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Project title: **ALTER ECO - Alternative tourist strategies to enhance the local sustainable development of tourism by promoting Mediterranean Identity**

Work package / Task.: **3 Testing / 3.1 Setting up of common methodologies**

Authors: Camatti Nicola, Jan Van der Borg, Silvio Giove Department of Economics of University of Venice Ca'Foscari. External support by Risposte Turismo srl and N. Gemignani for the graphic layout.

D3.1.1 – Testing methodological guidelines

Deliverable D.3.1.1 Testing methodological guidelines	3.1: To enhance sustainable the development policies for more efficient valorization of natural resources and cultural heritage in coastal and adjacent maritime areas of a sustainable and responsible coastal and maritime tourism in the MED Area

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Executive Summary

The main objective of the present deliverable is the setting up of common methodologies and tools (e.g. ICT) for diagnosis, modelling and evaluation of tourist destinations.

This deliverable will be based on previous projects and reference documents in the sustainable tourism field (exhaustive review of existing support methods and tools).

The resulting guidelines will be connected to the activities to be realised for pilots in order to select which methods and tools help them better to break down the barriers identified in task 3.2.

The overall framework foresees first of all an identification of sustainability aspects/issues but in general to achieve the enhancement of a balance among tourist attraction, as an economic source of growth, and the conservation of the classical Mediterranean City Model as an example of sustainability. This task will also include the characterization and value of classical Mediterranean city; compact, complex and diverse, based in CAT-MED.

1. INTRODUCTION

1.1 Alter-ECO context

Alter-ECO project is a tourism-development plan in the context of Interreg MED Programme (Transnational European Cooperation Programme for the Mediterranean area), a European Regional Development Fund programme that aims to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach.

The considered area comprises many parts of thirteen European Countries that counts for 10% of European citizens.

In the period 2014-2020 Interreg MED Programme will support a stronger collaboration among many kinds of actors of these thirteen Mediterranean countries. The main goal is optimizing existing results achieved in the previous period (2007-2013) as well as facilitating new cooperation frameworks for all partners situated in the Programme cooperation area.Interreg MED Programme had established seven key cooperation principles aiming at consolidating the character of future projects and their related activities:

1. Thematic concentration
2. Result-orientation
3. Transnationality
4. Territorial relevance
5. Sustainability
6. Transferability
7. Capitalization

These principles are in line with the promotion of development and good governance and are supported by the European Union Cohesion Policy.

Alter-ECO project starts from an analysis of recent Mediterranean tourist developments that have lead many maritime cities to exceed on numerous occasions their carrying capacity, thus undermining their urban quality of life and social cohesion.

According to Alter-ECO principles, it is important to start over from Mediterranean identity implementing some alternative tourist strategies supported by public and private stakeholders.

For reaching this objective the project tries to apply to some Mediterranean neighborhoods and cities existing methodologies and tools arisen in previous high impact projects in the field of sustainable tourism or proposed by key specialists in the field.

The activities of the project will provide policy makers with a clearer framework for the governance and management of tourism in the Mediterranean and at the same time will foster a community of purpose between public and private stakeholders in order to create new business opportunities. Alter-ECO will contribute to improve knowledge and decision making capacities, including a better use of observation, monitoring and planning in the field of sustainable tourism.

Some aspects represent the background of the main topic of the discussion; first of all, the need to reinvent the urban spaces in the Mediterranean cities. Among the world urban spaces that suffered a huge exploitation due to several reasons, the Mediterranean urban spaces occupy the first places because of the intensity of pressure during the last decades. In particular, as mentioned by Gospodini et al. (2008), the main aspects of a Mediterranean city were the presence of an ancient port – where the residential area developed in the surroundings – and its natural position near to the sea.

The concept of city regeneration lies on the revitalization of historical center of cities in which other areas (more modern or more popular) have taken greater importance, and it always requires a long-term strategic view, combined with a determined political support throughout each phase. In the specific case of Mediterranean cities, some reasons caused this general degeneration which cannot be in toto ascribed to tourism pressure but also to other factor such as the growth in population, the immigration of people from internal areas and a widespread growth of disparity on the Mediterranean society.

During the years, the politics of city regeneration have concerned several aspects, linked to the renovation of both obsolete structures and the urban economy through real city marketing campaigns. The politics of city regeneration promoted by CAT-MED project and the current Alter-ECO one are in line with the general objectives of sustainable tourist development, and they have to refer to specific forecast and management models that could be adopted in the involved destinations.

The provisional models aspire to identify – as precisely as possible – the number of tourists that can visit a destination during a certain period, with the help from mathematical models and using historical data which could be useful in order to have an initial reference point for the work.

The main aim of provisional tools is to elaborate – starting from residential and socio-economic data concerning the destination – an adequate maximum number of arrivals that can be brought to the attention of stakeholders and public authorities of the area. The concept at the base of this

purpose is the Carrying Capacity, a management principle which, after alternate periods, have still not established as an essential landmark for public tourism managers. The aspired number is clearly really approximate and can be modified based on needs; it should be a landmark to undertake some intervention for limitation of tourist pressure on the destination through concrete political actions in this direction.

1.2 Purpose, intended audience and scope (of this deliverable)

The main purpose of this deliverable is to resume some common methodologies and tools for diagnosis, modeling and evaluation of tourist destinations based on previous projects and reference documents in the sustainable tourism field.

The common methodologies and tools resulting will be compiled in D.3.1, as guidelines for pilots to select which methods and tools help them better to break down the barriers that hinder the possibility of achieving a balance among tourist attractions as an economic source of growth and the conservation of the classical Mediterranean City Model as an example of sustainability.

This task will include the characterization and value of classical Mediterranean city; compact, complex and diverse, based in CAT-MED but will not renounce to deal with examples of non-Mediterranean best practices.

1.3 The tourism sustainability aspects/issues

One of the fundamental issues for the future of the Tourism sector will be adopting a sustainable development in the following years. This issue is not a new one as it has already being addressed at least from the UNCED Conference in 1987, in which the Brundtland Report "Our Common Future" has been produced.

The official definition of sustainability as regards tourism sector has been provided by WTO in 2005: "Sustainability principles refer to the environmental, economic and socio-cultural aspects of tourism development and a suitable balance must be established between these three dimensions to guarantee its long-term sustainability".

Over the years many aspects to evaluate the impact of tourism in a destination have been elaborated: current important aspects include carrying capacity, social responsibility and integration between tourists and local people.

Since tourism demand is essentially one of environmental and cultural values that should be preserved and properly presented for a better service, it is more evident how important is the link between tourism and its surrounding environment.

UNWTO has identified five pillars to base Sustainable Tourism Development on:

1) **Tourism policy and governance**: a clear tourism policy has to be promoted by all the public authorities that deal with this sector. In addition to tourism ministries also the presence of structures and mechanisms for engaging public, private and third sector stakeholders, including local communities, has to be considered.

2) **Economic performance,** investment and competitiveness: the main aspects of this pillar are the business and investment environment and the position of trade liberalization in the tourism sector not to mention the issues of market access and product quality.

3) **Employment,** decent work and human capital: the objective for all the sector should be a smart planning of human resources in order to meet the needs of the sector but also to provide them with decent jobs, good conditions of employment and a relevant training.

4) **Poverty reduction and social inclusion**: a strong objective for the future of the sector will be the contribution to poverty reduction. In particular UNWTO has identified some useful mechanisms for this purpose such as strengthening local supply chains, working with the informal sector, developing community-based initiatives and securing collateral benefits from tourism.

5) **Sustainability of the natural and cultural environment**: in this case the main focus is on the mechanisms to monitor the various impacts in a tourist destination with a particular attention to climate change. Besides monitoring it is also important to find new solutions and practices for a sustainable tourism development, also with the help of ICT solutions.

Among the most important aspects of Sustainable Tourism Development, Carrying Capacity has had a leading role in the past years in convincing Tourism stakeholders to reconsider their role in the degradation of tourism destinations.

According to the definition given by WTO, the carrying capacity of a tourist destination may be defined as "the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic and social environment".

Initially studies about Carrying Capacity were conducted only from an unidimensional perspective, mainly biological or sociological, but recent studies underlined the necessity to study this phenomenon taking into account both quantitative and qualitative aspects.

More than a monolithic and unique number, Carrying Capacity seems to be represented by a

combination of more capacities that measure different dimensions of the destination: an "ecosystem capacity" measuring how many resources are available in an habitat in relation to anthropogenic pressure, an "experiential capacity" related to the aesthetic satisfaction that a group of tourists could have toward a destination and a "socio-economic capacity" that measures the general satisfaction of local people toward tourism. On the one hand ecosystem capacity is generally objectively computable while experiential and socio-economic capacities are more difficult to determine.

Given these facts two main issues seem to be at the heart of the overall matter: both a numerical "capacity issue" (how many tourists can be accommodated in a given area before a negative effect could arise) measurable through quantitative methods and a psychological "perception of capacity" (how many tourists could be acceptable before causing a deterioration of visitors satisfaction) using quantitative and qualitative methods together. More than a scientific value Carrying Capacity seems to rather represent a management concept.

After an initial resistance of some operators, the TCC (Tourism Carrying Capacity) approach has finally affirmed his role in Tourism planning studies: even if there is still much to be done, the necessity of monitoring the impacts and finding alternative ways has become more impellent.
A three-way split has asserted itself as the most effective way to analyze Carrying Capacity:

Carrying Capacity	
The physical carrying capacity	"the maximum number of people who can use a site without an unacceptable alteration in the physical environment and without an unacceptable decline in the quality of experience gained by visitors" (Mathieson and Wall, 1982; Simón et al., 2004);
The social carrying capacity	the level of tolerance of the host population for the presence and behavior of tourists in the destination area;
The economic carrying capacity	the ability to absorb tourist functions without squeezing out desirable local activities and avoiding the decline of the tourist destination caused by the disruption of the local attractions.

Table 1: Carrying Capacity

Each of these three dimensions has a different type of impact measurement and it is the object of chapter 3.2 and 3.3 to review some of these methods and tools to offer a broadest possible overview. One of the first famous examples of carrying capacity assessment has been done for the

city of Venice (Costa, Van der Borg, 1988), considering many factors that have being used also in the following years for other destinations.

It could be surely affirmed that the fundamental area in which carrying capacity analysis could have a crucial role is Environmental Planning where decisions have to be made about the allocation of land use that deals with the matter of how many infrastructures or superstructures in a certain terrain can be installed or removed to have a sustainable use of land.

The role of public power in decisions related to tourist attractions is firmly established by now: tourist attractions are particular valuable assets that must be considered on a par with other public goods, worthy to be given a particular public safeguard.

Determining the threshold of maximum acceptable tourists in a certain area is a complex operation that has to be done considering the specific aspects of the destination: such a computation work has to consider different parameters when considering mountain destinations, coastal destinations or urban destinations.

1.4 The CAT-MED experience

CAT-MED experience in sustainable project-planning is a good example of how a sustainable development policy is possible especially within a network of cities that collaborate one another to share their best practices and solutions.

According to the CAT_MED final document (Sustainable urban models Work methodology and results) "Mediterranean cities have been unable to avoid the cultural dominance of the diffuse urban model. The Agenda 21 or other proposals regarding important modifications of urban planning, whilst being widely accepted on a theoretical basis, have rarely been put into practice. As a matter of fact, as we enter into the second decade of the 21st century, one of the main obstacles that the Mediterranean cities will have to overcome should they wish to be energy efficient and reduce CO_2 emissions, is how to deal with and change the areas of the cities created during the last few decades. These relatively new areas usually have a central motorway that provides the backbone to the city, giving access to the various clusters of houses, taking predominance over public areas. The CAT-MED project has aimed to show the best characteristics of the Mediterranean city, highlighting their ability to save natural resources and reduce CO_2 emissions, and their relation to possible future natural risks, predicted by the International Energy Agency and the United Nations Climate Change Panel, if human behaviour does not change considerably".

Since its constitution in 2011, CAT-MED project has been active in many activities related to Sustainable Development Planning: first of all "The Green Apple Project" that aims to build or

restore some neighborhoods in various Mediterranean cities in a sustainable way (es. Casal Bertone in Rome and Pajaritos-Nazaret in Sevilla) following the model of the traditional Mediterranean cities. The typical Mediterranean urban landscapes have some common characteristics such as a certain population density, sufficient levels of urban compactness and high complexity in the mix of uses and functions.
Among the most glorious in world's history, the Mediterranean cities have been able to create a successful urban model in which communication and exchange of goods and services are facilitated by short distances and flexible road concepts.

The whole project is based upon a common set of 23 indicators that have been created to measure the index of sustainability of a city as objectively as possible. These indicators are grouped in 5 categories covering the different areas of City Management practices:

- **Territorial Management and Urban Design** (Population density, Urban Compactness, Urban Complexity, Green zones and recreation areas, Green zones and recreation areas proximity)
- **Mobility and Transport** (Traffic modal split, Proximity of public transport stops, Proximity to bicycle lanes and paths, Percentage of pedestrians streets and walkways, CO^2 emissions)
- **Natural Resources Management** (Energy consumption, Water consumption, Waste management and removal, Air quality, Noise pollution)
- **Social and Economic Cohesion** (Proximity to basic services, Social housing ratio, Labor force participation and unemployment rate, Evolution of the tourist frequency, Environmental activities in primary school)
- **Complementary social and economic indicators** (Average household income, Poverty index, Income inequalities).

Interesting to notice within the indicators a possible range for "EVOLUTION OF THE TOURIST FREQUENCY" (19). Regarding this aspect the CAT-MED project described as "the existence of seasonality can generate an excessive concentration of tourism in certain seasons. This involves several negative consequences such as unstable employment (temporary and precarious contracts in this sector), overcrowding, public services and infrastructure overload (higher generation of waste, water and energy consumption), traffic congestion and crowing, and therefore, lower quality in the provision of services and a negative perception by the tourists. The definition of development plans and tourism strategies should try to establish measures that mitigate the seasonality, combining different types of tourism packages and offers. These strategies should benefit the more equitable evolution of the tourist frequency, focusing not only in the high season of the year. We could establish the percentage ranges of tourists and overnight stays per month between 6% and 11% as the desirable levels of the Mediterranean cities participating in this project."

2. METHODOLOGY

2.1 Description of the methodology

Under advice of Project Partners the theme of the research has been immediately focused on Tourism Sustainable Development, Crowd Management and Social Sustainability Assessment.

