

Spatial Environmental Impact of Climate Change and Carbon in MBA Programs

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Abstract:

This research reports and explores the existing gap in the field of the business industry, as reference to the integration of climate change and carbon management in MBA programs. Climate change influences every industry in today's life and it is a challenge for companies' leaders to deal with these changes. It is essential to create the baseline and the necessary background of knowledge to future leaders in order to improve the companies' governance and the process of decision-making. The objective of this research was to examine two questions: how both the top MBA schools and the accredited MBAs incorporate the environmental issue of climate change into their taught programs and furthermore, how this information is distributed in a worldwide scale. The data source was the analysis of the content of top 100 MBA programs' web pages and the 100 accredited MBA programs worldwide. The conclusions and results have also been based on the findings of clustering techniques that were used. The vast majority of the examined business schools have no reference to the issue of climate change despite its impact on a wide range of fields and its significance in today's situation.

Key Word: climate change; environmental impact; spatial analysis; GIS; carbon; global warming;

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I. Introduction

Climate change and global warming is top in mind for many executives and media attention in this issue is high, political concerns are strong and the corporate carbon footprint has become a topical subject¹⁻⁴. Global climate change caused by anthropogenic activities was first identified back nearly 200 years and the warming effect was recognized in 1827 from a French scientist, Jean-Baptist Fourier⁵⁻⁸.

Global warming has converted from an environmental issue to a topical financial issue as the last decades climate change has influenced a wide range of aspects and its impacts will be greater in the future⁹⁻¹². Thus, it would be highly interesting to define which of the existing business schools incorporate the climatic change into their offered curricula as future leaders of the biggest companies will be students who studied at the most prestigious business schools¹³. With other words, it is essential to examine if they have the necessary management skills in order to cope with climate change and its effects^{14,15}.

It is important to improve the environmental performance of a company in order to gain a better financial performance without necessarily increasing the cost¹⁶. MBA teaching is an apparatus for corporations to achieve a better financial performance considering that MBA programs offer the necessary management skills in their graduates. It is a common knowledge that natural ecosystems are more vulnerable to human activities because they lost their adaptive capacity. Consequently, the sustainability has become one of the foremost issues facing the world. Sustainability gained more ground in the field of business because the changes in the natural environment lead to that direction¹⁷. Businesses and companies must recognize that it is a need to change their strategy and that a business-as-usual approach cannot provide them with the willing profit¹⁸.

The overall aim of the project was to develop a method in order to evaluate the awareness of the Business Schools and their offered MBA programs, to digitize the results and to employ statistical analysis techniques in a GIS treatment of the data. This is an attempt to discover whether there exists spatial clusters of Climate Change (CC) focused local businesses and MBA programs.

Moreover, the purpose of this research was first to identify whether or not business schools worldwide have taken into consideration the important topic of global warming and climate that changes and how they assimilate this topical issue through their program overview. This is a key and primary part in this project. The second step of the research includes exploring whether exists spatial clusters of companies and MBA programs focusing on Climate Change, Carbon and Global Warming (CC, C or GW)^{11,19,20}.

Clusters of businesses focusing on CC and MBA schools which incorporate CC, C or GW in their curricula in the same geographic area can be explained by the requirements of companies to easily approach skilled labour, the requirements of business schools to directly observe the existing expertise for teaching and finally, by a collaboration between the university and the local businesses. This research aims to identify in which level the market will be influenced and through the visualization of the results in maps, can conclude with a better understanding of the competitiveness.

II. Material And Methods

In order to map academic interest in climate change, a quantitative analysis was conducted of the attention to the topics of Climate Change, Carbon and Global Warming (CC, C or GW) in the online curricula of the 200 selected MBA programs. The analysis focuses on the year of 2018 and two MBA categories were considered: a) the 100 top MBA programs worldwide and b) the 100 accredited MBA programs worldwide, in order to assess whether there exists a statistical difference between the inclusion of CC within top MBA schools and within others, like the accredited.

