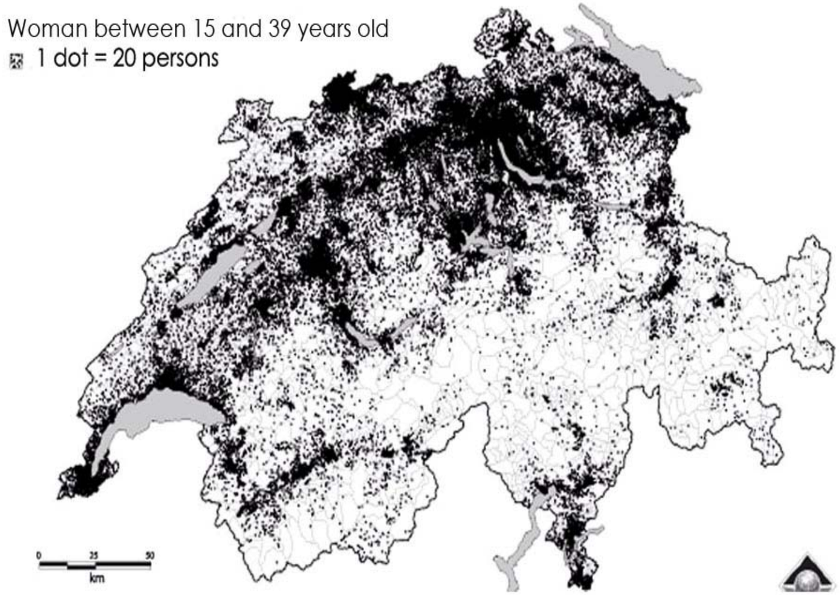

Figure 4. Dot Density Map
Source: Microgis Geomatics, 2004
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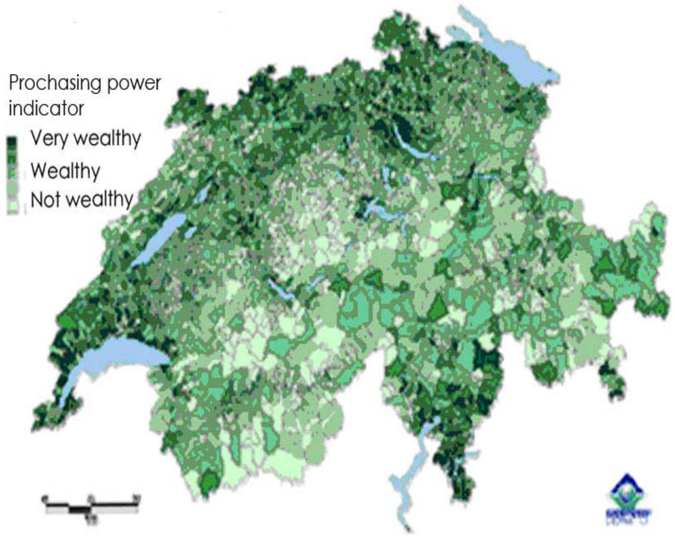


Figure 5. Choropleth Map
Source: Microgis Geomatics, 2004
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

The geographic information contains either an explicit (latitude and longitude or national grid coordinates) or implicit (address, postal code or road name) geographic reference. The geographic references allow features (such as a business or forest) and events (such as a chemical spill) located on the surface of the earth for analysis. Implicit references can be derived from explicit references through geo-coding. Basically, there are two different types of geographic information, namely the vector model (see Figure 6) and the raster model (see Figure 7).

In the vector model (see Figure 6), information about points, lines and polygons are encoded and stored in a relational database as a collection of *x* and *y* coordinates (attributes). The raster model (see Figure 7) is used to capture continuous features or objects as a collection of grid cells called "pixels" (picture elements). Each pixel is assigned a unique value that may represent continuous or discrete values. These raster-based GIS can supply data about implicit spatial relations which can be applied in remote sensing systems.

GIS IN CONSTRUCTION

In the area of market studies, Wyatt and Ralphs (2003) explained that GIS can perform geographical analysis which was used to support decision-making in different

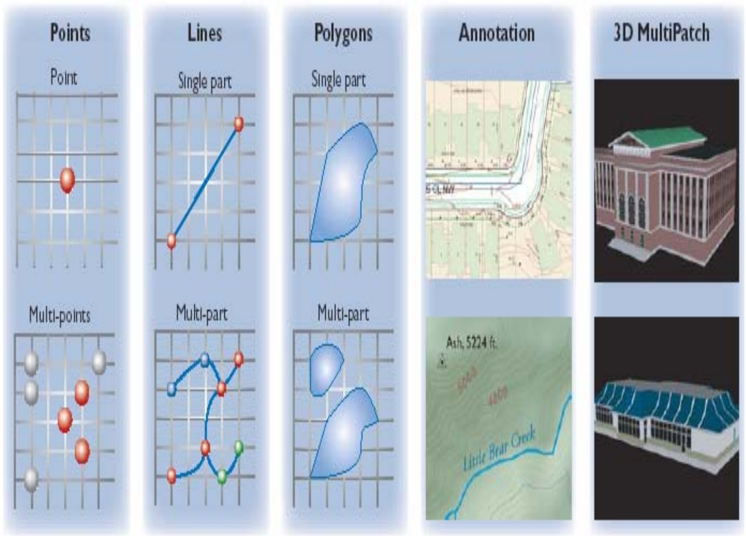


Figure 6. Common Vector Feature Representations
Source: ESRI, 2004
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

