Deliverable due date: 31 May 2019

D1.7 Ecosystem for big players in the urban field
WP1, Task 1.2.

Transition of EU cities towards a new concept of Smart Life and Economy

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Project Acronym	**mySMARTLife**	
Project Title	**Transition of EU cities towards a new concept of Smart Life and Economy**	
Project Duration	1st December 2016 – 30th November 2021 (60 Months)	
Deliverable	D1.7 Ecosystem for big players in the urban field.	
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Contributing beneficiary(ies)	CAR, ENG, ENH, HEN, FVH, SEZ	
Task description	TASK 1.2: Smart Economy In this task, an open innovation strategy for cities to improve efficiency and effectiveness of their innovation processes will be defined. Active understanding on new technologies and cooperation with suppliers, RTOs, academy and citizens will be promoted to create service value. This strategy will be led by ESA, experts in business development, and will define how a technology will be tested not only at technology but also at economy level. Each type of intervention is going to be considered, and for each player, their accompanying business models, considering that from the cities' perspective, the business models are different. Subtask 1.2.2: Ecosystem for big players. Companies will give their inputs as key drivers in the replication process. This perspective is of interest for lighthouse and followers cities to find out what is the needed ecosystem for these big players to replicate their participation in other areas of the city.	

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Table of Content

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

Table of Figures

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Table of Tables

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Abbreviations and Acronyms

Acronym	Description
mySMARTLife	Transition of EU cities towards a new concept of Smart Life and Economy
MNE	Multinational Enterprises
TOPSIS	Technique of Order of Preference by Similarity to Ideal Solution
FPIS	Fuzzy positive ideal solution
FNIS	Fuzzy negative ideal solution
AHP	Analytical Hierarchy Process
EC	European Commission
EU	European Union
E	Expert
NI	Not important
LI	Low Importance
SI	Somewhat important
VI	Very important
EI	Extremely important
fDi	Foreign Direct Investment
WP	Work Package
ICT	Information and Communications Technology
SCC	Smart Cities and Communities

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1. Executive Summary

The main goal of mySMARTLife project is to develop an urban transformation strategy implementing different interventions in the fields of energy efficiency, electric mobility and ICT platforms to support cities in the transition from traditional to smart city model. In this new context, many private enterprises expand their traditional boarders searching for new markets. Most of them tend to look for new locations in cities that offer certain favorable conditions and are relevant from the given business perspective.

Many European cities compete to attract the big companies because these generate enormous benefits in terms of economic and social development, contributing in a significant way to the sustainability of the area. Local governments need to identify what key variables companies consider in their strategic decision-making processes, when entering new markets. If and only if public authorities know what the big companies are looking for, they will be capable to adapt their municipal strategies in order to be more attractive than their rivals.

Obviously, the decision-making process is far from being homogenous. Each sector demands different features, although it is possible to find common requirements and behavioral patterns. Considering how important the energy sector is for the development of smart cities in Europe, in this study, we focus on the European multinational enterprises from the energy sector. Specifically, we are interested in those, which have renewable, sustainable and green products and services in their portfolio and can be located and integrated within an urban area, and thereby contributing to the development of that area as a smart city.

Based on an extensive literature review and own expertise, the authors provide an initial list of variables and sub-variables considered relevant by these European enterprises, when facing a decision-making problem concerning the expansion of their services to new markets (locations). Then, managers from European multinational energy enterprises working on SCC1 projects made a pairwise comparisons, based on the Analytic Hierarchy Process, using each manager's individual judgement on how much more important is one (qualitative or quantitative) location factor with respect to another. After that, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) has been applied to assess the importance of each sub-criteria. In order to capture respondents' uncertainty and hesitance, the authors allowed managers to express their opinions in linguistic terms (i.e. very important, somehow important, not important, etc.)

The main findings of this report indicate that half of the importance of the location decision made by these leaders corresponds to the government and the market-related criteria. This means that aspects such as city's potential customers, access to financial support provided by city governments or city government bureaucracy level or degree of transparency belong to a set of complex and highly valued criteria for managers in the energy sector. In contrast, the same analysis shows that low importance is given to both the general economic indicators of city's host country and the structural factors such as the city size or its

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culture and language. These type of factors are almost non-existent and not considered, when an enterprise in the energy sector has to decide whether to grow in one European city or another.

This report contributes to the location theories by providing a novel and original framework providing a hierarchy of factors influencing the attractiveness of a European city location to the energy industry companies. The new model explains, why a multinational energy firm seeking new cities to implement its district heating or retrofitting services (or related green services) chooses to locate to one specific city.

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2. Introduction

2.1 Purpose and target group

This deliverable is a result of the actions related to the Task 1.2 - Smart Economy (subtask 1.2.2 - Ecosystem for big players). It focuses on gaining a deeper understanding of what characteristics cities need to develop or reinforce in order to increase their attractiveness for big companies. Big enterprises offering their services and products in a city contribute, together with the SMEs, to a stronger local commercial landscape guaranteeing an economic and technical development for the region as well as the new employment opportunities for the citizens.

Considering how important the energy sector is in the development of smart cities in Europe, where the public authorities are willing to develop and promote new renewable energy services as a part of their strategies to keep fighting the climate change, this report examines the European multinational enterprises and their location selection criteria Having identified the key variable influencing these business decision, local governments will be able to adapt their strategic plans and construct interesting ecosystems for these companies.

Our aim is to make a contribution to location theories by providing a novel and original methodology based on structuring the problem as a hierarchy that aims to explain, why a multinational firm from the energy sector looking for new cities to implement its district heating or retrofitting services (or related green services) chooses to settle in one location and not another. Many mayors will be keen on learning if their urban policy is aligned with the recommended activities attracting more enterprises, whose activity impacts the area in a positive way. Our study indicates what areas of impact they should prioritize, while deciding about an investment with limited resources.

2.2 Contributions of partners

The following table depicts the main contributions of participating partners in the development process of this deliverable.

Table 1: Contribution of partners

Participant short name	Contributions
ESA	Overall methodological development and redaction of all the section of the deliverable.

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Participant short name	Contributions
CAR	Coordination of partners and survey dissemination.
ENG	Analysis and validation of the survey, and answer it.
HEN	Analysis and validation of the survey, and answer it.
ENH	Analysis and validation of the survey, and answer it.
FVH	Analysis and validation of the survey, and consultancy.
SEZ	Supporting dissemination of the survey and review.

2.3 Relation to other activities in the project

The following table depicts the main relationship of this deliverable to other activities (or deliverables) developed within the mySMARTLife project, which should be considered along with this document for further understanding of its contents.

Table 2: Relation to other activities in the project

Deliverable Number	Contributions
D1.6	This deliverable studies what are the key elements of cities' business models (socials matters, environmental matters or political issues with as much importance as economic viability) to make possible a project for a city and how they can be taken into account when replicating or scaling up interventions
D1.8	This deliverable will find what are the elements that can help the development of ecosystems for SMEs, star-ups and local economy.
D1.9	This deliverable focuses on the study of innovative business models in the project (procurement, crowdfunding, leasing on innovation, RES, ESCO models, etc.) to understand how they work and can be replicated.
D6.13	This deliverable will find out what are the innovative funding schemes, opportunities, and best practices to create an investment plan for the implementation of the interventions.
D8.3	This deliverable focuses on the development of market analysis to identify and construct business cases and business models for industrial partners. The objective is to transfer the results from the Exploitation Roadmap of Results into economic feasible business models.

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D8.9	This deliverable will focus its attention on the business models of the most promising intervention from the point of view of industrial partners.

2.4 Methodology

We have followed these phases throughout the process:

1. **Literature review, identification of criteria and sub-criteria:** identification of main criteria and sub-criteria from the literature review: factors influencing the company's location decision have been identified, based on the literature review process. We have investigated and analysed only the literature, which is strategically and managerially relevant for the goal of our study, which is to understand the criteria taken into account, when the energy sector operating multinational enterprises (MNE) takes the business location related decisions. Our main goal at this stage was to highlight a group of coherent and general factors and sub-factors influencing business location.
2. **Assessment and validation:** the first evaluation was done by the authors and external experts to validate the relevance of the identified groups, to redefine some sub-criteria or to add the additional aspects, which might have been missing.
3. **Survey and data collection:** the list of criteria and sub-criteria was transformed into a survey that was sent to multiple companies of the energy sector. The main objective was to capture their opinion on the relative importance of the criteria and sub-criteria, when the company faces a strategic location-related decision.
4. **Data analysis**: we analysed the data collected from the surveys. We first identified the similarities (consensus) among the answers of the respondents. Then, we aggregated the individual statements and applied a fuzzy analytical, hierarchical process to obtain the importance weight of the various criteria.
5. **Conclusions and recommendations to municipality governments:** we seek to communicate the results of the data analysis process through a decision scheme, which is useful for politicians governing the city and seeking to attract the new MNEs. This way, the authorities obtain a tool allowing them to assess the attractiveness of the city investment landscape and implement innovative actions to improve its profile.

2.5 Acknowledgments

The authors would like to thank all the partners involved in subtask 1.2.2. (ENG, ENH, HEN, FVH, SEZ and CAR), for technical assistance, support and proactive attitude. ESADE wants to thank the participants of the distributed survey. Without their effort and selfless contribution provision of this deliverable would not be possible.

3. Theoretical Background

3.1 Introduction

This report is entitled “Ecosystem for big players in the urban field”. The term ecosystem has its origins in the ecology. It was first used in 1935 in a publication by the British ecologist Arthur Tansley with the purpose to explain the importance of transfers of materials between organisms and their environment. However, the ecosystem concept is nowadays widely applied to other fields such as medicine, business management, environment or the social sector. The term “ecosystem” highlights the idea of a dynamic entity, which is a subject of disturbances and is influenced by both - external and internal factors. In this deliverable, the word ecosystem is used to describe the urban characteristics and conditions that simultaneously guarantee the equilibrium, the dynamism and the development of multinational enterprises (also referred to as big players).

As bacteria is the key for many ecological ecosystems, large corporations are important elements for the urban ecosystem. It is critical that the ecosystem of the urban cities is in equilibrium and is well adapted to the needs of economic entities, which are able to positively impact the municipalities. The report “Our Common Future”, which has been published back in 1987 by the World Commission on Environment and Development of the United Nations, pointed out that multinational companies have the power to contribute to sustainable development and to bring far-reaching changes and improvements needed in the face of climate change and unsustainable practices. Moreover, it also warned about the necessity of taking critical and decisive political actions required to manage scarce environmental resources in the future. More specifically, it asked the governments to realize and face the upcoming urban crisis.. Cities are one of the key actors having an influence and the ability to fight for the sustainable and balanced urban ecosystem.

Business tends to go to the places where certain relevant factors are offered. These elements respond to specific objectives set by the urban decision-makers. It is often very difficult to find a single solution, i.e. a single municipality, that offers all the conditions and having the expected indicators at the desired level. Thus, the company clearly faces a multi-criteria decision. The relative importance of the location determinants varies according to the considered aspects such as the willingness to invest abroad and the nature of the product or service offered by the multinational enterprises (Martí, Alguacil and Orts, 2017). Even if the company is determined to enter the new market with a product or service fitting the new economic environment, differences in perception will occur as people interpret and perceive phenomenon such as corruption or prestige in a diverse way.

In this study, we focus on European multinational enterprises (MNE) from the energy sector. Especially those having a kind of renewable, sustainable and green products and services in their portfolio, which can be implemented and developed within an urban area and thereby contribute to the development of that area as a smart city. The main objectives of this research are to identify the criteria taken into account when

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selecting a city for offering new, renewable energy services (specifically retrofitting or district heating services) to potential clients and to conduct a comprehensive analysis of the location strategy implemented by these multinational energy enterprises. We restrict the scope of this location problem to a local-municipalities level and to European cities.

It is assumed that the objective decision is not exclusively based on the potential financial benefits but also involves an analysis of the local social and environmental aspects. Hence, the MNE selects the best possible city (or municipality) among a given set of alternatives considering multiple and divers criteria. But what is the rationale behind such a decision making process?

Answering this question is critical for the future of urban-policy making in Europe. City mayors are highly interested in attracting the MNEs, since the multitude of positive impact of the inherent innovations and the social benefits of the given services provided by the new companies have already been verified (Ciulla, Galatioto and Ricciu, 2016; Hargreaves et al., 2017; Jafari and Valentin, 2017).

3.2 The municipalities: rankings and domains

If one priority of the city is to attract more MNE of the energy sector offering green sustainable solutions (such as district heating or retrofitting), it is critical that the city mayor understands how MNE of this type take a location decision and which are the main variables having the highest priority for the managers involved in the decision-making process. For instance, are the market-related factors influencing supply and demand metrics more or less important than e.g. a Corruption Perception Index of the city? If it is more important, then to what extend supply and demand indicators are more relevant than the existing corruption scale perception? Moreover is the city's infrastructure development level as important as the tax incentives offered to the MNEs?

The attractiveness of cities is a relative and subjective aspect. It can depend on a variety of factors such as personal characteristics of the decision-maker or the goals and nature of the decision. However, there are many methodologies at our disposal trying to integrate different criteria and compare cities. A wide range of indexes exists. They analyse different aspects of European cities and provide a ranking or a classification of them. For example, to mention a few; the European Green City Index, the yearly fDi's (foreign Direct investment) European Cities and Regions of the Future Ranking, the Ranking of European Medium-sized cities or the Mercer's Quality of Living survey etc.

The European Green City Index assesses the environmental impact and intentions of Europe's major cities. The Green City Index series (Shields et al., 2009) is a research project conducted by the Economist Intelligence Unit (EIU) and sponsored by Siemens, which seeks to analyse the issue of urban environmental sustainability by creating a unique tool that helps cities benchmark their performance and share best practices. The index measures the environmental performance of more than 120 cities in Europe, Latin

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America, Asia, North America and Africa. Most are capital cities, large population hubs and business centres that were picked independently. Depending on the region, specific indicators used for the regional indexes differ slightly. For example, the European Green City Index evaluates 16 quantitative (usually data from official public sources) and 14 qualitative indicators (qualitative assessments of the city's environmental policies) classified in 8 categories, which merit equal weighting. These are:

- **Water**: water consumption, system leakages, wastewater system treatment, water efficiency and treatment policies.
- **Waste and land use:** municipal waste production, waste recycling, waste reduction policies, green land use policies.
- **Transport:** use of non-car transport, size of non-car transport network, green transport promotion, congestion reduction policies.
- **Buildings:** energy consumption of residential buildings, energy-efficient buildings standards and energy-efficient buildings initiatives.
- **Energy**: energy consumption, energy intensity, renewable energy consumption and clean and efficient energy policies.
- **CO_2**: CO_2 intensity, CO_2 emissions and CO_2 reduction strategy
- **Environmental Governance:** Green action plan, green management, public participation in green policy.
- **Air quality**: nitrogen dioxide, sulphur dioxide, ozone, particulate matter, clean air policies.

Each European city receives an overall index ranking and a separate ranking for each individual category. Based on the above listed categories, we identify the nature of the index, which is clearly useful for those enterprises that consider the environmental image of a city, when taking a location decision. It provides us with an overview of the main factors contributing to a comprehensive environmental evaluation of a city.

The yearly fDi's European Cities and Regions of the Future Ranking (fDi Magazine, 2018) seeks to find the most promising cities and regions across the whole Europe. This ranking is has been created by the fDi intelligence division of the Financial Times and is based on data collected from sources such as fDi Benchmark (online databases and location assessment tools to appraise the attractiveness of countries and cities worldwide for specific sectors and investment projects) and fDi Markets (real-time monitoring of investment projects, capital investment and job creation with powerful tools to track and profile companies investing overseas). For the 2018/2019 ranking, data was collected from 301 cities under five categories: Economic Potential, Labour Environment, Cost Effectiveness, Infrastructure and Business Friendliness. Locations scored up to a maximum of 10 points for each data point, which were weighted by importance to the fDi decision-making process in order to compile the subcategory rankings and the overall ranking.

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Another interesting European ranking for the purpose of this research is the Ranking of European Medium-Sized Cities (Vienna U. Giffinger et al., 2007), developed by the Centre of Regional Science at Vienna University of Technology as a leading partner in collaboration with the Department of Geography at University of Ljubljana and the OTB Research Institute for Housing, Urban and Mobility Studies at the Delft University of Technology. It represented an overview of the European medium-sized cities at that time (time-series data was not the scope of the ranking). Despite this drawback, the report is an interesting analysis, as it classifies medium-sized cities under the six smart city categories.

The Mercer's Quality of Living City Ranking is based on the daily life preferences for these expatriate employees and their families who are sent to work abroad. The ranking, whose scope is global, has its European version and it gives a lot of information on European cities in relation to its quality of living as an international assignee. For instance, its Location Evaluation Reports assess more than 135 locations worldwide on 14 factors that make up daily life for expatriates and their families. Ratings for the 14 factors produces an overall evaluation score for the location and provides recommendations for the incentive payment. Its quality of living methodology is based on the following categories:

- Consumer goods availability
- Economic environment
- Housing
- Medical and Health considerations
- Natural environment
- Political and social environment
- Public services and transport
- Recreation
- Schools and education
- Socio-cultural environment.

The report of The State of European Cities 2016 "Cities leading the way to a better future", released by the European Commission gives an overview of the performance of European cities with regard to the priority themes of the Urban Agenda for the EU (jobs and skills, poverty, climate change mitigation and adaption, energy transition, air quality, mobility, etc.). Some relevant conclusions from this report are summarised below:

- Cities are no longer seen as only a source of problems
- Cities attract working-age and foreign-born residents
- Cities generate growth and jobs but some risk falling into the middle-income trap
- Cities are centres of innovation and education

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- Cities contribute to achieving the targets of the Europe 202 strategy
- Housing in cities is expensive, small and crowded
- European cities are relatively safe but city dwellers tend to feel less secure
- Cities offer accessibility but must improve green mobility
- Cities are more resource efficient
- Many cities still struggle to reduce air pollution below EU thresholds
- Cities are committed to reducing greenhouse gas (GHG) emissions and adapting to climate change
- City governments are increasing their autonomy and their scale

In relation to this last point, in many countries, cities have expanded beyond their municipal borders and commuting distances have increased, further extending the reach of these economies. To better reflect this new urban reality, more and more countries have established metropolitan governments and/or merged municipalities.

It is clear that urban-policy making in Europe is an enormously powerful tool to contribute to the Sustainable Development Goals, and specifically, to impact the 2030 Urban Sustainable Development Goal of the United Nations aiming at making the cities safe, inclusive, resilient and sustainable. However, even if cooperation between European cities is a common practise, each city has to improve its competitive profile at a municipal level and urban politics is a key instrument for strengthening position among the competing European counterparts.

The actions in the domains, which a municipality could influence and the respective budgets are usually planned and forecasted annually The above-mentioned domains are usually as listed below: :

- Governance /Administration
- Education
- Employability
- Connected City (IoT- citizens)
- Social Services/Health
- Sustainability or Environment
- Cultural Services
- Tourism
- Urban Mobility/Transportation
- Urban Planning/Construction
- Safety (Physical /Virtual)

However, each city has its own departments and classification and understanding of the domains. There is an infinite number of possibilities to aggregate roles and tasks in a municipal government.

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In relation to the purpose of this study, we are interested in prioritising all these categories based on the specific goal of increasing attractiveness for MNE. What should the cities do to attracts the multinational energy enterprises? Are policy makers aware of the “key ingredients” to use if they want these enterprises to deploy their services in the cities? Do they know, which categories are the most relevant for the business managers? What are their preferences, when taking a market entry decision and implementing sustainable services/products in a new European city?

The six most-common categories used to define smart cities are smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. These six key words that helps us to understand the smart city concept were introduced by Boyd Cohen, an urban development researcher. According to the definitions given by Brussels Smart city, these six action areas are explained as:

- The smart economy: it is a city that wants to position itself as a capital of the new economy and innovation as well as a centre that draws people to it.
- Smart governance: it is a city whose public services have entered the digital era with efficient online services, WIFI and the use of digital data produced in the city.
- The smart environment: it is a city which reconciles its roles as a living space, for mobility, an economic centre… while reducing its footprint on the planet (reduced consumption of energy and natural resources and reduced polluting emissions).
- Smart mobility: it is the city which organises itself to offer an alternative to car congestion and pollution by promoting the effectiveness of means of collective and sustainable travel.
- The smart population: it is a city which fosters the development of its citizens by levelling out inequalities and encouraging them to acquire skills.
- The smart living environment: it is a city which pushes itself up to the highest level in terms of health and safety for example

However, it seems like each city and country has its own definition and concept of what a smart strategy is: zero carbon city, efficient city, sustainable city, resilient city, responsible city, laboratory city, etc. There are as many definitions as cities.

Caragliu et al believe a city turns smart, when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance. As we can see, this definition includes the six main axes or dimensions: a smart economy; smart mobility; smart environment; smart people; smart living; and, smart governance (Caragliu, Bo and Nijkamp, 2009).

Depending on the definition, some of those aspects play a more pronounced role. Some definitions put an emphasis on the technological aspects of the smart city concept, while other tend to highlight the

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environment and social responsibility-related aspects of the phenomenon. The application domains extracted from an in depth-analysis of literature review are (Pelegrín, 2010):

- Resources (utilization and management): deals with natural resources, energy, water monitoring and management.
- Transportation: relates to application of ICT solutions for transportation management, as well as intelligent transportation products and smart mobility in general.
- Urban infrastructure: refers to buildings, agglomeration and urban sprawl management with the ICT.
- Living: covers education, health, safety and quality of life in urban space.
- Government: public and e-services delivery; e-democracy and participation; accountability and transparency as well as administration's efficiency within the city.
- Economy: covers areas that reflect domestic product in city; innovative spirit; employment; and e-business.
- Coherency: deals with social issues related to digital divide; social relations; and ICT connectivity.

Other authors (Neirotti *et al.*, 2014) propose a categorisation of possible domains of the SC concept, to which technology and policy interventions can be applied. They group the application domains into two categories, further divided into sub-fields:

- Hard Domains
  - Energy grids,
  - Public lighting, natural resources and water management,
  - Waste management,
  - Environment,
  - Transport, mobility and logistics,
  - Office and residential buildings,
  - Healthcare,
  - Public security.
- Soft Domains
  - Education and culture,
  - Social inclusion and welfare,
  - Public administration and (e-) government,

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- Economy.