- MBA programs taught in English worldwide
- Full-time MBAs, completed in one year studies. The rationale for this choice is clearly because The Economist' ranking includes only full time MBA programs.

The top MBA schools were categorized according to each business school's location according to the top 100 MBA ranking and those are: US, Asia, Australia, Canada, Europe and UK. Moreover, the data was separated the UK from Europe and Canada from America, as regions, because in the hierarchy of MBA programs taught in English there are some continents which are leaders.

Furthermore, to have an overview of the current situation it was essential to identify another side, for that reason, an organized list was made of the MBA programs worldwide which are obviously below the top 100 but they have gained an accreditation. Several web pages was used which are essential to mention as valuable tools. Those are EQUIS, which is the European Quality Improvement System and it is a distinction for all kinds of schools and also for business schools which has established its prestige and recognition worldwide. Moreover, AACSB, which is the Association for Advance Collegiate Schools of Business and finally AMBA, which is the Association that accredits MBA programs in a global standard²¹.

In order to compose the list with the accredited MBA programs data was collected, from a really useful web site, www.findmba.com, all the business schools that exist globally according to previously mentioned regions. After having collected all the existing business schools, all accredited programs had retrieved from the same web site: www.findmba.com, and were categorized as previously: US, Asia, Australia, Canada, Europe and UK. Randomly selected 47 accredited MBAs in US, 8 in Asia, 5 in Australia, 19 in Europe and 17 in UK. The accredited programs for each region were chosen according to the previously existing percentages in the top 100 ranking in order to have an equal comparison. The rationale for the random selection is to have neutral criteria during the procedure of selection. The result was a list with the 100 accredited business schools. Both top and accredited MBA programs were considered, as they represent major source of executives for the biggest companies.

The next step was to analyze in total 200 MBA curricula and to examine how many times selected key words are found in each MBA's curriculum. For that purpose, a content analysis was made which is an approach to the analysis of documents and texts that seek to quantify content in terms of predetermined categories and in a systematic and replicable manner²². This used method produced valid and relevant data. The next step was to search for the following phrases: Climate Change, Carbon or Global Warming (CC, C or GW). The search was conducted in each MBA's section where the offered modules were presented. The purpose of the content analysis was to identify how many times the key phrases are found only in the courses' title or in the courses' description, in order to have an equal baseline to compare and rank the business schools. For this purpose, a scoring matrix was created. Using this method, was easier to rank the MBA programs according to their CC, C or GW performance and according to the level in which they incorporate CC in their program modules and consequently to evaluate them according to whether they provide their students with the necessary managerial skills to deal with climatic change.

After having analyzed all the 200 web pages, the next step was to Geo-locate these business schools and to collect all their post-codes. The aim of this procedure was to identify a number of existing companies around the Geo-located business schools. The latter analysis focused exclusively on UK. The identification of the companies conducted using several UK databases with the necessary information. The final aim of this procedure was to create clusters of companies related to climate change and carbon consultancy around the business school with the intention to explore whether there exists spatial correlation between the MBA teaching on CC, C or GW and the presence of local businesses working on these issues. Cluster analysis has become a common tool that applies spatial statistics methods to assess the relation between variables.

In order to apply Statistical Analysis in data CrimeStat III was used. This software has been used in previous research projects in order to cluster graffiti incidents and identify how location can influence this phenomenon. Using Distance Analysis routine in CrimeStat, NNINDEX was calculated in order to have an indicator of effective clustering^{23,24}.

Afterwards, using STAC method²⁵ in CrimeStat III which is a Hot Spot Analysis routine that searches for and identifies the densest clusters of incidents based on the scatter plot of points on the map and it identifies the major concentrations of points for a given distribution^{12,26}. In order to run the STAC routine it was compulsory to define the parameters (Table no 1). The search radius is a key parameter and the larger we set it the more incidents are included in the Hot Cluster.

Table no 1 Summarized parameters which were used during the clustering production in order to conclude with the best illustration of my results.