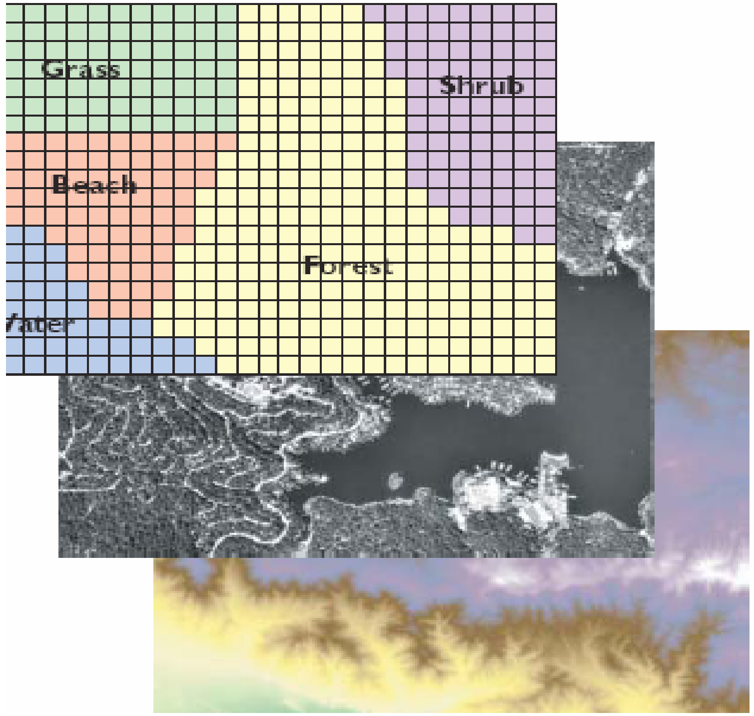


Figure 7. Raster Datasets for Imagery Data
Source: ESRI, 2004
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

market sectors such as retail, leisure, finance and property. Demographic data was analysed to produce statistical information about the population groups, customer profiling, store location planning, and development. This in turn enables the different sectors to define customer locations and identify catchment areas. In the real estate industry, it is important and crucial to have an accurate market analysis. GIS can assist in property market analysis through feasibility studies for investing and developing a particular property at the correct time in the most suitable location. These help to identify profitable investment locations. GIS can also help to reveal property trends that assist residential and commercial property investment decision-making using choropleth maps.

Publications and research into the applications of GIS in the construction industry are, however, few and far between. Most applications of GIS in construction are for large construction projects over a long duration covering a large area where there is a need to consider factors other than construction and design such as environmental effects, property boundaries, routing options and other factors. For instance, GIS was used in the pipeline route selection process for the Metropolitan Water District of Salt Lake and Sandy to supply drinking water approximately 9 km through mostly developed areas of two communities. In this case, GIS allowed for a logical selection and ranking of alternatives, resulting in one final alignment corridor that was acceptable to all stakeholders in the project (Luettinger and Clark, 2005). Furthermore, GIS was also useful in analysing the suitability for construction aggregates recycling sites using regional transportation network and population density features. It can measure the spatial relations between existing aggregates recycling sites, transportation networks, population density distribution, and natural aggregates production sites. This data-driven analysis used regional relationships to quickly delineate the general areas most likely to be of interest to the construction and aggregates industries as sites for both current and future recycled aggregates production, and to the land management community for planning and zoning evaluation related to future recycled aggregates production (Robinson and Kapo, 2004).

By extension, GIS can be used in site investigation by using a database for the storage of descriptive soil data. With the aid of GIS, construction firms can relate this data to a display of the corresponding locations of boreholes, and a graphical user interface (GUI) to facilitate the input, query, and output of data, in addition to drawing bore logs. Additionally, GIS can also relate descriptive project information to graphical displays showing geographic locations on digital maps on a computer screen. This is useful for design-build organisations who can benefit from a single database for foundations analysis, design, and construction planning; hence, enabling the integration of design and construction (Cheng and O'Connor, 1996).

Cheng and O'Connor (1996) developed a system named ArcSite, which was a GIS integrated with database management systems (DBMSs) to assist designers in identifying suitable area to locate temporary facilities. This automated site layout system proposed a knowledge acquisition method to systematically acquire and interpret experts' knowledge and experience in site planning. ArcSite demonstrated that GIS is a promising tool for solving construction layout problems. This opened up a new way of thinking in the management of spatial information for construction planning and design.

DATA COLLECTION INSTRUMENT

This present study focuses on macro level analysis using five key economic parameters that included the GDP, population, and Value Added (VA) by construction, agriculture and manufacturing.

The data were obtained via the online national accounts statistics database of established organisations such as the UN, IMF and WB. However, extracting secondary data from these sources are not without problems. To retain consistency and compatibility of data, most of the data were collated from a single source, namely the UN, which currently provides the most readily available and reliable source in terms of its comprehensive coverage and uniformity of data. The data collected were in accordance with the 1993 System of National Accounts computational format where appropriate missing data for countries between 1985 and 1990 was extrapolated through "linear interpolation at point" method using SPSS 13.0.

ArcView GIS 3.2 provides comprehensive mapping, data use and analysis tools along with simple editing and geo-processing capabilities. It comprises the following suite of applications to demonstrate its capabilities in advanced mapping symbology, editing tools, metadata management and on-the-fly projection.

ArcMap: This is a comprehensive map authoring application that enables all map-based tasks such as cartography, map analysis and editing to be performed. Geographic layers can be created to symbolise, analyse and compile GIS datasets. A table of contents, called the attributes table, allows the organisation and control of the drawing properties in the GIS data layers within the data frame. Figure 8 shows a map of the EU produced using ArcMap.

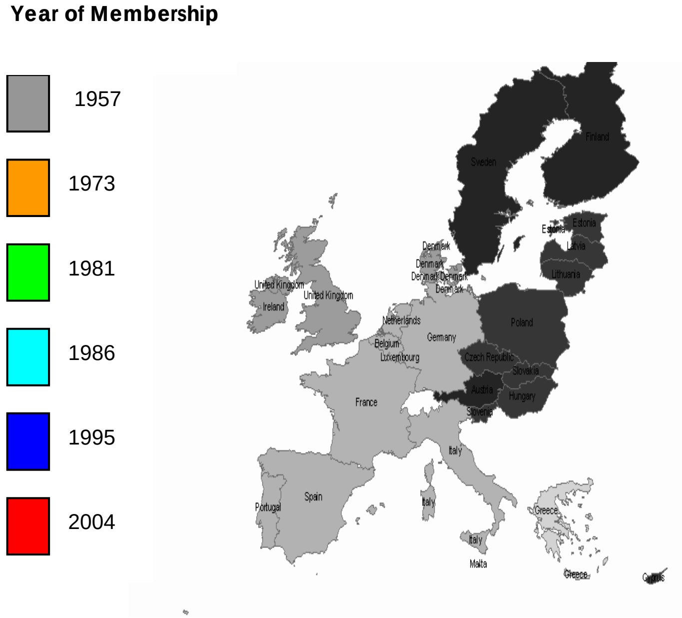


Figure 8. The 25 EU Member States and Membership Year Prepared Using ArcView GIS 3.2
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

ArcScene: This ArcView GIS 3D viewing application allows navigation through three-dimensional data. By adding data via shape-files, rasters, geo-database layers, with a z-component (denoting height), etc., the data set can then be viewed in 3D format. The z-component can be attribute value such as population, GDP, etc., for a region. Like ArcMap, the data imported into ArcScene will be displayed using symbology that can be modified. Once the symbology for the ArcScene view is set, the animation can be defined.