The literature review has been based mainly on internet research resulting in the identification of 28 tools and methods for Sustainable Crowd Management practice.

Three additional case studies are more focused on the measurement of Tourism social impacts on the local community.

Methods and ICT tools are listed in a table in chapter 2.2 but are discussed extensively in chapter 3.2 and 3.3, where the functioning of some of these methods and tools is widely explained.

2.2 Surveying existing M&T (methods and ICT tools)

The following table shows a list of methods and ICT tools used in Crowd Management practice all over the world:
Further details regarding each of the ICT tool and/or initiative are described in the following pages.

Number	ICT Tool/Initiative	Country	Source
1	A proposal of Visitors Flow Management during Haji Event in Mecca	Saudi Arabia	Owaidah A. A., *Haji Crowd Management via a mobile augmented reality application: a case of The Haji Event, Saudi Arabia*, University of Glasgow, 2015
2	IBeacon Technology in Sail Amsterdam 2015 Experience	Netherlands	https://itunes.apple.com/nl/app/sail/id1011875872?l=en&mt=8

Number	ICT Tool/Initiative	Country	Source
3	Amsterdam Beacon Mile Explorer	Netherlands	https://itunes.apple.com/nl/app/amsterdam-beacon-mile-explorer/id1030668251?mt=8&ign-mpt=u0%3D4
4	(UAF) Urban Analysis Framework	UK	http://www.crowddynamics.com/products/uaf.php
5	IoT-based Monitoring and Control System in Mogao Grottoes	China	Bomin S., Yabo D., *Visitor Management and Carrying Capacity at World Heritage Sites in China*, pp. 78-85, 2013
6	In-Joy-Life Smart Tourism	Taiwan	Lee C. K. et al., *Taiwan Perspective: Developing Smart Living Technology*, AUSMT International Journal of Automation and Smart Technology 1 (1), pp. 93-106, 2011
7	Dante Project	EU	http://danteproject.eu/?q=home
8	An application of Gayer's "Economic Climate Tracer" to Portugal Tourism Market	Portugal	Andraz J., Rodrigues P.M.M., Monitoring tourism flows and destination management: Empirical evidence for Portugal, CEFAGE Working Paper, 2016
9	A review of Visitor Management Tools from University of Hradec Králové, Czech Republic	Czech Republik	Zelenka J., Kacetl J., *Visitor management in protected areas*, Czech Journal of Tourism, 2(1), 5-18.
10	TFM (Tourism Flow Model)	New Zealand	http://www.mbie.govt.nz/info-services/sectors-industries/tourism/tourism-research-data/other-research-and-reports/pdf-and-document-library/tourism-flows-model-summary.pdf

Number	ICT Tool/Initiative	Country	Source
11	A GIS-based Model for Tourist Flow Data Management	New Zealand	http://www.landcareresearch.co.nz/publications/researchpubs/Barringer_tourist_flow_data.pdf
12	ProtegeGX Visitor Management	New Zealand	https://www.ict.co/Protege-GX
13	An Experiment held in Fukuoka for monitoring People Flow in the city	Japan	Morioka M. et al., *City Management Platform Using Big Data from People and Traffic Flows*, Hitachi Review, vol. 64, n° 1, 2015
14	LAC (US Forest Service's Limits of Acceptable Change)	USA	Stankey G. H. et al., The Limits of Acceptable Change (LAC) System for Wilderness Planning, United States Department of Agriculture General Report,
15	ROS (Recreational Opportunity Spectrum)	USA	http://www.tba.co.nz/kete/PDF_files/ITP105_recreational_opportunity_spectrum.pdf
16	Crowding Management in relation to LAC and ROS	USA	http://www.tba.co.nz/kete/PDF_files/ITP102_crowding_management.pdf
17	Zoning	USA	http://www.tba.co.nz/kete/PDF_files/ITP310_zoning.pdf
18	VIM (Visitor Impact Management)	USA	http://www.utok.cz/sites/default/files/data/USERS/u28/VIM.pdf
19	GSTC Destination Criteria	International	http://www.gstcouncil.org/en/gstc-criteria-hotels-tour-operators-destinations/criteria-for-destinations.html

Number	ICT Tool/Initiative	Country	Source
20	The European Tourism Indicator System	EU	*The European Tourism Indicator System: ETIS toolkit for sustainable destination management, Publications Office of the European Union, 2016*
21	UNWTO Sustainable Tourism Indicators and Destination Management	International	http://sdt.unwto.org/sites/all/files/pdf/finrep.pdf
22	The Travel & Tourism Competitiveness Report 2017	International	http://www3.weforum.org/docs/WEF_TTCR_2017_web_0401.pdf
23	The Total Impact Measurement and Management Model (TIMM)	International	https://www.pwc.com/gx/en/sustainability/publications/total-impact-measurement-management/assets/pwc-timm-report.pdf
24	An application of TIMM Model to Cyprus	International	http://www.socialvalueuk.org/app/uploads/2016/03/Measuring_Tourisms_Impact.pdf
25	Sustainable Tourism in Protected Areas: Guidelines for Planning and Management	International	http://cmsdata.iucn.org/downloads/pag_008.pdf
26	A Review of Technology innovations and applications in sustainable destination development	UK	http://shura.shu.ac.uk/9168/

Number	ICT Tool/Initiative	Country	Source
27	Policies, methods and tools for visitor management – proceedings of the second International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas, June 16–20, 2004, Rovaniemi, Finland	International	http://www.metla.fi/julkaisut/workingpapers/2004/mwp002.htm
28	A case of Carrying Capacity Evaluation in Vieste, Italy	Italy	https://ideas.repec.org/p/wiw/wiwrsa/ersa10p576.html
29	Goal programming synthetic indicators: An application for sustainable tourism in Andalusian coastal counties 2010	Spain	Ecological Economics 69 (2010) 2158–2172 www. e lsevi e r.com/locate/ecolecon

Table 2: Methods and tools used in crowd management

Here are listed three examples of measurement of tourism social impacts on a destination, related mainly to the themes of loss of local identity and quality of life of the destination.

Number	Method	Source
1	Case Study - Thailand	Soontayatron S.,*Thai Interpretation of Socio-cultural Impacts of Tourism Development in Beach Resort,* American Journal of Tourism Management, 2(2), 2013, pp. 29-35
2	Case Study - Cyprus	Spanou E., *The Impact of Tourism on the Sociocultural Structure of Cyprus*, Tourismos Il (1), 2007, pp. 145-162
3	Case Study - Turkey	Türker N. and Öztürk S., *Perceptions of Residents Towards The Impacts of Tourism in the Küre Mountains National Park, Turkey*, 2013

Table 3: Three case studies of measurement of tourism social impacts on a destination

3. SURVEY OF EXISTING METHODS & ICT TOOLS

3.1 The need of creating new methods & ICT tools for diagnosis, modelling and evaluation of tourist destinations

The tourism industry - with its flows of persons who move from their residence destination for a certain period, all the stakeholders and operators involved in several activities and fields, public and private entities who regulate and drive tourism development - is growing year by year and has reached high volumes of tourists, products, services and operators. According to UNWTO figure, international tourist arrivals have globally increased from 25 million in 1950 to 278 million in 1980, 674 million in 2000, and 1,235 million in 2016.

At the projected rate of growth, international tourist arrivals worldwide are expected to reach 1.4 billion by 2020, and 1.8 billion by the year 2030 (UNWTO Tourism Highlights 2017 Edition).

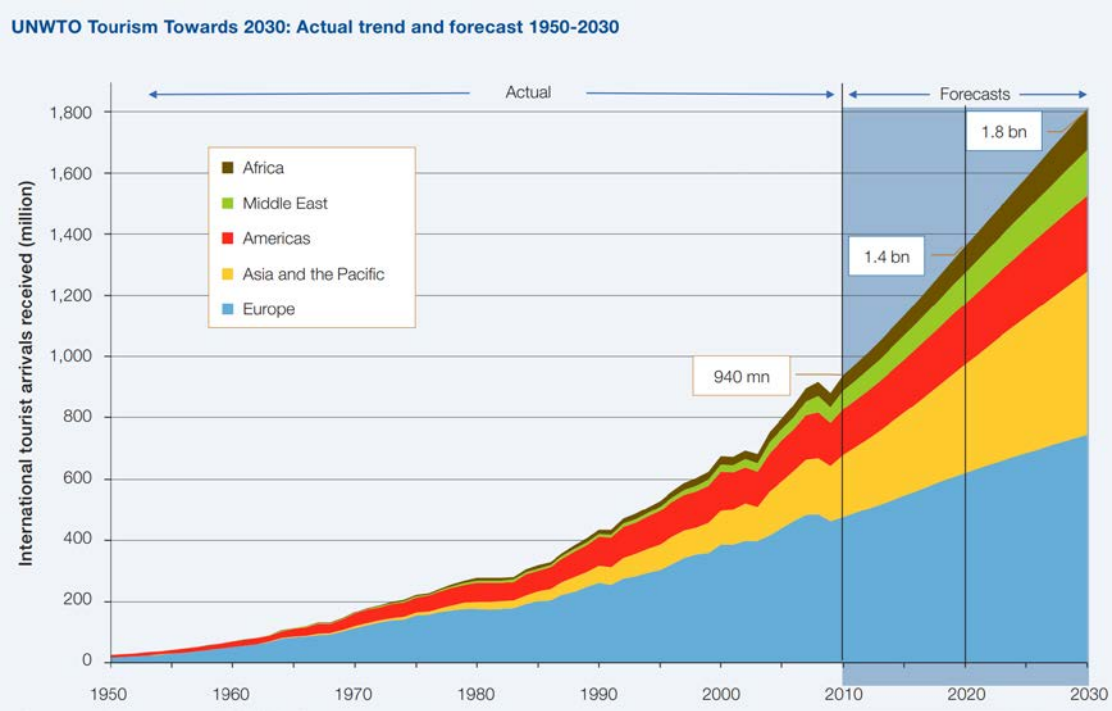

Figure 1: Tourism actual trend and forecast 1950-2030

Source: UNWTO (2017), Tourism Highlights 2017 Edition.

At a global level this growth in tourist numbers has implied consequences (on cities and destinations) that go in different directions: some territories have – positively or negatively – reacted to tourism flows that discovered the destination and were interested in visiting it. Other areas, on the other hand, have forced themselves to attract tourism flows, by implementing and developing a supply chain and a structure able to welcome tourists and meet their needs and expectations. Now there are some destinations that are consolidating their position in the tourism framework, while others are starting to host and govern tourism flows or are planning to do this.

The development of tourism industry and its growth have always implied positive benefits and impacts on areas and stakeholders who operate there; these implications reflect on several sectors and activities linked – directly or indirectly – to the tourism one. The tourism field not only creates revenue, trade and work, but also contributes to the image of a destination; it is strictly connected with the local communities and can favour investments and implementing works on infrastructures and on offer of products and services, by creating wealth.

However it should be underlined that tourism creates not only positive impacts, but also negative ones, such as overcrowding, pollution and conflicts with local communities. The tourism destinations sometimes suffer for these negative effects which also affect the social sustainability; some pictures of overcrowded cities went around the world, from the Italian Cinque Terre to Venice, from Dubrovnik (Croatia) to Barcelona (with the protests of residents), etc. Many cities have exceeded their carrying capacity and the tourism phenomenon has caused obstacles on quality of life and social cohesion.

These different impacts cause the necessity to regulate and govern the tourism flows and the whole local tourism industry of a destination, in order to optimize the positive effects and reduce the negative ones. Each destination has to take the maximum advantage from the benefits derived by tourism, but at the same time has to foresee, avoid or contain negative consequences. The new technologies are – and will be – very useful for monitoring, evaluating and forecasting the tourism flows, in order to find the best solution for governing the phenomenon and for developing the tourism sector in a sustainable way.

3.2 The identification of sustainability aspects and dimension from literature review

The sustainability, as already mentioned before, is a crucial aspect and aim in the tourism industry and for the involved destinations. The identification of the several aspects of sustainability and its dimension is really important to manage the development of tourism sector. The three identified dimensions of the sustainability (economic, environmental and socio-cultural) should be balanced

and guaranteed in the tourism development. The pillars identified by the UNWTO for sustainable tourism development link together the three dimensions referring to economic performances, employment, social inclusion, natural and cultural environment.

The sustainability can be measured on the basis of several indicators (economic, environmental and socio-cultural) which deal with different practices of city management, such as territorial management and urban design, transport, social cohesion, economic structure, natural resources. One of the most important elements of the sustainability is the carrying capacity (physical, social and economic), which provides with useful indications on the potential tourism dimensions without undermining the destination.

The sustainability can be identified and measured by different methods and tools, which are based on the indicators previously mentioned.

3.3 Methods

The development of ICT has been fundamental for the elaboration of new and more efficient provisional models and especially for the achievement of real tourism flow management tools. These tools are different one each other and have increased their efficiency both in the provisional and the management phase.

Between the most used tools to manage the tourist flows, there are more "traditional" tools like sensors, cameras and GPS, and also more technological ones like Beacons or IoT. The present frontier of technological innovation is precisely the IoT (Internet of Things) which implies the internet connection of things and places with the possibility to communicate information about them to anyone who is nearby connected. This has positive results on data communication about the crowd dimension and it can facilitate the development of more rapid systems of flows management based on real time data.

In this section it will be proposed a review of existing methods for diagnosis, modeling and evaluation of tourist destinations. In addition to specific models of diagnosis of Destination's sustainability also specific Case Studies were analyzed in order to evaluate the efficiency of the methods. It will be given a special importance to some case studies in which the social sustainability is the measured value.

Giving a precise evaluation of the degree of Sustainability of a destination is an hard task given the different variables involved in the process.

A first example of determination of social-economic carrying capacity concerns the city centre of Venice and has been formalized in Costa and Van der Borg (1988) and in Canestrelli and Costa (1991). A linear programming model has been built in order to maximize the income from tourism

under capacity restrictions, which were for example the accommodation availability, catering facilities, parking facilities, transport and mobility, waste disposal services and the space available in Saint Mark's Cathedral.

The emerged results indicated in 25,000 visitors per day (as a combination of 15,000 tourists and 10,000 excursionists) the maximum number that can be supported by the historical settlement.