Radius	Min points/cluster	Number of standard Deviations for the ellipses
100 km	5	1.5X

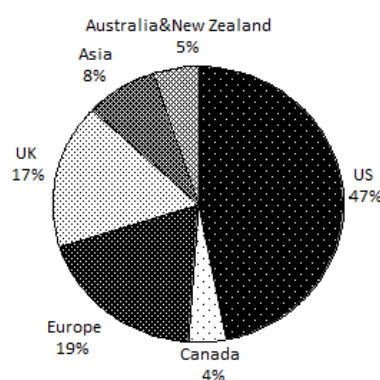
III. Results & Discussion

This section is subdivided along the two level analysis: a worldwide overview and an analysis focusing on UK. The results had wide variety with reference to the existence of those three key phrases searched in the MBA programs curricula. There are lots of programs that have none reference to CC, C or GW or an elective course concerning the global climate change, but on the other hand there are several that have an extensive citation regarding to CC, C or GW. An important finding of this analysis is that it does not depend on the prestige and the position that each MBA school has in the ranking if it incorporates CC, C or GW in their MBA curriculum.

Worldwide overview

To continue, as one can observe from this list, almost half of the MBA schools contained in the top 100 ranking, are located in US. Canada consists of the 4% of the total ranking which means that is represented by 4 business schools in the top 100 ranking despite the fact that Canada is in the second position in the full 100 ranking. In addition, Australia and Asia are represented by small percentages in the total 100 ranking. Here, it is a need to pay attention in an important issue which is the reason that Africa is not represented by any business school in the total ranking, this would be a highly interesting topic for further research related to this field.

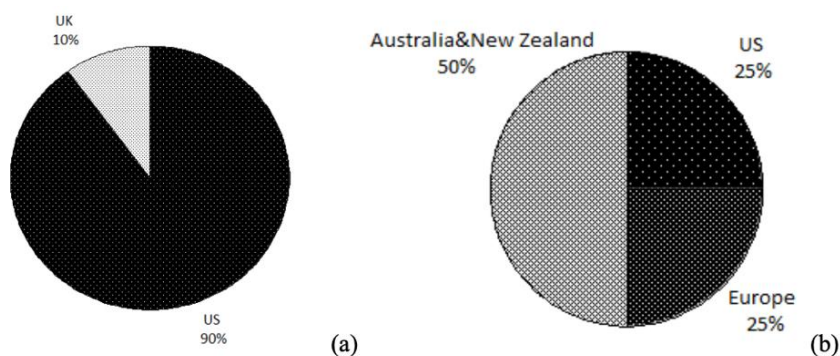
Figure no 1 Distribution of MBA programs according to the 6 selected regions: US, Canada, Europe, UK, Asia and Australia & New Zealand.



After having analyzed the content of the web pages of the 200 business schools, we can reach to some conclusions that can be summarized below:

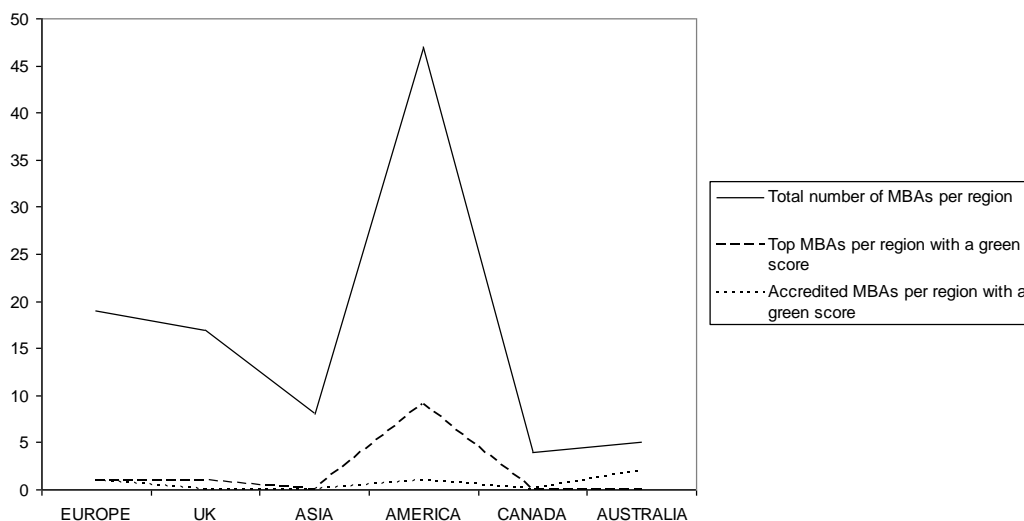
- Only the 29% of the total list of the top universities offer an elective course or have embodied CC, C or GW in their Master in Business Administration curricula.
- The 21% is observed in the first 50 positions and only 8 of the programs are ranked from the middle of ranking until the bottom offer a course focusing on CC, C or GW in the taught master.
- From the 29 programs identified in the top 100 list, the half of them are located in US, the one third in Europe, the minority is located in both Asia and Australia and none can be found in Africa.