Arc Catalogue: This is a geo-database useful for organising and managing all GIS information, such as maps, globe, datasets, models, metadata and services. It performs five main functions: (1) browse and find geographic information; (2) record, view and manage metadata; (3) define, export and import geo-database schemas and designs; (4) search for and discover GIS data on local networks and the World Wide Web; and (5) administer ArcGIS Server.

THE EUROPEAN UNION (EU)

Formed in 1957, the EU is an intergovernmental and supranational union currently consisting of 25 European countries, known as member states. (Note: at the time of writing, two new member states, Romania and Bulgaria, were expected to join the EU in 2007). The geographical locations of EU member states are shown in Figure 8 which was developed using ArcView GIS 3.2.

General economic overview: Over the past few decades, Europe's global market share (in GDP terms) was declining gradually due in part to emerging economies such as China, India and Russia. Nevertheless, the EU still maintained a large portion of the global market share at approximately 33% in 2004. This was despite a dip from 44% in 1970.

However, the overall 20-year GDP trend for the EU seems to be in good shape. There was a persistently rising trend during the mid 1980s to 1990 and over a 10-year period from 1994 to 2004 despite a dip in 1990 which resulted in the lowest annual growth of –7.47% throughout the 20-year history. This was due in part to the global economic recession which also affected many other countries globally. According to the European Commission (1994), the economic environment in late 1993 and early 1994 was one of recession and growing unemployment throughout Europe. Hence, construction output had fallen to 10% of GDP during that period of time. According to UNECE (2003), the slow-down in economic growth first began in the western countries in 2000. This explained the decrease in GDP growth between 2000 and 2003. A growth trend was eventually noted between 2003 and 2004. This seems to be due in part to the admission of ten new member states which seem to bode well for the overall EU economy in the future.

GDP PER CAPITA

The top six richest countries in the EU were developed member states from Western Europe and the poorest countries which ranked between the 17th and 25th positions were mainly emergent member states from Eastern/Central Europe between 1985 and 2004 (Table 1).

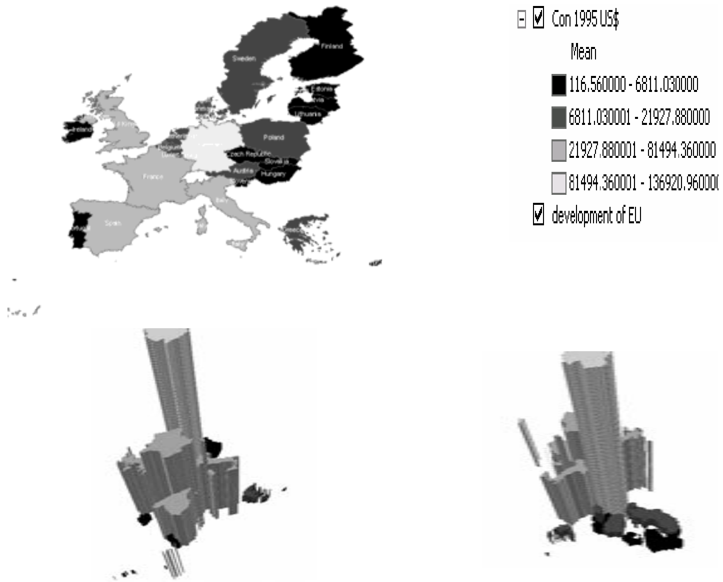
Luxembourg and Denmark consistently occupied the 1st and 2nd ranked positions in both 1985 and 2004. According to Euromonitor International (2004), GDP per capita in Luxembourg was more than twice the EU25 average in 2004, while Denmark's GDP per capita was around 20% above the EU25 average. Ireland showed the fastest progress when its GDP per capita ranking leaped from the 12th position (1985) to the 8th (2004) position. Ireland's GDP growth rate had been around 10% per year since 1995 (UNECE, 2003).

TRENDS IN CONSTRUCTION

The GIS results were presented in 2D and 3D formats for analysis. A detailed analysis was carried out for 1985, 2004, mean VA and its mean annual growth over the 20-year period.

Table 1. Ranking of EU Countries Based on GDP Per Capita (1985–2004)

Country	1985 GDP per capita (US$)	1985 ranking	2004 GDP per capita (US$)	2004 ranking
Luxembourg	28,306.43	2	63,261.71	1
Denmark	30,022.40	1	40,024.41	2
Austria	24,361.17	4	35,787.65	3
Sweden	25,286.30	3	35,102.52	4
Finland	23,704.78	6	34,348.11	5
Germany	24,141.85	5	33,297.67	6
Belgium	22,269.53	8	32,230.78	7
Ireland	11,870.39	12	32,208.20	8
France	22,932.98	7	31,451.50	9
Netherlands	21,888.84	9	31,451.50	10
United Kingdom	15,678.23	11	24,490.28	11
Italy	15,808.29	10	21,726.35	12
Spain	11,693.36	13	19,935.59	13
Cyprus	7,854.37	16	15,945.17	14
Greece	10,459.00	14	14,833.20	15
Slovenia	9,016.90	15	14,075.12	16
Portugal	7,471.29	17	12,654.07	17
Malta	5,792.23	18	11,183.80	18
Czech Republic	5,187.15	19	6,594.09	19
Hungary	4,636.88	20	6,225.73	20
Estonia	4,084.18	21	5,398.06	21
Slovakia	3,814.20	22	5,160.57	22
Polang	3,340.69	23	5,122.12	23
Latvia	3,200.76	24	3,699.81	24
Lithuania	2,299.31	25	3,045.26	25



Southern Perspective

Northern Perspective

Figure 9. Mean Value Added by Construction (1985–2004)
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

Analysis for 1985: Higher construction volume existed for Western European countries. The top three countries were Germany, France and Italy (see Figure 9) while the lowest three countries were Malta, Estonia and Luxembourg. Central/Eastern European countries, together with Finland, Portugal, Malta, Ireland and Greece seemed to have the lowest VA by construction. (Note: the "Northern" and "Southern" perspectives in the figure are meant to provide clearer illustrations of different countries in the EU).