The considered restrictions are the number of beds (the model tends to give priority to tourists for available bed spaces, rather than excursionists), the availability of water transport and the carrying capacity of Saint Mark's Cathedral. Therefore the evaluated carrying capacity of Venice – without fluctuation in demand – was about 10 million visitors per year.

Using the traditional touristic data of arrivals, overnight stays and bedrooms capacity to build some indexes could be a good starting point, as suggested by an Italian case study (Maggi E., Fredella F. C., 2011) in which the famous touristic locality of Vieste is analyzed just combining this kind of data with other values.

The main indexes used by the authors were:

1. The number of secondary homes
2. The index of tourist density: number of tourist arrivals per km² and number of overnight stays per km²
3. The index of land use: the sum of arrivals plus population per km²
4. The index of number of bed places per population
5. A first index of saturation: number of arrivals divided by number of inhabitants
6. A second index of saturation: number of tourist overnight stays per 1000 residents night stays

Of particular importance are the two indexes of saturation that let you measure the level of the effective human land consumption both from an arrival point of view and from an overnight one.

A particular application of these two indexes has been to calculate the level of saturation of Vieste's beaches, depending on the length of each beach coastline and on the number of bed places of the accommodation establishments located near the beach: the minimum sustainability standard applied was of three square meters of beach per person.

Name of beaches	Length of	Tourism	Max	Effective	Difference

	beach coastline (m)	square meters	number of users (A)	users (B)	(A-B)
Sfinalicchio	460	11.920	1,385	1.577	**-192**
Crovatico	320	10.996	535	475	60
Chianca	216	9.430	850	720	130
Scialmarino	2.850	133090	15.570	19.692	**-4122**
Molinella	380	21.850	1,515	1.650	**-135**
Braico Defensola	100	7.388	950	947	3
S. Lorenzo Defensola	195	2.920	194	186	8
Baia San Felice	120	1.600	400	1.344	**-944**

Table 4: The most saturated beaches of Vieste

Source: Maggi E. Fredella F. C., 2011.

The measurement of physical carrying capacity should in particular consider some levels or thresholds that hinder the environmental value of the destination.

A study of University of Aegean led by Coccossis and other scholars (Coccossis et al., 2002) proposes six levels:

- Acceptable level of congestion or density in key areas/spatial units such as parks, museums, city streets, etc.
- Maximum acceptable loss of natural resources (i.e. water or land) without significant degradation of ecosystem functions or biodiversity or loss of species.
- Acceptable level of air, water and noise pollution on the basis of tolerance or the assimilative capacity of local ecosystems
- Intensity of use of transport infrastructure, facilities and services.
- Use and congestion of utility facilities and services of water supply, electric power, waste management of sewage and solid waste collection, treatment and disposal and telecommunications.
- Adequate availability of other community facilities and services such as those related to public

health and safety, housing and community services, etc.

A very famous model [14][1] elaborated by US Forest Services to manage increasing levels of recreational use in wilderness areas has been playing an important role in the land planning field of the last years: the Limits of Acceptable Change model (LAC). The LAC has been developed in response to the need of managers for a means of coping with increasing demands on recreational areas in a visible, logical fashion. The LAC could be considered a reshaping of the traditional carrying capacity concept, starting the analysis from the conditions desired in the area rather than on how much use an area can tolerate. The LAC is a model elaborated especially for natural areas but there have been also some cases of application in urban locations. It is a complete model that involves both an evaluation phase and an operative phase divided into nine steps:

1) Identification of the main area's issues and characteristics
2) Identification of particular opportunity classes: subunits of the area where different conditions are provided and each area needs different kinds of management tools
3) Identification of resources and social conditions in which management activities will take place: a set of indicators to base the management tools on
4) Inventorying of the resource and social conditions.
5) Definition of standards for each indicator in each opportunity class. (The standards should preferably based on inventory data)
6) Identification of alternative allocations of the area among the various opportunity classes.
7) Analysis of the various costs and benefits of each alternative, in terms of environmental impacts and impacts on visitors as well as administrative costs.
8) Identification of alternatives based on the analysis of the step 8
9) Implementation of the selected alternative and establishment of a monitoring program.

One of the most delicate operations for tourism managers is the fifth one: appropriate standards for each indicator are to be strictly related to the current situation of the destination. From a managerial point of view [14 and 16][2] the definition of standard is the phase in which careful computational operations have to be done in order to frame the environmental and social

[1] [14] Full reference at line 14 in paragraph 2.2.

[2] [14 and 16] Full reference at line 14 in paragraph 2.2.

situation in a proper manner: standards should assure a perfect balance between environment and overall current population, comprising local people and tourists.

Opportunity Class	Factor	Indicator	Standard
Semi-primitive	Campsite conditions	Camps per 500 acres (200 ha) Devegetated area/5 acres (2 ha) Condition class	Not more than 15 sites in any 500 acres (200 ha) Not over 2,500 ft² (245 m²) No class 5 sites; not more than three class 4 sites in any 500 acres (200 ha)
Primitive	Campsite conditions	Camps per 500 acres (200 ha) Devegetated area/5 acres (2 ha) Condition class	Not more than eight sites in any 500 acres (200 ha) Not over 1,000 ft² (100 m²) No class 5 sites; not more than one class 4 site in any 500 acres (200 ha)
Pristine	Campsite conditions	Camps per 500 acres (200 ha) Devegetated area/5 acres (2 ha) Condition class	Not more than two campsites in any 500 acres (200 ha) Not over 200 ft ² (19 m²) No class 4 or 5 sites; not more than one class 3 site in anv 500 acres (200 ha)

Table 5: Elaboration of standards for visitor capacity in a fictional natural area based on some indicators and opportunity classes

Source: Stankey G. H., 1985

In this table three opportunity classes (semi-primitive, primitive and pristine) were established to analyze a fictitious natural area according to land use and presence of particular biological species and just a factor is analyzed: the presence of campsites. According to precise calculations for each type of class a reference standard is elaborated to assess how many campsites could be built in an area without an excessive environmental exploitation.

Physical carrying capacity is without a doubt an essential starting point for every tourism impact analysis but it must necessarily be integrated by social and economic considerations.

Taking into account the needs of local community and tourists is the main objective of a serious Tourism policy and measuring the perception of a destination both from a tourist and from a local perspective is a useful operation for assessing social and economic sustainability as the more social sustainability deteriorates the more tourist willingness to pay decreases: Bimonte S. and Punzo L.F. (2005) call this "*snob-effect*".

The ideal method to investigate destination's perception is the interview, usually submitted both to tourists and local people basing the survey on some variables associated to respondents like qualification, income or the relationship between the respondent and tourism.

A research conducted in some Tuscany (Bimonte S. and Punzo L. F., 2003) cities points out a different degree of perception of environmental problems based on the qualification of respondents: both tourists and local people with a lower level of education perceived the environmental congestion as a less critical problem in comparison with unemployment and criminality.

Among the most recent methods used to evaluate social impacts in a destination "Social exchange theory" [3] has been used in many studies and seems to be one of the most effective. The principle of social exchange theory suggests that exchanges will occur if the process creates valued rewards as well as offering more benefits than costs. The theory involves the exchange of resources between individuals or groups when interacting; for instance, there is the exchange during the processes of interaction between host residents and visitors. The theory explains the variability in response to tourism by individuals and various groups in the social exchange process which engage at the individual and community stage, in particular what is put in evidence is that individuals or groups decide exchanges after weighing benefits and costs. Individuals' attitudes depend on the perceptions of exchange they are making. Subsequently, individuals who evaluate and perceive beneficial rewards in the exchange, have different perceptions from those who perceive the exchange as harmful. In the tourism prospect, these principles suggest that residents are willing to enter into an exchange with tourists if they can collect some benefits without incurring unacceptable cost. If local residents theoretically believe tourism is a valuable source, and the costs they gain do not exceed the benefits, the exchange will support tourism development.

Social exchange theory is supported by plenty of research evidences that suggest the exchange system is useful for the evaluation of tourism impacts. Consequently, there are numerous reports that residents who perceive benefits from tourism are more likely to support tourism. Nevertheless, there are also several studies that report these residents have a more negative attitude towards

[3] Full reference at line 14 in paragraph 2.2.

tourism than others. This means those residents who benefit from tourism have positive perceptions of the tourism impacts; but with some reservations of the impacts of tourism. However, previous application has not involved culture change processes that might be associated with social exchange where cultural expressions are the basis of the exchange. In addition, this theory is tested by many scholars but nobody takes cultural background of host residents in to an account in term of the application. A case study from the Thai village of Koh Samu studied by Soontayatron S. (2012) considered also cultural background as a fundamental component of the evaluation taking into account the Buddhist *forma mentis* of Thai people in relation to their tendency to avoid conflicts in social situations and live with problems. This research adopted a constructivist paradigm (we can investigate reality just starting from the particular situation) with qualitatively semi-structured interviews as the primary methods. Local residents' behavior patterns and the interactions between them and tourists on a day to day basis as well as residents' perceptions and attitudes towards socio-cultural impacts of tourism development in Koh Samui were investigated. Snowball technique was adopted for recruiting the interviewees: the first respondent convinced other people from their acquaintance to join the research (in this case with sixteen interviews).

The interviews were transcribed and data from field notes were initially organised by themes into categories. New categories and sub-categories were developed from the data. The data were categorised into themes and copied into new files under the theme headings. Thus data were categorized in qualitative content analysis, some blocks of text were used more than once as they related to more than one theme. In this study, the four resident types offered a classification system which facilitated the conceptualisation of certain characteristics and experiences linked with social exchange theory.

1. Type one or 'Extensive contact' included local people who had regular direct contact with tourists and depended on tourism. They might be unemployed if there was no tourism.
2. Type two or 'Partial contact' covered local residents who had regular contact with tourists, as well, but they were not reliant on tourism for work.
3. Type three or 'Neutral concerned with tourism' represents local residents who had indirect or no frequent contact with tourists and received only a part of their income from tourism.
4. Type four or 'No contact with tourism' included local people who had no contact with tourists or saw them only in passing.

Many answers from Thai people showed a compromise in considering tourism impact on their community: even if many perceived that tourism brought many problems like drug and criminality they considered also the other side of the coin in that tourism let many people get out of poverty and have more efficient services in their village. In particular people that were more involved in tourism

industry showed a clear understanding of tourism impact on their community but never gave the impression to have doubts about a possible alternative development for their village without tourism while people with a "neutral concern with tourism" or "no contact with tourism" were the most critical and more worried about ongoing socio-cultural quality as this is likely a contributing factor in their sense of belonging and community attachment. Even though some of them were exasperated with tourism development in order to transform their social system to materialism and cash system, they still had a strong sense of belonging to their mother land so residents who have a high sense of community attachment had negative attitudes toward tourism development. Soontayatron noticed also that "Thai smile" so strange and fascinating for Western people was more and more going to disappear due to a strong Western influence in touristic localities.

Social exchange theory explains this dynamics on the principle that local residents willingly enter into an exchange with tourists if they can collect benefits, without incurring heavy expense cost. If local residents theoretically believe tourism as valuable source and the costs they gain do not exceed the benefits, the exchange will support tourism development while local people that had no chance or will to join the "tourism community" did not perceive benefits from the situation but only threats and bad consequences.

There could also be a difference in tourism impact perception depending on the entrepreneurial attitude of the community. A 2013 case study compares three touristic localities in Turkey's Black Sea region (Pınarbaşı, Azdavay and Şenpazar) and shows that positive perceptions were always higher in Pınarbaşı, in which touristic development had been strongly encouraged with a great support from population at least ten years before. The aim of the research was to evaluate the perceptions of local communities towards social, cultural, economic and environmental impacts of tourism in their communities. In this research a structured survey was conducted with residents, local authorities, and NGOs face to face. A 2-page questionnaire was designed. There were two sections with 25 impact statements on the positive and negative economic, social, and environmental impacts that tourism caused in the overmentioned villages.

The respondents were asked to rate the items on an ordinal scale ranging from 1= "greatly decreasing" to 5= "greatly increasing". The mean of 3 represents neutral attitude toward tourism impacts or the perception that the current level of tourism has no significant positive or negative impact on the community. The first part, consisting of 8 statements, was a list of potential tourism impacts upon the host community, such as an increase in standard of living, employment opportunities, entertainment facilities or human relations. The second part, with 17 questions, explored the respondents "perceptions of impacts by the influx of tourists into the community such as crime, pollution or traffic congestion". In the following table the mean values calculated over all the questionnaires collected in the three Turkish localities are shown.

Type of impact	Mean

Type of impact	Mean
Economic impact	
Standard of living	3,20
Transportation	3,48
Employment	3,02
Arts and handicrafts	2,91
Agriculture	2,67
Revenue	3,16
Prices of services and goods	3,46
Prices of houses and land	3,43
Restaurants and souvenir shops	3,43
Social impact	
Enterntainment	3,31
Human relations	3,48
Theft and burglary	2,91

Table 6: Measurement of Tourism impact in Pınarbaşı, Azdavay and Şenpazar (Turkey)

Source: Türker N. and Öztürk S., 2013

Transportation and traffic congestion were two of the major aspects detected with respectively 3,48 and 3,51 but among social impacts issues Friendliness and Changes in personal appearance obtained the two highest values above all. The more complete is the information collected about a destination the more the assessments of tourism impact are reliable since tourism effects on a

destination are very difficult to determine in specific numeric values. In figure 1 a resume of the most useful indicators for social sustainability are provided, divided into 6 categories:

1. **Demography**
2. **Tourist Flow**
3. **Employment**
4. **Social Behaviour**
5. **Health and Safety**
6. **Psychological issues**

Some interesting points that seem to have no relations with tourism are instead interesting indicators that compare tourism with the social context around it. First of all, the ratio between the migrant labor and the local population labor (to be compared with the national average) as an important indicator to evaluate working conditions and relationship between local and migrant community. Second the rate of school abandonment: in this case the highest the number of school abandonments the least the destination is perceived as a pole of scientific, economic, social and cultural development but just as a "monocultural" tourism location. An important issue is a serious comparison between tourists' satisfaction level and residents satisfaction's level that must be evaluated according to different parameters but with equal measure.