All these different sets of the urban domains will be needed, when analysing the literature and more importantly, while developing the final list of criteria and sub-criteria being the basis of the survey. Besides, they will allow us to clearly identify the areas, where a city authorities can take actions.

3.3 European MNE in the energy sector: moving towards a low carbon economy

People's well-being, industrial competitiveness and the overall functioning of society are dependent on safe, secure, sustainable and affordable energy. According to the European Commission's science and knowledge services, the energy sector, covering extraction, production and distribution directly employs about 1.6 million people and generates an added value of €250 billion to the European economy, corresponding to 4% of value added of the non-financial EU business economy (EU Science Hub).

In the framework of the EU Sustainable Development Strategy, the European Commission has developed security of energy supply, climate change mitigation policies and adopted a number of regulatory measures aiming at introducing low-carbon innovative technologies, which will ultimately impact the market structure of the sector. The EU has also endorsed an ambitious GHG emission reduction targets and accompanying targets for the decarbonisation of the energy sectors.

In this complex policy context, there is a need to design local, regional and national policies to meet these targets. For the purpose of this analysis, we focus on understanding and analysing MNEs established in the energy sector. Remember that, by definition, these organizations control production of goods and services in at least one country other than its home country. Hence, taking location decisions is part of their main strategy. More specifically, our objective is to collect qualitative and quantitative data from those that are currently offering sustainable and renewable-energy-related solutions in their portfolio. In 2014, EU countries agreed on a new renewable energy target and reducing their final energy consumption by at least 27% until 2030. The renewable energy industry plays and will play an important role in helping the EU meet its energy targets.

We have compiled the data as well as opinions and preferences reflected e.g. in the location strategies of 10 European multinational enterprises. Information has been obtained directly from the directors or senior managers, since they are responsible for planning and taking location-related strategic decisions. In table 3 we provide the relevant characteristics, defining the MNEs participating in this project. Data is presented on an aggregated level and refers to the situation of the last closed year (2018).

It is important to highlight the fact that the majority of the interviewed companies have been established at the beginning of the twentieth century (several, formed even earlier) and many of them were initially stated-owned. They have traditionally offered basic products and services related to energy, transportation and communication. They are now huge, private owned multinationals with thousands of employees, who

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operate not only in their home country but also internationally. Actually, some of these MNEs have a total economic turnover greater than that of many small states. It is also relevant to mention, that the organizational structure of these enterprises is complex and mostly based on a subsidiary model. Their foreign subsidiaries tend to respond to local competitive circumstances and develop local responses, while at the same time, being strategically aligned to the whole organization.

Table 3: Features of the participants: MNE in the energy sector

Main characteristics of MNE in the energy sector, target of this study.
They are all well-stablished companies founded before the nineties. Even some of them, were set up in the 19th century.
Headquarters are not necessary placed in big cities or capitals (well-known) European cities and can vary between cities such as Stavanger, Barcelona or Amersfoort.
Their growth is a result of first, organic growth and then, mergers and acquisitions.
A vast majority were initially owned by the state. Some still have a public shareholder.
Their current revenues are usually thousands of millions of Euros, ranging from 4.000 million to more than 25.000 million Euros.
Number of employees ranges from 16.000 to 150.000 .
International market, beyond Europe.
Complex hierarchal organizations and subsidiary model predominance
Very active in corporate social responsibility activities and currently, transforming their operations for the benefit of the triple concept of sustainability

We assume all these MNEs are totally aware that the issue of sustainability will play a critical role for their future success. Besides, this refers not only to Corporate Social Responsibility (CSR) in the sense of social responsibility but it also includes all the aspects related to environmental responsibility, which is year by year becoming more critical to corporate performance. Many external stakeholders (media, politics, consumers, non-profit entities, etc.) put lots of pressure on multinationals because of their environmental performance. Recent studies show how the relationship between CSR and stock prices may evolve over time and also, in how far the stakeholders can influence company's results. (Flammer, 2013). The positive

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reaction to the announcement of eco-friendly initiatives may significantly decrease, while the negative reaction to the announcement of an eco-harmful behaviour increases.

The authors of the study focused on the MNEs, because the companies can take up a role of the developers, operators, architects or engineers responsible for designing, implementing and installing sustainable services in the city (for instance, a heat network implementation, also known as “district heating” or “district heat “, or the retrofitting of buildings. On the one hand, the development of heat networks in cities is an essential element of the carbon content and environmental impact reduction through e.g. fighting the air pollution. (Olsson, Wetterlund and Söderström, 2015; Hargreaves et al., 2017; Morvaj, Evins and Carmeliet, 2017). On the other hand, according to the European Commission, buildings are responsible for approximately 40% of energy consumption and 36% of CO2 emissions in the EU. Currently, about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient. Therefore, retrofitting of the existing buildings has the potential of significant energy savings and it can also generate other economic, social and environmental benefits. It has a major impact on the affordability of housing and the issue of energy poverty. Therefore, European directives (Energy Performance of Buildings Directive 2010 and the Energy Efficiency Directive 2012) are transposed by Member States into national legislation and hence, at a municipality level, policy makers, shall be highly interested in attracting all type of economic agents whose activities contribute to addressing important socio-economical challenges.

3.4 Methodology: some notions

In this section, we will give some basic mathematical notions, which are the basis used for the analysis of the data extracted from the survey and obtaining the final results. First, the analytic hierarchy process is presented. This multicriteria decision making approach will be applied in the analysis phase to identify the criteria weights. Secondly, the concept of using fuzzy variables to capture uncertainty and imprecision of respondents is detailed. Thirdly, a brief explanation of the TOPSIS approach is provided as it will be the basis for obtaining the final taxonomy of sub-criteria.

First of all, it is important to mention that methodology used in this report is not based on statistics (for example, normally distributed samples) rules and therefore a minimum sample size of 30 would be required for the assessment of data. In Analytic Hierarchy Process (AHP) and other multicriteria decision making tools the threshold value for a fairly valid analysis is certainly lower than that. With a half a dozen or eight responses from experts gathered, the methodologies proposed in the following paragraphs are consistent and stable (Daim, Udbye and Balasubramanian, 2013). The number of experts considered for this study is enough as accumulated knowledge in top strategic positions in multinational enterprises in the energy sector is concentrated in few people and besides, more importantly, we apply the AHP methodology instead of asking the experts to just provide a simple, straight ranking of the criteria. Moreover, introducing fuzzy ranges in qualitative data allows us to extract more information from an ambiguous context even if the

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number of respondents (experts) is low compared to other crisp contexts (where respondents are not allowed to hesitate).

3.4.1 AHP and consistent preference relations

The AHP is a multicriteria decision making approach, in which factors are arranged in a hierarchic structure (Saaty, 1990). AHP is a theory of relative measurement (Brunelli, 2015). This is the selected method chosen for this study as it allows us to identify the criteria and sub-criteria that are important for the location decision of energy sector operating MNEs and arrange them in a hierarchic structure descending from an overall goal to criteria, sub criteria and alternatives in successive levels. Besides, it is a valuable decision methodology for group decision making that helps to minimize biases, and in this case, we need to capture the opinion of a team of experts from the MNEs in the energy sector in the most effective manner.

The AHP has been extensively adopted in many practical decision-making applications. It is probably the most widely used multi-criteria decision-making method worldwide. In this section, we will briefly explain the fundamentals of this method. The AHP proposes a decomposition of a decision making process into the following steps (Saaty, 2008):

1. Define the problem and determine the kind of knowledge sought.
2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels (criteria on which subsequent elements depend) to the lowest level (a set of the alternatives, options, candidates, etc.).
3. Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.
4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level are obtained.

The scale of numbers that indicates how much more important one element is over another, used in AHP by Saaty, is exhibited in the following table:

Table 4: Verbal judgements used by Saaty

Verbal Judgement	Numerical Value
Extremely Important	9
	8

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Very strongly more important	7
	6
Strongly more important	5
	4
Moderately more important	3
	2
Equally Important	1

This is the scale used in our survey for part 1. We have decided to use crisp value as a measurement for the intensity of experts' preferences. However, an AHP version, which accounts for uncertainty and vagueness exists. The fuzzy AHP is a popular methodology to account for uncertainty and is extracted from the theory of fuzzy sets initiated by Zadeh (1964). In the fuzzy AHP entries of the pairwise comparison matrices are expressed in the form of fuzzy numbers (Brunelli, 2015), it means that the expert can choose more than just one number of the above table. For instance, we may encounter an expert who is not sure whether one comparison is strongly more important or moderate more important.

One of the most commonly used shapes of fuzzy numbers for modelling preferences is the triangular fuzzy number. Once, we have a fuzzy pairwise comparison matrix expressed in triangular fuzzy entries, we derive the priority vector. Usually, a priority vector with triangular fuzzy numbers as components is obtained by an extension of the geometric mean method. But the solution obtained in this optimization problem can be ambiguous. How we rank fuzzy numbers is not trivial. Therefore, for the purpose of our analysis, we prefer not to use the fuzzy AHP for the first part of the survey.

Once we have the pairwise comparison matrix expressed in crisp values, the ratio scales can be derived from the principal Eigen vectors (which is used to estimate the priority vector) and the consistency index is derived from the principal Eigen value. However, other methods to derive the priority vector (such as the least square method or the normalized columns method) exist. It is important, as our respondents are experts, to measure the consistency of their judgements or to ask questions in a way that helps minimize inconsistencies. Experts, who are totally rational would be capable of expressing their judgements in a pairwise comparison matrix, for which each entry is exactly $a_{ij} = {}^{w_i}/_{w_j}$ for all i, j. This matrix holds the transitivity condition and would be called a consistent matrix. The following condition holds true (Saaty, 2008):

$$a_{ik} = a_{ij}a_{jk} \quad \forall i, j, k,$$

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Direct comparison a_{ik} can be obtained by all indirect comparisons $a_{ij}a_{jk}$. For example, if we do have the values of B and C in this pairwise comparison matrix of 6x6 obtained from the pairwise comparisons questions to our respondents, assuming consistency, we can deduce the value of component A.

$$\begin{pmatrix} a_{11} & \cdots & a_{16} \\ \vdots & \ddots & \vdots \\ a_{61} & \cdots & a_{66} \end{pmatrix}$$

$$\begin{pmatrix} 1 & A & B & & & \\ & 1 & & & & \\ & C & 1 & & & \\ & & & 1 & & \\ & & & & 1 & \\ & & & & & 1 \end{pmatrix}$$

This implies that the experts never do contradict themselves, when expressing their preferences, which in a real–world situation is very uncommon as many factors can induce inconsistencies. Actually, the fact that we ask them to express the strength of the preference is always a very difficult task that causes the majority of inconsistencies. To understand this issue better, refer to the example given by Jafar (Rezaei, 2015). Jafar's proposal consists of dividing the pairwise comparisons into two main categories: (1) Reference comparisons and (2) Secondary comparisons. Comparison a_{ij} is defined as a reference comparison if i is the best element and/or j is the worst element. And, comparison a_{ij} is defined as a secondary comparison if i nor j are the best or the worst elements and $a_{ij} \geq 1$.

We have built the questions of our survey, while following some of the recommendations and ideas proposed in Jafar's Best-worst multi-criteria decision-making method. If we think of our comparison matrix of the 6 main criteria, the total number of possible comparisons is 36. As the elements in the diagonal are 1, we have 6 comparisons with a value $a_{ii} = 1$. The remaining 30 comparisons, half of them are $a_{ij} \geq 1$ and the other half are the reciprocals. From the first 15 comparisons, 9 are reference comparisons and the rest are secondary comparisons, which can be deduced from the reference ones.

Nevertheless, we have considered only 5 necessary questions to deduce all the pairwise comparison matrix and obtain a perfectly consistent matrix, following a proposed method for constructing consistent fuzzy preference relations from a set of n -1 preference data (Herrera-Viedma *et al.*, 2004). This allows us to ask less questions to the experts and obtain perfectly consistent judgements. This is based on a new characterization of the additive consistency condition, which states that for checking additive consistency of a fuzzy preference relation P, it is only necessary to check those triplets of values(i, j, k) verifying $i \leq j \leq k$. The process is summarized as follows (Herrera-Viedma *et al.*, 2004):

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To construct a consistent multiplicative preference relation A' on $X = \{x_1, \dots, x_n, n \geq 2\}$ from $n-1$ preference values $\{a_{12}, a_{23} \dots, a_{n-1n}\}$ we need to apply these steps:

1. Compute the rest of the preference values B as:
   a. $B = \{a_{ij}, i < j \,\Lambda\, a_{ij} \notin \{a_{12}, a_{23} \dots, a_{n-1n}\}\}$, $a_{ij} = a_{ii+1} \cdot a_{i+1i+2} \dots \cdot a_{j-1j}$
2. Set $a = \max B$
3. $A = \{a_{12}, a_{23} \dots, a_{n-1n}\} \cup B \cup \{a_{12}, a_{23} \dots, a_{n-1n}\}^{-1} \cup B^{-1}$
4. The consistent multiplicative preference relation A' is obtained as $A' = f(A)$ such that:
   a. $f: \left[\frac{1}{a}, a\right] \to [\frac{1}{9}, 9]$,
   b. $f(x) = x^{1/\log_9 a}$

For example, suppose that one of the experts has provided his judgements on the set of six criteria $\{c_1, c_2, c_3, c_4, c_5, c_6\}$ by answering five questions. He has certain knowledge to assure that criterion six c_6 is more important than criteria c_1, c_4 , x_5 and much more important than criteria c_2. Besides, he says that criterion c_3 is somewhat more important than criterion c_6.

For this example, the resulting matrix, when constructing the consistent multiplicative preference relation is depicted in the following table. Each entry i,j denotes the comparison of importance between row C_i with column C_j

Table 5: An example of a consistent multiplicative preference relation (the ratio of Saaty is not preserved)

	C1	C2	C3	C4	C5	C6
C1	1,00	1,29	0,05	1,00	1,00	0,14
C2	0,78	1,00	0,04	0,78	0,78	0,11
C3	21,00	27,00	1,00	21,00	21,00	3,00
C4	1,00	1,29	0,05	1,00	1,00	0,14
C5	1,00	1,29	0,05	1,00	1,00	0,14
C6	7,00	9,00	0,33	7,00	7,00	1,00

As we see here, the ratio scale of 1/9 and 9 proposed by Saaty is not preserved. The transformation function f is applied to obtain the following matrix, which is also a consistent multiplicative preference relation.

Table 6: An example of a consistent multiplicative preference relation (the ratio of Saaty is preserved)

	C1	C2	C3	C4	C5	C6
C1	1,00	1,18	0,13	1,00	1,00	0,27

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C2	0,84	1,00	0,11	0,84	0,84	0,23
C3	7,61	9,00	1,00	7,61	7,61	2,08
C4	1,00	1,18	0,13	1,00	1,00	0,27
C5	1,00	1,18	0,13	1,00	1,00	0,27
C6	3,65	4,32	0,48	3,65	3,65	1,00

From this matrix, we can derive the ratio scales of the six criteria as proposed by Saaty.

3.4.2 Fuzzy variables to capture uncertainty

Using judgements from the managers, consultants and experts of the MNEs is necessary if we want to really capture their subjectivity and hesitancy. We will explain here the methodology used to capture their uncertainty and imprecision will be explained in this chapter. This framework will be used for analysing part 2 of the survey.

We know that expressing an opinion with an exact value is really hard in strategic decisions. In section 2 of the survey, the respondents are allowed to express their judgements less precisely as this is an inherent nature of complex decisions in business environments. Actors happen to hesitate about the relative importance given to each of the 27 sub-criteria, which are linguistically evaluated (none, somewhat, extremely important, etc.). Linguistic descriptions, which are usually summary descriptions of complex situations, are fuzzy in essence (Dubois and Prade, 1980). Since fuzzy variables capture measurement uncertainties as part of experimental data, they are more in line with the reality than the crisp variables (Klir and Yuan, 2002).

Membership functions of ordinary fuzzy sets are often overly precise. They require that each element of the universal set will be assigned to a particular real number. However for some concepts and contexts, in which they are applied (for instance, in group decision making) we may be able to identify appropriate membership functions only approximately, i.e., we may only be able to identify meaningful lower and upper bounds of membership grades for each element of the universal set (Klir and Yuan, 2002). These types of fuzzy sets are called interval-valued fuzzy sets (Sambuc 1975), defined formally by the following function, where E([0, 1]) denotes the family of all closed intervals of real numbers in [0, 1]:

$$A: X \rightarrow E([0,1])$$

An example of a membership function of this type is given in the following figure. A(x) is represented by the segment between the two curves, which express the lower and upper bounds. Thus, A(a) = (a_1,a_2). IVFSs

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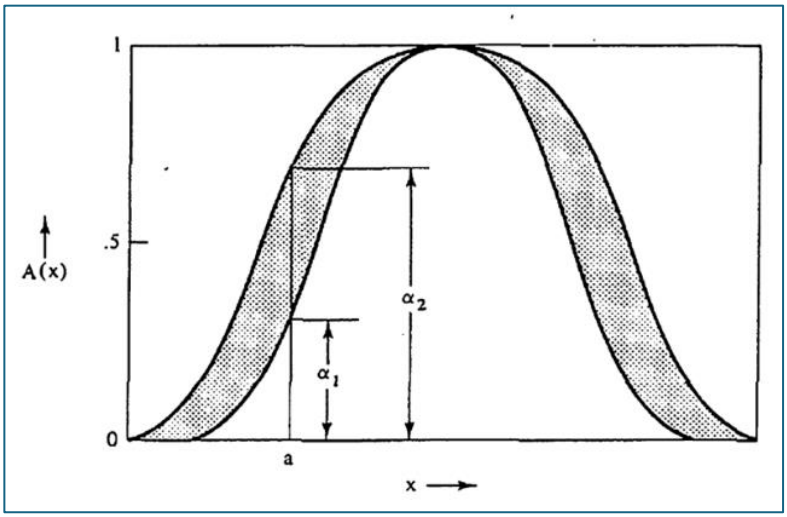
reflect uncertainty by the length of the interval membership degree. Figure 1 shows the graphical representation of an interval-valued fuzzy set.

Figure 1: Interval-valued fuzzy set representation example



Besides IVFSs, researchers have defined other extended fuzzy sets such as intuitionistic fuzzy sets (IFSs) (Atanassov 1986), neutrosophic sets (NSs) (Smarandache 1998), and hesitant fuzzy sets (HFSs) (Torra and Narukawa 2009).

In our multi-expert decision making problem, we consider five fuzzy sets that represent the concepts of not important, low importance, somewhat important, very important, extremely important. In this case, we consider a linguistic hierarchy of 5 labels for all respondents and hence, we do not have the problem of multigranularity.

The linguistic variables used in the rating are illustrated in the following table:

Table 7: Linguistic variables used in the study

NI	Not Important
LI	Low Importance
SI	Somewhat Important
VI	Very Important

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EI	Extremely Important

3.4.3 TOPSIS to rate each sub-criteria

As we have seen, preferences of experts can be described in linguistic terms, which can be expresses in fuzzy numbers. We will use the concept of the Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) methodology, which was proposed by Hwang and Yoon to determine the final ranking of all sub-criteria. The fundamental idea behind this method is to compute distances to both the positive-ideal solution (PIS) and negative-ideal solution (NIS) simultaneously (Chen, 2000). As AHP, it is also a very well-known MCDM technique.

A systematic approach to extend the TOPSIS to the fuzzy environment is proposed for solving group-decision making (Chu and Lin, 2013). In this case, TOPSIS along with appropriate linguistic variables is used to choose the importance weight of the criteria and the ratings for alternatives with respect to criteria. In our case, we are interested in rating the 27 sub-criteria and hence, we apply TOPSIS to calculate distances between sub-criteria (we see sub-criteria, as if they are alternatives to be evaluated according to their importance).

Suppose that a decision group has K persons and the rating of each alternative j (observation, action, etc,.. in our case it applies to the sub-criteria) with respect to the main goal of the decision can be calculated as:

$$\omega_j = \frac{1}{K}\left(\omega^1{}_j + \omega^2{}_j + \omega^3{}_j, \dots, + \omega^k{}_j\right)$$

Where $\omega^i{}_j$ is the importance given by the ith decision maker to the *jth* sub criteria and expressed in fuzzy numbers. The fuzzy positive ideal solution (FPIS) and fuzzy negative ideal solution (FNIS) are defined to be the maximum and minimum ω_j for $j = 1, k$,respectively. This refers to the sub-criteria (A^+), where aggregation of opinions produces the fuzzy set with maximum importance and the sub-criteria registering a summation, which results in the lowest importance judgement (A^-). Then, the distance of each sub-criteria from A^+ and A^- is calculated:

$$d_j^+ = d(A^+, \omega_j) \text{ and } d_j^- = d(A^-, \omega_j)$$

Where d is the distance between two fuzzy sets.

To determine the ranking of alternatives (sub-criteria), TOPSIS proposes calculating the closeness coefficient:

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$$CC_J = \frac{d_j^-}{d_j^+ + d_j^-}$$

Obviously, an alternative is closer to the FPIS and farther from FNIS as the coefficient approaches 1. Therefore, according to this coefficient, we can determine the ranking order of all alternatives (sub-criteria) and select the best one (or the best ones).

A numerical example is explained in the following lines. Suppose that an industrial company desires to hire a new supplier for its second most important row material. The decision is strategic. After preliminary screening, a pool of three candidates remains for evaluation. Suppose, there is one decision-maker, who is in charge of evaluating the decision and to select the most suitable supplier. Five criteria have been identified as the most relevant ones for this decision process: (1) price (C_1), (2) Customer service (C_2), (3) Technological advancement (C_3), (4) past experience with previous clients (C_4) and (5) proximity (C_5).