Analysis for 2004: In contrast to 1985, the overall VA by construction had improved as the lowest VA by construction in 2004 increased by 72% whilst the highest VA by construction decreased by 16%. Countries that remained in the same class region (as indicated by the legend in Figure 9) were mainly the ten new member states. As they have only joined the EU in mid-2004, it was not surprising that they have the lowest construction volume compared to the rest. Notably, Spain showed the most significant improvement, leaping from the 3rd to 1st class region; this was due to the effects of its successful industrial renewal and economic modernisation programs that resulted in an increase in domestic demand that was buoyed by private consumption, public infrastructure and booming construction activities (Euromonitor International, 2004).

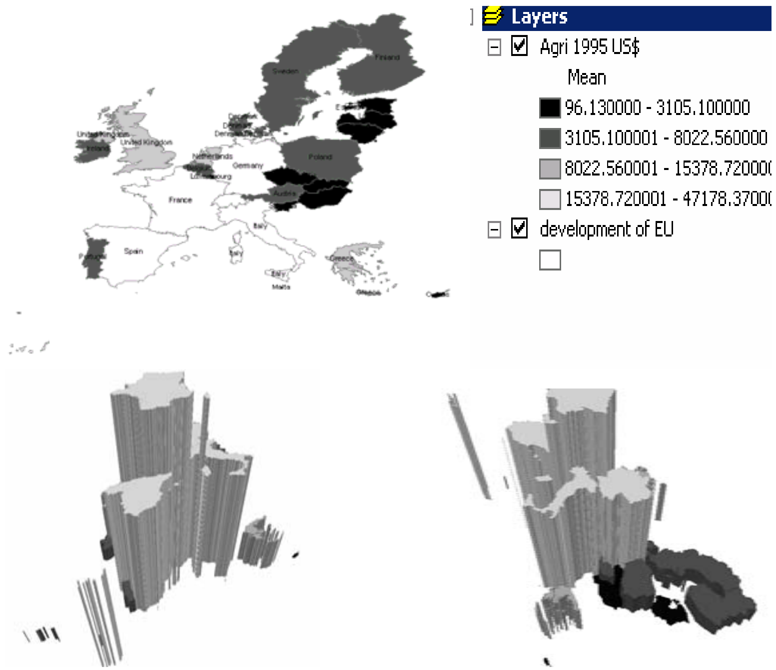
Mean VA by construction (1985–2004): Even though the spatial distributions indicated that the percentage share of the EU construction market for each country had changed between the 1985 and 2004 volume, nevertheless, the spatial distribution for the mean value indicated that there were actually minimal spatial distribution changes during the 20-year period. The percentage share distribution of each country in the EU was proportionally the same throughout the 20 years except for Poland, where it shifted upwards from the 4th to the 3rd (Figure 9) class region. This could be due to Poland's impressive economic performance during the 1995–2000 period. Moreover, its demand for infrastructure, especially roads, was in urgent need of attention and hence, this helped to boast its construction industry further.

Mean annual growth of construction: There appeared to be a pattern to suggest that countries with comparatively higher mean annual growth were those countries having smaller construction volume (Turin, 1969). A comparison was therefore made between countries with the highest and lowest percentage share and mean annual growth. The comparison showed Germany with the largest construction volume but with the lowest mean annual growth as compared to Malta and Estonia. Apart from Estonia, Ireland was another country among those with the highest mean annual growth in construction. Ireland's rapid growth in construction also helped to explain its improvement in GDP per capita ranking described earlier.

The above analysis coalesced with Bon and Pietroforte's (1990) finding that the more developed a country is, the less would be its construction demand due to its existing building stock. This decline trend for the role of the construction sector appears to set in with economic maturity.

TRENDS IN AGRICULTURE

The top three countries with the highest VA by agriculture in the EU were France, Italy and United Kingdom while the lowest three countries were Malta, Estonia and Luxembourg. The ten new member states have the lowest VA by agriculture except for Poland. Comparing between 1985 and 2004, the overall VA by agriculture had increased. The lowest VA by agriculture increased by 15%; with a corresponding increase of 17% for the highest VA by agriculture. The role of agriculture in Lithuania appeared to have diminished relative to other countries as it shifted downwards from the 3rd to the 4th class region. The overall mean VA by agriculture had increased (see Figure 10).



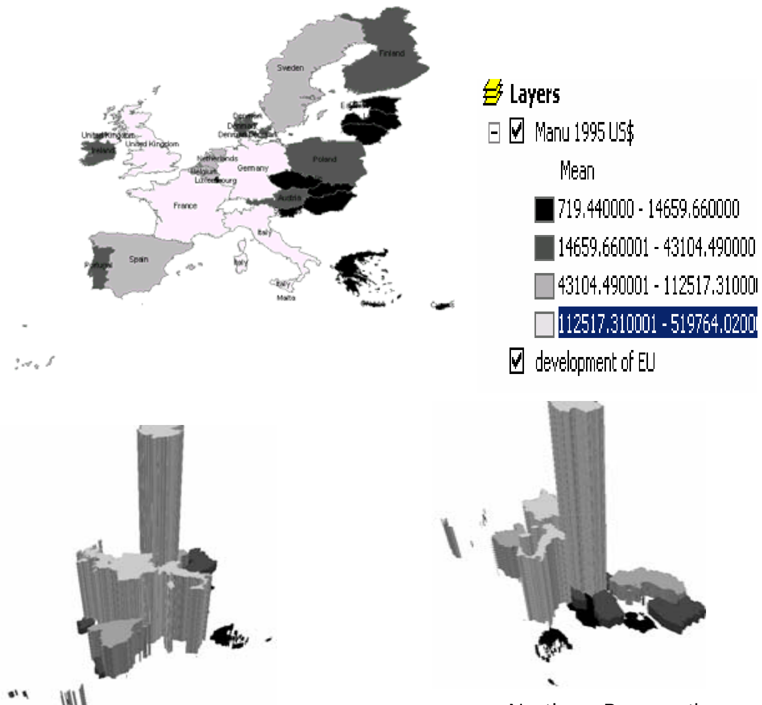
Southern Perspective Northern Perspective