SOCIO-DEMOGRAPHIC INDICATORS			
Issues	**Sustainability Indicators**	**Sustainable Tourism Indicators**	**Tourism Carrying Capacity Indicators** *(see Special Note, pa. B4)*
1. Demography			
	Population growth rate, age structure		
	Population density (person/km²)		
2. Tourism Flow			
			Tourist/inhabitants: • Max value (peak period) • Min-Average value

SOCIO-DEMOGRAPHIC INDICATORS			
			Number of beds places per 100 inhabitants
			Number of over-nights per 100 inhabitants
			Number of arrivals per 100 inhabitants
			Number of tourists per square meter of site/key area (i.e. beach, square, museum, natural/cultural site, etc.): • Max value (peak period) • Min-Average value
			Tourists/territory surface: • Max value (peak period) • Max-Averafe value
			Tourists/month (distribution during the year)
3. Employment			
	Employment record in traditional activities (agriculture, fishing, etc.)		Tourist bed places/local people employed
Issues	**Sustainability Indicators**	**Sustainable Tourism Indicators**	**Tourism Carrying Capacity Indicators** *(see Special Note, pa. B4)*
6.2 Residents satisfactio		Rate of residents satisfied with current level of tourism	Number of residents complaints (i.e. from noise

SOCIO-DEMOGRAPHIC INDICATORS			
n's level		development	
		- Number of retail establishments/number of establishments serving local need (as opposed to tourists) - Number of local establishments open year - around /total number of local establishments	
			Rate of residents which benefit from tourism (local employers + local employers/total population)
			Displacement of members of local population due to tourism development

Table 7: Socio-demographic indicators for tourism sustainability

Source: Coccossis H. et al., 2002.

Socio-demographic indicators have been highly devalued in the past years but are now being more and more considered as a fundamental key to create both a balance between tourists and local people and a higher quality tourism product. The more complete the model for tourism impact evaluation the best for tourism operators that have to implement concrete actions in the destination.

PricewaterHouse company has proposed a particular kind of impact measurement model that tries to evaluate the "total impact" that a particular economic sector has on a territory: the TIMM model (Total Impact Measurement and Management).

The Travel Foundation in association with PricewaterHouse has proposed a specific case study

that tries to apply TIMM model [23 and 24][4] to the tourism industry in Cyprus. TIMM model tries to provide an holistic view of social, environmental, tax and economic dimensions in order to quantify and monetize the impacts. TIMM considers four key categories of impact:

- economic impact that covers the effect of an activity on the economy in a given area by measuring the associated output or value added (and changes in employment);
- tax impact that covers the associated tax contribution;
- environmental impact that measures the value of the impacts on society of the emissions to air, land and water and the use of natural resources; and
- social impact that values the consequences of the activities on societal outcomes such as livelihoods, skills and cultural heritage.

A separate estimation of each impact is done to build in a second moment a general comparison.

When dealing with impact TIMM model differentiates three kinds of levels at which considering them:

- Direct: the impacts that result directly from the business' activities;
- Indirect: the impacts generated in the supply chain which support the business' and customers' activities; and
- Induced: the impacts generated by the spending of the employees involved in the business' activity and those in the associated supply chain.

The scope of the pilot study in Cyprus was defined as:

- eight hotels used by TUI Group which are a subset of its operations in Cyprus and cover 60,000 TUI customers travelling to Cyprus21;
- all impacts accruing in Cyprus as a result of TUI Group's activities in these hotels in 2013: the pilot is a snapshot of one year and excludes travel to and from Cyprus and impacts accruing outside Cyprus (except Greenhouse Gases (GHGs), which have a global impact); and
- the impacts were assessed in gross terms by assuming that none of TUI Group's customers would otherwise have visited Cyprus: thus, it does not consider the impacts which would arise in the absence of TUI Group's presence in Cyprus (e.g. if another tour operator stepped in the fill the gap).Figure 2 provides an overview of how the total direct, indirect and induced impacts of TUI Group's operations in Cyprus were estimated using the TIMM framework. Data were collected directly from the eight pilot hotels in scope, the airport handler, the ground handler and TUI Group itself. They included financial and fiscal data, energy and fuel use data and procurement data. Interviews were conducted with government departments and local municipalities in Cyprus. Two surveys of 603 hotel employees and holiday advisors were also conducted to understand their earnings, spending and saving patterns. In the case of hotel employees, the survey was also used to assess their quality of life.

[4] [23 and 24] Full reference at line 14 in paragraph 2.2.

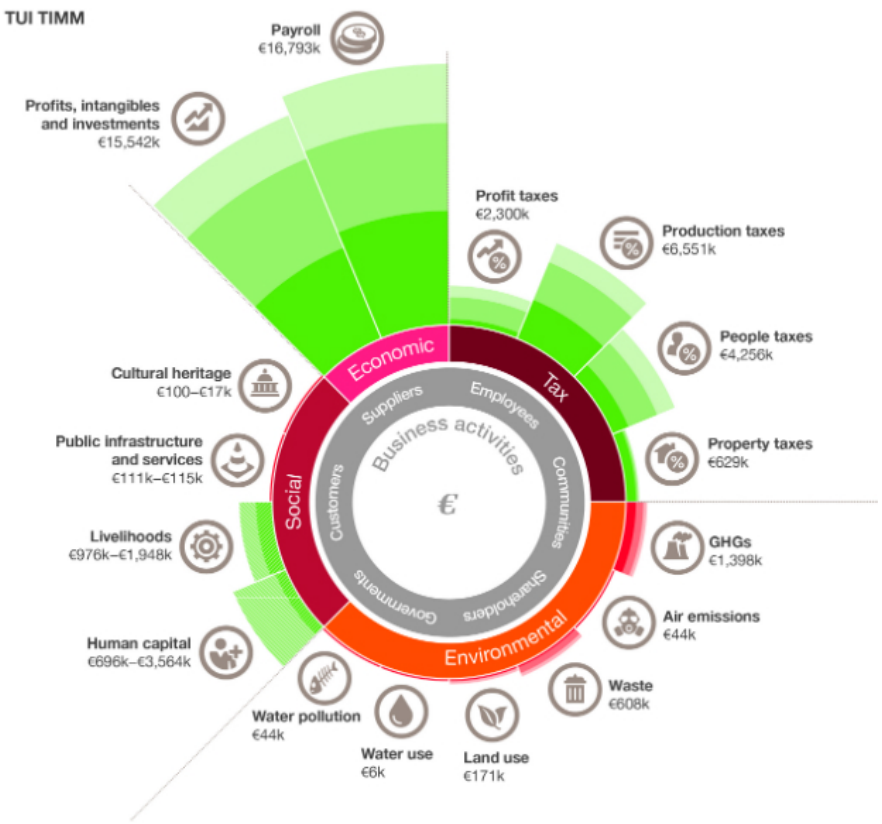

Figure 1 - TIMM model assessment applied to Cyprus tourism economy
Source: The Travel Foundation, 2015.

An effective tourism impact analysis should be always flanked by a model of prevision of Tourist Flows in a destination.

One of the most famous tourist flow prevision model is the TFM (Tourism Flows Model), elaborated on behalf of New Zealand Ministry of Tourism. The TFM has two main components: (1) The dynamic tourism flows component which provides past, present and future estimates of tourist movements in New Zealand; and (2) The static tourism activity component which provides past, present and future estimates of tourism activity within specific areas of New Zealand.

All the visitors are classified into three main categories:

- International visitors: people who visit New Zealand from a foreign country and stay for a

continuous period of less than 365 nights.

- Domestic overnight travelers: residents who travel outside their usual environment within New Zealand for between one and 365 nights.
- Domestic day travelers: residents who travel at least 40 km from home within New Zealand and return within the same day. The TFM tries to simulate the outputs of the decision making behavior of tourists. The decision making process considered in the TFM can be summarized as:

1) Where do you want/need to go?
This is influenced most significantly by where you usually live and what season you are travelling in. The data indicates that the origins of tourists have a large bearing on the destination(s) they visit and that most destinations are highly seasonal. Purpose of travel is the other major determinant but the data does not currently support that level of segmentation.

2) How will I get there?
This question relates not only to the mode of transport used but also to the physical route taken. Transport modes and routes generally depend on travel distance, availability of transport modes and duration of trip.

3) What will I do when I get there?
This question relates to the things that people do once they reach their destination. This includes the consumption of goods and services which results in direct tourism expenditure (e.g. spend on accommodation, food, transport, commercial attractions and retail) as well as the non-commercial activities they engage in.

The first step of the analysis is an accurate cartographic representation of tourist flows in New Zealand according to the mean of transport: mainly road and air.

In the TFM Summary of New Zealand Ministry of Tourism (Vuletich S. and Becken S., 2007) we can find an example of several maps of New Zealand in which tourist road and air flow are represented according to the type of traveler (International visitor, domestic overnight traveler and domestic day traveler). Further maps are built concentrating on specific source markets that are very important for New Zealand (for example Australian, Japanese and Northern European markets): the analysis is even extended to specific regions to have a more specific focus on particular national destinations.

Once we understand where and how people from various origins travel within New Zealand, we combine these patterns with forecasts of visitor growth to estimate how the demand for travel is likely to change in the future. After a pooled analysis of tourists source market and national traffic data an assessment about the tourist activities in New Zealand is done considering some particular factors:

- Visits (by origin or purpose)
- Visitor nights (by origin or purpose)
- Expenditure (by origin or purpose)
- Accommodation type used
- Transport type used
- Activities undertaken
- Age group
- Travel style

A further complication is that it is not practical to model flows between every possible location in New Zealand. It is therefore necessary to define a smaller number of locations or "nodes" which are broadly representative of the main tourism origins and destinations in New Zealand. In reality each node represents a wider tourism catchment; hence there is just one node for each catchment. The dominant tourism destination in each catchment is designated as the node, and the node acts as the connection point into the various transport networks. Each catchment has been called TFA (Tourism Flow Area) and has been geocoded in order to represent a single geographical entity.

Modeling activity on data obtained about the various TFAs of New Zealand is of fundamental importance to have more "representative" information: an example could be aggregating data from a quarter perspective to a seasonal one or from a source market perspective to a continental one.

Another important part of modelling activity is the use of conversion rates to translate trip numbers to estimates of passenger movements along trip segments.

The conversion rate is influenced by the attributes of the trip such as what type of trip it is, who is taking it, what season they're taking it in and in which year. Conversion rates are derived from the historical data by dividing the number of observed trip segment flows by the total number of trips. This calculation is done for every origin market x trip segment x time period x season x travel mode x travel type combination.

The conversion rates derived from aggregated data are assumed to apply to every season, year and geographic region within the aggregation. The trip number data has been aggregated in exactly the same way as the trip segment data to ensure that the resulting conversion rates are valid. The historical flows are derived by multiplying the appropriate conversion rates by the trips generated in the selected time period.

For example, if the user wants to observe tourism flows for the season of autumn/winter 2003 the model calls the conversion rates for autumn/winter 2003 and multiplies them by the trips taken in autumn/winter 2003. If the user wants to observe tourism flows for the year of 2003 the model calls

the conversion rates for each season in 2003 and cross multiplies these with the trips taken in each season of 2003 and sums them to get an annual total.

Other examples of measurement, evaluation and management of carrying capacity can be founded in the cruise tourism industry. The cruise sector has rapidly increasing worldwide during the last decades and destinations (and their ports) need to define the limits and the possibilities in order to host these tourism flows in the best way. Cruise industry in fact has important impacts on local economies, but big volumes of passengers and cruise ships are often responsible of congestions phenomenon. The figure below shows the relationship within cruise industry and carrying capacity and impacts which derive from cruise.

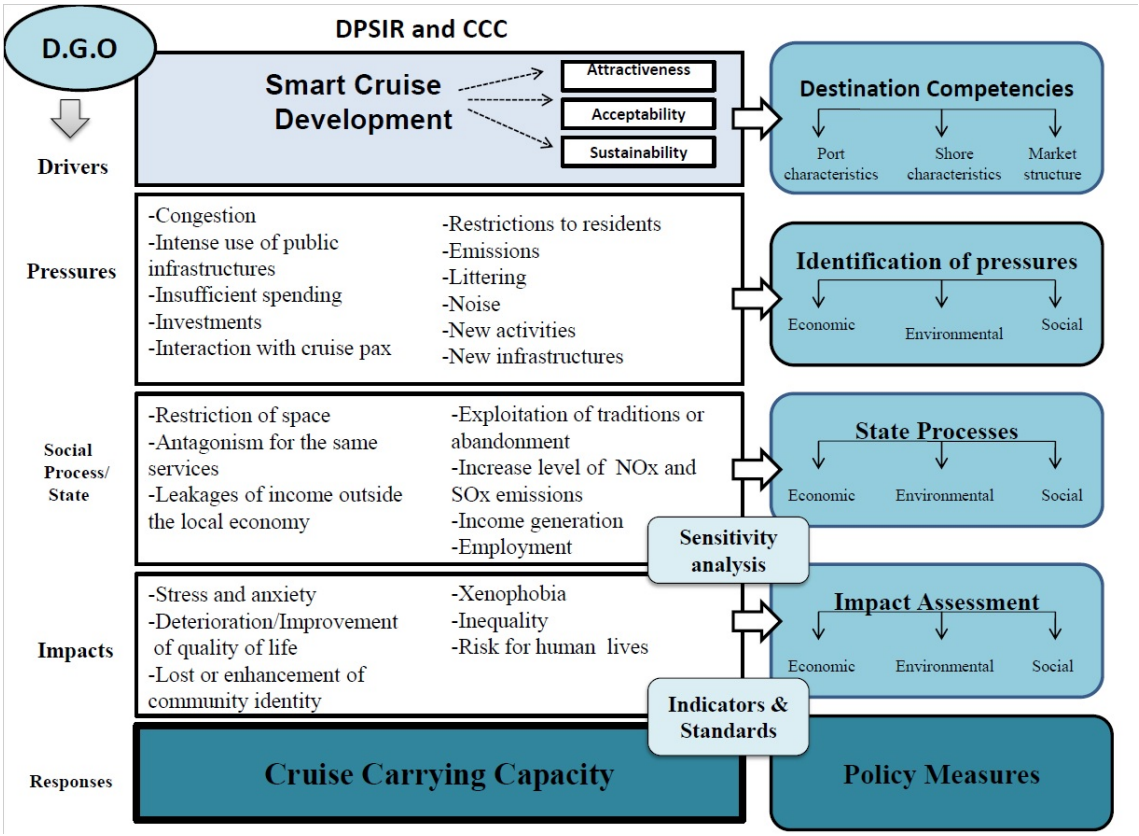

Figure 2 - The Cruise Carrying Capacity concept

Source: "Cruise carrying capacity: A conceptual approach", E. Stefanidaki and M. Lekakou, 2014

Note: D.G.O. stands for "Destinization–Gigantism–Oligopolisation" paradigm while DPSIR and

CCC to "Drivers Pressures State Impact Response" framework and Cruise Carrying Capacity.

