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Islands in Europe: Development of an Island Tourism Multi-Dimensional Model (ITMDM)

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ABSTRACT
This paper introduces an island tourism multi-dimensional model. Its aim is to develop an approach for integrating quantitative models and qualitative techniques into a coherent and useful methodology. The island tourism multi-dimensional model is divided into several modules as presented in the paper. They include geographic information system applications, economic impact assessment, forecasting modeling, accessibility modeling, seasonality modeling and alternative modeling. Forecasting models, economic impact assessments and geographic information systems can be used to project forecasts and demonstrate sustainable and economic development issues. The paper demonstrates that the outcomes of the accessibility and seasonality modules can be used to generate strategic plans of marketing segments, service engagement and community involvement. It suggests that by using alternative modeling the output of quantitative analyses and the input of private, voluntary and public sectors at community, business and governmental levels can be integrated with each other. Copyright © 2006 John Wiley & Sons, Ltd and ERP Environment.

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Introduction

During the last decade of the 20th century, the European Union (EU) has witnessed major political changes. The enlargement of the Union, not only to the East, but also to the South, has significant consequences for all the member states. Islands are privileged with exceptional natural and cultural environments, but also bear many constraints. Half of the West European coastline belongs to the islands, where the concentration of inhabitants along the shores, and the pressures exerted by tourism activities, results in complex and costly requirements in terms of management and development (Eurisles, 2002).

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One way to measure the vulnerability of the islands and to promote a balanced development has been to estimate the carrying capacity of an island (McElroy, 2003; Coccossis and Mexa, 2004). Carrying capacity considerations include three basic components: physical–ecological, socio-demographic and political–economic. The physical–ecological set comprises all fixed (the capacity of natural systems) and flexible (e.g. electricity, transportation, water supply, sewerage, health services, law and order services, shops etc) components of the natural and cultural environment as well as infrastructure. Social carrying capacity includes both the levels of tolerance of a host community and the quality of the experience of visitors of a destination. The political–economic component refers to the impacts of tourism on the local economic activities and structure. When estimating carrying capacity, the three components should be considered with different weights of importance among different destinations. For instance, these differences may include the characteristics of the tourism destinations (coastal, protected, rural, mountain, historical) and the tourism/environment interface (McElroy, 2003; Parpairis, 2004). However, the complex character of tourism impacts on islands is only partly captured by the concept and methodology of carrying capacity, with its primary focus on economic and quantitative factors. Coccossis and Mexa (2004) provided a detailed discussion of the advantages and disadvantages of the carrying capacity assessment technique.

In addition to the issues of island tourism carrying capacity assessments, the field of maritime and air transport is probably the sector where community legislation has the greatest number of provisions specific to island situations. For example, some islands are geographically closer to other member states than to their own state, and could benefit from a 'public service obligations' (PSO) system (e.g. public air and/or maritime transport) to develop trades among these countries. Examples include Bornholm (Denmark) with regard to Sweden, or Corsica (France) with respect to Italy.

The European Commission, asked to look at this matter by the island of Bornholm (Denmark), is exercising a great deal of circumspection, and is disposed to authorize the imposition of a 'public service obligations' (PSO) system only on the service between Bornholm (Denmark) and Sweden, on the grounds that this link is shorter than the direct Bornholm–Copenhagen link (Eurisles, 2003; Billing and Chen, 2004). A comprehensive model that can integrate both quantitative and qualitative modules into a coherent approach to evaluate the overall development status of islands is greatly needed.

Background of Study

The introduction and development of the island tourism multi-dimensional model (ITMDM) is part of an EU funded 'Gederi' project launched by the Island Commission focusing on development of policies for sustainable tourism involving 11 island regions of Europe. This includes the Balearics (Spain), Bornholm (Denmark), Crete (Greece), Corsica (France), Gotland (Sweden), Gozo (Malta), Ionian (Greece), Sardinia (Italy), Sicily (Italy), Western Isles (Great Britain) and Aland (Finland). The overall goal of this EU Island Gederi project is to use the regional 'know-how' structures in each island region in order to provide better information to the insular political and administrative actors. Eight main themes are included in the EU island project: (1) what the meaning of accessibility is in the island environment, (2) sustainable tourism in the islands, (3) what strategies can be adopted to encourage people to remain living on or move to islands suffering from depopulation, (4) how the mismatch between the supply of training and the demands of the employment market in the island environment can be resolved, (5) how the image of the island can be used as a means of developing and marketing local products, (6) how to improve the islands' rapid response capability in the face of major natural or environmental risks, (7) what sort of higher education policies could make an effective contribution to the

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economic development of the islands and (8) which integrated strategy for the development and management of island regions?