Figure 10. Mean Value Added by Agriculture (1985–2004)
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

Similar to construction, there was a trend to indicate that countries which have attained comparatively higher mean annual growth rates were those countries having lower agriculture volume. France which has the highest agriculture volume yielded only 0.99% mean annual growth as compared to the Czech Republic and Malta which yielded 5.34% and 0.86% respectively even though both have much lower agriculture volume. This was however contrary to the trends displayed in most Central/Eastern European countries like Estonia, Latvia and Lithuania which have the lowest VA by agriculture and also negative mean annual growth. The fall in share of agriculture in Ireland was most significant due to its rapid expansion into the information and communication technologies (ICT) industry and high end services.

TRENDS IN MANUFACTURING

The top three countries with the highest VA by manufacturing in the EU were Germany, France and Italy while the lowest three were Estonia, Malta and Cyprus. The ten new member states were among those having lower VA by manufacturing. Between 1985 and 2004, the overall VA by manufacturing had increased (see Figure 11). The lowest VA by manufacturing increased by 92%. The corresponding increase for the highest VA by manufacturing was 23%. However, the spatial distribution



Southern Perspective

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Figure 11. Mean Value Added by Manufacturing (1985–2004)
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remained the same for both years except in Finland. The proportional contribution by each country appeared to remain constant. According to Euromonitor International (2004), Finland had several world-class industries like Nokia which played a prominent role in the electronics industry. This helped to boost the contribution of the manufacturing sector to GDP.

All member states achieved positive mean annual growth. The mean VA by manufacturing showed that more countries were in the lighter region (Figure 11). This suggests that most countries actually experienced growth during the 20-year period that was not reflected in 1985 and 2004 per se.

Similar to construction and agriculture, there was also a trend to indicate that countries with comparatively higher mean annual growth were those countries with smaller manufacturing volume. Germany which had the highest manufacturing volume yielded only 1.17% mean annual growth as compared to Estonia and Ireland which yielded 3.05% and 7.18% respectively, even though both have a much smaller manufacturing base.

Between 1985 and 2004, the overall GDP in the EU had improved. Between this period of time, the lowest and highest GDP increased by approximately 125% and 47%, respectively. Although manufacturing in most countries had increased, Italy and the UK shifted from being in the 1st class region (1985) to the 2nd class region (2004). The shift in spatial trend was because Italy had one of the lowest rates of growth among the industrialised countries.

TRENDS IN GDP

The GDP is a useful indicator for assessing the size of the market. In addition, changes in the GDP reflect the growth and health of a particular market. From the analysis so far, it was not surprising to find Germany, Italy, France and the UK among the highest contributors to the share of EU's GDP in 1985.

Between 1985 and 2004, the overall GDP in the EU had also improved. Between this period of time, the lowest and highest GDP had increased by approximately 125% and 47%, respectively. Overall, the GDP in the EU had increased (see Figure 12).

Similar to the above sector analysis, countries which have attained comparatively higher mean annual growth were those countries having lower GDP volume. Germany which had the highest GDP yielded only 2.05% mean annual growth as compared to Malta and Ireland which yielded 4.39% and 6.15%, respectively.

An interesting phenomenon can also be noted in Ireland. Even if Ireland had achieved the highest mean annual growth of 6.15%, this rate of growth was not adequate enough to raise Ireland's position out of the 4th class region in Figure 12. This seems to suggest that its contribution to the EU relative to its counterparts as a whole remained rather constant throughout the 20 years.

The overall trend suggests that countries which have performed well in 1985 and 2004 were in fact on a more or less stage of stagnancy in terms of their low mean annual growth rates such as in Germany, France, etc. In recent years, economic growth had slowed down in all western economies, even in Ireland, which had experienced the most intense growth in the last decade as the GDP hovered around 10% per year since 1995. Despite the slow-down, the GDP in Ireland still increased 5.7% in 2001 (UNECE, 2003). This seems to suggest that countries with low GDP have higher growth potential and development.

TRENDS IN POPULATION

The population trend was rather constant for all EU member states over the 20-year period. However, the overall population in all countries had increased. The top three most populated countries were Germany, the UK and France (see Figure 13) while the lowest three were Malta, Luxembourg and Cyprus. Most of the 25 member states were in the 1st and 2nd quartile region with only eight member states (Ireland, Finland, Lithuania, Estonia, Latvia, Slovakia, Denmark and Slovenia) in the 3rd and 4th class region. In the EU, it appears that countries with larger

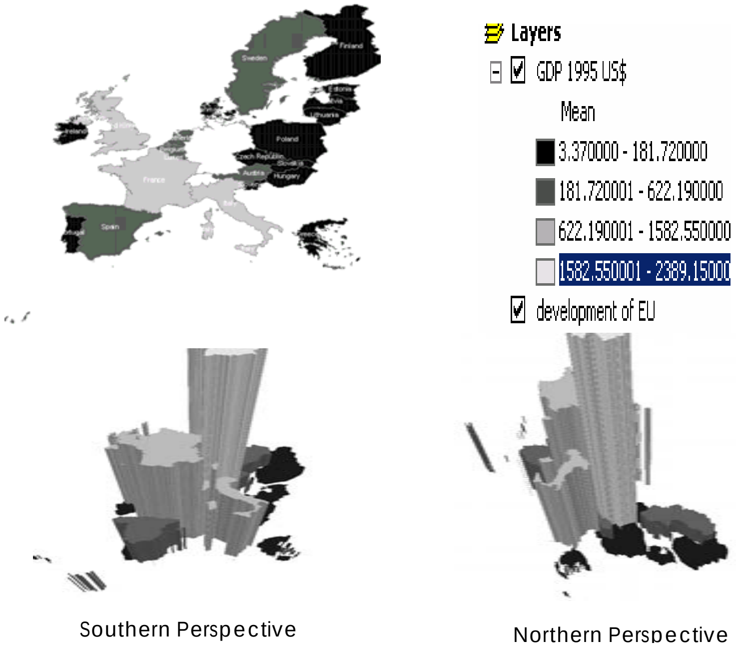

Figure 12. Mean GDP (1985–2004)
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