Figure no 2 (a) Top MBA programs having a course related to CC, C or GW per each region. (b) Accredited MBA programs offering a course related to CC, C or GW per region.



In Figure no 2 are summarized the results from the contents analysis for the 200 MBA programs, top and accredited. In the 100 top ranking, in UK found 1 MBA program and in US found 9 MBA programs offered a course related to CC, C or GW. None MBA program offering a course contained CC, C or GW in its title or abstract have found in Europe, Asia, Canada and Australia. In the 100 accredited ranking, 1 MBA program offering a course related to CC, C or GW have found in US and Europe and 2 MBA programs in Australia & New Zealand. As one can observe from Figure no 3, there is only a small fraction of MBA programs, both top and accredited, that have taken into consideration that they need to offer courses related to CC, C or GW, in order to provide their graduates with the necessary management skills.

Figure no 3 Relative climate change, carbon management and global warming teaching by both top and accredited MBA programs.



There is no considerable difference between the 100 top and the 100 accredited MBAs in their teaching of climate change. Both were considered equally as they both provide big companies with the skilled executives. Goodall (2010) in her paper suggests that the rise of the prestige of business schools and the greatest demand in MBA programs is likely to be linked to the increasing demand in management²⁷. Potential MBA students are attracted by the promise of immediate seniority that elite business schools offer, by this it is meant top ranked MBA programs and also those who have an accreditation to differentiate them for the rest of the MBA programs^{27,28}. That can be observed by the fact that there are MBA programs in the last positions of the ranking that offer a course with a reference to CC, C Or GW and on the other hand there are MBA programs in the first positions of the total ranking with no reference to CC, C or GW.

These results confirm the fact that it is a necessity for business schools to recognize the opportunities and the challenges associated with climate change. Several companies have realized the importance of this topical issue and they include groups of scientific experts in their staff in order to seek solutions and advice for a 'greener' strategy²⁹.

Moreover, most of the Business Schools that offer a course related to CC, C or GW, according to their curricula, are located to the capital of a country or a large city of a US State: CEU Business School is located in Budapest, the capital of Hungary, Edinburgh Business School is located in the capital of Scotland, Griffith Business School is located in Brisbane, the capital of Queensland. This fact can be a proof that the policy making of this city is strongly related to climate change strategies and that is more likely to adapt better on climate change and global warming. Table no 2 summarizes these findings, there are listed all the MBA programs offering a course related to CC, C or GW and where each business schools located.

Table no 2 List of top and accredited MBA programs having an offered course related to CC, C or GW and their location. The majority of the Business schools are located in a capital or in the largest city of the state or country.