Some of the indicators of monitoring cruise carrying capacity are of economic, social and environmental kind:

- economic indicators:
  - income from cruise tourism / total regional income;
  - changes of the income from cruise activity;
  - employees in the cruise sector (permanent and seasonal) / total employment;
  - spending per passenger;
  - changes of the public investments for cruise;
- social indicators:
  - ratio of local residents to cruise passengers;
  - community restrictions to locals during cruise days;
  - criminal incidents with cruise passengers involved;
  - protection of archaeological places;
  - environmental organizations or citizens' movements related to cruise matters;
- environmental indicators:
  - constructions that alters natural or build environment;
  - waste per cruise passenger/residents waste production;
  - energy consumption per cruise passenger / total power consumption;
  - NO_x/cruise ship or per cruise passenger;
  - SO_x/cruise ship or per cruise passenger;
  - number of days exceeding standards (if exist);
  - environmental violations per cruise ship;
  - protected areas harmed by passengers' activities.

The elements of each type of sustainability in the cruise industry are illustrated in the figure below, where a fourth kind of sustainability is added: the technical one.

3.4 ICT tools

The aim of this paragraph is to give an overview of some of the common ICT tools used in the field of Tourism related mainly to tourism sustainability and visitors management.

Trying to classify such tools is not an easy task but the classification proposed by GSMA in its "GSMA Smart Cities Guides": is able to give an effective framework of the situation:

1) Network-led crowd management techniques: require no additional infrastructure or buy-in as they employ existing 2G, 3G and 4G mobile networks. These platforms offer several extensions to standard mobile networks to allow for the accurate positioning of a mobile handset or other data device directly connected to the network. Mobile networks are able to instantly give the approximate position of a group of handsets through triangulation, and thus can be used by a service provider to quickly setup a crowd monitoring service. The network can be partitioned into very granular grids, and the number of people within each grid square counted. Movement of people from grid square to grid square enables a picture of crowd movement to be created.

2) Mobile phone-led crowd management techniques: Accurate positioning data of certain sub-sets of people can be obtained by engaging people directly through their smartphones, using the handset as a positioning device. This can be useful for certain events or venues where a defined group of people (for example, ticket holders) have opted-in to provide very detailed data to the event organisers. The opt-in is typically via terms and conditions on an app download, or could be a condition of an e-ticket. The app then relays accurate positioning information taken from the device's GPS sensor or local beacons, via the app provider, to the event organizer.

3) Personal/Wearable devices: A good example of this is Disney World, which offers its visitors a 'Magic Band' containing a transmitter, which allows the park to track the visitor, while enabling the visitor to pre-book certain attractions or get priority access to them. The band also acts as a ticket for entrance to the park. These types of device can provide a very accurate service, tailored to precisely meet the needs of the venue or event. They can be linked to credit cards for payments and programmed to only give access to certain areas. But they are expensive to design, manufacture and supply to visitors. Companies, such as Sendrato and AGT International, supply wearable device solutions specifically for large crowd events, such as music festivals, where each visitor has a dedicated wristband that contains RFID technology. The wristband can then be tracked, used for access control and for remote payments in some scenarios. A mobile operator can enable these services by working with the solution provider to connect the relevant RFID readers positioned around a site to the IoT.

4) Sensor-led devices: Mobile-enabled IoT sensors, such as video cameras and Bluetooth beacons, are an important tool in crowd management, particularly in small, contained areas. By using these sensors, people can be counted and tracked without the need for larger data sets. The advantage of using mobile-enabled sensors is that they can be placed at the most appropriate point, for example, in a doorway, where it would be difficult to place sensors relying on fixed network connections. The use of mobile connectivity also allows a high density of sensors to be deployed, resulting in more accurate crowd behavior data.

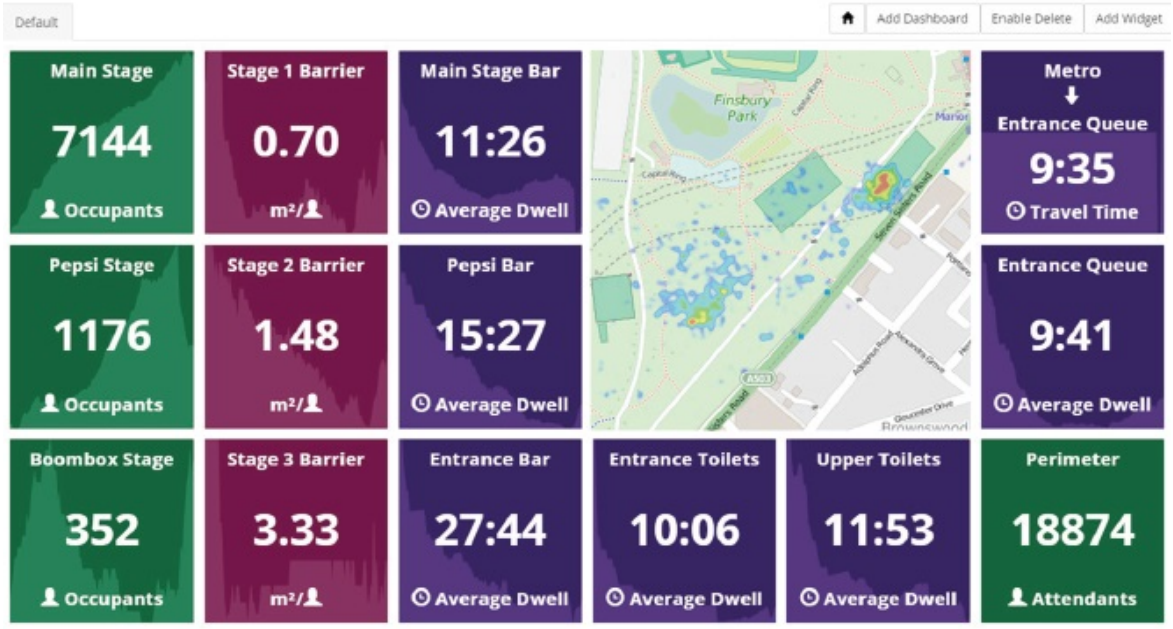

Figure 3 - ICT & crowd management: four mobile opportunities

Source: GSMA (2017), GSMA Smart Cities Guide: Crowd Management

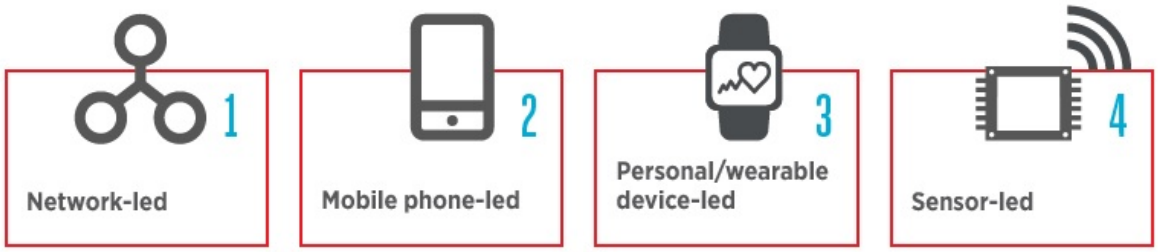

Figure 4 - Example of a dashboard for a music festival combining network data and IoT sensors to gauge crowd densities

Source: GSMA (2017), GSMA Smart Cities Guide: Crowd Management

Types of IoT sensors include Bluetooth beacons, cameras, general traffic counter, infrared counters or sensors embedded in the pavement or road. They are suited to long-term deployments designed to build up a picture of people flows over time. The use of embedded SIM cards or LPWA networks makes it simple and cost-effective to connect these sensors to a mobile operator's management platform.

A first example to underline is a project for a Crowd Management Augmented Reality application to be used in Mecca to manage the large amount of pilgrims that each year takes part in Haji event.

The core of this tool is using a GPS (Global Positioning System) application to build a system of navigation aids that could help the client in orienting and avoiding crowded places.

Here are some methods that could be used as navigation aids in an AR application:

- Using a virtual map that shows the users' location on that map.
- Provide indicators of the path to be followed, such as virtual lines or arrows.
- Using spoken directions, such as "go ahead east for 100 feet".
- Using virtual binoculars as users could see long distances help them find their way.

If a user would like to get help finding his/her way from an AR application, the application must require the users' current location. In addition, know where he/she wants to go by using databases of locations and objects of the environment, to determine a reasonable route for him/her to take.

A clear disadvantage of GPS application is the fact that it is not completely usable inside building because GPS receivers require a clear view of the sky but technologies are improving day by day and nowadays we could count on a combination of high-speed wireless data exchange (3G, 4G and WiFi), high-end camera sensors, low cost GPS receivers, accelerometers and gyro sensors.

The main parts of this Mobile Augmented Reality (MAR) applications are:

- **The server**: responsible for content storage and retrieve the data from a database as enquired by the client.
- **The client** (the user): is responsible for content adaptation and letting the user interact.
- **Registration component**: the process of assisting the mobile device, to determine its position in the real world to identify the surrounding information, and transform any local information into the users' view.
- **Content component**: using the information to initiate streaming-relevant content from the server to the client.
- **User interface component:** is responsible for presenting the content on a mobile device's screen.
- **Hajj Databases (HDBs)**: proposed distributed databases to collect, analyze and organize the pilgrim's data. These databases have the potential to search and mine among the pilgrim's data. In addition, it could be conjunct with other wireless and sensor technologies (e.g. GPS) of the proposed application. In addition, these databases could be accessed by everyone, who has the authorization and works for the Saudi government, especially the Saudi Hajj Authorities (event's organizers). They could be distributed all over the Hajj ritual places and in Mecca city.

The main goal of Haji MAR system in relation to our argument should be the tracking of people movement inside an area. For example, because of the lack of guidance services at Hajj, using MAR by Hajj staff could gather information for pilgrims, to guide and help them to reunite with

his/her group. This guidance could be done by directing them and alerting their group guide. Hajj staff could also locate and identify the geolocated places (POIs of Hajj) by positioning the camera of MAR devices, such as smartphones or tablets. When a location is identified, the process of AR takes place by describing the pointed place on the staffs' screen device. In addition MAR applications could be also used as video camera sensors, and connected to a central control station for Hajj surveillance systems. Therefore, these applications are considered as links between the Hajj operators on this station and Hajj staff on the ground. Because of the high capability of MAR for communications and data transmissions between the Hajj staff, the control station is remotely monitoring the Hajj areas and capturing different types of information that is gathered by the Hajj staffs.

The so-called CMMAR (Crowd Management Mobile Augmented Reality) provides different types of information constantly and instantly. In addition, this information is shared among the users of this system. Moreover, the components of this application are GPS, digital compass and accelerometer and help the application to determine user's location and angle view.

The most important functions of this application could be:

- **Data Capture**: during the Hajj event, information is constantly exchanged to coordinate the crowd management activities; and to make sure everyone is safe in the crowd. Hajj staff and other stakeholders at Hajj event could inform any unpleasant situation. This information would be, such as textual messages, radio communications, sharing the view from their camera feeds of their devices…etc., from their handheld devices (smartphones or tablets) to each other. In addition, they could send their location information to each other and this information could be also sent to their supervisors in Hajj control room, who are in charge of them, as they could track their teams all the time

- **Data retrieval**: after the data are captured, they are analyzed, to retrieve the required information that was requested by the client. The information is ready to be retrieved to the client by the application server. In addition, based on the user's location, this information is shown on his tablets' screen. Moreover, this information is shared among other Hajj staff, to manage the crowd and identify their locations.

After information about the situation is recollected through CMMAR tools, they are immediately sent to the databases, to be analyzed for making decisions regarding this problem. Therefore, decisions will be executed by Coordination between Hajj staff on the ground, and Hajj operators in Hajj control room. In the case of a lost pilgrim as soon as he/she starts to panic out and wonders how to return to his/her family or group again, s/he tries to find any Hajj official, who works on the ground, to seek help from him. At this point, this official starts to use the CMMAR application on his tablet for instance, to identify this lost pilgrim, by scanning his/her ID number. The application will start to analysis and search for his/her data at Haji Databases. The application server will fetch

the result of this search, and then it is sent to the application again, to view the result on the official's tablet. In addition, he could send an SMS to his group guide. This SMS contains the lost pilgrims' details as well as his location information (time, longitude and altitude), to get him/her back to his/her group.

Figure 5 - Sustainable cruise industry

Source: Cruise Gateway North Sea.

An efficient Sustainability assessment could also be provided in relation to the buildings' energetic performance of a destination. In this regard Project EPISCOPE, a part of Intelligent Energy Europe Plan for Energy monitoring and supporting for sustainable energy solution, has created a set of indicators that try to measure buildings energetic performance in relation to the specific characteristics of the single infrastructure. The goal of the EPISCOPE project was to make energy renovation in the European housing sector more transparent and effective. The project implemented pilot actions on different scales and aligned and compared them in a qualitative way. The conceptual framework was based on national residential building typologies developed during the previous IEE project TABULA. These classification schemes for national building stocks were extended to a 6 further countries. The main project activity was to track the energy saving progress of certain housing stock entireties on local, regional or national level. The implementation rate of different refurbishment measures was determined and compared with those activities which were necessary to attain the relevant climate protection targets. A major

objective of the EPISCOPE project is to lay a basis for the tracking of the energy refurbishment progress of housing stock entities in the field of thermal protection and heat supply (heating and hot water) against the background of energy saving and climate protection needs.
During the project different residential building stocks have been analyzed in 16 European countries – from local housing portfolios to regional or national housing stocks.
The process of energy performance analysis has been based on two phases:

1. Monitoring: reliable data of the building stock have to be collected and updated regularly (by representative surveys). Basic information is characterized by "monitoring indicators";
2. Scenario analysis: a model of the building stock is established and scenario analysis of possible future development (refurbishment and new buildings) is carried out. Scenario indicators describe basic assumptions and the most important results.