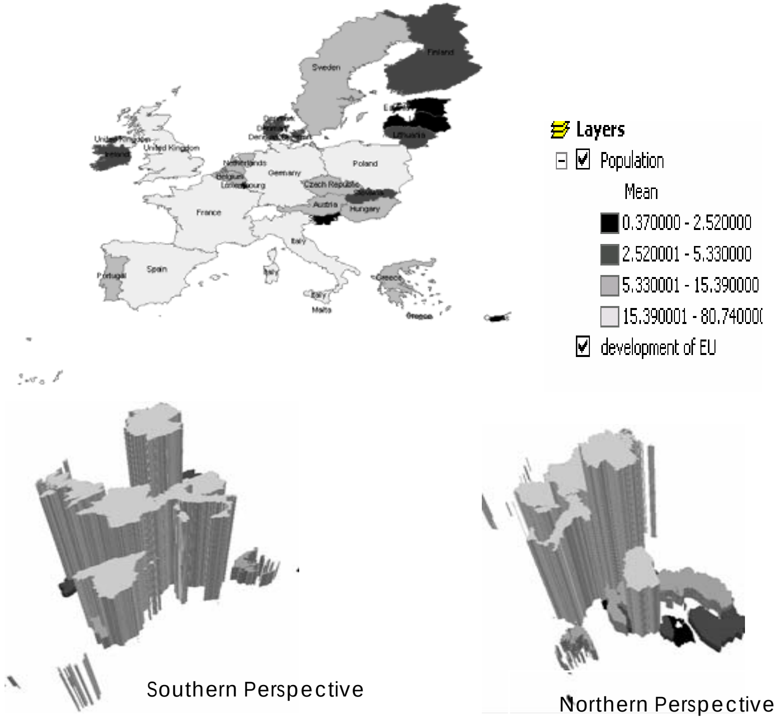

Figure 13. Mean Population (1985–2004)
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

geographical areas have a correspondingly larger population base as well. However, Sweden and Finland being relatively large countries were only sparsely populated. This seems to explain their high GDP per capita described earlier.

REGRESSION ANALYSIS

This study also set out to establish if there are relationships between construction and agriculture, manufacturing, GDP and population. Confidence level was set at 95%; hence, if significance value does not exceed 5%, it suggests that there are relationships between construction and the following variables: agriculture, manufacturing GDP and population. The coefficient of correlation and coefficient of determination, r^2, were collated. The coefficient of correlation measures the strength and the direction of a relationship between two variables while the r^2 result is a measure of how certain one can be in making predictions with the line of best fit (Jaisingh, 2000).

Relationship Between Construction and Agriculture

Latvia, Austria and Lithuania were the top three countries with r^2 greater than 0.8. The Czech Republic, Finland, Slovenia and Germany have the four lowest r^2 results.

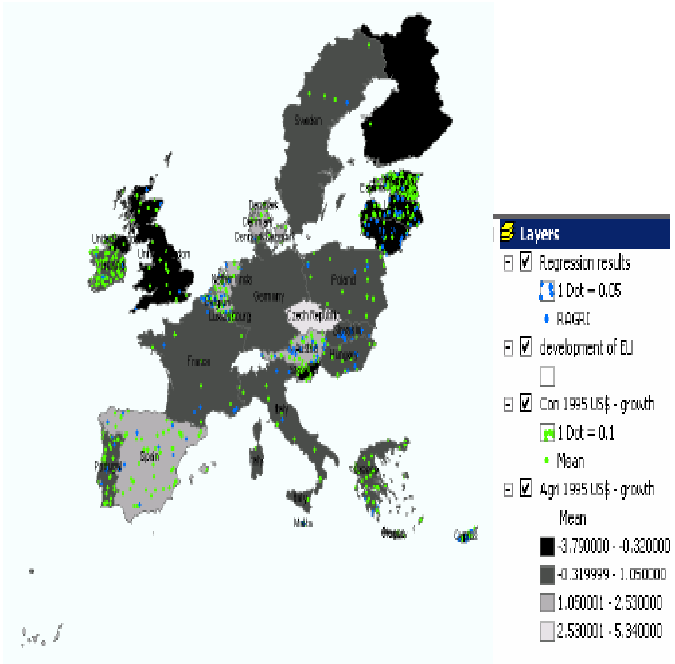

Figure 14. Dot Density Map Using Mean Annual Growth for Construction and Agriculture
Note: Blue dots – r^2 results; Green dots – construction mean annual growth rate; Choropleth base map – mean annual growth of agriculture.
(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

Countries which have the highest and lowest correlation coefficient results were analysed from GIS representation (see Figure 14) using mean annual growth rates. Austria has high mean annual growth for construction and agriculture which supported the high correlation results to ascertain that both sectors have a relationship. However, despite their regression results, it is surprising to note that Latvia and Lithuania both have positive mean construction growth with negative agriculture growth.

The regression results for the Czech Republic showed that there is no relationship between its construction and agriculture industries. This was reflected from its negative mean annual growth of construction and high mean annual growth of agriculture. A possible explanation is that the high growth of agriculture suggests that the country has not reached its full developmental potential yet and hence its construction demands were not as high. However, such regression results were not observed in Finland, Slovenia and Germany.