Top MBAs	located in	capital of	not capital but
STEPHEN M.ROSS BS	Detroit	-	largest city in the State of Michigan
MCCOMBS SOB	Austin	Texas	-
HARVARD BS	Boston	Massachusetts	-
BOSTON UNIVERSITY SCHOOL OF MNGMT	Boston	Massachusetts	-
TUCK SOB	Hanover	-	-
JESSE H JONES GRADUATE SOB	Houston		4th largest city in the State of Texas
MIT SLOAN SOB	Cambridge	-	-
COLUMBIA BS	New York City	New York	
WAKE FOREST UNIVERSITY SOB	Winston-Salem		4th largest city in the State of N.Carolina
BS UNIVERSITY OF EDINBURGH	Edinburgh	Scotland	
Accredited MBAs			
CEU Business School	Budapest	Hungary	-
Griffith University - Griffith Business School	Brisbane	Queensland	-
University of Waikato	Hamilton	-	N.Zealand's 4th largest urban area
University of Vermont	Burlington	-	largest city in the State of Vermont

Senior managers are more aware about reducing their company footprint and this is a necessity in order to do companies address to climate change¹ and to avoid the worst impacts of climate change. Companies and headquarters that are located in big cities and capitals is more likely to influence the country's policy and also the political process as its location is more potent than any other location³⁰

Focusing on UK

The analyzed data is a snapshot of the existing situation at one moment in time, however the appearance of new companies is likely to happen and it is possible to observe changes regularly. The greater the number of companies related to CC, C or GW in the vicinity, the higher the MBA climate change teaching content and the more they adapt the idea of climate change.

Agglomeration is a term used to describe the concentration of companies at a specific location in urban space. It is a common knowledge that headquarters and companies do not locate randomly but according to some economic criteria related to profit maximizing. These economic clusters which derive from the companies' concentration constitute an attraction employment within the city. When companies clustered together in space, this creates an economic force which influence the establishment of other companies as an agglomeration is a factor which leads to the success of businesses in urban areas^{31,32}. Clustering companies creates a competitive environmental and also increases the productivity as they become more competitive and there is always the tendency to enlarge the cluster by new business formation^{33,34}. This hypothesis is based on this fact assuming that the existence of a company cluster can lead to the concentration of more business schools in the area.

With regard to the climate change, companies which offer carbon consultancy or are related to climate change are supposed to offer greater availability of specialized information than at other locations. But, as the components within a cluster are interactive among them there is the possibility to observe bad performance by one part and this can result the failure of the others³⁵.

The data represented in Table no 3 constitute the statistical analysis of each city's companies related to CC, C or GW. In the following table, summarized the companies that have found to be located in each UK city

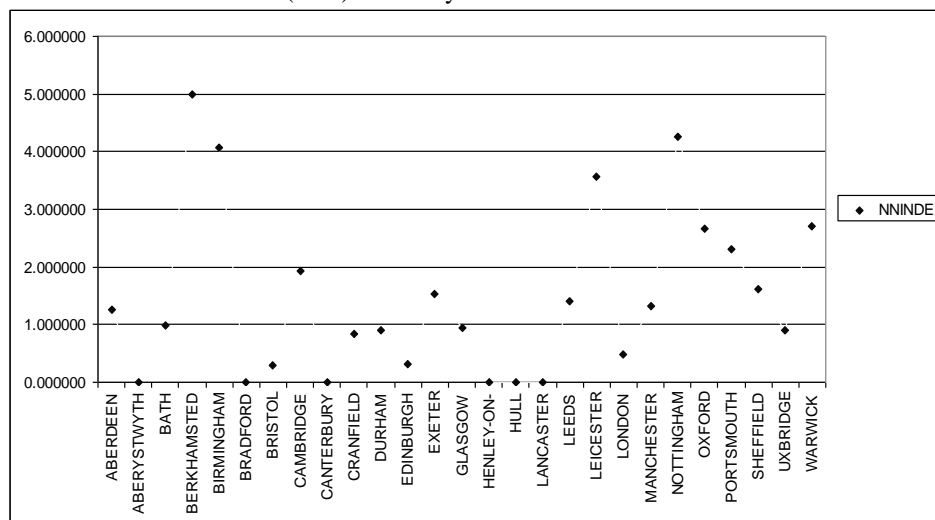
and also the business schools that are located within. Furthermore, calculated some statistical parameters. NNINDEX is a distance statistic for point pattern data sets that gives the analyst an indication of the degree of clustering of the points. In this analysis, there were some cities that only have one recorded company related to CC, C or GW and for those cities it was not possible to calculate the NNINDEX.