The step one for this decision process is to ask the decision-maker to assess the importance of the five criteria. Suppose, he uses the linguistic weighting variables expressed in the following table:

Table 8: Linguistic variables for the importance weight of each criterion. An example

Very low (VL)	(0,0,0.1)
Low (L)	(0,0.1,0.3)
Medium low (ML)	(0.1,0.3,0.5)
Medium (M)	(0.3,0.5,0.7)
Medium High (MH)	(0.5,0.7,0.9)
High (H)	(0.7,0.9,1.0)
Very High (VH)	(0.9,1.0,1.0)

Then, we suppose the decision-maker uses a different table of linguistic variables for the rating of the potential suppliers candidates.

Table 9: Linguistic variables for the ratings of alternatives. An example

Very poor (VP)	(0,0,1)
Poor (P)	(0,1,3)
Medium poor (MP)	(1,3,5)
Fair (F)	(3,5,7)

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Medium good (MG)	(5,7,9)
Good (G)	(7,9,10)
Very good (VG)	(9,10,10)

In the following tables, the linguistic evaluations given by the expert with respect to each criterion and in relation to each alternative are illustrated.

Table 10: The linguistic evaluation given by the decision maker to express the criteria importance. An example

Criterion 1	MH
Criterion 2	VH
Criterion 3	H
Criterion 4	VH
Criterion 5	MH

Table 11: The ratings of the three suppliers by the decision maker under all five criteria. An example

Criterion 1	Supplier 1	MG
	Supplier 2	MG
	Supplier 3	F
Criterion 2	Supplier 1	F
	Supplier 2	VG
	Supplier 3	VG
Criterion 3	Supplier 1	G
	Supplier 2	G
	Supplier 3	VG
Criterion 4	Supplier 1	VG
	Supplier 2	VG
	Supplier 3	MG
Criterion 5	Supplier 1	F
	Supplier 2	G

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	Supplier 3	MG

These evaluations are transformed into triangular fuzzy numbers in order to construct the fuzzy decision matrix and fuzzy weights of the three candidates and then, the fuzzy normalized decision matrix as shown in the following tables:

Table 12: The fuzzy decision matrix and fuzzy weights. An example

	C1			C2			C3			C4			C5		
S1	5,0	7,0	9,0	3,0	5,0	7,0	7,0	9,0	10,0	9,0	10,0	10,0	3,0	5,0	7,0
S2	5,0	7,0	9,0	9,0	10,0	10,0	7,0	9,0	10,0	9,0	10,0	10,0	7,0	9,0	10,0
S3	3,0	5,0	7,0	9,0	10,0	10,0	9,0	10,0	10,0	5,0	7,0	9,0	5,0	7,0	9,0
Weigth	0,5	0,7	0,9	0,9	1,0	1,0	0,7	0,9	1,0	0,9	1,0	1,0	0,5	0,7	0,9

It is important to mention that this methodology can only be used as fuzzy for the evaluation of candidates or alternatives, i.e., a fix number in the weight of criteria might be used. The idea of fuzzy TOPSIS is related to the calculation of distances between fuzzy numbers as we will see in this example.

Table 13: The fuzzy normalized decision matrix. An example

	C1			C2			C3			C4			C5		
S1	0,56	0,78	1,00	0,30	0,50	0,70	0,70	0,90	1,00	0,90	1,00	1,00	0,30	0,50	0,70
S2	0,56	0,78	1,00	0,90	1,00	1,00	0,70	0,90	1,00	0,90	1,00	1,00	0,70	0,90	1,00
S3	0,33	0,56	0,78	0,90	1,00	1,00	0,90	1,00	1,00	0,50	0,70	0,90	0,50	0,70	0,90

We then construct the weighted normalized fuzzy decision matrix as in the following table.

Table 14: The fuzzy weighted normalized decision matrix. An example

	C1			C2			C3			C4			C5		
S1	0,28	0,54	0,90	0,27	0,50	0,70	0,49	0,81	1,00	0,81	1,00	1,00	0,15	0,35	0,63
S2	0,28	0,54	0,90	0,81	1,00	1,00	0,49	0,81	1,00	0,81	1,00	1,00	0,35	0,63	0,90
S3	0,17	0,39	0,70	0,81	1,00	1,00	0,63	0,90	1,00	0,45	0,70	0,90	0,25	0,49	0,81

The next step is to determine the FPIS and FNIS as:

A+ = [(1,1,1), (1,1,1), (1,1,1), (1,1,1), (1,1,1)]. and. A- =[(0,0,0), (0,0,0), (0,0,0), (0,0,0), (0,0,0)]

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As previously explained, while defining the TOPSIS, the process follows with the calculation of the distance of each supplier from FPIS and FNIS, respectively. The calculated distances are computed and illustrated in the following table. Firstly, the distance of each fuzzy number with respect to the FPIS and FNIS is calculated and then, for each supplier, the sum of all criteria distances are summed.

Table 15: Distance measurement to FPIS and FNIS of each criteria for each supplier candidate. An example

		Distance to A+	Distance to A-
Criterion 1	Supplier 1	0,496	0,628
	Supplier 2	0,496	0,628
	Supplier 3	0,621	0,472
Criterion 2	Supplier 1	0,539	0,521
	Supplier 2	0,110	0,941
	Supplier 3	0,110	0,941
Criterion 3	Supplier 1	0,314	0,795
	Supplier 2	0,314	0,795
	Supplier 3	0,221	0,858
Criterion 4	Supplier 1	0,110	0,941
	Supplier 2	0,110	0,941
	Supplier 3	0,366	0,708
Criterion 5	Supplier 1	0,654	0,425
	Supplier 2	0,436	0,666
	Supplier 3	0,535	0,565

Table 16: Total distance measurement. An example

	Distance to A+	Distance to A-
Supplier 1	2,113	3,310
Supplier 2	1,466	3,971
Supplier 3	1,854	3,544

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Finally, with the distances to FPIS and FNIS calculated, the closeness coefficient of each supplier is computed and the results are:

$CC_{supplier\ 1} = 0{,}61036$

$CC_{supplier\ 2} = 0{,}73036$

$CC_{supplier\ 3} = 0{,}65654$

Therefore, according to the closeness coefficient, the ranking order of the three suppliers is supplier 2, supplier 3 and supplier 1. The best selection according to this method is option number 2.

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4. Data assessment, collection and results

In the following sections, first, the comprehensive analysis of the literature review phase is explained and deepened. Some results and contributions from the authors are already presented in this first chapter. Secondly, the process of data collection from the experts is explained in details. Finally, the methodological tools are applied to the specific multi-criteria location problem of this study and some exploratory analysis is conducted to highlight the initial results.

4.1 Strategic location decisions made by MNE: a literature review process.

A set of relevant eligible literature on strategic decisions related to site location decision problems faced by business with similar characteristics to the MNEs of the energy sector or with related products or services has been performed with a systematic literature review process. This helped us in developing an initial list of variables/factors/criteria considered relevant for the MNE, when expanding its operations to the new markets/locations..

On the one hand, in the first step, we have selected the articles published only by academic peer-reviewed journals, written solely in English, containing the keywords such as “location”, “decision(s)” and “business” and not older than 5 years. A filter has been set with Web of Science using the timespan option and the topic basic search tool including title, abstract, author keywords and keywords plus. We have obtained 54 results. Secondly, we have read all the titles and abstract papers to reject the ones, whose objectives and topics were not related to the purpose of this particular research. As a result, a total of 20 papers remained. We have read those papers in detail and tried to identify and distinguish the key explanatory factors for site location in decision making for the multinational enterprises or similar economic agents.

In parallel, we have also used Scopus to search for the relevant journal articles, written solely in English, using the expression “location decisions”, limiting the results to subject area of “business”, “management” and “accounting” for the items published not earlier than 5 years ago. A total of 72 results have been found. A review of the title and abstract of each of the results has been conducted and articles being not appropriate for the purpose of this study have been rejected. Finally, a total of 29 articles remained. We have excluded some papers already found in the previous process of review with Web of Science. Similarly, we have read those papers in detail and tried to identify and distinguish key factors influencing site location in decision making situations done by multinational enterprises or similar economic agents.

On the other hand, later on, a more detailed literature review on specific journals using additional more precise keywords such as municipalities or energy business locations or renewable energy decision-making has been performed. Moreover, the relevant articles cited in the bibliography of the aforementioned

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publications, which had a direct connection to the purpose of this study have also been analysed. In this case, we have found it relevant to include some peer-reviewed articles from previous years in the study.

4.1.1 General findings

This complex phenomenon of location decision, involving many interrelated and conflicting criteria that can vary over time and over industry type, has been widely studied in specific industries: the business service industry (Rubalcaba *et al.*, 2013), retail industry and stores (Eckert, He and West, 2015; Gabriela and Mihai Article, 2017; Reigadinha, Godinho and Dias, 2017), industrial plants and facilities for supply chain management (Zhuang, 2014; Chang and Lin, 2015; Spalanzani, Ageron and Zouaghi, 2016; Anvari and Turkay, 2017; Haddou Amar, Abouabdellah and Ouzzani, 2017; Ketokivi *et al.*, 2017; Heikkilä, Martinsuo and Nenonen, 2018), hospitals and medical facilities (Stummer *et al.*, 2004; Wu, Lin and Chen, 2007), agro-industrial firms (Polyzos, 2015), logistics companies (Verhetsel *et al.*, 2013; Dijkstra and Roodbergen, 2017), bank industry and financial service providers (Prager, 2014), entrepreneurship (Espitia-Escuer, García-Cebrián and Muñoz-Porcar, 2014; Ferreira *et al.*, 2016), restaurant chains and hotels (Chen and Tsai, 2016; Puciato, 2016; Cró and Martins, 2018; Song and Ko, 2018) and even, the aerospace industry (Wheatley, Gzara and Jewkes, 2015).

Firstly, it is interesting to underline several results obtained in previous articles which are relevant to mention before starting this literature review procedure. For instance, the conclusions reached by Rubalcaba and Gago (Rubalcaba and Gago, 2010). Even if their research is focused on advanced business services sector (comprises computer services, R&D, tests and technical services and personnel services) and uses data of 1997, it is done in different European regions (precisely, France, UK, Austria, Belgium and Finland) and it tests the relevance of traditional location factors (demand, supply and market factors). Their results show that the influence of locational determinants varies to a great extent depending on the type of service, the region and country considered, as well as the presence of capital regions. This latter conclusion emphasises the importance of national differences and service peculiarities (not all innovative services behave in the same way) as explanatory factors.

The company size has clearly an impact on the location criteria ranking (Spalanzani, Ageron and Zouaghi, 2016). According to this empirical research done with companies in France, large companies add new criterion (such as the existence of scientific research centres) to the common list of location factors and exclude others (such as managerial skills for implantation). This warns us that understanding the location factors in the decision-making process of MNE is a complex phenomenon.

It is also important to bear in mind that decision-making process with regard to choosing the right location carries huge financial risks and responsibility for a company. Location strategy is extremely important in sectors such as the hotel industry since the establishment of a hotel requires a long-term fixed investment

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and a huge amount of capital. Besides, it is very difficult to rectify the failure of a hotel location (Song and Ko, 2018). It is also extremely relevant for manufacturing plants. Plant location has an impact on costs, stocks and logistics network but it is usually based on subjective preference of high ranking managers (Chang and Lin, 2015). Nonetheless, the growth of a specialist site selection consulting industry is a testimony to the complexity and importance of the decision (Phelps, Wood and Ãã, 2018). In their paper, the authors highlight the scale of the information costs involved and the value added and markets made by these specialists and consultants assisting with the search, specification, negotiation and enforcement costs that the MNEs must face in the fdi location decision.

Finally, it is important to highlight the fact that the three pillars of sustainability have already been simultaneously considered in decision making process in relation to the location problem. We have found some decision support frameworks for the facility (or service) location that incorporate the triple bottom line accounting assumption of sustainability (Govindan *et al.*, 2016; Türkay, Saraçoğlu and Arslan, 2016; Anvari and Turkay, 2017). The results indicate that there are methods that can balance the economic, environmental and social pillars. The sustainability and actions conducted in accordance with its principles became one of the major success factors for a decision.. Social and environmental impacts of business are more and more important, gaining the significance comparable to the one of financial performance and having influence on the latter.

A wide variety of technical instruments and mathematical models have been used to solve this problem. However, based on the literature review, there are certain challenges:

- We haven't found any model that incorporates a comprehensive and complete set of variables specific for the green energy services. Precisely, there is no model gathering all the variables that might be significant for energy industry offering district heating and retrofitting services.
- Very few models incorporate the triple bottom line of accountability. The social aspects or the environmental impact are usually missing.
- The importance of each criteria or sub-criteria is usually a given parameter.
- Models usually do not deal with fuzzy logic and fuzzy thinking of humans.
- Real-time data and accessibility to all data that we want.

Therefore, it seems like the results of the model serve as a support tool for the decision process of the managers, which is also based on other elements not contemplated in the model used.

It is important to highlight the fact that since the scope of our analysis includes the European cities, there are some conditions that are out of this study as they are given for granted. For instance, we have found several rankings mentioning the important role played by city sanitation (includes aspects such as infectious diseases, water availability or sewage) when companies decide where to establish locations abroad and

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send expatriate workers. However, in this sense, some of the e.g. sanitation' aspects are not relevant for companies looking for a new location in Europe as European cities perform very well with regard to the fundamental life quality related aspects . However, it could be a key characteristic if the study was done in a different geographical context. Actually, when studying business location decision, scale and context are critical aspects for the analysis.

4.1.2 Results: Our key table on relevant location variables for MNE in the energy sector

In this section, we first present the final table resulting from the complete literature review process and then, we give an explanation of each criteria in the following paragraphs. As previously explained, there is a great amount of information in relation to location strategies in the business sector. We have done a great effort to synthetize and extract the key elements for the specific objectives of this study. Actually, after a first draft obtained from the literature review process, a workshop with ESADE experts was held to collect the practitioners and experts opinion on each of the criteria. The session was a key aspect of this phase since some classifications were modified and better adapted to the business sector of energy companies.

We believe that the table below contributes to the development of research oriented to understand how multinational enterprises make location strategic decisions. The following table shows the resulting list of six criteria and its corresponding sub-criteria. A brief explanation is given in the second column to summarize and give a better understanding of each sub-criterion. In the third column, a reference list of academic papers, which includes fundamental research on the specific criteria are provided.

Table 17: Summary of relevant criteria for MNEs

Criteria	Sub-criteria (Description[1])	Literature
CHARACTERISTICS OF THE CITY'S HOST COUNTRY OR REGION: *The main geographic, economic, social and political factors that characterize the city's host country or region.*	**Home-Host Country Distance** The geographic distance between the MNE headquarters or its main area of operations and the city (new location).	(Rubalcaba and Gago, 2010; Gooris and Peeters, 2013; Rubalcaba *et al.*, 2013; Blanc-Brude *et al.*, 2014; Prager, 2014; Adler and Hashai, 2015; Shao and Shang, 2016; Ketokivi *et al.*, 2017)
	Host country GDP per capita The country's economic output per person.	
	Host country level of welfare state The degree to which the city's host country (or region) protects and promotes the well-being of its citizens in terms of as health, equal opportunities, equitable distribution, etc.	
	Host country political stability perception The perception of a country's political order and system	

[1] The MNE: we refer to the Multinational company belonging to the energy sector that seeks to expands its renewable and green energy services to other European municipalities.

The city: we refer to the municipality being analyzed as a potential candidate where to expand the MNE services.

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Criteria	Sub-criteria (Description[1])	Literature
	(e.g. safe, predictable, uncertain, with several political coups, etc.).	
	Host country's corruption perception The perceived level of public sector corruption, i.e., the misuse of public power for private benefits.	
CITY STRUCTURAL FACTORS: *The predominant characteristics that distinguish one city from another in terms of long-term stablished or structural factors.*	**The city size** The city size in terms of inhabitants living in the full municipal area or urban system.	(Rubalcaba-Bermejo and Cuadrado-Roura, 1995; Maria and Carod, 2002; Rubalcaba and Gago, 2010; David *et al.*, 2013; Bhat and Singh, 2014; Neirotti *et al.*, 2014; Zhuang, 2014; Spalanzani, Ageron and Zouaghi, 2016)
	City's cultural and language distance perception The perceived differences between the values, communication styles and language of the city and the MNE's own organizational culture.	
	City's climate characteristics The main features of the predominant climate of the city (temperature, rain, wind, etc.).	
	City's connectivity - infrastructural features Transport infrastructure, in terms of service quality, rail and road networks, public transport level, airport connections, etc., both within the city and with other cities.	
	City's reputation, image and prestige The business sector's long-term impression regarding the city and its "positioning" efforts in comparison with other cities.	
THE CITY'S GOVERNMENT AND ITS POLICIES: *The conditions and environment offered by the city government in terms of doing business.*	**City government degree of transparency** Transparency of the city government in terms of holding public officials accountable, fighting corruption, opening decisions and law to discussion and government meetings with the press and public.	(R. Giffinger *et al.*, 2007; Felix and Hines, 2013; Pickett *et al.*, 2013; Bhat and Singh, 2014; Romadona, Azizatunnishak and Monica, 2017)
	City government bureaucracy level The friendliness and ease (or the opposite) of the city's regulatory framework for setting up new businesses. For instance, are administrative procedures for starting a new enterprise in the city highly complicated?.	
	Access to financial support provided by city government The financial support and aid (e.g. tax incentives) given by the city government for the creation or development of new ventures or projects.	
	City government support to public-private partnerships (PPP) The extent to which the city government promotes PPPs, creating a good regulatory environment for collaborations.	

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Criteria	Sub-criteria (Description[1])	Literature
SOCIOECONOMIC CONTEXT OF THE CITY: *The quantitative economic features and subjective aspects of the city's economic and social environment.*	**City GDP per capita** The city's economic output per person.	(Dubé, Brunelle and Legros, 2016; Spalanzani, Ageron and Zouaghi, 2016; Ketokivi *et al.*, 2017; Phelps, Wood and Ãã, 2018)
	Municipal economic budget The capacity of the city's annual budget revenues to cover expenditures and finance all type of necessities for the city.	
	City R&D expenditure The relative importance of research and development expenditure in the city's annual budget.	
	The service economy of the city The city's provision of services such as financial services, information technology, retail services or education.	
	Stakeholders' pressure in the city The perception of the presence of stakeholders in the city and their influence on the way businesses operate in the city.	
ENVIRONMENTAL CONDITIONS OF THE CITY: *The progress of the city towards a greener and more environmentally sustainable model.*	**Citizens' environmental awareness** The awareness and understanding of the city's citizens regarding the environment and environmental problems.	(Spalanzani, Ageron and Zouaghi, 2016; Türkay, Saraçoğlu and Arslan, 2016; Anvari and Turkay, 2017; Hammad, Akbarnezhad and Rey, 2017)
	City's air quality The quality air of the city and levels of urban air pollution.	
	Degree of city transition to renewables The extent to which the city relies on renewable energy sources for electricity generation or heat supply.	
MARKET CONDITIONS FOR ENERGY FIRMS IN THE CITY: *The specific market conditions and agglomeration effects related to the services and products offered by the energy MNE.*	**Competition intensity in the city** The concentration of competitors in the city, who offer similar services to those of the MNE.	(Rubalcaba and Gago, 2010; Rubalcaba *et al.*, 2013; Bhat and Singh, 2014; Zhuang, 2014; Chen and Tsai, 2016; Dubé, Brunelle and Legros, 2016; Song and Ko, 2018)
	Pool of skilled labor in the city The availability of specific human resources needed by the MNE to implement its services in the city.	
	Access to needed suppliers The accessibility of the inputs and materials needed to implement or construct the services offered by the MNE.	
	City's potential customers The number of potential clients, living in the city, willing to buy the MNE green services or products.	
	City's degree of know-how, innovation and technological exchanges The innovative environment of the city in terms of know-how and technological best practices transfer between economic agents such as universities, clusters, R&D departments, etc.	

An explanation of each category is briefly presented in the following paragraphs.

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4.1.2.1 Characteristics of the city's host country (or region)

Several research have been done to investigate the relevant effects of host country characteristics on the location decision of MNEs (Rubalcaba and Gago, 2010; Shao and Shang, 2016). The results of decisions taken at regional and municipal level are strongly influenced by national profiles and specific location attributes (Blanc-Brude *et al.*, 2014).

When talking about home-host country distance, three dimensions of distance between home and host countries have been distinguished; geographic, cultural and institutional (Gooris and Peeters, 2013). The geographic distance is further broken down into the spatial and temporal components. Internal uncertainties caused by the interactions between geographically dispersed and culturally different onshore and offshore units and external uncertainty, result from the unpredictability of institutionally distant environments. The authors argue that the distance between home and host countries produces different organizational costs depending on the governance mode (vertical integration or outsourcing) chosen when firms enter the new locations.

Some MNEs show strong tendency towards regionally focused location configurations, which can take the shape of regionally focused MNEs or of globally dispersed MNEs with regional structures (Adler and Hashai, 2015). Hence, we also include the category of city's host region characteristics, when it is applicable and the influence of the region is really high. For instance, in a research done in the US, on the factors determining locations of alternative financial service providers, the authors found that the number of financial enterprises per capita is significantly related to demographic characteristics of the county population and the state laws and regulations (Prager, 2014).

We decide to include, as sub-criteria in this category, quantitative aspects such as the distance from home country or the country GDP per inhabitant (its potential economic growth) as well as the perception of country corruption level or political stability as significant MNEs location choice factors. The table below shows a list of the 5 sub-criteria, which are considered essential for this criteria and the directions preferred by a multinational[2]:

Table 18: Sub-criteria for characteristics of the city's host country (or region) criterion

Sub-criterion 1: Home-Host Country Distance The geographic distance between the MNE headquarters or its main area of operations and the city (new location). Direction: Negative

[2] Positive indicates that the highest the value of this indicator, the most preferred by multinationals. On the contrary, negative indicates that the multinationals prefer this indicator to be as low as possible.