This paper introduces an island tourism multi-dimensional model (ITMDM) aiming at developing and integrating quantitative models and qualitative techniques into a coherent and useful methodology that is related to the eight themes above directly and indirectly. The island tourism multi-dimensional model (ITMDM) is designed to investigate the evolution of economy and society and its interaction with geography and environment to advance understandings of island tourism dynamics under selected time-series factors.

Development of Modules

ITMDM is divided into several different modules including geographic information system (GIS) applications, economic impact assessment (EIA), forecasting modeling, accessibility modeling, seasonality modeling and alternative modeling (see Figure 1). Forecasting models, economic impact assessments (EIAs) and geographic information systems (GISs) can be used to project forecasts and demonstrate sustainable and economic development issues. For example, the following six components will be combined into trip-making behaviors under the forecasting, EIA and GIS modules: (1) demographic characteristics (such as who are they?), (2) geographic characteristics (such as where do they come from?), (3) how they make their trip decisions, (4) what resources they use, (5) what kind of activities they engage in and (6) what their spending patterns are. A series of European island tourism studies (provided by these participating islands) will be used to provide historical trends in the components of trip-making behaviors and tourist flows. This will primarily be carried out through compilation of existing documentation, statistics, surveys and reports.

An island tourism development related department needs to provide accessibility in various public destinations by identifying and removing barriers where possible to remove and/or reduce physical, architectural, information, communication and seasonal barriers. In addition, the department ensures services, information and communication barriers are minimized through the wide array of tourist services that a destination provides. The outcomes of the two modules (accessibility and seasonality) will generate strategic plans of marketing segments, service engagement and community involvement.

Alternative modeling can integrate the output of quantitative analyses (e.g. forecasting, EIA, GIS and segments) with the input of private, voluntary and public sectors at community, business and governmental levels in order to investigate the degree of tourism development and needs of sustainable planning. Table 1 displays the suggested variables for the overall modules. Specific variables for each module are listed in the following individual module sessions.

[I] Sustainability	[III] Accessibility
• Socio-cultural indicators	• Facility
• Political–economic indicators	• Network/transportation support systems
• Physical–ecological indicators	• Types of tourist
[II] Seasonality	[IV] Qualitative analyses
• Weather	• Perceptions of island policy makers
• Types of event/festival	• Perceptions of residents
• Support of facilities, policy makers and residents	Perceptions of business owners and/or managers

Table 1. Overall list of suggested variables

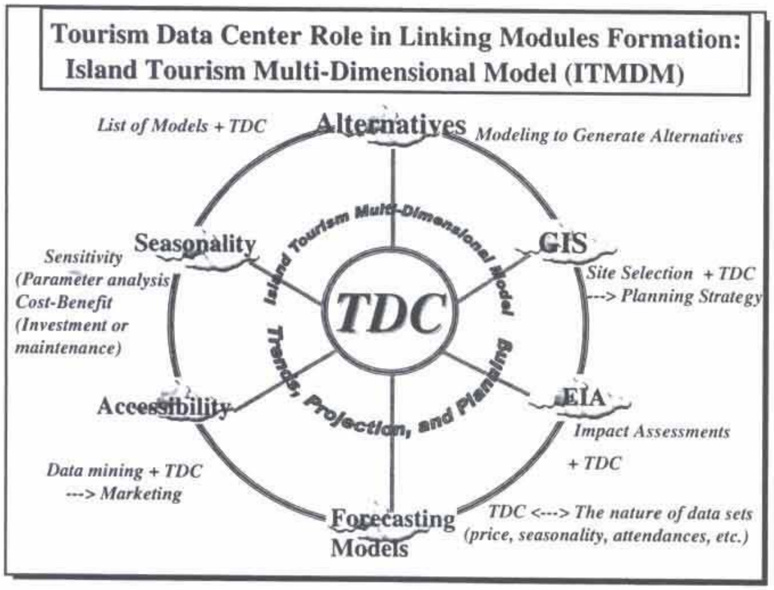

Figure 1. Island tourism multi-dimensional model (ITMDM)
Note: TDC = Tourism Data Center.