Table no 3 Statistical Analysis of the UK cities which were selected according to the sample of institutes. NNINDEX is a distance statistic for point pattern data sets that gives the analyst an indication of the degree of clustering of the points.

UK_CITY	COMPANIES	MBA's	NNDISTANCE	EXPECTEDNN	NNINDEX
ABERDEEN	2	1	6363.642503	5069.516742	1.255276
ABERYSTWYTH	1	1			
BATH	4	1	4604.5781	4684.5491	0.98293
BERKHAMSTED	2	1	25731.723728	5153.518216	4.993040
BIRMINGHAM	3	2	19185.309799	4723.875528	4.061350
BRADFORD	0	1			
BRISTOL	11	1	689.965074	2312.711907	0.298336
CAMBRIDGE	2	1	4331.393137	2255.514631	1.920357
CANTERBURY	0	1			
CRANFIELD	2	1	6406.968425	7716.953738	0.830246
DURHAM	5	1	9585.259613	10565.841188	0.907193
EDINBURGH	10	2	808.488569	2612.680616	0.309448
EXETER	3	1	3062.992294	1997.665304	1.533286
GLASGOW	7	2	2322.104118	2437.358054	0.952714
HENLEY-ON-THAMES	1	1			
HULL	0	1			
LANCASTER	0	1			
LEEDS	5	1	7367.416241	5252.237618	1.402720
LEICESTER	3	1	8821.893525	2472.212235	3.568421
LONDON	81	4	1069.369392	2202.762015	0.485468
MANCHESTER	7	2	2682.948364	2032.284077	1.320164
NOTTINGHAM	6	1	7497.359701	1763.212031	4.252103
OXFORD	6	1	3726.328033	1393.436998	2.674199
PORTSMOUTH	2	1	6337.181357	2741.897153	2.311240
SHEFFIELD	6	1	6363.447992	3915.514015	1.625188
UXBRIDGE	2	1	3434.748960	3802.959374	0.903178
WARWICK	2	1	16135.653684	5946.427499	2.713504

Representing the NNINDEX in a scatter plot (Figure no 4) R(NNI) can range from 0.0 for an incident distribution that have all the points at the same location, through 1.0 for a random distribution of points. If the NNINDEX has a value greater than 1 this can be evidence that the incidents are widely dispersed, otherwise if NNINDEX has a value smaller than 1 then the points are actually closer together and this can be an evidence for clustering. By observing from the Figure no 4 and Table no 3 and taking into consideration the above mentioned criteria, cities such London that has 81 companies (Figure no 5), Edinburgh that has 10 companies (Figure no 6) and Bristol that has 11 companies (Figure no 7), have enough data set points to apply clustering techniques.

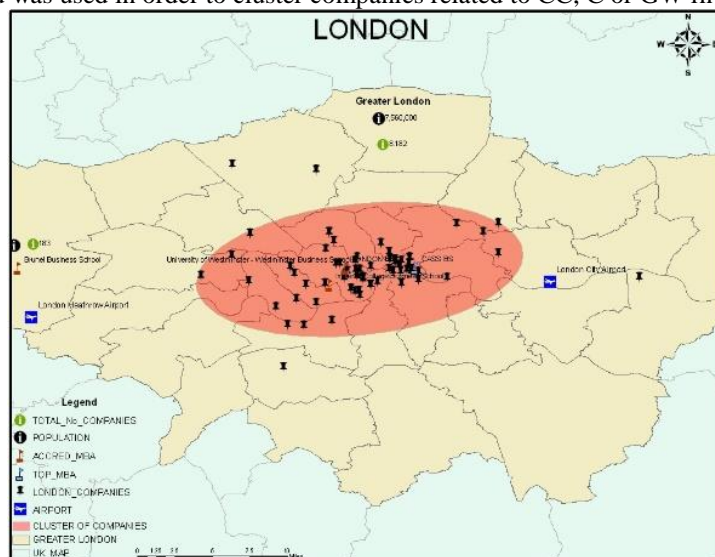
Figure no 4 Statistical representation of the NNINDEX per each UK city. NNINDEX can range from 0.0 for an incident distribution, through 1.0. In order to have an incident distribution to be clustered, the expected value of R (NNI) is usually less than 1.0.