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Sub-criterion 2: Host country GDP per capita The country's economic output per person. Direction: Positive
Sub-criterion 3: Host country level of welfare state The degree to which the city's host country (or region) protects and promotes the well-being of its citizens in terms of as health, equal opportunities, equitable distribution, etc. Direction: Positive
Sub-criterion 4: Host country political stability perception The perception of a country's political order and system (e.g. safe, predictable, uncertain, with several political coups, etc.). Direction: Positive
Sub-criterion 5: Host country's corruption perception The perceived level of public sector corruption, i.e., the misuse of public power for private benefits. Direction: Negative

4.1.2.2 City structural factors

There are some inherent structural characteristics of the city, which are implicitly taken into account when considering a new location. These are e.g.: language, population (number of inhabitants), city area (Squared km) (Rubalcaba and Gago, 2010; Neirotti et al., 2014) or climate (Spalanzani, Ageron and Zouaghi, 2016). The relationship between size and economic performance of cities in the European context has been tested (David et al., 2013). According to the authors, in the long run, it is important to recall that the advantage of size is clear. However, from their results, it appears that it is not size *per se* that makes the difference, but structural features and position within national, European and global networks (which, is particularly related to size). The characteristics of a municipality strongly affects the location decision of industrial establishments, however these decisions are different depending on the sector considered (Maria and Carod, 2002).

Some cities, regions and countries concentrating many multinationals are associated with a high level of reputation and prestige (Rubalcaba and Gago, 2010; Rubalcaba et al., 2013). The 'follow the leader' effects (Daniels, 1993) are very important, especially in contexts dominated by uncertainty. One firm reduces the risk of failure by locating offices in previously tested places. The international profile of the city measured by indicators such as the number of international events (fairs and exhibitions) or the number of headquarters of the main world companies (Rubalcaba-Bermejo and Cuadrado-Roura, 1995) are factors to be included in the model, since they affect the city's attractiveness degree. Intangible assets are hence really important, when facing a site selection or location decision problem.

Due to knowledge and expertise gathered in previous authors' research projects, we also include an aspect related to the city's infrastructure (connectivity in terms of coastal access or closeness to an International hub airport). There is an empirical research done with multinational corporations in the U.S. that indicates that access to highway transportation is an important factor influencing location decisions (Zhuang, 2014).

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We also find this aspect a relevant factor in an empirical work done in France (Spalanzani, Ageron and Zouaghi, 2016).

We decide to include, as sub-criteria in this category, quantitative aspects such as the city size as well as the city's reputation, image and prestige. The table below shows the list of the 5 sub-criteria, which have been considered essential to define and the direction preferred by a multinational:

Table 19: Sub-criteria for city structural factors criterion

Sub-criterion 1: The city size The city size in terms of inhabitants living in the full municipal area or urban system. Direction: Positive
Sub-criterion 2: City's cultural and language distance perception The perceived differences between the values, communication styles and language of the city and the MNE's own organizational culture. Direction: Negative
Sub-criterion 3: City's climate characteristics The main features of the predominant climate of the city (temperature, rain, wind, etc.). Direction: N/A
Sub-criterion 4: City's connectivity - infrastructural features Transport infrastructure, in terms of service quality, rail and road networks, public transport level, airport connections, etc., both within the city and with other cities. Direction: Positive
Sub-criterion 5: City's reputation, image and prestige The business sector's long-term impression regarding the city and its "positioning" efforts in comparison with other cities. Direction: Positive

4.1.2.3 The city's government and its policies

When facing a strategic decision related to expanding into a new market or diversifying products or services, managers usually pay great attention to socio-political aspects, which are usually difficult to define , measure and compare. This indicates that more relevant factors (beyond the analysis of demand and supply indicators) exist. For instance, in relation to administrative issues related to politics, we can mention existence of tax incentives, possible institutional barriers to settle down an enterprise (Felix and Hines, 2013) or the existence of supporting facilities (Romadona, Azizatunnishak and Monica, 2017). Involvement of communities, neighbourhoods and private organizations in the municipality government decisions are also a key factor (Pickett *et al.*, 2013)**.**

The table below shows the list of the 4 sub-criteria, which have been considered essential to define this criterion and the direction preferred by a multinational:

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Table 20: Sub-criteria for the city's government and its policies criterion

Sub-criterion 1: City government degree of transparency Transparency of the city government in terms of holding public officials accountable, fighting corruption, opening decisions and law to discussion and government meetings with the press and public. Direction: Positive
Sub-criterion 2: City government bureaucracy level The friendliness and ease (or the opposite) of the city's regulatory framework for setting up new businesses. For instance, are administrative procedures for starting a new enterprise in the city highly complicated?. Direction: Negative
Sub-criterion 3: Access to financial support provided by city government The financial support and aid (e.g. tax incentives) given by the city government for the creation or development of new ventures or projects. Direction: Positive
Sub-criterion 4: City government support to public-private partnerships (PPP) The extent to which the city government promotes PPPs, creating a good regulatory environment for collaborations. Direction: Positive

4.1.2.4 Socioeconomic context of the city

Economic development level of a city is also considered, when facing the decision, since the more economic expansion and growth a city exhibits the more likely it is to engage with potential clients (Rubalcaba *et al.*, 2013). On the one hand, as relevant quantitative economic aspects we consider: GDP of the city per capita, unemployment rate (%), municipal economic activity (annual Budget of the city) and city expenditure on Research and Development projects. For instance, evidence shows that the total number of jobs in the direct vicinity is an aspect that can contribute positively or negatively, when choosing a business location. It depends on the type of sector (Dubé, Brunelle and Legros, 2016).

On the other hand, there are other qualitative and fuzzy aspects, which are of great importance. Market dynamism (or risk perception) indicates the degree, to which new businesses are registered and companies going bankrupt. The service economy is another relevant qualitative factor. Some businesses usually grow in parallel to certain services such as financial services, telecommunications or public administration services, since they benefit from each other. (Rubalcaba and Gago, 2010). Finally, the perception of stakeholders (non-profit organizations, civil society, non-governmental, etc.) their presence and pressure. The agents can have a moderating role in product diversification and influence the financial performance of MNEs (Surroca and Tribó, 2013; Su and Tsang, 2015).

Actually such aspects bring to mind the word ecosystem. Important policy insight can be found by encouraging policy-makers to replace conventional industry thinking with the new ecosystem thinking

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(Ketokivi *et al.*, 2017). Just like a biological ecosystem, an economic system is characterized by networks of interactions and interdependencies.

Considering the importance of quantitative aspects as city GDP per capita as well as the relevance of other subjective aspects found in the literature review, the table below shows the list of the 5 sub-criteria, which have been considered essential to define this criterion and the direction preferred by a multinational:

Table 21: Sub-criteria for the socioeconomic conditions of the city criterion

Sub-criterion 1: City GDP per capita The city's economic output per person. Direction: Positive
Sub-criterion 2: Municipal economic budget The capacity of the city's annual budget revenues to cover expenditures and finance all type of necessities for the city. Direction: Positive
Sub-criterion 3: City R&D expenditure The relative importance of research and development expenditure in the city's annual budget. Direction: Positive
Sub-criterion 4: The service economy of the city The city's provision of services such as financial services, information technology, retail services or education. Direction: Positive
Sub-criterion 5: Stakeholders' pressure in the city The perception of the presence of stakeholders in the city and their influence on the way businesses operate in the city. Direction: Negative

4.1.2.5 Environmental conditions of the city

An increasingly important criterion for site location is related to the critical ecological side of the urban sustainability concept. Considering the values and vision of the enterprises being studied, we decided to add the environmental sustainability criteria at municipal level as an important factor to be included in the decision-making process of the managers, who are totally aware of the environmental consequences caused by urbanisation. They might prefer to settle down in municipalities, where authorities does politics in favour of the future generations and the Planet by implementing strategies to mitigate climate change and minimise its environmental footprint.

Some decision frameworks have been developed promoting sustainable development (Türkay, Saraçoğlu and Arslan, 2016; Anvari and Turkay, 2017; Hammad, Akbarnezhad and Rey, 2017). Anvari and Turkay observed that even though the best-fit solution may not be exactly the ideal solution to reach each objective, it is not very far from it. Simultaneously, the method can perfectly balance the three pillars of sustainability.

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The decision-maker can improve the social and environmental landscape of the city by a marginal increase in his own economic cost. Moreover, this cost will be returned in the long-term as customer loyalty and gaining competitiveness in each industry. It is important to bear in mind that social factors are more challenging to incorporate in the model since they cannot be defined and measured directly (Türkay, Saraçoğlu and Arslan, 2016).

The table below shows the list of the main 3 sub-criteria, which have considered essential to define this criterion and the direction preferred by a multinational:

Table 22: Sub-criteria for environmental conditions of the city criterion

Sub-criterion 1: Citizens' environmental awareness The awareness and understanding of the city's citizens regarding the environment and environmental problems. Direction: Positive
Sub-criterion 2: City's air quality The air quality of the city and levels of urban air pollution. Direction: Positive
Sub-criterion 3: Degree of city transition to renewables The extent to which the city relies on renewable energy sources for electricity generation or heat supply. Direction: Positive

4.1.2.6 Market conditions for energy firms in the city

Comprehensive literature exists (Faggio SERC, Olmo Silva and Strange Rotman, 2014; Zhuang, 2014; Dubé, Brunelle and Legros, 2016; Musil and Eder, 2016; Martí, Alguacil and Orts, 2017) studying the positive effects and competitive advantage for firms as well as for regions (or other geographical scale) resulting from the proximity of economic activity of the same type. There is plenty of evidence for the advantages and benefits of economic concentration or co-location (or clustering) of industries of the same type. It is important to consider the three Marshall's agglomerative forces (1890) as explanatory factors: the access to a pool of skilled labour (human resources), the share of inputs and outputs and the know-how exchanges or technological (innovative) spillovers. That is the reason, why this criterion is comprehensively and extensively explained in the following paragraphs.

We have found several differences in the relative importance of the role played by these agglomerative forces depending on the industry type. Some researchers documented clear heterogeneity in the role played by the various Marshallian forces in the agglomeration of different industries (Faggio SERC, Olmo Silva and Strange Rotman, 2014; Dubé, Brunelle and Legros, 2016; Martí, Alguacil and Orts, 2017; Diodato, Neffke and O'Clery, 2018), highlighting the relative importance of the different drivers of agglomeration across industries (inputs-outputs, skilled labor or know-how exchanges) and showing how the main forces behind agglomeration externalities have changed over the course of a century.

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For instance, according to Diodato et al. the labour channel's greatest impact on coagglomeration patterns is found in industries in arts & culture, architecture & engineering, media and knowledge-intensive business services, in comparison to other sectors analysed such as Transportation equipment, Telecommunications or Petroleum and coal manufacturing. Besides, Diodato et al. concluded that whereas value chains were the main organizing principle of the spatial configuration of industries at the start of the twentieth century, their importance has dropped to a point, where they have been overtaken by local pools of specialized labour as the main driver of industrial coagglomeration. As a result, their findings, based on US cities, suggest that large cities increasingly derive their strength from the ease, with which the skills circulate in their economies. Also the estimations done by the Spanish authors in relation to Spanish Multinationals reveal differences between manufacturing and services foreign direct investments in several local factors, such as the skilled labour and financial risk (Martí, Alguacil and Orts, 2017). For instance, domestic skills are particularly relevant for services industry, hence the effect of a higher availability of skilled labour in a country is stronger in the service sector than in the manufacturing sector. Specifically, when it comes to deciding about where to construct a new plant in United States, the results of Zhuang indicate that agglomeration economies, wages, the availability of potential workers and the access to highway transportation and well-developed road infrastructure are important factors influencing location decisions of multinational corporations in the U.S (Zhuang, 2014).

In relation to demand oriented factors, business needs to be close to their customers . The proximity and location of current and potential clients are key elements explaining business services concentration (Rubalcaba and Gago, 2010). Demand estimation is a key criteria in the strategy of location decisions, modelled for example, in an empirical study, where a group considers a restructuring of a hotel chain network by opening new hotels or closing existing hotels in a metropolitan city (Song and Ko, 2018)**.** Population growth rate of the vicinity has also been found a significant factor affecting the store performance in a restaurant chain (Chen and Tsai, 2016).

In relation to know-how exchanges, some authors (Musil and Eder, 2016) support the idea that it is sometimes necessary to focus on extreme niches in order to develop a successful cluster, where a critical mass of R&D actors enables local buzz and local spill-over effects. The latter are highly valued by the enterprises. Specifically, Musil and Eder examine the highly concentrated ICT cluster in Vienna. The authors recommend that cluster initiatives should incorporate a thematic (specialization in niches) as well as a spatial focus (walking distance cluster). If this is achieved, actors in a cluster can benefit from face-to-face contacts and urban planners should build upon existing structures rather than develop clusters from scratch.

Nonetheless, some authors (Funk, 2015) when trying to explain the relationship between geography and innovation, demonstrate the importance of considering both, firms' local external environments and their internal patterns of collaboration in tandem. Their findings show that firms can be successful innovators whether they are located in the heart of Silicon Valley or in the more remote areas of the American Midwest, Regardless the environment, being successful requires making the most of where they are. The author

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states that cense concentrations of firms in places like Silicon Valley or Boston are attractive, because they facilitate local knowledge transfer and offer other well documented benefits (Owen-Smith and Powell, 2004). Managers, however, might have reasons for favoring other locations that are less proximate to rivals; in that case, the findings of his study suggest, closely monitoring patterns of collaboration among employees might attenuate some of the innovation disadvantages of isolation.

Furthermore, we have also found additional empirical research (Bhat and Singh, 2014; Dubé, Brunelle and Legros, 2016) supporting the assumption that some industries prefer not to cluster. They state that the majority of the firms in knowledge-intensive industries choose to locate in municipalities with diversified economic environments, while manufacturing and manual labour prefer to locate in more specialized clusters.

Finally, the table below shows the list of the main 5 sub-criteria which are/have been considered essential to define this criterion and the direction preferred by a multinational:

Table 23: Sub-criteria for market conditions for the energy firms in the city criterion

Sub-criterion 1: Competition intensity in the city The concentration of competitors in the city, who offer similar services to those of the MNE. Direction: Negative
Sub-criterion 2: Pool of skilled labor in the city The availability of specific human resources needed by the MNE to implement its services in the city. Direction: Positive
Sub-criterion 3: Access to needed suppliers The accessibility of the inputs and materials needed to implement or construct the services offered by the MNE. Direction: Positive
Sub-criterion 4: City's potential customers The number of potential clients, living in the city, willing to buy the MNE green services or products. Direction: Positive
Sub-criterion 5: City's degree of know-how, innovation and technological exchanges The innovative environment of the city in terms of know-how and technological best practices transfer between economic agents such as universities, clusters, R&D departments, etc. Direction: Positive

4.2 Survey and judgements collection from experts and managers

Let's remember the main purpose of this research study; to provide the cities with a hierarchal framework of criteria, which govern the decision making process of multinational enterprises of the energy sector seeking to launch their sustainable and green products in a new European city. There is a wide range of possible European cities to settle in. Each city has its own characteristics, which represent the value of criteria used by the managers and experts of each multinational to evaluate each city and make the final decision.

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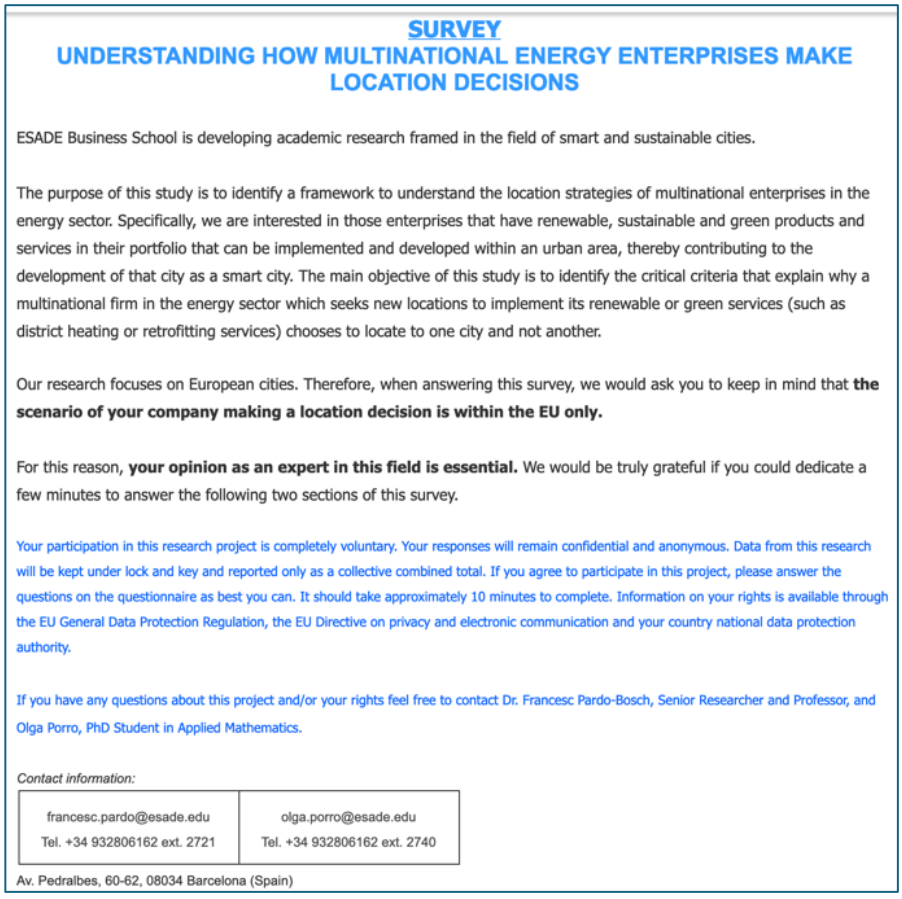
We have contacted a group of experts and managers of MNEs in the energy sector. Each one is an information source. We need these experts and managers to examine their preferences against the set of identified criteria and sub-criteria in linguistic assessments. A specific survey was prepared considering the review of literature done in the previous section and the feedback provided by some of the participants and partners in the project during the validation phase of the criteria and sub-criteria list. The survey was implemented using a software tool (Qualtrics) and distributed online among these group of experts and managers. In cases, where a personal contact or interview has been possible, we have conducted the survey face by face.

Several draft versions were tested before reaching the final survey that was distributed among the respondents. First of all, we briefly explained the purpose of the survey (figure 2) so the respondents could understand, why their opinions are relevant.

Figure 2: Introduction to the survey



SURVEY

UNDERSTANDING HOW MULTINATIONAL ENERGY ENTERPRISES MAKE LOCATION DECISIONS

ESADE Business School is developing academic research framed in the field of smart and sustainable cities.

The purpose of this study is to identify a framework to understand the location strategies of multinational enterprises in the energy sector. Specifically, we are interested in those enterprises that have renewable, sustainable and green products and services in their portfolio that can be implemented and developed within an urban area, thereby contributing to the development of that city as a smart city. The main objective of this study is to identify the critical criteria that explain why a multinational firm in the energy sector which seeks new locations to implement its renewable or green services (such as district heating or retrofitting services) chooses to locate to one city and not another.

Our research focuses on European cities. Therefore, when answering this survey, we would ask you to keep in mind that **the scenario of your company making a location decision is within the EU only.**

For this reason, **your opinion as an expert in this field is essential.** We would be truly grateful if you could dedicate a few minutes to answer the following two sections of this survey.

Your participation in this research project is completely voluntary. Your responses will remain confidential and anonymous. Data from this research will be kept under lock and key and reported only as a collective combined total. If you agree to participate in this project, please answer the questions on the questionnaire as best you can. It should take approximately 10 minutes to complete. Information on your rights is available through the EU General Data Protection Regulation, the EU Directive on privacy and electronic communication and your country national data protection authority.

If you have any questions about this project and/or your rights feel free to contact Dr. Francesc Pardo-Bosch, Senior Researcher and Professor, and Olga Porro, PhD Student in Applied Mathematics.

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The survey consisted of two sections. In the first section of the survey (figure 3), we asked the respondents to express the relative importance among the main criteria. We also asked them to measure this relative

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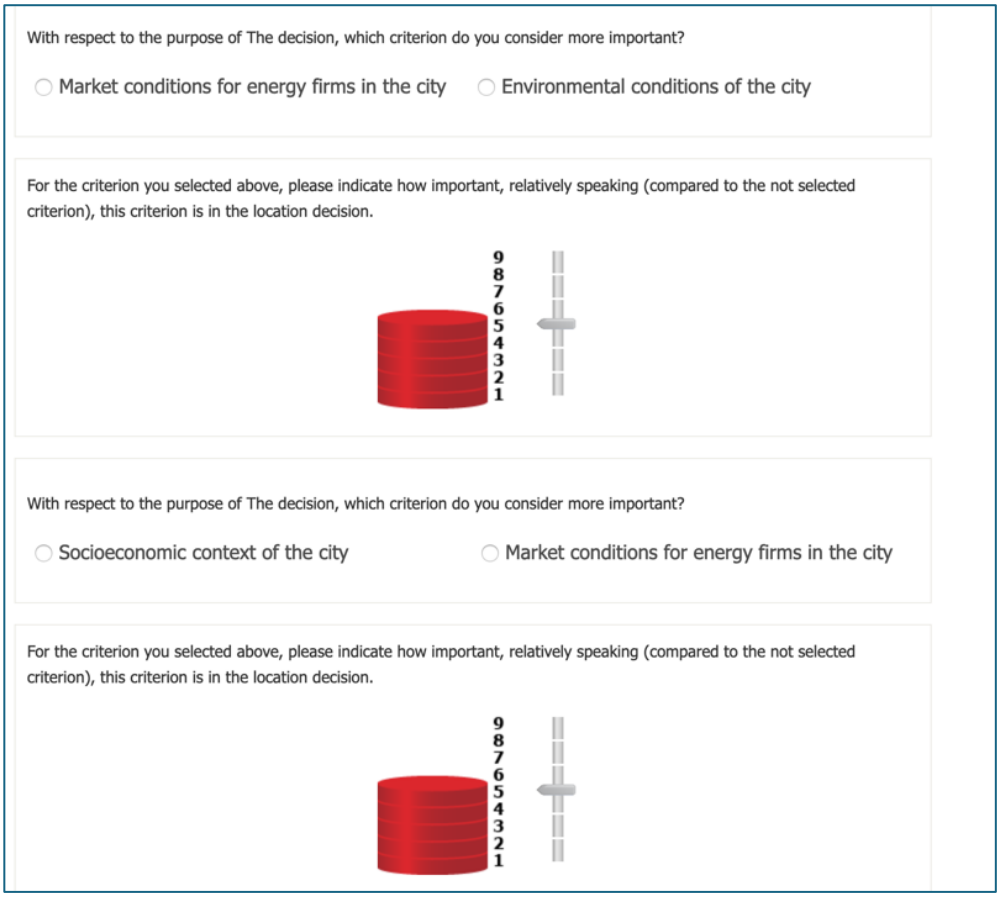
importance in a 1-9 scale. In this part, we wanted the experts to give an answer (we didn't allow them to leave the question in blank) and we controlled for inconsistencies.