The assigned indicator scheme ("monitoring indicators") intends to deliver the necessary basic information about thermal protection and heat supply on the one hand; on the other hand the applied quantities must be compatible to the information which can be collected by practicable, reliable surveys. At first, monitoring indicators have to be collected through interviews from people who know well the requested information (e.g. house owners). Some of the main monitoring indicators are set out below.

M.1 Basic of the Building stock	Complete building stock	Old building stock	New building
	e.g. bs ...2012/2012	e.g. bs ...1980/2012	e.g. bs ...2011-2012/2012
number of buildings			
Number of apartments			
national reference area [m²]			
sources / remarks			

Table 8: Basic data of the building stock

Source: Energy Performance Indicators for Building Stocks

M.2.1 Building insulation: Basic information state trends of modernisation			
	Complete building stock	Old building stock	Percentages related to…
walls			
Insulation improved (from original state)	20,40%	25,30%	(e.g.) building number
Insulation improeved (area-weighted)	15,00%	19,40%	element area
Average tickness of improved insulation	4,70%		average of element area
Annual rate of insulation improvement	0,65%/a		(e.g.) n.building
Annual rate of insulation improvement	0,51%/a	0,63%/a	element area
Average tickness of insulation (recent modernisation)	8,4cm		average of element area
roofs / upper floor celling			
table like walls			
ground floors / cellar cellings			
table like walls			
windows {example of minimum standard} (improvement to at least themal protection double glasing)			
table like walls			
sources / remarks	Complete/old stock: % $bs_{\dots 2010/2010}$ / $bs_{\dots 1980/2010}$[1] annual rates/recent insulation thinkness: mean value 2007/2010		

Table 9: Data about building insulation

Source: Energy Performance Indicators for Building Stocks.

In this project and dealing with the scenario indicators, we must underline that they are referred to a

certain period of time (5 years or more) and not to a single year like for monitoring indicators. In the example of figure 10 all the values are just mean values of the period.

Following table shows the indicators of the European Tourism Indicator System (ETIS[5]) that are available for the city of Malaga - one of the pilot areas of Alter-ECO project including only the indicators the city is monitoring and not all the indicators of ETIS.

The tables provide further indicators with concrete figures. In this project and dealing with the scenario indicators, we must underline that they are referred to a certain period of time (5 years or more) and not to a single year like for monitoring indicators.

Section	Indicator Reference #	Indicator	Destination Results
A Destination management	A.2.1	Percentage of tourists and same day visitors that are satisfied with their overall experience in the destination	98.4%
	A.2.2	Percentage of repeat/return visitors (within 5 years)	86.9%
B. Economic Value	B.1.1	Number of tourist nights per month	5·93 nights
	B.1.2	Number of same day visitors per month	178,664 persons
	B.1.3	Relative contribution of tourism to the destination's economy (% GDP)	77%
	B.1.4	Daily spending per overnight tourist	47.94€
	B.1.5	Daily spending per same day visitor	35.42€
	B.2.1	Average length of stay of tourists (nights)	5·93
	B.2.2	Occupancy rate in commercial accommodation establishments per month and average for the year	76.72%
	B.3.1	Direct tourism employment as percentage of total employment in the destination	15%
Social and Cultura –	C.1.1	Number of tourists per 100 residents	710 tourists

[5] [23 and 24] Full reference at line 14 in paragraph 2.2.

	C.1.3	Number of beds available in commercial accommodation establishment per 100 residents	3.20 beds
	C.4.2	Percentage of commercial accommodation establishments participating in recognised accessibility information schemes	100%
	C.4.3	Percentage of public transport that is accessible to people with disabilities and with specific access requirements	100%
	C.4.4	Percentage of tourist attractions that are accessible to people with disabilities and/or participating in recognised accessibility information schemes	100%
D Environmental Impact	D.1.1	Percentage of tourists and same day visitors using different modes of transport to arrive at the destination	83.12%
	D.1.2	Percentage of tourists and same day visitors using local/soft mobility/public transport services to get around the destination	59.29%
	D.4.1	Percentage of sewage from the destination treated at least at secondary level prior to discharge	100%
	D.6.3	Percentage of annual amount of energy consumed from renewable sources (MWh) compared to overall energy consumption at destination level per year	0.6%

Table 10: A project of Crowd Management Mobile Augmented Reality application to be used in Mecca (Saudi Arabia)

Source: Owaidah A. A., 2015

Framework(s)	Place of analysis	Method(s)
Social-economic carrying capacity	Venice	Linear programming model under capacity restrictions >
Beyond carrying capacity	Vieste (Italy)	Indexes (including saturation)
Tourism Carrying Capacity Assessment	not a specific case	Levels of thresholds and indicators
Limits of Acceptable Change (LAC) model	Natural areas	Evaluation phase and operative phase (9 steps)

Social impacts (focus on local community)	Tuscany cities (Italy)	Interviews connected to qualification of respondents
Social impacts (focus on local community)	not a specific case	Social exchange theory
Social impacts (focus on local community)	Koh Samu (Thailand)	Qualitatively semi-structured interviews
Community tourism impact perception	Turkey's Black Sea region 3 coastal destinations	Questionnaire (two sections with 25 impact statements)
Total Impact Measurement and Management (TIMM) model	Cyprus	Assessment based on data collection, several surveys resulting in four key categories
Tourism Flows Model (TFM)	New Zealand	cartographic representation of tourist flows combined with forecasts of visitor growth estimations. Geocoding and modeling activity
Cruise Carrying Capacity	not a specific case	Indicators
TABULA project classification schemes	not a specific case	Two steps: monitoring indicators and scenario analysis (supported by surveys)
European Tourism Indicator System (ETIS)	Various cases	Indicators

Table 11: recap of some methods described in 3.3

In the ETIS indicators framework it could also cited the experience of MITOMED[6].

That project aiming to promote an integrated management model of maritime and coastal (M&C)

[6] Models of Integrated TOurism in the MEDiterranean. A transnational project co-financed by the European Regional Development Fund within the MED Programme 2007-2013 for Territorial Cooperation. started in July 2014.
Further reference at Annex 1 Set of MITOMED Indicators within the "Action plan for maritime and coastal tourism in the Mediterranean"

tourism in the Mediterranean ended with a validated Action Plan for Maritime and Coastal Tourism in the Mediterranean. In the development of the MITOMED project the improvement of the knowledge of data, products, services but also policies and thus pertaining to the sector was achieved through an assessed set of indicators based on the NECSTouR model. Project partners provided feedback in terms of feasibility and relevance to a list of 119 indicators covering the 10 NECSTouR topics and including, as a basis, the ETIS indicators and lists of indicators from other countries, previous projects and academic research. In particular this included the previously tested Tourism indicator systems for maritime & coastal purposes. After this process a final set of 34 indicators to be tested by project partners was completed.

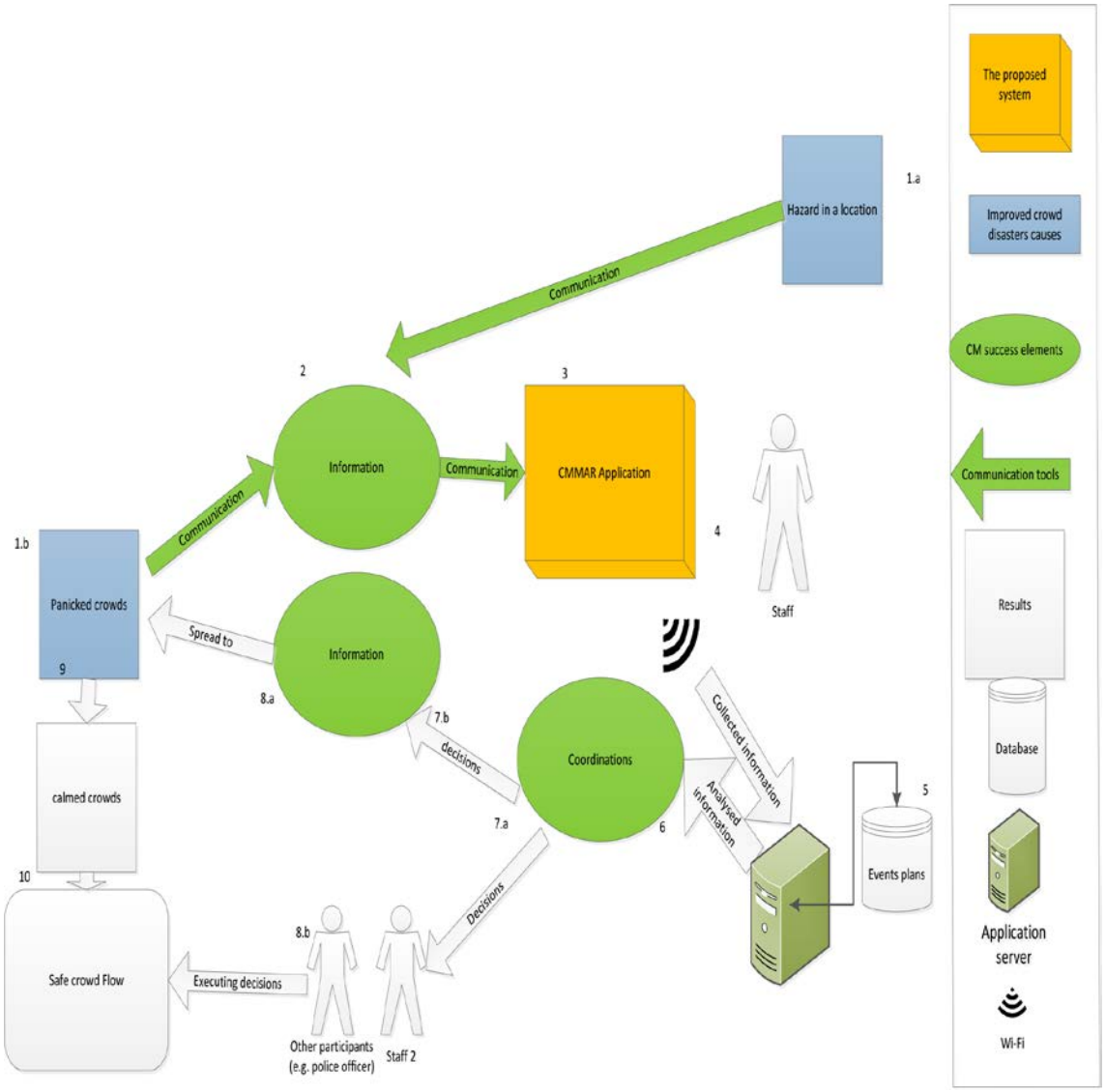

Figure 6 - A project of Crowd Management Mobile Augmented Reality application to be used in Mecca (Saudi Arabia)

Source: Owaidah A. A., 2015.

Another interesting case of crowd monitoring comes from Singapore, a rich nation that is going to invest a great part of public money in questions regarding Smart City projects and especially Smart Transports. One of this numerous projects called Grid360 has been developed by StarHub in Singapore, that allows the city to examine different data sets as new transport options come online and routing options become more complex.

The data available includes aggregated and anonymous geo-location data to understand crowd densities, travel patterns and the group profile of the crowds travelling. Grid 360 works by overlaying a *grid of small hexagonal tiles* over Singapore, allowing areas of interest to be highlighted. This grid is tied to a database of points of interest and transport networks.

Other fields of application of Crowd management services can be related for example to an airport plan for when people are arriving at security queues and it becomes very important to monitor the impact that wait time may have on passengers arriving at gates. Through intelligent placement of mobile-enabled IoT sensors, train stations can monitor how many people are queuing at ticket machines or waiting to get through barriers. Among the most critical themes of Crowd Management, Traffic management plays his part and it could be a decisive source of nuisance both for local people and tourist community. Connected Corridors Project, developed by AT&T firm, involves using new technologies to understand and ultimately manage a transportation corridor. A transportation corridor is defined as a largely linear geographic band in or near a population center and all the elements of surface transportation it contains, including freeways, city streets, bus and rail lines, waterways, bicycles and pedestrian pathways, and so on.

By bringing the most-advanced technologies together in dynamic and flexible ways (GPS, social networking technologies, data analytics, and "big data" computing), researchers are beginning to understand road network performance at a level of temporal and spatial detail never before possible. This understanding offers the potential to optimize the performance of road systems, both by helping transportation operators manage those systems and by engaging with travelers directly. Connected Corridors is using the capabilities and information available through these technologies to build a prototype.

The fundamental steps in this technical effort are:

- **Gathering data** about corridor behavior from many different sources.
- **Developing mathematical models** that accurately describe current traffic conditions in the corridor and can predict what they will look like in the near future (over the next five minutes, fifteen minutes, one hour, etc.).
- **Building software** that uses the models to help traffic managers choose the best interventions to improve traffic flow.

- **Developing communication interfaces** and connections so traffic managers can centrally control the corridor elements (ramp meters, traffic signals, etc.) necessary to improve traffic conditions.
- **Integrate traveler communication** into the system so travelers can get corridor information in multiple ways

The following table resumes the main aspects of Connected Corridors Project:

Strategy	Benefit
Coordination of freeway ramp meters and arterial signal systems	Leverage the capacity of both freeway and arterials to help traffic around congestion or incidents
Arterial signal synchronization	Optimize traffic flow along arterial streets
Dynamic route guidance and flow rerouting	Offer alternative routes around congested areas
Transit signal priority	Accelerate transit service by giving buses priority on arterials and on-ramps
Real-time travel demand monitoring	Enable transportation managers to see the actual extent and locations of traffic demand on the corridor
Smart parking	Locate available parking spaces at transit stations and private parking garages
Traveler communication	Provide information on traffic conditions, transit services, parking, alternate route/trip/mode options
Mode and time shift incentivization	Motivate travelers to change how (car, bus, bicycle, etc.) and when they travel

Table 12: Strategies and Benefits of Connected Corridors Project

Source: Berkeley University of California (http://connected-corridors.berkeley.edu/why-icm/research-and-technology).

An interesting project in the field of Flow monitoring is "Mobile World Capital Barcelona", developed by the private-public partnership World Capital in collaboration with the municipality of Barcelona.