Moreover, London is the capital of UK and Edinburgh is the capital of Scotland. Additionally, Bristol is England's sixth most populous city. Figure no 4 represents each UK city's NNINDEX, cities which have a NNINDEX between 0-1 and especially above 0.5 can ideally be clustered and we can apply further statistical analysis in them (Figure no 5,6 & 7). What is interesting in this result is that those three cities are: London a capital city of UK, Edinburgh the capital of Scotland and Bristol is within the group of English core cities. Consequently, they are centers of policy and decision making with regard to climate change and carbon management and we suggest that this is the reason that companies have found to be more concentrated in these cities. Furthermore, wherever companies related to CC, C or GW are concentrated is more likely to have more MBA programs having a course related to CC, C or GW.

In London, contrary to expectations this study did not find a direct correlation of the two variables. London is a center of management and policy making. There are several factors which influence this fact and these are: London is overpopulated and companies are major consumers of high-skilled and well-paid employees, 5 airports are located within the area of Greater London and that is an evidence that transport infrastructures is really important for firm location because it provides the opportunity of exchanging information between cities^{26,36}. Moreover, London, Edinburgh and Bristol are within the sample of EU cities which offer non-stop intercontinental flights and big firms prefer to be established in places that are hubs for transportation networks³⁷.

Figure no 5 Applying Clustering techniques in the City of London. STAC (Spatial and Temporal Analysis) method was used in order to cluster companies related to CC, C or GW in London.



In order to produce Figure no 5, 6 & 7, software CrimeStat III and ArcGIS were used. Conducted Hot Spot Analysis in order to define whether or not, companies related to CC, C or GW, which are concentrated in an urban area influence the existence of MBA programs and consequently the distribution of the idea of adoption to climate change. From this analysis, the result is that this is more likely to happen in big urban areas with a big market like London, in capital cities like Edinburgh, in which it is the center of policy and decision-making and in big and important cities like Bristol as it is within the group of English core cities.

In Figure no 5, 6 & 7 are represented the existing found clusters of companies which leads in the conclusion that companies are located in large urban areas, with large population, where other companies are already located and near to efficient transportation networks.

Figure no 6 Cluster companies providing an environmental consultancy related to climate change and carbon using STAC method in Bristol City.