- We just asked for specifically 5 pairwise comparisons. This allowed us to construct the full pairwise comparison matrix, which is consistent.
- It is better to ask less but more specific questions rather than many since the information overload and the lack of time could discourage respondents to answer correctly.

Figure 3: First section of the survey



In the second section of the survey (figure 4), we were interested in the relative importance of all the 27 sub-criteria. In this case, respondents could use a 5 qualitative scale to express their judgements: from not important to extremely important. If they were hesitant between **two or three judgements** (for instance, they were not sure whether a criteria is somewhat important or very important, or they knew that a criteria is somewhat important or below) **they had the option to check both or all three boxes.**

Finally, a total of 10 selected experts and managers with more than 10 years of experience in the field have responded to the survey. Due to the methodology used, this number of experts is appropriate (Daim, Udbye and Balasubramanian, 2013).

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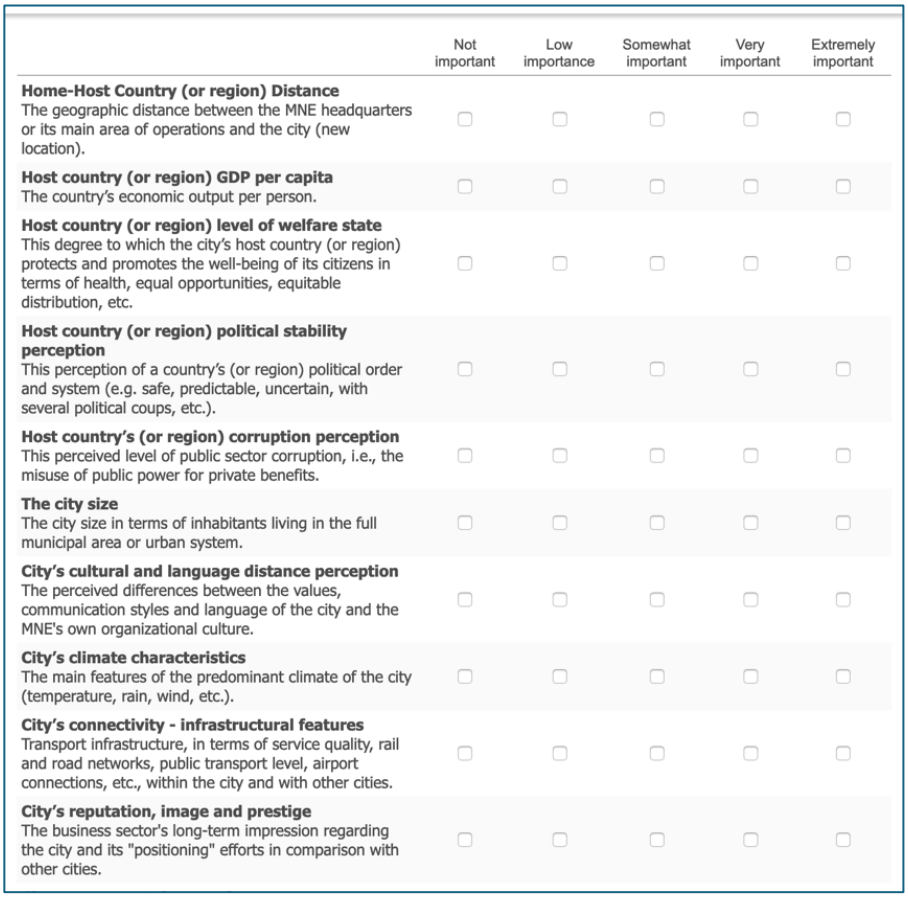
Figure 4: Second section of the survey



	Not important	Low importance	Somewhat important	Very important	Extremely important
Home-Host Country (or region) Distance The geographic distance between the MNE headquarters or its main area of operations and the city (new location).	☐	☐	☐	☐	☐
Host country (or region) GDP per capita The country's economic output per person.	☐	☐	☐	☐	☐
Host country (or region) level of welfare state This degree to which the city's host country (or region) protects and promotes the well-being of its citizens in terms of health, equal opportunities, equitable distribution, etc.	☐	☐	☐	☐	☐
Host country (or region) political stability perception This perception of a country's (or region) political order and system (e.g. safe, predictable, uncertain, with several political coups, etc.).	☐	☐	☐	☐	☐
Host country's (or region) corruption perception This perceived level of public sector corruption, i.e., the misuse of public power for private benefits.	☐	☐	☐	☐	☐
The city size The city size in terms of inhabitants living in the full municipal area or urban system.	☐	☐	☐	☐	☐
City's cultural and language distance perception The perceived differences between the values, communication styles and language of the city and the MNE's own organizational culture.	☐	☐	☐	☐	☐
City's climate characteristics The main features of the predominant climate of the city (temperature, rain, wind, etc.).	☐	☐	☐	☐	☐
City's connectivity - infrastructural features Transport infrastructure, in terms of service quality, rail and road networks, public transport level, airport connections, etc., within the city and with other cities.	☐	☐	☐	☐	☐
City's reputation, image and prestige The business sector's long-term impression regarding the city and its "positioning" efforts in comparison with other cities.	☐	☐	☐	☐	☐

4.3 The analysis: Solving our multi-expert location problem

Based on the methods briefly explained before, we proceed to analyse the data gathered from our experts and investigate the location decision problem which we are interested in.

4.3.1 Building a hierarchy to analyse the decision:

As we have learned, the AHP structures a decision making process in a very straight-forward and clear manner. In our case, we seek to structure the strategic location decision making process faced by the MNE in the energy sector. We need to **first build the hierarchy for this decision**, i.e., draw the decision modelling, which is shown in the following figure.

Figure 5: New European city selection for MNE in the energy sector who seek to expand its green and renewable business products/services

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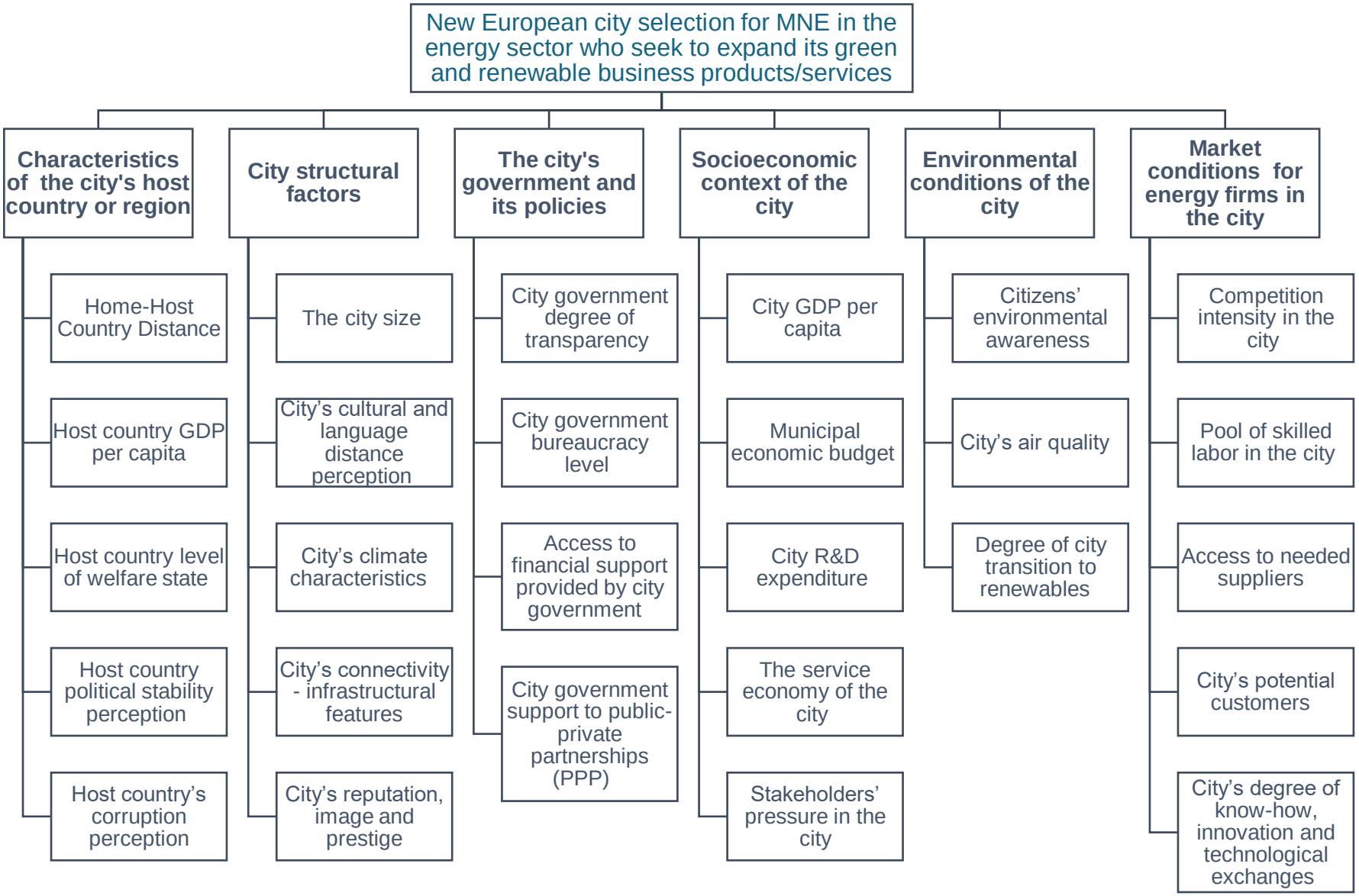

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In the first (or top) level, we find the overall goal of the decision-maker (the MNE of the energy sector): “Choosing a new European municipality to implement my products and services”. In the second level, we find the six criteria, which contribute to the goal, and in the third level we include the sub-criteria, needed for this complex location problem. Finally, on the bottom level, we would place the candidate European cities, which are to be evaluated in terms of the criteria and sub-criteria from the above levels.

After a systematic literature review process and expert’s knowledge gathering (we have also requested participation of some experts to ensure that all criteria are being considered), we have identified six main criteria, which we consider predominant, when a multinational in the energy sector decides whether or not to do business in a particular city. Besides, to serve both consistency and redundancy, it is best to keep the numbers of elements seven or less (Saaty and Ozdemir, 2003). As shown in the hierarchical graph, each criteria includes several sub-criteria (ranging from 3 to 5 sub-criteria per criterion) and it is relevant to highlight that some are intangible variables, while others are quantitative in their nature. There is a total of 27 sub-criteria.

4.3.2 Deriving relative priorities for the criteria

Not all the 6 identified criteria have the same importance. Following the second step of the AHP process, we need to get the elicitation of pairwise comparison judgements. Through the survey, we have obtained relative judgements from experts, consultants and managers of multinational enterprises in the energy sector, who are facing this multicriteria location decision problem. We first asked (in 5 questions of pairwise comparisons): Which of the two criteria being compared (e.g. market conditions in the city or socioeconomic context of the city), is considered more important by the energy MNE seeking a new city to expand its green and renewable services? We took the sixth criteria of market conditions for the energy firms as the basis. Then, for each question, we asked respondents to decide a numerical value for assessing the importance of their preference judgement in each of the compared pairs. We used the Saaty’s pairwise comparison scale of 9 numerical values.

Hence, if an expert considers that market conditions in the city is very strongly more important than city host country characteristics, the intersection row “market conditions” and column “city host country characteristics”, in the pairwise comparison matrix, will contain a value of 7. The reciprocal of this value (1/7) will be placed in the city host country characteristics – market conditions cell. The resulting ten matrices of the pairwise comparisons of the criteria given by the each of the ten respondents are shown below (left-hand side), with the associated consistent multiplicative matrix in a ratio 1/9 – 9 (right-hand side), after the four steps previously mentioned are applied:

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Expert 1:

Table 24: Consistent multiplicative matrices for expert 1

	C1	C2	C3	C4	C5	C6
C1	1,00	1,00	1,17	1,17	1,17	0,17
C2	1,00	1,00	1,17	1,17	1,17	0,17
C3	0,86	0,86	1,00	1,00	1,00	0,14
C4	0,86	0,86	1,00	1,00	1,00	0,14
C5	0,86	0,86	1,00	1,00	1,00	0,14
C6	6,00	6,00	7,00	7,00	7,00	1,00

→

C1	C2	C3	C4	C5	C6
1,00	1,00	1,19	1,19	1,19	0,13
1,00	1,00	1,19	1,19	1,19	0,13
0,84	0,84	1,00	1,00	1,00	0,11
0,84	0,84	1,00	1,00	1,00	0,11
0,84	0,84	1,00	1,00	1,00	0,11
7,56	7,56	9,00	9,00	9,00	1,00

Expert 2:

Table 25: Consistent multiplicative matrices for expert 2

	C1	C2	C3	C4	C5	C6
C1	1,00	1,29	0,05	1,00	1,00	0,14
C2	0,78	1,00	0,04	0,78	0,78	0,11
C3	21,00	27,00	1,00	21,00	21,00	3,00
C4	1,00	1,29	0,05	1,00	1,00	0,14
C5	1,00	1,29	0,05	1,00	1,00	0,14
C6	7,00	9,00	0,33	7,00	7,00	1,00

→

C1	C2	C3	C4	C5	C6
1,00	1,18	0,13	1,00	1,00	0,27
0,84	1,00	0,11	0,84	0,84	0,23
7,61	9,00	1,00	7,61	7,61	2,08
1,00	1,18	0,13	1,00	1,00	0,27
1,00	1,18	0,13	1,00	1,00	0,27
3,65	4,32	0,48	3,65	3,65	1,00

Expert 3:

Table 26: Consistent multiplicative matrices for expert 3

	C1	C2	C3	C4	C5	C6
C1	1,00	56,00	1,14	64,00	56,00	8,00
C2	0,02	1,00	0,02	1,14	1,00	0,14
C3	0,88	49,00	1,00	56,00	49,00	7,00
C4	0,02	0,88	0,02	1,00	0,88	0,13
C5	0,02	1,00	0,02	1,14	1,00	0,14
C6	0,13	7,00	0,14	8,00	7,00	1,00

→

C1	C2	C3	C4	C5	C6
1,00	8,38	1,07	9,0	8,38	3,00
0,11	1,00	0,12	1,07	1,00	0,35
0,93	7,81	1,00	8,38	7,81	2,79
0,11	0,93	0,11	1,00	0,93	0,33
0,11	1,00	0,12	1,07	1,00	0,35
0,33	2,79	0,35	3,00	2,79	1,00

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Expert 4:

Table 27: Consistent multiplicative matrices for expert 4

	C1	C2	C3	C4	C5	C6
C1	1,00	0,06	0,05	0,11	0,17	0,33
C2	18,00	1,00	0,86	2,00	3,00	6,00
C3	21,00	1,17	1,00	2,33	3,50	7,00
C4	9,00	0,50	0,43	1,00	1,50	3,00
C5	6,00	0,33	0,29	0,67	1,00	2,00
C6	3,00	0,17	0,14	0,33	0,50	1,00

→

C1	C2	C3	C4	C5	C6
1,00	0,12	0,11	0,20	0,27	0,45
8,05	1,00	0,89	1,64	2,21	3,64
9,00	1,11	1,00	1,84	2,47	4,07
4,88	0,60	0,54	1,00	1,34	2,21
3,64	0,45	0,40	0,74	1,00	1,64
2,21	0,27	0,24	0,45	0,60	1,00

Expert 5:

Table 28: Consistent multiplicative matrices for expert 5

	C1	C2	C3	C4	C5	C6
C1	1,00	2,33	0,08	0,11	0,06	0,33
C2	0,43	1,00	0,04	0,05	0,02	0,14
C3	12,00	28,00	1,00	1,33	0,67	4,00
C4	9,00	21,00	0,75	1,00	0,50	3,00
C5	18,00	42,00	1,50	2,00	1,00	6,00
C6	3,00	7,00	0,25	0,33	0,17	1,00

→

C1	C2	C3	C4	C5	C6
1,00	1,64	0,23	0,27	0,18	0,52
0,60	1,00	0,14	0,16	0,11	0,31
4,30	7,09	1,00	1,18	0,78	2,25
3,63	5,98	0,84	1,00	0,66	1,90
5,46	9,00	1,26	1,50	1,00	2,86
1,90	3,13	0,44	0,52	0,34	1,00

Expert 6:

Table 29: Consistent multiplicative matrices for expert 6

	C1	C2	C3	C4	C5	C6
C1	1,00	1,00	1,00	2,33	2,33	0,33
C2	1,00	1,00	1,00	2,33	2,33	0,33
C3	1,00	1,00	1,00	2,33	2,33	0,33
C4	0,43	0,43	0,43	1,00	1,00	0,14
C5	0,43	0,43	0,43	1,00	1,00	0,14
C6	3,00	3,00	3,00	7,00	7,00	1,00

→

C1	C2	C3	C4	C5	C6
1,00	1,00	1,00	2,60	2,60	0,28
1,00	1,00	1,00	2,60	2,60	0,28
1,00	1,00	1,00	2,60	2,60	0,28
0,38	0,38	0,38	1,00	1,00	0,11
0,38	0,38	0,38	1,00	1,00	0,11
3,45	3,45	3,45	9,00	9,00	1,00

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Expert 7:

Table 30: Consistent multiplicative matrices for expert 7

	C1	C2	C3	C4	C5	C6
C1	1,00	0,75	0,04	0,13	0,50	0,25
C2	1,33	1,00	0,06	0,17	0,67	0,33
C3	24,00	18,00	1,00	3,00	12,00	6,00
C4	8,00	6,00	0,33	1,00	4,00	2,00
C5	2,00	1,50	0,08	0,25	1,00	0,50
C6	4,00	3,00	0,17	0,50	2,00	1,00

→

C1	C2	C3	C4	C5	C6
1,00	0,82	0,11	0,22	0,61	0,38
1,22	1,00	0,13	0,29	0,75	0,46
9,00	7,37	1,00	2,13	5,57	3,45
4,21	3,45	0,46	1,00	2,60	1,61
1,61	1,32	0,17	0,38	1,00	0,61
2,60	2,13	0,29	0,61	1,61	1,00

Expert 8:

Table 31: Consistent multiplicative matrices for expert 8

	C1	C2	C3	C4	C5	C6
C1	1,00	1,25	0,08	0,75	0,50	0,25
C2	0,80	1,00	0,07	0,60	0,40	0,20
C3	12,00	15,00	1,00	9,00	6,00	3,00
C4	1,33	1,67	0,11	1,00	0,67	0,33
C5	2,00	2,50	0,17	1,50	1,00	0,50
C6	4,00	5,00	0,33	3,00	2,00	1,00

→

C1	C2	C3	C4	C5	C6
1,00	1,19	0,13	0,79	0,57	0,32
0,83	1,00	0,11	0,66	0,47	0,27
7,51	9,00	1,00	5,94	4,27	2,43
1,26	1,51	0,16	1,00	0,72	0,41
1,75	2,10	0,23	1,39	1,00	0,57
3,08	3,69	0,41	2,43	1,75	1,00

Expert 9:

Table 32: Consistent multiplicative matrices for expert 9

	C1	C2	C3	C4	C5	C6
C1	1,00	1,00	1,00	0,17	1,00	0,17
C2	1,00	1,00	1,00	0,17	1,00	0,17
C3	1,00	1,00	1,00	0,17	1,00	0,17
C4	6,00	6,00	6,00	1,00	6,00	1,00
C5	1,00	1,00	1,00	0,17	1,00	0,17
C6	6,00	6,00	6,00	1,00	6,00	1,00

→

C1	C2	C3	C4	C5	C6
1,00	1,00	1,00	0,11	1,00	0,11
1,00	1,00	1,00	0,11	1,00	0,11
1,00	1,00	1,00	0,11	1,00	0,11
9,00	9,00	9,00	1,00	9,00	1,00
1,00	1,00	1,00	0,11	1,00	0,11
9,00	9,00	9,00	1,00	9,00	1,00

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Expert 10:

Table 33: Consistent multiplicative matrices for expert 10

	C1	C2	C3	C4	C5	C6
C1	1,00	1,00	0,02	1,00	0,02	0,14
C2	1,00	1,00	0,02	1,00	0,02	0,14
C3	56,00	56,00	1,00	56,00	1,33	8,00
C4	1,00	1,00	0,02	1,00	0,02	0,14
C5	42,00	42,00	0,75	42,00	1,00	6,00
C6	7,00	7,00	0,13	7,00	0,17	1,00

→

C1	C2	C3	C4	C5	C6
1,00	1,00	0,11	1,00	0,13	0,34
1,00	1,00	0,11	1,00	0,13	0,34
9, 00	9,00	1,00	9,00	1,17	3,11
1,00	1,00	0,11	1,00	0,13	0,34
7,69	7,69	0,85	7,69	1,00	2,65
2,89	2,89	0,32	2,89	0,37	1,00

A priority vector is obtained for each of the 10 matrices and the resulting weights for each criterion for the ten experts are presented in the following table number 5. The highest weight for each expert is marked bold. In the following table, the resulting weights obtained with AHP methodology are presented for each expert and for each criterion (rows). Hence, a total of sixty percentages is shown.

Table 34: Criteria weights of the 10 experts

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Expert 8	Expert 9	Expert 10
CHARACTERISTICS OF THE CITY'S HOST COUNTRY OR REGION	8%	7%	**38%**	3%	6%	14%	5%	6%	5%	4%
CITY STRUCTURAL FACTORS	8%	6%	5%	28%	4%	14%	6%	5%	5%	4%
THE CITY'S GOVERNMENT AND ITS POLICIES	7%	**50%**	36%	**31%**	25%	14%	**46%**	**49%**	5%	**40%**
SOCIOECONOMIC CONTEXT OF THE CITY	7%	7%	4%	17%	21%	5%	21%	8%	41%	4%
ENVIRONMENTAL CONDITIONS OF THE CITY	7%	7%	5%	13%	**32%**	5%	8%	11%	5%	34%
MARKET CONDITIONS FOR ENERGY FIRMS IN THE CITY	**63%**	24%	13%	8%	11%	**48%**	13%	20%	**41%**	13%

A dispersion graph is used to display the main patterns in the distribution of each criteria weight.