Relationship Between Construction and Manufacturing

Compared to the regression results for agriculture and construction, more countries seem to have a relationship between manufacturing and construction. The r^2 results ranged between 0.006 and 0.961. In 19 out of 25 countries,

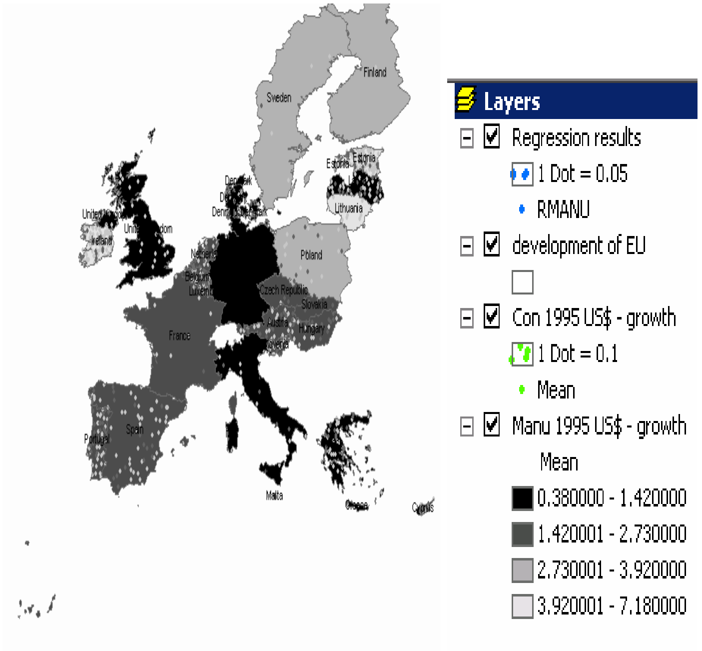

Figure 15. Dot Density Map Using Mean Annual Growth for Construction and Manufacturing

Note: Blue dots – r^2 results; Green dots – construction mean annual growth rate; Choropleth base map – mean annual growth of agriculture. *(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)*

there is a relationship between construction and manufacturing (see Figure 15). The highest r^2 can be interpreted as that 96% of the variations in construction can be explained by the manufacturing variable.

The top six countries, with r^2 greater than 0.9, were Estonia, Ireland, Greece, Luxembourg, Portugal and Spain. The lowest three countries with r^2 less than 0.05 were Germany, Lithuania and the UK.

Estonia and Ireland have high mean annual growth for construction and manufacturing, thus supporting their high correlation results and hence ascertaining that both sectors have a relationship. The corresponding results for Greece, Luxembourg, Portugal and Spain also seem to suggest that there was a relationship between construction and manufacturing in these countries.

Germany, Lithuania and the UK do not show strong regression results even though all have positive growth in both sectors except for Germany. Although Germany yielded negative mean construction annual growth and positive mean agriculture growth, there seemed to be no strong indication to show a relationship between construction and manufacturing.

Relationship Between Construction and GDP

Compared to agriculture, there seem to be more countries with a relationship between construction and GDP, and the number of countries coincided with that of manufacturing. The top four countries, with r^2 greater than 0.9, were Austria, Ireland, Luxembourg and Spain. The lowest three countries with r^2 less than 0.05 were Germany, Finland and Sweden (see Figure 16).

Austria and Ireland have high mean annual growth rates for construction and GDP which seem to support their high correlation results. The same observations were also seen in Luxembourg and Spain. Germany, Finland and Sweden do not show strong regression results even though all have positive growth in both sectors except for Germany. Although Germany reported negative mean construction annual growth and positive mean GDP growth, the relationship between these two variables seemed to be weak. This seemed to be consistent with Bon and Crosthwaite's (2000) observation that beyond a certain stage of development, the construction sector may not keep pace with GDP growth and therefore made a smaller contribution to economic growth.

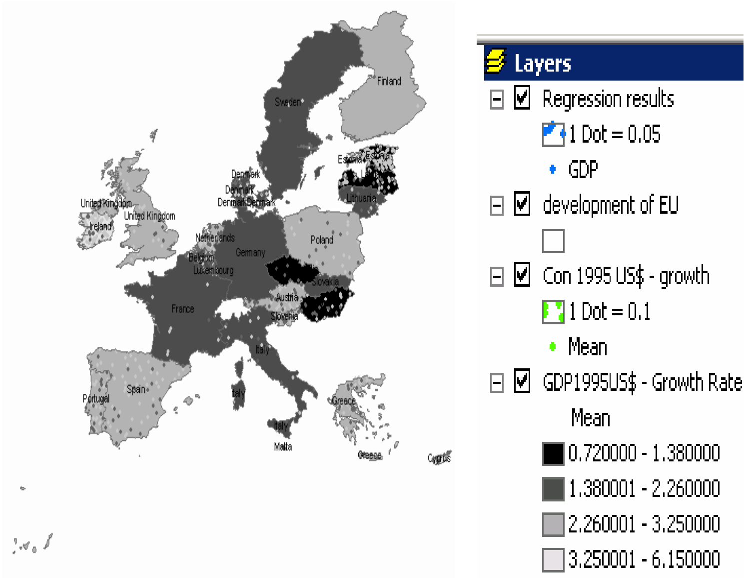

Figure 16. Dot Density Map Using Mean Annual Growth for Construction and GDP

Note: Blue dots – r^2 result; Green dots – construction mean annual growth rate; Choropleth base map – mean annual growth of GDP

(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

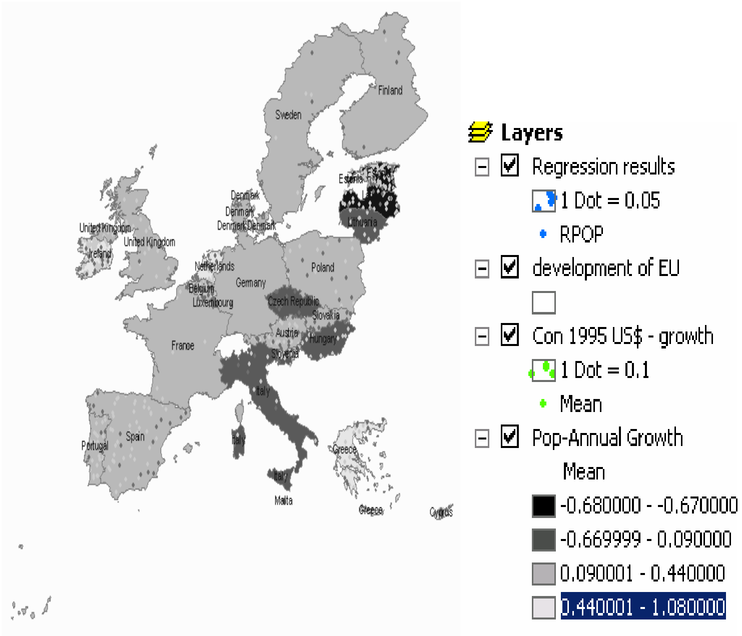

Figure 17. Dot Density Map Using Mean Annual Growth for Construction and Population

Note: Blue dots – r^2 result; Green dots – construction mean annual growth rate; Choropleth base map – mean annual growth of population.