A series of mobile-enabled sensors around the site have been set up to track the number of visitors in total and the direction from which they approach the site. By deploying IoT-enabled sensors, Mobile World Capital have been able to provide the city with detailed information on the number of visitors to the piazza throughout the day and their arrival route, enabling transport modes to be analysed and the city to set up ticket booths at appropriate locations to encourage the sale of additional tickets to visitors outside the Sagrada Familia. This is mainly related to the need of the city to evalue the impact that excursionist have on the city, as it is very difficult number to measure unlike the visitors that stay in tourist accommodations.

Similarly to Barcelona also the Belgian city of Antwerp, through a collaboration with Orange Belgium and Cropland gave rise to an efficient system of crowd monitoring. Orange Belgium, active in telecommunication industry, is able to provide a real-time data stream of the location of all mobile phones connected to its network within a given area. This positioning data is derived from an analysis of the connection of phones to masts across 2G, 3G and 4G networks, as well as

use of a timestamp to accurately position a device. Mobile phones in the area are all given a unique, anonymous ID. This data is displayed via a crowd monitoring tool developed by Orange Belgium and Cropland for the City of Antwerp to use for security, mobility and city marketing purposes. This dashboard shows the density of people within small squares across the given area, and allows the city to monitor the crowd in real-time. It can also be used to forecast the number of people that will be entering certain areas as people arrive at the event and move around the venue. Orange Belgium and Cropland are also using the same solution to monitor visitor flow at fixed locations. The traditional 'Sinksenfoor' fair in Antwerp that starts each May is one of five events using the same technology to monitor people flow around the fair over a six week period to establish how effective the layout is and if there are opportunities to change it. The Orange Belgium service has several benefits. As it relies only on network data, all devices connected to the Orange network can be tracked. The data is held by the network for a considerable time after the event, so historic data can be examined alongside real-time data to spot any significant trends

In another case study from the famous destination of Mogao grottoes (Dunhuang, China) it is underlined how an IoT environmental monitoring system could be useful also for crowd management issues. Through the integration of an existing automatic meteorological station and a sandstorm monitoring system, an enhanced meteorological monitoring system has been established in the site with a project for a future warning system for flood disaster that monitors the water flow of the Daquan River. The micro-environmental monitoring system in caves consists of low power wireless sensors, wireless gateways and data service management software. The low power wireless sensors are responsible for collecting microenvironmental parameters such as air temperature, humidity and carbon dioxide, transmitting the data to the wireless gateways deployed outside the caves by means of a wireless ad-hoc network, which can overcome signal blocking problems caused by the various shapes of caves. The system adopts also an active RFID technique to locate the site guides in real time to obtain accurate data on tour groups entering and leaving a cave, through which the accurate number of tourists in each cave and the distribution of tourists in the whole site can be instantaneously known. A correct environmental monitoring activity in Mogao Grottoes is closely related to crowd management practices as overcrowding is one of the various reasons of frescoes' deterioration.

Figure 7 - Structure of Micro-environmental monitoring and controlling system in Mogao Grottoes (China)

Source: Bomin S., Yabo D., 2013

An additional and very widespread tool for counting people or trying to give an average valuation of the number of people in a delimited area is the typical electronic device that through the medium of wi-fi connection tracks the number of mobile phones in a certain area and, with the aid of a *cloudbox* that recollects all the data, analyzes this number and recalculate it to obtain a number of esteemed people passing through a certain area.

Usually to have a reliable evaluation of the number of people in a city, it is worth installing some of these devices in particular and strategic spots so that the device could have a reliable group of data to work on (ex. Viabox ML1 experiment in Spain).

4. A COMMON M&T FRAMEWORK

4.1 Literature review to find common elements and aspects and the DSS

As detailed in the previous chapter of this document it is possible to already count on many tools and methods for diagnosis, modelling and evaluation of tourist destinations.

We had identified tools like sensors, cameras and Gps, but also more recently iBeacons or IoT (Internet of Things) ones. The possibility to exploit these latter ones such as IoT tools relies on the need of internet connection of things and places with the possibility to communicate information about them to anyone. Future flows management will be more and more based on real time data. According to Alter-ECO preliminary study (D.3.2.1) the development of ICT is fundamental for the elaboration of new and more efficient provisional models and especially for the achievement of real tourism flows management tools. These tools are different one each other and have increased their efficiency both in the provisional and the management phase.

Successful decision making needs information. Finding the right data for decision making is a general problem, but it is particularly true for tourism management, in which marketing research data are poor and frequently lack comparability.

The complex nature of tourism makes it hard for policy-makers and planners to define to develop appropriate policies. Regarding to this aspects decision makers might benefit from a Decision Support System (DSS) that can couple the intellectual resources of individuals with the capabilities of models to improve the quality of decisions.

A general accepted definition of a "Decision Support System (DSS)" describe it as an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions (Power, 2002).

DSS in tourism refers to demand-oriented systems such as the destination management or consumer-oriented travel-counseling systems (Wöber and Gretzel, 2000). A DSS is usually built to help finding a solution to a certain problem or to evaluate an opportunity. As such it is called a DSS application (Matzarakis, de Freitas, Scott, 2007). A DSS usually uses models and is built (often by end-users) as an interactive and iterative process. It supports all phases of decision-making and may include a knowledge component. A DSS can be used by a single user on a PC or can be web-based in order to be uses by many people at different locations. A major characteristic of a DSS is

the inclusion of at least one model. These models can represent systems or problems with various degrees of abstraction. Most DSS analyses are performed numerically with mathematical or other quantitative methods (Turban et al., 2003). DSSs support the intellectual resources of human decision makers through the design of computer models and the simulation of real-life experiences, DSSs continue to improve the quality of decisions by standardizing the process and logic information managers' choices and making the criteria for determining appropriate outcomes systematic (Piccoli and Wagner, 2003).

According to Power (2002) DSS can be categorized into five types:

- Most communications-driven DSSs are targetted at internal teams, including partners. Its purpose are to help conduct a meeting, or for users to collaborate. The most common technology used to deploy the DSS is a web or client server. Examples: chats and instant messaging softwares, online collaboration and net-meeting systems.

- Most data-driven DSSs are targeted at managers, staff and also product/service suppliers. It is used to query a database or data warehouse to seek specific answers for specific purposes. It is deployed via a main frame system, client/server link, or via the web. Examples: computer-based databases that have a query system to check (including the incorporation of data to add value to existing databases.

- Document-driven DSSs are more common, targeted at a broad base of user groups. The purpose of such a DSS is to search web pages and find documents on a specific set of keywords or search terms. The usual technology used to set up such DSSs are via the web or a client/server system. Examples:

- Knowledge-driven DSSs or 'knowledgebase' are they are known, are a catch-all category covering a broad range of systems covering users within the organization seting it up, but may also include others interacting with the organization - for example, consumers of a business. It is essentially used to provide management advice or to choose products/services. The typical deployment technology used to set up such systems could be slient/server systems, the web, or software runnung on stand-alone PCs.

- Model-driven DSSs are complex systems that help analyse decisions or choose between different options. These are used by managers and staff members of a business, or people who interact with the organization, for a number of purposes depending on how the model is set up - scheduling, decision analyses etc. These DSSs can be deployed via software/hardware in stand-alone PCs, client/server systems, or the web.

A typical planning process in a DMO is shown in the following figures. It may be considered as a large feedback cycle in which each phase is connected through processing many elements

generating outputs.

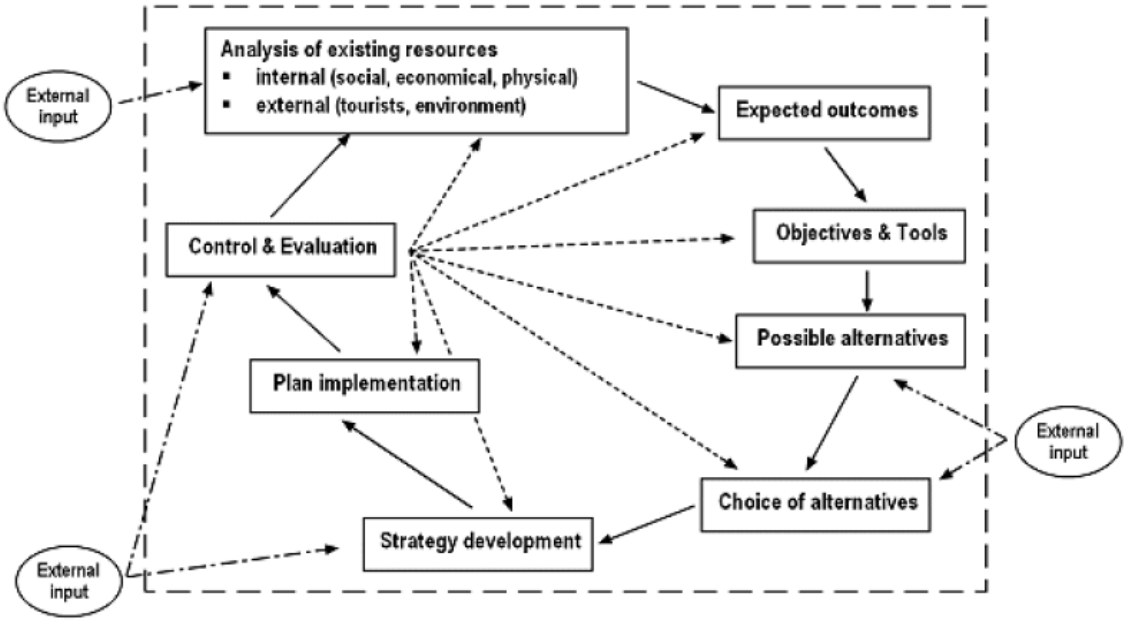

Figure 8 - Schematic representation of a DMO planning process

Source: adapted from Loy Puddu, 2005

According to a literature review more and more evident seems the need to support the marketing process with increasingly sophisticated destination marketing information systems (DMISs). Ritchie identified since 2002 which may be the key tasks for building a provincial/state DMIS :

1. tracking the current situation (Gathering and communicating current information which tracks visitors and their use of travel and tourism products in their visits to province) ;
2. measuring travel motivators (Measuring motivation to travel to province on an ongoing basis) ;
3. gathering competitive market intelligence (Monitoring marketing activities, initiatives, success of the key competitors for tourism product on an ongoing basis);
4. recognizing new opportunities (Profiling growing areas of potential and market trends for tourism to province);
5. evaluating marketing activities (Evaluating marketing activities, initiatives and campaigns);
6. monitoring industry satisfaction (Monitoring satisfaction of tourism operators with local tourism board performance);

7. measuring return on investment (Assessing the return on investment of the overall program on an annual basis).

4.2 DSS prototype proposed for Alter-Eco project. A proposal for Pilots

TTC refers to an Optimal mixture between touristic activity and available resources and it implies a "Compromise Solution" ("Sustainable and efficient planning and managing of a location, without compromising Environmental, Economic and Social characteristics of the site"). Operationally, as explained above, TCC can be understood as a Linear Programming Problem (LP) as follows:

$$\begin{cases} \max_x c_1x_1 + c_2x_2 + \ldots + c_nx_2 \\ b_{1,1}x_1 + b_{1,2}x_2 + \ldots + b_{1,n}x_n \geq d_1 \\ b_{2,1}x_1 + b_{2,2}x_2 + \ldots + b_{2,n}x_n \geq d_2 \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ b_{m,1}x_1 + b_{m,2}x_2 + \ldots + b_{m,n}x_n \geq d_m \\ x_1, x_2, \ldots, x_m \geq 0 \end{cases}$$

where the sub-systems ("Model of Venice" – Van der Borg) are:

1. HB = n° available beds in hotels
2. NHB = n° available beds in extra-hotels
3. L = n° lunches
4. P = individual n° available park positions
5. T = individual n° of available urban travels
6. WD = solid waste capacity
7. SMV = max n° of daily visits in San Marco Church (not a renewable resource)

Three different extensions are considered but only the third will be developed in prototype form in the context of AlteErco project:

MODEL 1.	Example with data
Linear Programming (LP) $max\ z = c_1TH + c_2\,NTH + c_3\,E$ c_1, c_2 ,c_3 = average daily individual expenditure $a_iTH+b_iNTH+c_iE \le d_i$ $X \ge o$ TH = n° of hotel tourists NTH = n° of extra hotel tourists E = n° of trippers	$max\ z = 220TH + 85{,}4NTH + 149E$ CONSTRAINTS HB → TH ≤ 9.000 NHB → TNH ≤ 1.600 L → 1,00TH + 0,75TNH + 0,5E ≤ 25.000 P → 0,33TH + 0,33TNH + 0,75E ≤ 30.000 T → TH + TNH + 2,00E ≤ 30.000 WD → 2,30TH + 2,00TNH + 0,70E ≤ 30.000 SMV → 0,47TH + 0,30TNH + 0,70E ≤ 10.000
MODEL 2.	**Example with data**
Fuzzy Linear Programming (FLP) (*Canestrelli, Costa*) $max\ z = c_1TH + c_2\,NTH + c_3\,E$ $a_ix \le b_i + \vartheta p_i$ a_i = Coefficients level of daily use from each category b_i = Optimal capacity level for residential popultation $b_i + \vartheta p_i$ = optimal capacity for touristic businessmen θ ϵ [0,1] Violation degree for b1 (compromise parameter)	$max\ z = 220TH + 85{,}4NTH + 149E$ HB → TH ≤ 9.000 + $\vartheta 2.000$ NHB → TNH ≤ 1.600 + $\vartheta 2.400$ L → TH + 0,75TNH + 0,5E ≤ 25.000 + $\vartheta 15.000$ P → 0,33TH + 0,33TNH + 0,75E ≤ 30.000 + $\vartheta 15.000$ T → TH + TNH + 2,00E ≤ 30.000 + $\vartheta 10.000$ WD → 2,30TH + 2,00TNH + 0,70E ≤ 30.000 + $\vartheta 30.000$ MV → 0,47TH + 0,30TNH + 0,70E ≤ 10.000 + $\vartheta 5.000$
MODEL 3.	**Example with data**
Fuzzy Goal Linear Programming (FGLP) Instead than maximise the total income: $max\ z = 220TH + 85{,}4NTH + 149E$ … each of the three stakeholder incomes could be maximised: max (220TH,85.4NTH,149E) Each Target and Goal can be transformed using membership functions (type of utility function) μ_i	$max\ \lambda$ $V_o(220TH + 85{,}4NTH + 149E) \ge \lambda$ HB → $\mu_1(TH) \ge \lambda$ NHB → $\mu_2(TNH) \ge \lambda$ L → … P → … T → … WD → … SMV → μ_7(0,47 TH + 0,30TNH + 0,70E) ≥ λ

4.2.1 A model (model 3) for optimising tourist flows based on the sustainability of resource consumption, which is based on Fuzzy Goal Programming

The approach uses appropriate values of features that are characterised by a minimum acceptable and maximum satisfaction value for every equation.