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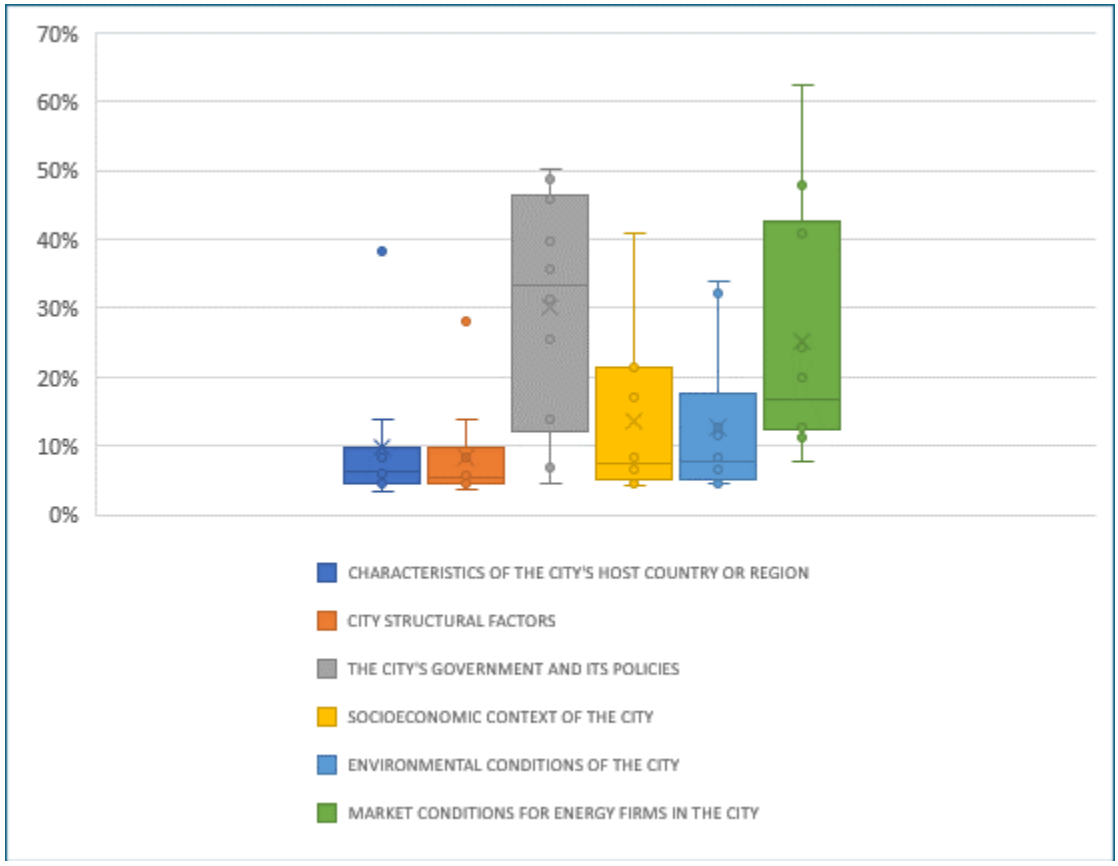
Figure 6: Graphical representation of weights' dispersion



In figure 6, a box plot is constructed for each criteria. A box plot is a simple way of representing data on a plot, in which a rectangle is drawn to represent the second and the third quartiles, with a line inside to indicate the median value. The lower and upper quartiles are shown as horizontal lines at either side of the rectangle. Therefore, for each criterion, the figure displays the five-number summary of a set of data (the minimum, first quartile, median, third quartile and maximum). Besides, the axis inside the rectangle shows the value of the mean, which might be above or below the median.

In relation to the median (middle quartile), which marks the mid-point of the data, this value is less than 10% in case of the four criteria: characteristics of the city's host country, city structural factors, socioeconomic context of the city and environmental conditions of the city. On the contrary, the median is around 16% and 33% for the criteria market conditions for energy firms and the city's government and its policies, respectively. Nonetheless, precisely these two criteria, compared to the prior ones, shows a higher size of the interquartile range (the middle box that represents the middle 50% of the criteria weights). This means that, some experts have different opinions on the relative importance played by these criteria.

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Considering this previous observations from the boxplot analysis, the mean is calculated to obtain a final weight for each criterion. In the following table, the mean of the criteria weights from the ten experts is shown:

Table 35: Aggregated criteria weights

Six Criteria	WEIGHT assigned
Characteristics of the city's host country or region	10%
City structural factors	8%
The city's government and its policies	30%
Socioeconomic context of the city	14%
Environmental conditions of the city	13%
Market Conditions for energy firms in the city	25%

4.3.3 Rating the 27 sub-criteria

As previously explained, the experts are allowed to express their judgements without being extremely precise. This is often the case, while making complex decisions in business environments. This is also the case in the 2nd part of the survey, where respondents are asked to evaluate 27 sub-criteria using a five terms linguistic scale (not important = NI, low importance = LI, somewhat important = SI, very important = VI and extremely important =EI). If they are not sure about whether to use one linguistic label or another, we capture the hesitancy in their answer. In the following table, the statements of all the experts (E_i) have been registered and in each column, we can see all the linguistic terms used by them to evaluate each criterion.

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Table 36: Linguistic terms used by each expert to evaluate the 27 sub-criteria

Sub-criteria // Experts' opinions	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
Home-Host Country Distance	VI	NI, LI	VI	VI	NI	LI	VI	LI	NI	SI
Host country GDP per capita	LI	LI,SI	LI	SI	LI	LI	SI	LI	NI	SI
Host country level of welfare state	LI	SI,VI	VI	LI	LI	SI	SI	LI	NI	SI
Host country political stability perception	SI	VI	EI	VI	SI	VI	VI	SI	NI	VI
Host country's corruption perception	LI	VI	EI	VI	LI	EI	VI	SI	NI	VI
The city size	VI	SI	VI	LI	LI	LI	LI	LI	SI	VI
City's cultural and language distance perception	SI	NI	LI,SI	SI	LI	SI	SI	SI	LI	NI
City's climate characteristics	NI	VI, EI	NI, LI	EI	SI	LI	VI	SI	SI	LI
City's connectivity - infrastructural features	VI	LI	SI,VI	VI	LI	VI	VI	SI	NI	SI
City's reputation, image and prestige	SI	LI	SI,VI	SI	SI	SI	SI	LI	NI	SI
City government degree of transparency	LI	VI	VI, EI	EI	NI,LI,SI,VI,EI	EI	VI	VI	NI	VI
City government bureaucracy level	LI	EI	SI,VI	VI	LI	VI	VI	VI	EI	VI
Access to financial support provided by city government	VI	VI	SI,VI,EI	SI	SI	SI	VI	VI	EI	VI
City government support to public-private partnerships (PPP)	VI	EI	VI, EI	SI	NI,LI,SI,VI,EI	SI	VI	VI	VI	VI
City GDP per capita	SI	SI	SI	LI	NI,LI,SI,VI,EI	LI	SI	LI	NI	VI
Municipal economic budget	SI	SI, VI	VI, EI	LI	SI	LI	VI	LI	LI,SI	SI
City R&D expenditure	SI	SI	SI,VI	LI	LI	LI	NI	LI	LI,SI	VI
The service economy of the city	SI	LI	LI,SI,VI	VI	SI	VI	VI	LI	LI,SI	SI
Stakeholders' pressure in the city	SI	SI, VI	VI, EI	VI	LI	SI	VI	SI	LI,SI	VI
Citizens' environmental awareness	LI	VI	VI, EI	EI	EI	SI	LI	LI	LI,SI	VI
City's air quality	LI	VI	SI	SI	VI	SI	NI	LI	LI	VI
Degree of city transition to renewables	LI	VI, EI	SI	EI	NI	LI	VI	VI	EI	VI
Competition intensity in the city	VI	SI, VI	VI, EI	LI	LI	SI	SI	LI	NI	SI
Pool of skilled labor in the city	VI	SI, VI	SI,VI,EI	LI	VI	VI	EI	LI	NI, LI	VI
Access to needed suppliers	VI	SI	SI,VI,EI	SI	SI	SI	VI	SI	LI,SI	VI
City's potential customers	VI	VI	VI, EI	EI	VI	VI	SI	SI	SI	EI
City's degree of know-how, innovation and technological exchanges	SI	LI	SI,VI	SI	EI	SI	NI	LI	SI, VI	VI

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Table 37: Sub-criteria evaluation in fuzzy numbers

Sub - criteria list	E1					E2					E3					E4					E5				
Home-Host Country Distance	0	0	0	1	0	0,5	0,5	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
Host country GDP per capita	0	1	0	0	0	0	0,5	0,5	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0
Host country level of welfare state	0	1	0	0	0	0	0	0,5	0,5	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
Host country political stability perception	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0
Host country's corruption perception	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0
The city size	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0
City's cultural and language distance perception	0	0	1	0	0	1	0	0	0	0	0	0,5	0,5	0	0	0	0	1	0	0	0	1	0	0	0
City's climate characteristics	1	0	0	0	0	0	0	0	0,5	0,5	0,5	0,5	0	0	0	0	0	0	0	1	0	0	1	0	0
City's connectivity - infrastructural features	0	0	0	1	0	0	1	0	0	0	0	0	0,5	0,5	0	0	0	0	1	0	0	1	0	0	0
City's reputation, image and prestige	0	0	1	0	0	0	1	0	0	0	0	0	0,5	0,5	0	0	0	1	0	0	0	0	1	0	0
City government degree of transparency	0	1	0	0	0	0	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	1	0,2	0,2	0,2	0,2	0,2
City government bureaucracy level	0	1	0	0	0	0	0	0	0	1	0	0	0,5	0,5	0	0	0	0	1	0	0	1	0	0	0
Access to financial support provided by city gov.	0	0	0	1	0	0	0	0	1	0	0	0	0,3	0,3	0,3	0	0	1	0	0	0	0	1	0	0
City government support to public-private partn.	0	0	0	1	0	0	0	0	0	1	0	0	0	0,5	0,5	0	0	1	0	0	0,2	0,2	0,2	0,2	0,2
City GDP per capita	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0,2	0,2	0,2	0,2	0,2
Municipal economic budget	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	0,5	0,5	0	1	0	0	0	0	0	1	0	0
City R&D expenditure	0	0	1	0	0	0	0	1	0	0	0	0	0,5	0,5	0	0	1	0	0	0	0	1	0	0	0
The service economy of the city	0	0	1	0	0	0	1	0	0	0	0	0,3	0,3	0,3	0	0	0	0	1	0	0	0	1	0	0
Stakeholders' pressure in the city	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	0,5	0,5	0	0	0	1	0	0	1	0	0	0
Citizens' environmental awareness	0	1	0	0	0	0	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	1	0	0	0	0	1
City's air quality	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0
Degree of city transition to renewables	0	1	0	0	0	0	0	0	0,5	0,5	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0
Competition intensity in the city	0	0	0	1	0	0	0	0,5	0,5	0	0	0	0	0,5	0,5	0	1	0	0	0	0	1	0	0	0
Pool of skilled labor in the city	0	0	0	1	0	0	0	0,5	0,5	0	0	0	0,3	0,3	0,3	0	1	0	0	0	0	0	0	1	0
Access to needed suppliers	0	0	0	1	0	0	0	1	0	0	0	0	0,3	0,3	0,3	0	0	1	0	0	0	0	1	0	0
City's potential customers	0	0	0	1	0	0	0	0	0	1	0	0	0	0,5	0,5	0	0	0	0	1	0	0	0	1	0
City's degree of know-how, innovation and technological exchanges	0	0	1	0	0	0	1	0	0	0	0	0	0,5	0,5	0	0	0	1	0	0	0	0	0	0	1

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Sub - criteria list	E6					E7					E8					E9					E10				
Home-Host Country Distance	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
Host country GDP per capita	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
Host country level of welfare state	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
Host country political stability perception	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0
Host country's corruption perception	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0
The city size	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0
City's cultural and language distance perception	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
City's climate characteristics	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0
City's connectivity - infrastructural features	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0
City's reputation, image and prestige	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
City government degree of transparency	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0
City government bureaucracy level	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
Access to financial support provided by city gov.	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
City government support to public-private partn.	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0
City GDP per capita	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0
Municipal economic budget	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	1	0	0
City R&D expenditure	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	0	1	0
The service economy of the city	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	1	0	0
Stakeholders' pressure in the city	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0,5	0,5	0	0	0	0	0	1	0
Citizens' environmental awareness	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0,5	0,5	0	0	0	0	0	1	0
City's air quality	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0
Degree of city transition to renewables	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0
Competition intensity in the city	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
Pool of skilled labor in the city	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0,5	0,5	0	0	0	0	0	0	1	0
Access to needed suppliers	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0,5	0,5	0	0	0	0	0	1	0
City's potential customers	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1
City's degree of know-how, innovation and technological exchanges	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0,5	0,5	0	0	0	0	1	0

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A sum and a normalization transformation is applied to each of the previous rows (corresponding to each sub-criterion). The resulting fuzzy number for each sub-criteria is presented in the following table:

Table 38: Normalized sum of expert's opinions in fuzzy numbers

Sub-criteria list	Not important	Low Importance	Somewhat Important	Very Important	Extremely Important
Home-Host Country Distance	0,25	0,25	0,10	0,40	0,00
Host country GDP per capita	0,10	0,55	0,35	0,00	0,00
Host country level of welfare state	0,10	0,40	0,35	0,15	0,00
Host country political stability perception	0,10	0,00	0,30	0,50	0,10
Host country's corruption perception	0,10	0,20	0,10	0,40	0,20
The city size	0,00	0,50	0,20	0,30	0,00
City's cultural and language distance perception	0,20	0,25	0,55	0,00	0,00
City's climate characteristics	0,15	0,25	0,30	0,15	0,15
City's connectivity - infrastructural features	0,10	0,20	0,25	0,45	0,00
City's reputation, image and prestige	0,10	0,20	0,65	0,05	0,00
City government degree of transparency	0,12	0,12	0,02	0,47	0,27
City government bureaucracy level	0,00	0,20	0,05	0,55	0,20
Access to financial support provided by city government	0,00	0,00	0,33	0,53	0,13
City government support to public-private partnerships (PPP)	0,02	0,02	0,22	0,57	0,17
City GDP per capita	0,12	0,32	0,42	0,12	0,02
Municipal economic budget	0,00	0,35	0,40	0,20	0,05
City R&D expenditure	0,10	0,45	0,30	0,15	0,00
The service economy of the city	0,00	0,28	0,38	0,33	0,00
Stakeholders' pressure in the city	0,00	0,15	0,40	0,40	0,05
Citizens' environmental awareness	0,00	0,35	0,15	0,25	0,25
City's air quality	0,10	0,30	0,30	0,30	0,00
Degree of city transition to renewables	0,10	0,20	0,10	0,35	0,25
Competition intensity in the city	0,10	0,30	0,35	0,20	0,05
Pool of skilled labor in the city	0,05	0,25	0,08	0,48	0,13
Access to needed suppliers	0,00	0,05	0,58	0,33	0,03
City's potential customers	0,00	0,00	0,30	0,35	0,35
City's degree of know-how, innovation and technological exchanges	0,10	0,20	0,40	0,20	0,10

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Now, we need to determine and specify, which is the Fuzzy Positive-Ideal Solution (FPIS) and the Fuzzy Negative-Ideal Solution (FNIS) for this specific situation. As we are interested in determining the ranking order of all sub-criteria and identifying the most important ones from the list created by the experts, the FPIS and FNIS are defined as the fuzzy number such as the following formula

$$NI * 1 + LI * 2 + SI * 3 + VI * 4 + EI * 5$$

results in the maximum and minimum respectively. This expression is calculated for all the 27 sub-criteria and the maximum and the minimum values are identified.

Table 39: Identification of the FNIS and FPIS

Sub-criteria defined to be the FNIS and FPIS, respectively	NI	LI	SI	VI	EI	Expression
Host country GDP per capita (MINIMUM)	0,10	0,55	0,35	0,00	0,00	**2,25**
City's potential customers (MAXIMUM)	0,00	0,00	0,30	0,35	0,35	**4,050**

Then, first, a distance measure is calculated for each alternative from FPIS and FNIS, respectively, i.e., each fuzzy number is compared, using a distance measure, with the City's potential customers *(0,10 0,55. 0,35 0,00 0,00)* and Host country GDP per capita *(0,00 0,00. 0,30. 0,35. 0,35)* fuzzy numbers, respectively. Secondly, a closeness coefficient (CC_i) of each alternative is calculated, indicating which sub-criteria are closer to the FPIS and farther from FNIS.

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Table 40: Distances to FPIS and FNIS and Closeness coefficients

	Distance to FPIS	Distance to FNIS	CC_i
Home-Host Country Distance	0,45922636	0,4486702	0,494186474
Host country GDP per capita	0,72494328	0	0
Host country level of welfare state	0,51515505	0,04773194	0,08479845
Host country political stability perception	0,13613157	0,70939575	0,838998019
Host country's corruption perception	0,18679102	0,5391067	0,742675838
The city size	0,53754472	0,15143978	0,219801433
City's cultural and language distance perception	0,55204537	0,1661347	0,231327355
City's climate characteristics	0,28170827	0,16762071	0,373046744
City's connectivity - infrastructural features	0,2842765	0,43944505	0,607201828
City's reputation, image and prestige	0,46729138	0,23552485	0,335115834
City government degree of transparency	0,1943949	0,77323656	0,79910234
City government bureaucracy level	0,22730123	0,68844467	0,751785694
Access to financial support provided by city government	0,10421017	0,72486113	0,874304934
City government support to public-private partnerships (PPP)	0,11547842	0,78504609	0,87176538
City GDP per capita	0,455196	0,08478144	0,157009221
Municipal economic budget	0,37113993	0,11568836	0,237636889
City R&D expenditure	0,56813224	0,03590085	0,05943523
The service economy of the city	0,31187276	0,24407105	0,439021084
Stakeholders' pressure in the city	0,18373526	0,42565104	0,698491317
Citizens' environmental awareness	0,26849315	0,28510942	0,515007397
City's air quality	0,36330243	0,19770444	0,352410019
Degree of city transition to renewables	0,16226667	0,52520731	0,763966821
Competition intensity in the city	0,35392134	0,1237674	0,259096336
Pool of skilled labor in the city	0,26823952	0,54226291	0,669045387
Access to needed suppliers	0,22305185	0,47926925	0,68240759
City's potential customers	0	0,72494328	1
City's degree of know-how, innovation and technological exchanges	0,23761658	0,22688866	0,488452307

We know that each sub-criterion belongs to one of the six criteria categories. For each criteria group, we calculate the degree of importance of its sub-criteria components by computing the relative weight of its CC_i. Then, we multiply this percentage by the parameter found in the previous section in relation to the aggregated criteria weights.

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Table 41: Computing the global weight of sub-criteria

	Partial weight (from relative CC_i)	Parameter (Criteria weight)	Weight of sub-criteria	Sub-criteria position
CHARACTERISTICS OF THE CITY'S HOST COUNTRY OR REGION				
Home-Host Country Distance	22,9%	10%	2,29%	3
Host country GDP per capita	0,0%	10%	0,00%	5
Host country level of welfare state	3,9%	10%	0,39%	4
Host country political stability perception	38,8%	10%	3,88%	1
Host country's corruption perception	34,4%	10%	3,44%	2
CITY STRUCTURAL FACTORS				
The city size	12%	8%	1,00%	5
City's cultural and language distance perception	13%	8%	1,05%	4
City's climate characteristics	21%	8%	1,69%	2
City's connectivity - infrastructural features	34%	8%	2,75%	1
City's reputation, image and prestige	19%	8%	1,52%	3
THE CITY'S GOVERNMENT AND ITS POLICIES				
City government degree of transparency	24%	30%	7,27%	3
City government bureaucracy level	23%	30%	6,84%	4
Access to financial support provided by city government	27%	30%	7,96%	1
City government support to public-private partnerships (PPP)	26%	30%	7,93%	2
SOCIOECONOMIC CONTEXT OF THE CITY				
City GDP per capita	10%	14%	1,38%	4
Municipal economic budget	15%	14%	2,09%	3
City R&D expenditure	4%	14%	0,52%	5
The service economy of the city	28%	14%	3,86%	2
Stakeholders' pressure in the city	44%	14%	6,14%	1
ENVIRONMENTAL CONDITIONS OF THE CITY				
Citizens' environmental awareness	32%	13%	4,10%	2
City's air quality	22%	13%	2,81%	3
Degree of city transition to renewables	47%	13%	6,09%	1

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	Partial weight (from relative CC_i)	Parameter (Criteria weight)	Weight of sub-criteria	Sub-criteria position
MARKET CONDITIONS FOR ENERGY FIRMS IN THE CITY				
Competition intensity in the city	8,4%	25%	2,09%	5
Pool of skilled labor in the city	21,6%	25%	5,40%	3
Access to needed suppliers	22,0%	25%	5,51%	2
City's potential customers	32,3%	25%	8,07%	1
City's degree of know-how, innovation and technological exchanges	15,8%	25%	3,94%	4

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Hence, the final ranking of all sub-criteria is obtained. In the following table a list of the 27 sub-criteria sorted by importance is shown. The top 10 have been highlighted:

Table 42: Final ranking of sub-criteria

1	City's potential customers	8,07%
2	Access to financial support provided by city government	7,96%
3	City government support to public-private partnerships (PPP)	7,93%
4	City government degree of transparency	7,27%
5	City government bureaucracy level	6,84%
6	Stakeholders' pressure in the city	6,14%
7	Degree of city transition to renewables	6,09%
8	Access to needed suppliers	5,51%
9	Pool of skilled labor in the city	5,40%
10	Citizens' environmental awareness	4,10%
11	City's degree of know-how, innovation and technological exchanges	3,94%
12	Host country political stability perception	3,88%
13	The service economy of the city	3,86%
14	Host country's corruption perception	3,44%
15	City's air quality	2,81%
16	City's connectivity - infrastructural features	2,75%
17	Home-Host Country Distance	2,29%
18	Municipal economic budget	2,09%
19	Competition intensity in the city	2,09%
20	City's climate characteristics	1,69%
21	City's reputation, image and prestige	1,52%
22	City GDP per capita	1,38%
23	City's cultural and language distance perception	1,05%
24	The city size	1,00%
25	City R&D expenditure	0,52%
26	Host country level of welfare state	0,39%
27	Host country GDP per capita	0,00%

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5. Discussion

Results indicate that municipalities can have a considerable influence on the variables valued by multinational enterprises in the energy sector. Actually the top 3 sub-criteria, most valued by these enterprises when making a location decision are: the amount of city's potential customers, the access to financial support provided by city government and the degree, to which the city promotes support to public-private partnerships (PPP). Clearly, as smart cities, priority should be given to the areas of smart governance and smart economy. They are less sensitive to the values of the indicators related to the smart environment, since they actually seek to generate this positive impact in the city where they are willing to operate.