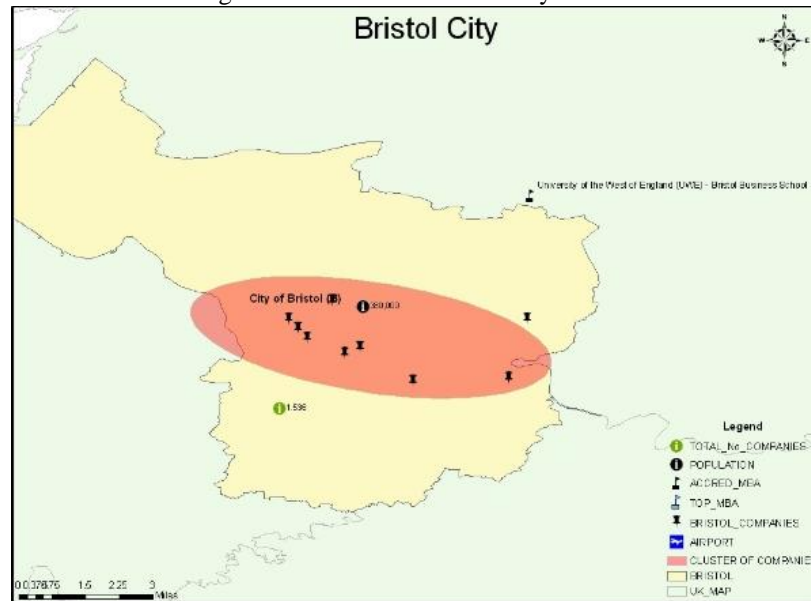
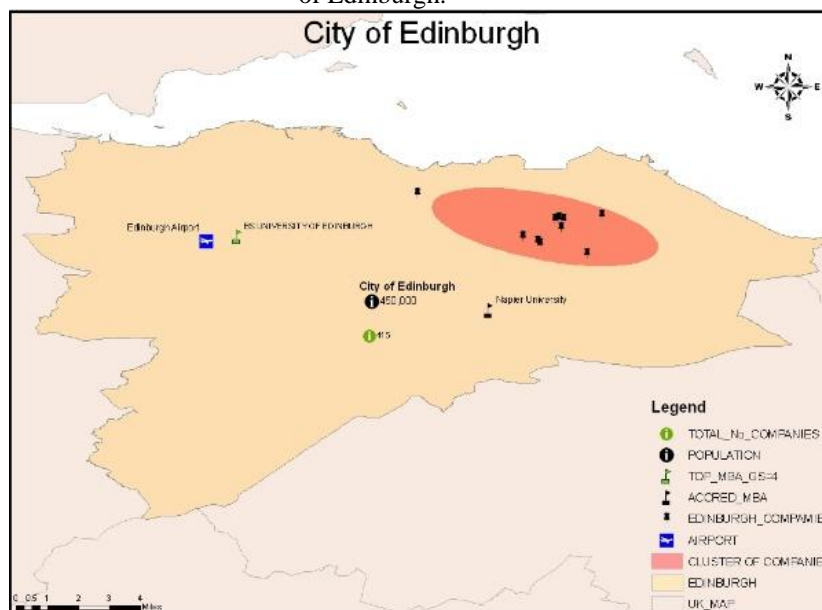


Figure no 7 Applying STAC statistical method in order to cluster companies related to CC, C or GW in the city of Edinburgh.



IV. Conclusion

This study examines whether companies concentration affect the number of business schools located in the same area. Companies are collected according to their specialization: those which are related to CC, C or GW. The research evidence should be treated cautiously because time was a constraint during the conduction of

this research. Nevertheless, it suggests that where the companies are clustered together are big urban areas or more specifically capitals where the policy and decision making are taking place.

The paper's hypothesis was tested using Statistical Analysis and Hot Spot Analysis. Moreover, the hypothesis was supported by multiple regression analysis with companies related to CC, C or GW being the dependent variable. The focus is on what extend clustered companies influence the existence of MBA programs in the area which are located. Control variables for area of the city, population, total number of companies, available transportation networks have been taken into consideration. Although the dataset is inevitably a fairly small one, it covers a panel of 27 UK cities and 34 UK business schools.

To summarize, it is urgent for business schools to address the topical issue of climate change as there is strong evidence about the effects of MBA graduates on corporate strategy. Edinburgh can be treated as an evidence for the paper's hypothesis as companies are clustered together within the area and it is the capital of the country, consequently it is the center of decision making and it also offer an MBA program having embodied CC, C or GW in its curriculum. In addition, Edinburgh constitutes the center of a green strategy, which clearly shows the active climate change adaptation.

This concern will become more pressing in the future as the next generations are more sensitive to these environmental issues. This is the reason why business schools and especially MBAs which are programs offered in young students, have to take to account that they need to offer the appropriate knowledge to their students. By this, it is meant that business schools have to provide their students with the right skills in order to face the climate change and to develop a strategy focusing on CC, C or GW for their company.

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