In its basic version, it does not consider seasonality as somewhat declinable over a period of time, but provides an "optimum" number of tourists per day from three categories, in order to best meet stakeholder expectations and minimise the impact, not only on the resident population, but also on the environment.

As a by-product, it also provides a sustainable value for the impact of tourism, given the current (measured) values of the three types of tourist.

The problem that needs to be addressed is the STRUCTURE of the model, i.e. how many /which equations should be considered, and what variables are of interest.

By analysing some of the literature, we usually consider no more than 7-10 equations, and a number of variables that take into account the various phenomena that contribute to the idea of SUSTAINABLE tourism (environmental impact, congestion, availability and supply of beds, transport, restaurants etc.).

Consider the output variables (simulation model results): TH, NTH, E, i.e. the number of tourists, hotels, non-hotels (B & B, etc.) and day trippers, whose average daily expenditure per capita are c1, c2, C3.

For contrast, we will consider as available data that which characterises the model in the various components of the concept of sustainability:

1. *HB = n ° available beds in hotels*
2. *NHB = n ° available beds in extra-hotels*
3. *L = n ° lunches*
4. *P = n ° individual available park positions*
5. *T = number of individual available urban travels*
6. *WD = solid waste capacity*
7. *SMV = max number of daily visits to San Marco Church (NOT a renewable resource)*

For each of these categories, appropriate constraints will be considered, each represented by a set of technical coefficients a_i, b_i, c_i, (For the first member, coefficients of the three variables) and d_i

(known term for the constraint).

The relative constraints therefore become, in the traditional linear programming model (the Fuzzy Goal Programming approach is not an appropriate extension)

$$a_iTH + b_iNTH + c_iE =< d_i$$

In addition to non-negativity constraints:

$$TH, NTH, E \geq 0$$

A. The FGP (Fuzzy Goal Programming) model

$$\begin{cases} \max_x \{f_1(x), f_2(x), \ldots f_n(x)\} \\ g_i(x) \geq d_i, \ i = 0, \ldots m, \\ x \geq 0 \end{cases}$$

$$v_i(x) = U_i(f_i(x)),$$

$$\mu_i(x) = V_i(g_i(x))$$

$$\begin{cases} \max_{x,\lambda} \lambda \\ v_i(x) \geq \lambda, \ i = 0, \ldots, n \\ \mu_i(x) \geq \lambda, \ i = 0, \ldots, m \\ x \geq 0 \\ \lambda \in [0,1] \end{cases}$$

Every constraint can be transformed as follows:

$$\mu_1 = \begin{cases} 1, & X \leq a \\ 1 - \dfrac{X-a}{b-a}, & a \leq T \ H \leq b \\ 0, & T \ H \geq b \end{cases}$$

can be transformed as follows:

$$X \leq b - (b-a)\lambda$$

In cases where the inequality is significantly less than zero (/ greater than one), the value of the object function will be equal to zero (/ one). In fact, considered as fully satisfied (i.e. equal to 1) are all the inequalities of the satisfied constrains with a value ≥ 1, while unsatisfied (thus with a value of zero) are all those of value ≤0.

In the latter case, the value of the object function, being the minimum of the values of each constraint (that is, the value of the object function λ) is zero.

It should be noted that the total satisfaction (the value of the object function, or the sustainability index) is equal to the minimum values of each constraint. We will therefore have the i-th constraint:

$$X_i \le b_i - (b_i - a_i)\lambda$$

B. Constraints and object functions in FGP

The problem of LP was:

$$X_i \le b_i - (b_i - a_i)\lambda$$

$$\max z = f_1 TH + f_2 NHB + f_3 E$$

$$TH \le D_1$$
$$NHB \le D_2$$
$$e_{3,1}TH + e_{3,2}TNH + e_{3,3}E \le D_3$$
$$e_{4,1}TH + e_{4,2}TNH + e_{4,3}E \le D_4$$
$$e_{5,1}TH + e_{5,2}TNH + e_{5,3}E \le D_5$$
$$e_{6,1}TH + e_{6,2}TNH + e_{6,3}E \le D_6$$
$$e_{7,1}TH + e_{7,2}TNH + e_{7,3}E \le D_7$$

Now, the problem becomes:

$$\max \lambda$$

$$f_1 TH + f_2 NHB + f_3 E \le b_0 - (b_0 - a_0)\lambda$$

$$T\ H \leq b_1 - (b_1 - a_1)\lambda$$
$$N\ H \geq b_2 - (b_2 - a_2)\lambda$$
$$e_{3,1}T\ H + e_{3,2}T\ N\ H - e_{3,3}E \leq b_3 - (b_3 - a_3)\lambda$$
$$e_{4,1}T\ H + e_{4,2}T\ N\ H - e_{4,3}E \leq b_4 - (b_4 - a_4)\lambda$$
$$e_{5,1}T\ H + e_{5,2}T\ N\ H - e_{5,3}E \leq b_5 - (b_5 - a_5)\lambda$$
$$e_{6,1}T\ H + e_{6,2}T\ N\ H - e_{6,3}E \leq b_6 - (b_6 - a_6)\lambda$$
$$e_{7,1}T\ H + e_{7,2}T\ N\ H - e_{7,3}E \leq b_7 - (b_7 - a_7)\lambda$$

In addition to that, we have to include the non-negative conditions for the three variables

$$T\ H, N\ T, H$$

The parameters to consider are therefore:

f_1, f_3, f_3 unit gains

$a_1, b_1, a_2, b_2, a_3, b_3, a_4, b_4, a_5, b_5, a_6, b_6, a_7, b_7$ u p i al ir t a y m

$e_{3,1}, e_{3,2}, e_{3,3}, e_{4,1}, e_{4,2}, e_{4,3}, e_{5,1}, e_{5,2}, e_{5,3}, e_{6,1}, e_{6,2}, e_{6,3}, e_{7,1}, e_{7,2}, e_{7,3}$ t e c c o ht

Unit gains and technical coefficients are defined a priori; utility parameters are set by the Decoder and the system will have to allow modulation.

The preceding equations can, however, be modified to take other types of impact and / or non-renewable resources into account, especially for specific case studies other than those for the city of Venice.

C. Measurement of overall sustainability

Given the current values (non-optimised, or the values sampled during the period of interest), the value for the economic sustainability of the impact, taking into account both the economic value and the impact on the territory, is equal to the minimum values for each constraint in the preceding linear program (with the warning that even if only one constraint is negative, the index is 0, and if all are greater than one, the index has a value of 1).

REQUIRED DATA

1. Daily individual expenditure for each category

2. Number of available beds, lunches, etc

a) Parks, individual travels (urban travel congestion), waste capacity

b) Not renovable resources: limits to people congestions in critical sites of the town

4.3 A common M&T framework

The pilot sites of Alter-ECO are (i) Valencia and Gandia of the Comunitat Valenciana Region, Spain, (ii) Malaga, Spain, (iii) Venice, Italy, (iv) Dubrovnik, Croatia, (v) Rhodes island of the Region of South Aegean, and (vi) Genoa, Italy. According to DELIVERABLE D.3.2.1 of this Alter-ECO project (Preliminary study for launching pilot activities) each of them has different characteristics both in the tourism sector offer and demand.

#	Pilot Area	Country
I	Valencia and Gandia	Spain (Comunitat Valenciana Region)
II	Malaga	Spain (Andalucia / Malaga)
III	Venice	Italy (Veneto)
IV	Dubrovnik	Croatia (Dubrovnik-Neretva County)
V	Rhodes	Greece (Region of South Aegean)

Table 13: The pilot sites of Alter-ECO

As briefly described in the table below Gandia and Rhodes Island are typical sun, sand and beach destinations while Valencia, Malaga and Genoa, are characterized mainly as urban tourism destination even if the pilot case of Genova will be Nervi a sea resort. It should be noticed that all pilot areas are also relevant cruise ports with Venice and Genova to be charactherized as Home Ports. The preliminary study D.3.2.1. also let emerge that many of the cases presents urban "cores" and historic centres with overcrowding and pressure in the carrying capacity).

#	Pilot Area	Main characteristic
I	Valencia and Gandia	Urban destination consolidated for leisure break trips with WHS sites (Valencia) and a classic sun and beach destination (Gandia).
II	Malaga	Urban tourist destination pivot of a strong sun and sea region (Costa del Sol).
III	Venice	Affected by overcrowding together with its Lagoon, is listed as a cultural WHS. On-going modifications of city structure
IV	Dubrovnik	Historic WHS with old walled city suffering concentration of demand and offer. Increasing international demand. Modifications of morphological structure
V	Rhodes	After Crete, the island of Rhodes is the most visited destination in Greece. Long average of stays and high seasonality. Overdependance on T.O. activity. Medieval city is WHS
VI	Nervi (Genoa)	The pilot of Genoa will be implemented in sea resort of Nervi (high quality destination)

Table 14: Main characteristicThe pilot sites

We refer to the D.3.2.1. document for a full analysis of the tourism flows, the economic impact of tourism, the changes and implications of mass tourism development and both the problems and opportunities for sustainable tourism development, the following matrix.

Regarding the single cases it is interesting to notice that:

- in Venice (pilot case III), the main old island is affected by overcrowding is suffering since years and the old city structure is experiencing daily modification. Moreover, there is still no accurate "real time" calculation of the tourist number and not even a model or instrument to support the determination of the optimal level of visitor number that allows to maximize the income of all operators in compliance with the principles of sustainability.

- in Dubrovnik (pilot case IV) tourism flows of visitors in the heritage site is uncertain and this - together with concentration of demand and offer in the Old City is the main issue. Referring to ICT tools a project of counters via cameras and WiFi is under way for UNESCO WHS and first results are expected this year;

As a more general list of possible activity (not necessarily related to ICT tools and Methods) it also emerged for example:

- the creation of quality labels for tourist apartments to reward those apartments that reach certain comfort levels (energy, accessibility, acoustic);
- incentives related to the use of alternative routes out of the city centers including signs and other marketing tools.

In order to set the feasible ICT tool(s) it may be interesting to recap the main threats that emerged in D.3.2.1 study for each of the pilot areas.

#	Pilot Area	Weakness and threats emerged in the preliminary study
I	Valencia and Gandia	Lack of environmentally sustainable indicators tracking Better positioning of rival Spanish destinations (Valencia) Digital presence in Valencia is not homogeneous Non-regulated lodgement offer Excessive budgetary reliance of Valencia's City council Seasonality, overcrowding and pressure in Gandia
II	Malaga	Slowness and apathy from the local administration (public spaces quality, new regulations, ...) The need to expand and connect the tourist areas with other zones of the historic centre as well as with the city House pricing in the historic center and population ageing Not enough shops, businesses and services on offer during holidays that coincide with cruise arrivals Overcrowding and pressure Difficulty to abandon the over-dependence on the use of the car and to fully support alternative mobility schemes
III	Venice	Shortage of funding for restoration and urban maintenance Reduction of the resident population in the historic city and in the other lagoon historical settlements. Concentration of tourist flows inadequate awareness of the universal values of the Site Irreversible change of the morphological characteristics of the lagoon eco-system, of its hydraulic dynamics, and tide levels transformed usage of the building heritage Unlimited and uncontrolled tourist development causing damage to heritage properties due to excessive use
IV	Dubrovnik	Inadequate differentiation of products and service standards. Inefficient destination management model- lack of coordination in tourism sector

#	Pilot Area	Weakness and threats emerged in the preliminary study
		Lack of management plan with UNESCO WHS Lack of clear mobility strategy in relation to tourism management Mass tourism frustration and resistance by local society Fragmented tourist offer and low cooperation level between stakeholders Abandoning of destination management concept
V	Rhodes	Over-dependences (few markets, few operators, few months); Increased competition; The migratory crisis in the Aegean Sea has also affected Rhodes.
VI	Nervi (Genoa)	The centre and some areas of the city have become attraction points but there are some areas of the city undiscovered by tourism. Need to improve the tourism in the city by working on city marketing, on social networks and on worldwide promotion.

Table 15: Weakness and threats emerged in the preliminary study

Taking into account the kind of tourism destination of the pilot cases as well as the preliminary study D.3.2.1 results the following table list feasible tool(s) that we suggest pilots may adopt.

#	Pilot Area	Feasible tool(s) pilots may adopt
I	Valencia and Gandia	ICT tools - counting people through Wifi Access Points to detect mobile phones ICT tools - update of a digital platform supporting Method - incentives and promotion of alternative routes and point of interest Deepenings - tourism hospitality offer structure (quality labels development)
II	Malaga	ICT tools - Mobile phone-led crowd management technique tests (including mobile enabled sensors). Method - Decision Support System (DSS) Deepening - B2B platform related to cruise schedule and other tourism events (from adapting opening times to better tourism management flows)
III	Venice	Method - Decision Support System (DSS) Method - develop ETIS indicators

		ICT tools - Mobile phone-led crowd management technique tests (including mobile-enabled sensors).
IV	Dubrovnik	ICT tools - counters through cameras (including WiFI equipment) and cloud system to recollect, analyze and share results in real time. ICT tools - system dedicated to mobility of tourists (connections more efficient and more sustainable) Method - Decision Support System (DSS) Deepenings - daily cruise tourism relevance vs. general mass tourism
V	Rhodes	ICT tools - system dedicated to mobility of tourists (connections more efficient and more sustainable) Method - develop ETIS indicators Deepenings - daily cruise tourism relevance vs.sun sea tourism
VI	Nervi (Genoa)	Tourist Flow Model (TFM) for understanding how to improve the local public transport offer. ICT tools - hi-quality system to integrate local offer (from 6 public museum to 4 historical parks) ICT tools - Augmented reality for natural offer (cultural heritage and botanical collections) Method - develop ETIS indicators

Table 16: Feasible tool(s) pilots may adopt

For more information:

Nicola Camatti
University of Venice, Department of Economics
Fondamenta S. Giobbe, 873 Venezia
nicola.camatti@unive.it