We are convinced that the results we discuss in the following paragraphs will be useful and of great value for many European municipalities, which seek to transform their economy into a more sustainable and smarter system. However, in relation to limitations of our research results we want to emphasize the following:

- The scope of our investigation is limited to the partners and companies related to H2020 programme and based on Europe.
- Based on the method used, experts were able to hesitate in some answers. Therefore, as it happens in real life complex situations, there is not an absolute truth.
- The ecosystem of MNE in the energy sector might work differently than other sectors, and hence, the same methodological approach could be used to investigate the decision location patterns and framework for other big multinationals in sectors such as e-commerce or food industry.

First, we want to highlight the main results extracted from the AHP process for the criteria weights. The relevant importance of the main criteria is visualized in figure 7.

On the one hand, results indicate the greatest importance given to **the city's government and its policies**. Therefore, the quality and efficiency of the political, managerial and administrative processes led by the city leaders is actually more valuable to a MNE in the energy sector than aspects such as the GDP of the country or the status of the infrastructures in the city. This stresses the importance of politics and decision-making processes regarding the city's economic and social development. As expected, the second most important criteria is the specific conditions of the energy market in the city. What is important here is that managers from multinationals perceive a reasonable amount of potential clients and an adequate situation in terms of suppliers, know-how, etc.

On the other hand, city structural factors and characteristics of the city's host country (or region) turned out to be the least relevant criteria. This emphasizes the fact that European cities gain new meaning and importance over other regional or national structures. Nowadays, the competitiveness is not among countries but among the **European cities**, which are developing their own image and reputation to attract

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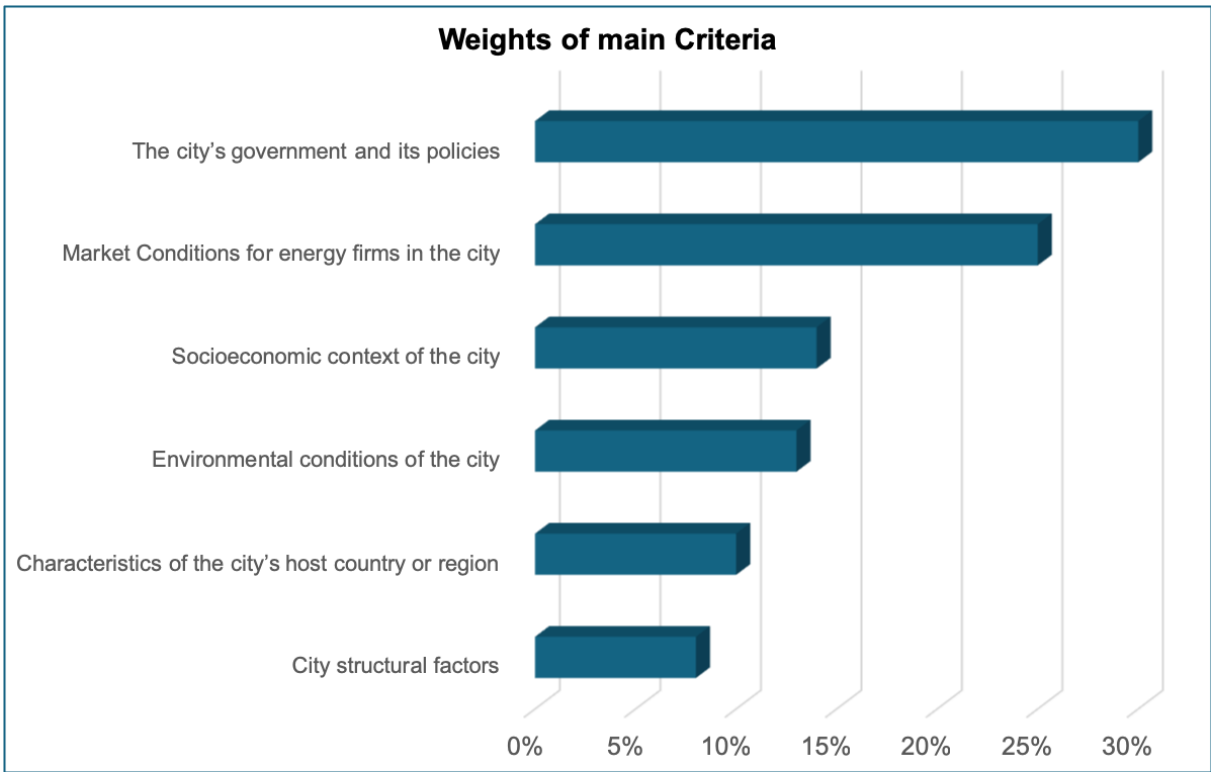
the attention of all the international economic agents. European cities need to position themselves in the European market as entities with their own autonomy.

Figure 7: Visual representation of main criteria weights



Each of these **six main criteria are explained and defined by some sub-criteria**. Figures 8 to 13 explain which aspects are more relevant for each criteria and therefore, better explained the overall percentage of each criteria. We present the criteria according to their own order of importance.

The **city's government and its policies** (figure 8) earns position number one in the ranking and its four sub-criteria show a very equal distribution of importance. It is interesting to see that actions directed to provide financial support to these multinational enterprises are placed at the same level as initiatives supporting public and private partnerships. MNE do not only value financial support in terms of economic resources but also, other types of support offered directly by the city authorities. Aspects such as the bureaucracy level and the degree of transparency should be valued above the average if the city's priority is to increase its chances to be chosen by a multinational enterprise from the energy sector.

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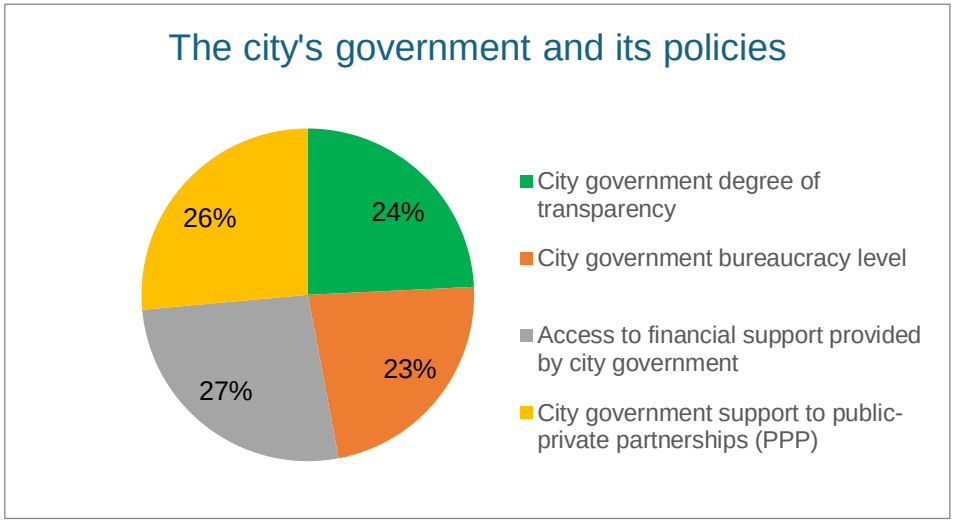
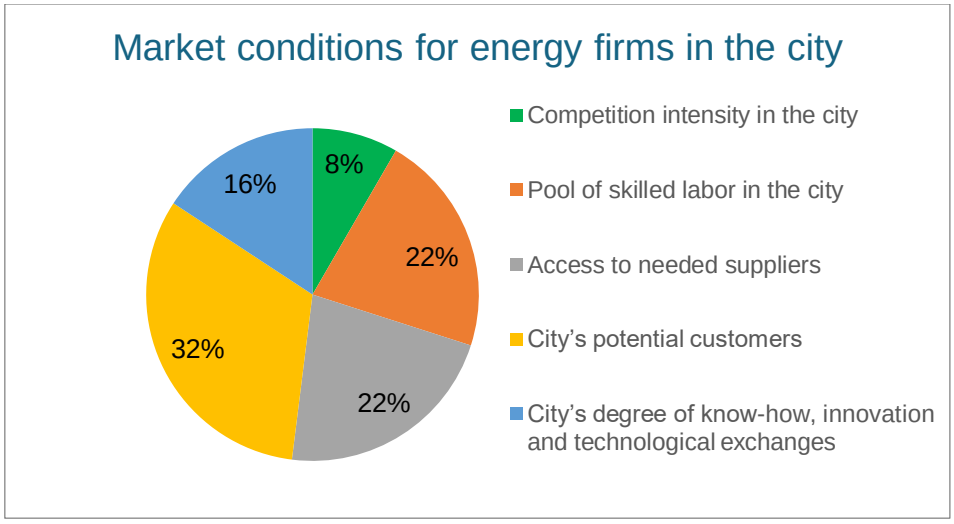
Figure 8: City's government and its policies sub-criteria distribution



Market conditions for energy firms in the city (figure 9) ranks second in the list. It is placed below the political criteria. The city's potential customers for the services or products offered by the MNE is the most relevant sub-criteria. It is equally important as the pool of skilled labor and access to needed suppliers. On the contrary, the competition intensity of similar enterprises offering related products or services is not considered as significant, when making the location decision. Hence, the priority is given to the existence of a considerable amount of potential clients.

Figure 9: Market conditions for energy firms in the city sub-criteria distribution



Out of the six criteria, **the socioeconomic context of the city** (figure 10) is placed third in the ranking of priorities. Unexpectedly, the majority of this criteria is explained by the stakeholders' pressure in the city.

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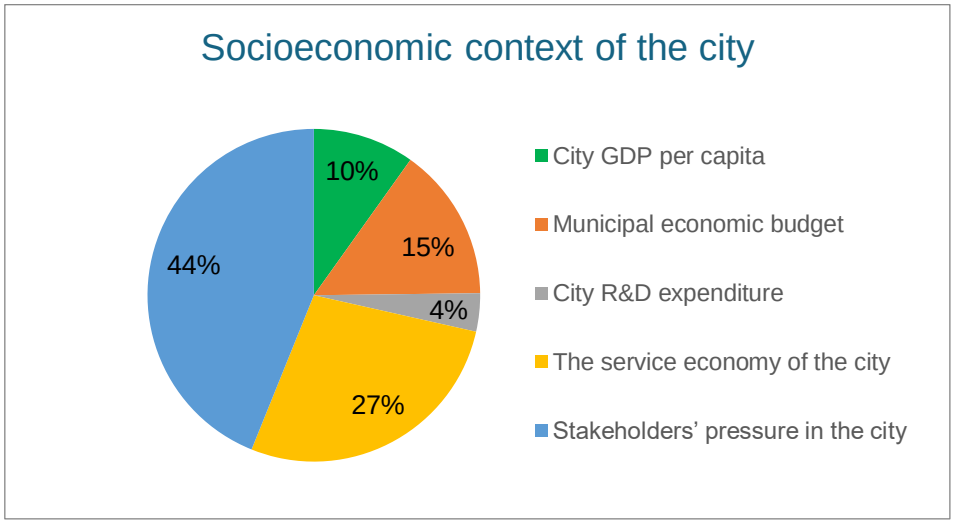
Similarly to what we have identified in the City's Host Country criterion, aspects such as the city GDP per capita or the municipal economic budget are placed in a lower importance level when compared to the influential pressure of stakeholders. So, it is highly recommended that city governments manage the cities with a stakeholders approach. For example, co-creating activities with those agents will help them on understanding their needs and interests.

Figure 10: Socioeconomic context of the city sub-criteria distribution



The **environmental conditions of the city** (figure 11) are still not placed in the top positions of the rankings. Actually, multinational enterprises are still putting into practice the three aspects of the sustainability concept, which is theoretically already well-developed. We expect to observe a growing importance of this criteria in the future.

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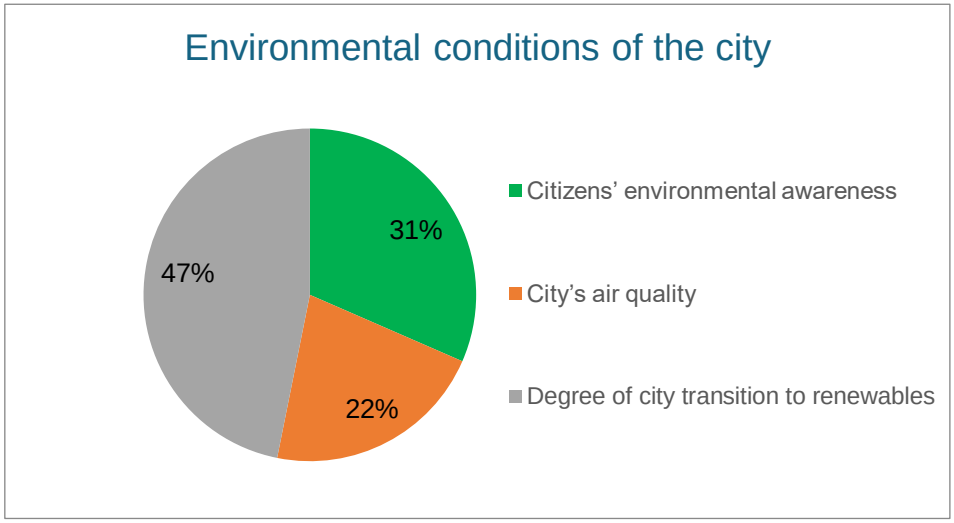
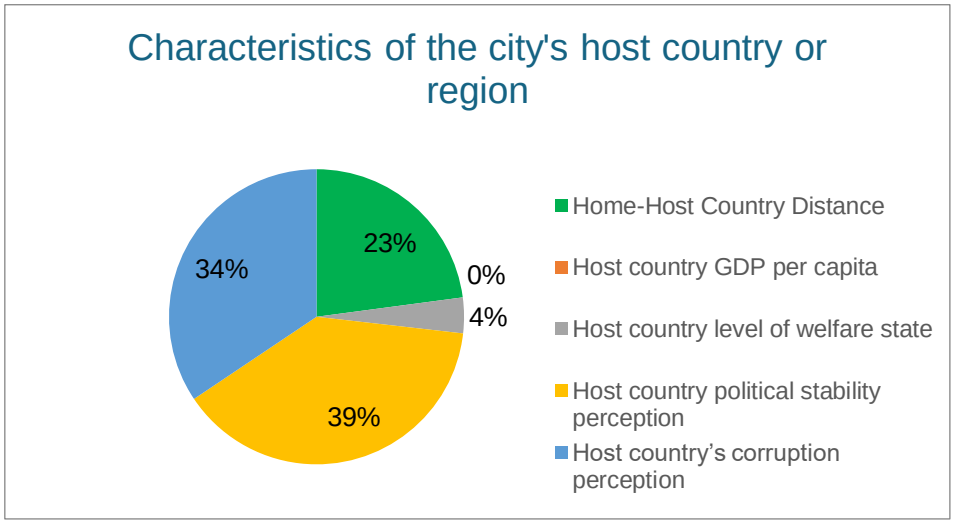
Figure 11: Environmental conditions of the city sub-criteria distribution



The **characteristics of the city's host country or region** (figure 12) is the second least relevant criteria evaluated by the experts. Nonetheless, if we go deeper inside this criteria, it should be highlighted that none importance has been given to the GDP per capita indicator, while compared to the sub-criteria related to political stability and corruption perception, which accounts for more than 70% of the criteria characterization. Therefore, if municipalities can have an influence and complement its political actions with its national (or regional) level government, they should recommend to make decisions that improve the political stability of the country and reduce the corruption. At this higher level, an indicator of an "almost non-existent corruption in the country" can have a higher impact on multinational enterprises decision making than an extraordinary growth of the GDP per capita.

Figure 12: Characteristics of the city's host country (or region) sub-criteria distribution



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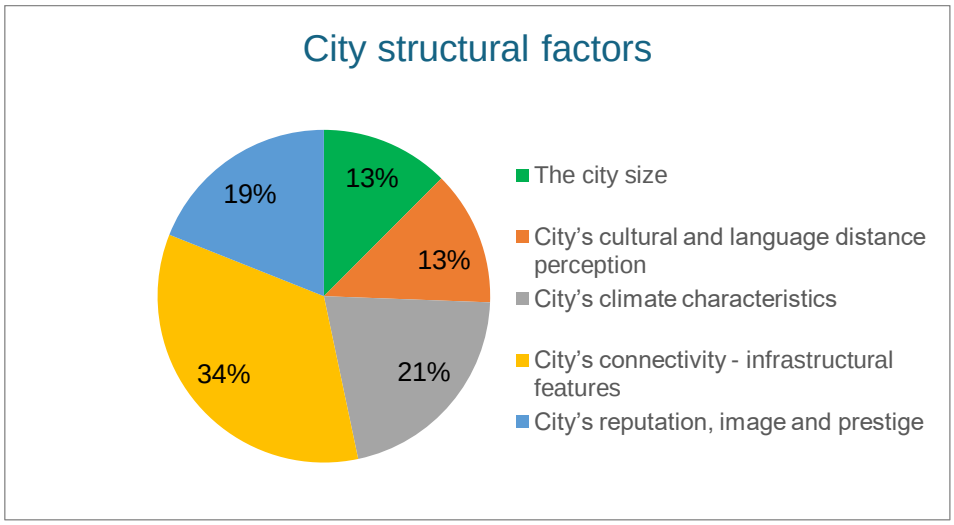
The **city structural factors** (figure 13) is the least important criteria in the ranking of multinational enterprises priority when deciding about a new location. However, the infrastructural features of the city are somehow relevant and shouldn't be completely neglected. Someone could think that the city size is a decisive aspect for multinational enterprises but based on our results, it is not. However, we will see that what is important is the forecast of the amount of potential clients that will buy the products and services offered by these multinationals in the new city. Similarly, the cultural and language distances are not considered obstacles for multinational enterprises that seek to expand in a completely different place.

Figure 13: City structural factors sub-criteria distribution



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6. Conclusions

It is the role of municipal governments to secure the economic, social and environmental sustainability of the city. European local government officials, with their political fiscal and administrative autonomy, have the responsibility to make the right decisions that contribute to this goal. This is easier said than done. Sometimes the advantages of taking a quick decision within a public sector could be greater than doing nothing or postponing the decision. Nonetheless, there are other complex situations, where a public agent must wait to have all the data and precisely calculate before making the right decision. Regardless the situation, public agents are nowadays increasingly face more and more complex situations with uncertainty and decisions have to be made in a world where technology grows fast, citizen's preferences change rapidly, national economics can fluctuate due to unexpected events and so on.

The aim of this report is to provide these decision makers with valuable information from the business ecosystem. In particular, multinationals from the energy sector. We have analyzed the current preferences of European Multinational Energy enterprises when deciding, which smart city to implement its products and services. The methodology used for gathering and analyzing the data provided by these big players is adapted to the complexity and uncertainty characterizing the strategic location decisions. The resulting framework is a complementary tool for city mayors and public agents who are constantly facing decision-making processes. This is not an analysis with the objective to rank cities, neither to make an absolute statement about the energy sector.

In the following paragraphs, we highlight the main conclusions regarding the content as well as the method used in this report:

- It is possible for municipalities to make more knowledge-based decisions that can lead to economic growth and an increase in measurable social and environmental impact. In a world where data-driven decisions it is a must in business environments, urban development decisions made by politics should also be backed by metrics, facts or figures related to its goals. This research helps municipalities to work towards some of its social, economic and environmental goals by leveraging verified, analysed data rather than merely shooting in the dark. Collecting, extracting and analysing insights from multinational enterprises in the energy sector in a rigorous and methodological way, allows the decision-makers in European cities to develop strategies and activities that this business sector as well as the citizens may benefit from in a number of areas.
- Location decision-making in the business context is widely studied in the academic literature. This report contributes to the development of location decision-making in the business energy sector with a specific approach oriented to local governments. It is also adapted to the uncertainty and ambiguity, which are predominant characteristics in this type of strategic decisions. The use of fuzzy sets to capture hesitance in respondents is essential if we pretend to accurately collect their

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reasoning and way of thinking. Besides, experts feel more comfortable if they are allowed to hesitate when giving their answers and as result, they give better and more sincere answers. To the best knowledge of the authors, this is the first time this approach has been used for assessing preferences of energy enterprises. This is useful for future work packages, in which authors need to gather information from an uncertainty and ambiguous context.