(Please refer to http://www.hbp.usm.my/jcdc for coloured version of the figure)

Countries with lower GDP and with lower construction volume seemed to support higher correlation results. This phenomenon was strongly demonstrated by countries in Central/Eastern Europe and other countries like Ireland, Greece and Portugal. As most Central/Eastern European countries were still in the developing stage, high construction expenditures were required for infrastructure and housing; thus construction contributed substantially to GDP growth.

Relationship Between Construction and Population

The regression results between construction and population yielded r^2 that ranged between 0.007 and 0.985. There seemed to be a relationship between construction and population in 17 out of the 25 EU countries (see Figure 17). The highest r^2 was interpreted as that 99% of the variation in construction can be explained by population.

Austria, Ireland, Luxembourg and Spain have high mean annual growth for construction and population with high correlation results, hence suggesting that construction and population seemed to have a relationship. Low regression results were seen in Hungary, Slovenia and Lithuania where their percentage share contribution to construction and population was on the low side. Countries with r^2 greater than 0.9 included Austria, Ireland, Luxembourg and Spain. Countries with r^2 less than 0.05 included Hungary, Slovenia and Lithuania.

There seemed to be no distinctive trends in Figure 17 as the distribution of correlation results (indicated by blue dots in the original GIS screen shot) were randomly distributed. Countries such as France, Germany, Italy and the UK which have high mean population and construction volume have low r^2. One explanation could be that these were all highly developed countries.

CONCLUSION

This study analysed and discussed construction trends in the EU generated using GIS and SPSS. It is noted that the wealthier countries in terms of GDP per capita over the 20-year period are still the developed countries like Luxembourg, Denmark, Austria, Sweden, Finland and Germany which coincided with Low's (1993) earlier findings. In terms of mean annual growth for construction, agriculture, manufacturing and GDP, these countries are frequently among those with the lowest growth rates together with France, Italy and the UK. There seems to be a trend that countries which attained the least mean annual growth for each of the above indicators are also those which have comparably higher GDP, VA by construction, agriculture and manufacturing. Hence, it appears that there is an inverse relationship between mean annual growth and absolute volume of the indicators above. Hence, growth of construction VA is more evident for less developed member states such as countries from Eastern/Central Europe.

There seems to be an overall increase of agriculture volume within the EU due to the admission of the Central/Eastern European countries where their economies are predominately more agriculturally based. Their economies showed rapid improvement over the years even though their percentage contributions to the increase in the EU economy and construction volume were not substantial when compared with the more developed countries in Western Europe. Despite the negative mean annual growth, there seem to be higher positive growth in GDP, construction and manufacturing for most of these Eastern/Central European countries. GIS representations clearly showed that these countries are beginning to contribute more significantly to the EU when compared to their more developed counterparts.

Over the study period, there appears to be an overall decrease in construction volume in the EU. However, the higher percentage contributions of construction are still from the more developed countries in Western Europe in the EU. A country worth mentioning is Ireland which is the only country to achieve double-digit growth rates when compared to other EU countries because of its accelerated economic progress since 1995.

Many countries seem to have a relationship with construction among the variables considered. This suggests that GDP, population, agriculture and manufacturing are important factors that affect the role and development of the construction industry within an economy. In the GIS representations using mean annual growth, the correlation results seem to be relatively low. However, the GIS representation demonstrated that it is capable of highlighting unique trends and features so that further detailed analysis of such trends and features can be carried out. In particular, the correlation results suggest that the larger and more economically developed the countries are, the relationships between construction and the other economic indicators would appear to be less discernible.

The analysis also suggests that wealthier countries like Germany, France, Italy and the UK contributed to a larger share of construction in the EU when compared to their counterparts. However, the lower mean annual growth rates among these four member states suggest that they contributed minimally to the overall growth of the EU construction volume over the 20-year period. This seems to suggest that they do not offer a better market proposition for global corporations in growth terms.

On the other hand, countries such as those from Eastern/Central Europe showed higher mean annual growth rates when compared to their larger and more developed counterparts. This seems to suggest that these developing countries offer a potentially more attractive construction market. With their accession to the EU in 2004, there would be efforts channeled towards development programs in these countries, hence further enhancing their seemingly better construction market potential. As these Eastern/Central European countries progress economically, it would not be surprising if their growth in agriculture may decrease because more focus will be placed on other industrial and construction activities.

There is an overall decrease in construction volume in the EU due to the lower construction growth rate in the developed member countries. From the spatial distribution analysis, the percentage shares of the VA by construction for most developed countries in Western Europe appear to be relatively consistent over the 20-year period considered. However, Eastern/Central European countries were also notable as their increasing needs for infrastructural developments generated more construction spendings. This aspect had considerably enhanced their percentage share of the EU construction volume. Among the developed countries, Ireland is the only country which consistently achieved accelerated growth rate when compared to its counterparts.

GIS representation using mean VA and mean annual growth was compared with correlation results and both results showed that construction in most countries have strong relationships with GDP, population, agriculture and manufacturing. It was also noted that the larger and more economically developed countries like Germany, France, Italy and the UK reflected weaker relationships between construction and other economic indicators.

The key objective of this study was to demonstrate how GIS may be applied for analysing international construction markets and their associated market trends. Because of words limitation, no attempt was made to explain the trends in greater details as reported earlier. The methodology described in the study may be extended to other regional groupings such as the Association of South-east Asian Nations (ASEAN), the Asia Pacific Economic Co-operation (APEC) Forum, etc.

Globalisation drives the need to increase the effectiveness of international marketing research to identify, evaluate and compare potential overseas market opportunities and to provide construction companies with market intelligence to help them anticipate events, take appropriate actions and prepare for dynamic global changes. The uniqueness of GIS lies in its capability to bring together diverse sets of data both from within the system and from external sources. It also provides a unique way of displaying data spatially to derive new patterns of information. This greatly enhances the process of analysis and thus makes it suitable to be employed as a useful marketing information system tool for global analysis. In the final analysis, however, there are obviously many variables that affect construction trends in the EU other than the broad-based economic parameters presented in the paper. This limitation should be noted for further research.

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