- Multiple-criteria decision aiding (MCDA), which is a sub-discipline of operations research, deals with complex situations with multiple conflicting criteria. In our daily life as well as in business, government or technological settings, we usually face problems without a unique optimal solution and some criteria are easily in conflict with others. This is exactly what a city's municipal government deals with every day. Economic evaluations confront the social impact measurements or technical barriers and might be in contradiction with environmental impact. Therefore, AHP or TOPSIS, which are tools from the MCDM field, have proven to be appropriate and adequate methods to use in such contexts.
- The use of AHP to rate criteria combined with TOPSIS to obtain the final ranking of sub-criteria computed with fuzzy linguistic term sets is a methodology that might be replicated with other experts and decisions makers from a different sector. For example, the process and methodology used to extract information from managers of multinationals in the energy sector can be similarly used to analyse preferences of IT companies which seek to expand its services to new European cities. It would be of great interest to compare the results of this study with the conclusions that might be obtained from IT experts opinions. Researchers would need only to adapt the questions in the survey for the IT context and replicate the process.
- The contribution of ESADE Business School has been crucial to better adapt this research to the characteristics of multinational companies in the energy sector. Practitioners from the business school were key to transform the first list of relevant variables extracted from literature review to a more adapted list of criteria and sub-criteria. This link between the theoretical exploratory analysis and the professional world contributed to a better design of the survey and a more accurate analysis of the obtained results.
- As seen in the final ranking of sub-criteria, fifty percent (50%) of the location decision made by multinationals in the energy sector is based on city's aspects related to government and market conditions. This emphasizes the importance of two aspects of the smart city concept, i.e., smart governance and smart economy. Politics can take action on these areas. In contrast, resulting from the analysis of criteria weights based on the AHP method, only a maximum of a 10% of the decision' weight is due to uncontrolled factors of the city government, i.e.city's host country characteristics and city structural factors.

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- Results from this report underline the importance of municipalities areas in which politics from the city level can take action on. Actually, the top 5 sub-criteria which are considered the most valuable ones for location strategic decisions in multinational enterprises in the energy sector are: city's potential customers, access to financial support provided by city government, city government support to public-private partnerships, city government degree of transparency and city government bureaucracy level. Except from the amount of potential customers, the local government of an European city possesses sufficient powers to impact these areas positively. Actually, these areas related to the smart economy and smart governance of the city. A lot of public policies could be implemented in this direction.
- In contrast, results from this report underline the low impact and importance of criteria in which local politics cannot take action on. The least valued sub-criteria are: city's cultural and language distance perception, the city size, city R&D expenditure, host country level of welfare state and host country GDP per capita. Except from the amount of money invested in R&D projects, the local government of an European city possess little influence over these areas.
- Considering the importance of the common accounting framework that incorporates three dimensions of performance: social, environmental and financial, which is increasingly being used in decision-making in business settings, someone might be surprised by the position obtained by the environmental criteria and its three sub-criteria. None of them are placed in the top 5 positions. However, this is explained by the fact that respondents of the survey are precisely multinationals from the energy sector that expect to produce its own environmental impact with its services or products. Therefore, when making the location decision, they are less sensitive to the values of these environmental indicators.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

7. References

1. Adler, N. and Hashai, N. (2015) 'The Impact of Competition and Consumer Preferences on the Location Choices of Multinational Enterprises', *Global Strategy Journal*, 5(4), pp. 278–302. doi: 10.1002/gsj.1102.
2. Anvari, S. and Turkay, M. (2017) 'The facility location problem from the perspective of triple bottom line accounting of sustainability The facility location problem from the perspective of triple bottom line accounting of sustainability', *International Journal of Production Research*. doi: 10.1080/00207543.2017.1341064.
3. Bhat, C. R. and Singh, P. (2014) *A Spatial Multivariate Count Model for Firm Location Decisions*. Available at: http://www.caee.utexas.edu/prof/bhat/ABSTRACTS/Spatial_Industry_Births.pdf (Accessed: 10 January 2019).
4. Blanc-Brude, F., Cookson, G., Piesse, J. and Strage, R. (2014) 'The FDI location decision: Distance and the effects of spatial dependence', *International Business Review*, 23(4), pp. 797–810. doi: 10.1016/j.ibusrev.2013.12.002.
5. Brunelli, M. (2015) *Introduction to the Analytic Hierarchy Process*, *SpringerBriefs in Operations Research.* doi: 10.1016/B978-0-12-416727-8.00003-5.
6. Brussels Smartt City (2019). What is a smart city?. Brussels Smart City. https://smartcity.brussels/the-project-definition#
7. Caragliu, A., Bo, C. D. and Nijkamp, P. (2009) 'Smart Cities in Europe', *Proceedings of the 3rd Central European Conference in Regional Science, Košice, October 7-9*, pp. 1–15. Available at: http://www.inta-aivn.org/images/cc/Urbanism/background documents/01_03_Nijkamp.pdf.
8. Chang, P.-Y. and Lin, H.-Y. (2015) 'Manufacturing plant location selection in logistics network using analytic hierarchy process', *Journal of Industrial Engineering and Management*, 8(5), pp. 1547–1575. doi: 10.3926/jiem.1456.
9. Chen, C. T. (2000) 'Extensions of the TOPSIS for group decision-making under fuzzy environment', *Fuzzy Sets and Systems*, 114(1), pp. 1–9. doi: 10.1016/S0165-0114(97)00377-1.
10. Chen, L.-F. and Tsai, C.-T. (2016) 'Data mining framework based on rough set theory to improve location selection decisions: A case study of a restaurant chain', *Tourism Management*, 53, pp. 197–206. doi: 10.1016/j.tourman.2015.10.001.
11. Chu, T.-C. and Lin, Y.-C. (2013) 'Improved extensions of the TOPSIS for group decisionmaking under fuzzy environment', *Journal of Information and Optimization Sciences*, 23(2), pp. 273–286. doi: 10.1080/02522667.2002.10698996.
12. Ciulla, G., Galatioto, A. and Ricciu, R. (2016) 'Energy and economic analysis and feasibility of retrofit actions in Italian residential historical buildings', *Energy and Buildings*. Elsevier B.V., 128(July), pp. 649–659. doi: 10.1016/j.enbuild.2016.07.044.
13. Cró, S. and Martins, A. M. (2018) 'Hotel and hostel location in Lisbon: looking for their determinants', *Tourism Geographies*, 20(3), pp. 504–523. doi: 10.1080/14616688.2017.1360386.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

14. Daim, T. U., Udbye, A. and Balasubramanian, A. (2013) 'Use of analytic hierarchy process (AHP) for selection of 3PL providers', *Journal of Manufacturing Technology Management*, 24(1), pp. 28–51. doi: 10.1108/17410381311287472.
15. David, Q., Peeters, D., Van Hammeb, G. and Vandermotteb, C. (2013) 'Is bigger better? Economic performances of European cities, 1960-2009', *Cities*. Elsevier Ltd, 35, pp. 237–254. doi: 10.1016/j.cities.2013.07.011.
16. Dijkstra, A. S. and Roodbergen, K. J. (2017) 'Exact route-length formulas and a storage location assignment heuristic for picker-to-parts warehouses', *Transportation Research Part E: Logistics and Transportation Review*, 102, pp. 38–59. doi: 10.1016/j.tre.2017.04.003.
17. Diodato, D., Neffke, F. and O'Clery, N. (2018) 'Why do industries coagglomerate? How Marshallian externalities differ by industry and have evolved over time', *Journal of Urban Economics*. Elsevier Inc., 106, pp. 1–26. doi: 10.1016/j.jue.2018.05.002.
18. Dubé, J., Brunelle, C. and Legros, D. (2016) 'A Micro-Spatial Investigation of a Nonmetropolitan Area in Canada', *The Review of Regional Studies Location Theories and Business Location Decision*, 46, pp. 143–170. Available at: www.srsa.org/rrs (Accessed: 10 January 2019).
19. Dubois, D. and Prade, H. (1980) *Fuzzy Sets and Systems: Theory and Applications*, *Mathematics in Science and engineering*. doi: 10.1137/1027081.
20. Eckert, A., He, Z. and West, D. S. (2015) 'An empirical analysis of tenant location patterns near department stores in planned regional shopping centers', *Journal of Retailing and Consumer Services*, 22, pp. 61–70. doi: 10.1016/j.jretconser.2014.09.007.
21. Espitia-Escuer, M., García-Cebrián, L. I. and Muñoz-Porcar, A. (2014) 'Location as a competitive advantage for entrepreneurship an empirical application in the Region of Aragon (Spain)', *International Entrepreneurship and Management Journal*, 11(1), pp. 133–148. doi: 10.1007/s11365-014-0312-9.
22. Faggio, G., Olmo Silva, L. and Strange Rotman, W. C. (2014) *Heterogeneous Agglomeration*. Available at: http://eprints.lse.ac.uk/58426/1/sercdp0152.pdf (Accessed: 11 December 2018).
23. fDi Magazine (2018) *fDi European Cities and Regions of the Future 2018/2019*. Available at: www.fDiIntelligence.com (Accessed: 2 January 2019).
24. Felix, R. A. and Hines, J. R. (2013) 'Who offers tax-based business development incentives?', *Journal of Urban Economics*, 75(1), pp. 80–91. doi: 10.1016/j.jue.2012.12.003.
25. Ferreira, J. J. M., Fernandes, C. I., Raposo, M. L., Thurik, R. and Faria, J. R. (2016) 'Entrepreneur location decisions across industries', *International Entrepreneurship and Management Journal*, 12(4), pp. 985–1006. doi: 10.1007/s11365-015-0370-7.
26. Flammer, C. (2013) 'Coporate social responsability and shareholders reaction: the environment awareness of investors', *Academy of Management Journal*, 56(3). doi: 10.5465/amj.2011.0744.
27. Funk, R. J. (2015) 'MAKING THE MOST OF WHERE YOU ARE: GEOGRAPHY, NETWORKS, AND INNOVATION IN ORGANIZATIONS', *Academy of Management Journal*, 57(1), pp. 193–222. doi: 10.5465/amj.2012.0585.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

28. Gabriela, M. and Mihai Article, D. (2017) *Models and Practice of Retail Location on the Romanian Market*, *Amfiteatru Economic Journal*. Available at: http://hdl.handle.net/10419/169085http://creativecommons.org/licenses/by/4.0/www.econstor.eu (Accessed: 9 January 2019).
29. Giffinger, R. *et al.* (2007) 'City-ranking of European Medium-Sized Cities', *Cent. Reg. Sci. Vienna UT*, pp. 1–12. Available at: http://www.smartcity-ranking.eu/download/city_ranking_final.pdf (Accessed: 16 January 2019).
30. Giffinger, R., Fertner, C., Kramar, H. and Meijers, E. (2007) *Smart cities Ranking of European medium-sized cities*. Available at: www.srf.tuwien.ac.at (Accessed: 2 January 2019).
31. Gooris, J. and Peeters, C. (2013) *Home-Host Country Distance in Offshore Governance Choices*. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.643.8499&rep=rep1&type=pdf (Accessed: 21 February 2019).
32. Govindan, K., Garg, K. , Gupta, J. and Jhab, P.C. *et al.* (2016) 'Effect of product recovery and sustainability enhancing indicators on the location selection of manufacturing facility', *Ecological Indicators*. Elsevier, 67, pp. 517–532. doi: 10.1016/J.ECOLIND.2016.01.035.
33. Haddou Amar, S., Abouabdellah, A. and Ouzzani, Y. El (2017) 'Location decision analysis: Multi-facility Weber problem morocco case study', in *2017 2nd International Conference on Knowledge Engineering and Applications (ICKEA)*. IEEE, pp. 133–137. doi: 10.1109/ICKEA.2017.8169916.
34. Hammad, A. W. A., Akbarnezhad, A. and Rey, D. (2017) 'Sustainable urban facility location: Minimising noise pollution and network congestion', *Transportation Research Part E: Logistics and Transportation Review*, 107, pp. 38–59. doi: 10.1016/j.tre.2017.09.005.
35. Hargreaves, A, Cheng, V, Deshmukh, S, Leach, MA and Steemers, K (2017) 'Forecasting how residential urban form affects the regional carbon savings and costs of retrofitting and decentralized energy supply', *Applied Energy*., 186, pp. 549–561. doi: 10.1016/j.apenergy.2016.02.095.
36. Heikkilä, J., Martinsuo, M. and Nenonen, S. (2018) 'Backshoring of production in the context of a small and open Nordic economy', *Journal of Manufacturing Technology Management*, 29(4), pp. 658–675. doi: 10.1108/JMTM-12-2016-0178.
37. Herrera-Viedma, E., Herrera F., Chiclana, F. and Luque, M. (2004) 'Some issues on consistency of fuzzy preference relations', *European Journal of Operational Research*, 154(1), pp. 98–109. doi: 10.1016/S0377-2217(02)00725-7.
38. Jafari, A. and Valentin, V. (2017) 'An optimization framework for building energy retrofits decision-making', *Building and Environment*. Elsevier Ltd, 115, pp. 118–129. doi: 10.1016/j.buildenv.2017.01.020.
39. Ketokivia, M., Turkulainen, V., Seppälä, T., Rouvinen, P and Ali-Yrkkö, J. (2017) 'Why locate manufacturing in a high-cost country? A case study of 35 production location decisions', *Journal of Operations Management*, 49–51, pp. 20–30. doi: 10.1016/j.jom.2016.12.005.
40. Klir, G. J. and Yuan, B. (2002) *Fuzzy sets and fuzzy logic: Theory and applications*, *Neurocomputing*. doi: 10.1016/s0925-2312(97)88327-0.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

41. Maria, J. and Carod, A. (2002) 'Determinants of Industrial Location. An Application for Catalan Municipalities', *Estudios sobre la Economia Española*, (EEE 138). Available at: http://www.fedea.es/hojas/publicado.html (Accessed: 21 February 2019).
42. Martí, J., Alguacil, M. and Orts, V. (2017) 'Location choice of Spanish multinational firms in developing and transition economies', *Journal of Business Economics and Management*, 18(2), pp. 319–339. doi: 10.3846/16111699.2015.1013980.
43. Morvaj, B., Evins, R. and Carmeliet, J. (2017) 'Decarbonizing the electricity grid: The impact on urban energy systems, distribution grids and district heating potential', *Applied Energy*. Elsevier, 191, pp. 125–140. doi: 10.1016/J.APENERGY.2017.01.058.
44. Musil, R. and Eder, J. (2016) 'Towards a location sensitive R&D policy. Local buzz, spatial concentration and specialisation as a challenge for urban planning - Empirical findings from the life sciences and ICT clusters in Vienna', *Cities*. Elsevier B.V., 59, pp. 20–29. doi: 10.1016/j.cities.2016.05.023.
45. Neirotti, P., De Marco, A., Corinna Cagliano, A., Mangano, G. and Scorrano, F. *et al.* (2014) 'Current trends in smart city initiatives: Some stylised facts', *Cities*. Elsevier Ltd, 38, pp. 25–36. doi: 10.1016/j.cities.2013.12.010.
46. Olsson, L., Wetterlund, E. and Söderström, M. (2015) 'Assessing the climate impact of district heating systems with combined heat and power production and industrial excess heat', *Resources, Conservation and Recycling*. Elsevier, 96, pp. 31–39. doi: 10.1016/J.RESCONREC.2015.01.006.
47. Owen-Smith, J. and Powell, W. W. (2004) 'Knowledge Networks as Channels and Conduits: The Effects of Spillovers in the Boston Biotechnology Community', *Organization Science*, 15(1), pp. 5–21. doi: 10.1287/orsc.1030.0054.
48. Pelegrín, B. (2010) 'José Lezama Lima, mythes et limites d'un système poétique', *Europe*, 88(979–980), pp. 139–150. doi: 10.1007/978-3-319-03167-5.
49. Phelps, N. A., Wood, A. and Ãã, A. M. W. (2018) 'The business of location: Site selection consultants and the mobilisation of knowledge in the location decision Planning the rurban View project The business of location: site selection consultants and the mobilisation of knowledge in the location decisio', *Article in Journal of Economic Geography*. doi: 10.1093/jeg/lbx016.
50. Picketta, S.T.A., Boone, C.G., McGrath, B. P., Cadenasso, M.L., Childers, D. L., Ogden, L. A., McHale, M. and Groveg, J. M. (2013) 'Ecological science and transformation to the sustainable city', *Cities*. Elsevier Ltd, 32, pp. S10–S20. doi: 10.1016/j.cities.2013.02.008.
51. Polyzos, S. (2015) 'Analyzing the Location Decisions of Agro-Industrial Investments in Greece', *International Journal of Agricultural and Environmental Information Systems*, 6(2), pp. 77–100. doi: 10.4018/ijaeis.2015040105.
52. Prager, R. A. (2014) 'Determinants of the Locations of Alternative Financial Service Providers', *Review of Industrial Organization*, 45(1), pp. 21–38. doi: 10.1007/s11151-014-9421-4.
53. Puciato, D. (2016) 'Attractiveness of municipalities in South-Western Poland as determinants for hotel chain investments', *Tourism Management*, 57, pp. 245–255. doi: 10.1016/j.tourman.2016.06.019.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

54. Reigadinha, T., Godinho, P. and Dias, J. (2017) 'Portuguese food retailers – Exploring three classic theories of retail location', *Journal of Retailing and Consumer Services*, 34, pp. 102–116. doi: 10.1016/j.jretconser.2016.09.015.
55. Rezaei, J. (2015) 'Best-worst multi-criteria decision-making method', *Omega (United Kingdom)*. Elsevier, 53, pp. 49–57. doi: 10.1016/j.omega.2014.11.009.
56. Romadona, I., Azizatunnishak, K. and Monica, A. A. (2017) 'Disparity in Determining Business Location: A Case Study in Unnes Sekaran Area', *Advanced Science Letters*, 23(8), pp. 7170–7172. doi: 10.1166/asl.2017.9320.
57. Rubalcaba-Bermejo, L. and Cuadrado-Roura, J. R. (1995) 'Urban Hierarchies and Territorial Competition in Europe: Exploring the Role of Fairs and Exhibitions', *Urban Studies*. Sage PublicationsSage UK: London, England, 32(2), pp. 379–400. doi: 10.1080/00420989550013149.
58. Rubalcaba, L., Gallego, J., Gallo, M. T., Garrido, R.*et al.* (2013) 'Business services location and market factors in major European cities', *Cities*, 31, pp. 258–266. doi: 10.1016/j.cities.2012.06.022.
59. Rubalcaba, L. and Gago, D. (2010) 'explanatory factors at European regional level', *The Service Industries Journal*, 23(1), pp. 77–94. doi: 10.1080/02642060412331300792.
60. Saaty, T. L. (1990) 'How to make a decision: The Analytic Hierarchy Process', *European Journal of Operational Research*, 48, pp. 9–26. doi: 10.1016/0377-2217(90)90057-I.
61. Saaty, T. L. (2008) 'Decision making with the analytic hierarchy process', 1, pp. 83–97. doi: 10.1504/IJSSCI.2008.017590.
62. Saaty, T. L. and Ozdemir, M. S. (2003) 'Why the magic number seven plus or minus two', *Mathematical and Computer Modelling*, 38(3–4), pp. 233–244. doi: 10.1016/S0895-7177(03)90083-5.
63. Shao, Y. and Shang, Y. (2016) 'Decisions of OFDI Engagement and Location for Heterogeneous Multinational firms: Evidence from Chinese firms', *Technological Forecasting and Social Change*, 112, pp. 178–187. doi: 10.1016/j.techfore.2016.07.023.
64. Shields, K., Langer, H., Watson, J. and Stelzner, K . (2009) *European Green City Index. Assessing the environmental impact of Europe's major cities (Miscellaneous) | ETDEWEB*. Available at: https://www.osti.gov/etdeweb/biblio/21274792 (Accessed: 2 January 2019).
65. Song, B. D. and Ko, Y. D. (2018) 'Quantitative Approaches for Location Decision Strategies of a Hotel Chain Network', *International Journal of Hospitality Management*. doi: 10.1016/j.ijhm.2017.08.004.
66. Spalanzani, A., Ageron, B. and Zouaghi, I. (2016) 'Manufacturing operations location decision: What are the main criteria?', *Supply Chain Forum*, 17(4), pp. 205–217. doi: 10.1080/16258312.2016.1240227.
67. Stummer, C., Doerner, K., Focke A., Heidenberger K. (2004) *Determining Location and Size of Medical Departments in a Hospital Network: A Multiobjective Decision Support Approach*, *Health Care Management Science*. Available at: https://0-link-springer-com.biblio.url.edu/content/pdf/10.1023%2FB%3AHCMS.0000005399.23600.69.pdf (Accessed: 10 January 2019).
68. Su, W. and Tsang, E. W. K. (2015) 'PRODUCT DIVERSIFICATION AND FINANCIAL PERFORMANCE:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731297.

THE MODERATING ROLE OF SECONDARY STAKEHOLDERS', *Academy of Management Journal*, 58(4), pp. 1128–1148. doi: 10.5465/amj.2013.0454.

69. Surroca, J. and Tribó, J. A. (2013) 'STAKEHOLDER PRESSURE ON MNEs AND THE TRANSFER OF SOCIALLY IRRESPONSIBLE PRACTICES TO SUBSIDIARIES', *Academy of Management Journal*, 56(2), pp. 549–572. doi: 10.5465/am).2010.0962.
70. The European Comission's science and knowledge service. Energy sector economic analysis. EU Science Hub. https://ec.europa.eu/jrc/en/research-topic/energy-sector-economic-analysis
71. Türkay, M., Saraçoğlu, Ö. and Arslan, M. C. (2016) 'Sustainability in Supply Chain Management: Aggregate Planning from Sustainability Perspective', *PLOS ONE*. Edited by P. Brañas-Garza. Public Library of Science, 11(1), p. e0147502. doi: 10.1371/journal.pone.0147502.
72. Verhetsel, A., Kessels, R., Goos, P., Too Zijlsta, T., Blomme, N., Cant, J., (2013) 'Location of Logistics Companies: A Stated Preference Study to Disentangle the Impact of Accessibility', *Journal of Transport Geography*, (0).
73. Wheatley, D., Gzara, F. and Jewkes, E. (2015) 'Logic-based Benders decomposition for an inventory-location problem with service constraints', *Omega (United Kingdom)*, 55, pp. 10–23. doi: 10.1016/j.omega.2015.02.001.
74. Wu, C.-R., Lin, C.-T. and Chen, H.-C. (2007) 'Optimal selection of location for Taiwanese hospitals to ensure a competitive advantage by using the analytic hierarchy process and sensitivity analysis', *Building and Environment*. Pergamon, 42(3), pp. 1431–1444. doi: 10.1016/J.BUILDENV.2005.12.016.
75. Zhuang, H. (2014) 'Location determinants of greenfield FDI in the United States: Evidence from 2003-2009', *International Journal of Economic Research*, 11(1), pp. 61–70.

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