Demography	Social behavior
Tourist flows	Health and safety
Employment	Psychological issues

Table 2. Political–economic indicators

Module 1. Geographic Information Systems (GISs): Spatial Analyses

Geographic information systems (GISs) have been adopted as a useful tool by a wide range of disciplines such as environmental planning, property management, infrastructure siting, emergency planning, automobile navigation systems, urban studies, market analysis and business demographics. Several researchers have applied GIS to tourism planning and management practices such as tourism resource inventories, site selections, visitor flow management (Chen, 2002) and resource allocations (Farsari and Prastacos, 2004). The main purpose of including the GIS module, at this stage, is to demonstrate the results in a spatial format. However, eventually, the GIS will be integrated with other listed analyses including EIA, forecasting and marketing segments by using computational codes to link each module.

Variables suggested for use under the GIS module are listed in Table 2. Some of these variables are easily available (at least for some of the islands) through secondary data sources, while others would entail more detailed investigations (e.g. mail-out surveys). The main variables suggested for use under this GIS module are related to 'political–economic' issues. The political–economic parameters refer to

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1. Tourism earnings and investments	3. Tourism policies
1.1 Ratio of net foreign exchange earnings relating to the tourist investments or to the functioning of tourist activity	3.1 Existence of specific tourism regional development plan
1.2 Inflow earnings from the expenditure prior to departure	3.2 Participation of destination in eco-labeling program (e.g. the EU 'Blue Flag' program for beaches)
1.3 Tourism receipts in absolute terms	3.3 Reference to tourism in broader national and/or regional development plans
1.4 *Per capita* tourist expenditure during stay	3.4 Existence of specific national and/or regional tourism policy
	3.5 Existence of national tourism development plan making reference to specific island
2. Employment	4. Public expenditure and revenue
2.1 Average annual employment (directly or indirectly) in tourist sector/total employment	4.1 Tourist tax (eco-tax) revenue/total tax revenue
2.2 Number of seasonal workers development	4.2 Tourist tax (eco-tax) revenue/public expenditure on tourism

Table 3. Indicative lists for sustainable tourism and political–economic indicators

tourism's impacts on local economic structure, activities etc, including competition among tourism sectors (Table 3).

Suggestions and Implementations of GIS

Using GIS as a tool to identify development levels of regions (islands), recommendations can be made for a range of policies (not one size fits all). In addition, maps can display the location of islands and allocations of resources. The geographic information systems (GISs) can provide comprehensive access to the database, query features, and create themes, layouts and reports. Based on the availability of data sets, more maps are essential for future island related projects.

The geographic information systems (GISs) can be used to identify various classes of island development throughout Europe. Using an island as a spatial unit, the analyses of suggested spatial data sets will include the following:

- creating maps to compare taxation to others nearby,
- mapping the neighborhoods (islands) to obtain funding for low-cost housing or under-developed areas,
- using maps to find the best locations for new attractions,
- using maps to control over-crowded/congestion issues,
- using maps to track the movement of various activities (recreational activities, crime movement etc) across neighborhoods and
- mapping the balance between population growth and quality of life for the participating islands.

Module 2. Economic Impact Analysis

In this study, both primary and secondary data may be used in conjunction with an input/output (I/O) model to determine the economic impacts of an activity. Initial direct expenditures of target population in the defined area by non-residents constitute the direct economic effects on the local economy positively and/or negatively. An input/output model can describe the economic importance of an activity in terms of changes in total industrial outputs, value added, labor income and employment (Chen *et al.*, 2001).

The direct expenditure contributions of trading in goods and services generated by non-resident travel parties to the study area (i.e. Bornholm, Denmark) are one component of the economic impacts of visitation to the defined region. Other economic impacts considered in this research are indirect and

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induced effects. Indirect effects result from the suppliers of business and agencies that sell goods and services to the factories and organizations that directly provide their products to non-resident visitors. Induced effects result from the direct and indirect effects generated by employee income in the defined region.

Total economic impact is the sum of direct, indirect and induced effects of visitor spending. The input/output (I/O) model calculates multipliers including direct, indirect and induced effects. The use of multipliers is to estimate economic impacts resulting from a commodity or an industry changing in final demand. In order to estimate economic effects caused by a new industry or an activity in final demand, multipliers are used as the magnitude to weigh the leakages and linkages among various industrial and tourism sectors of the local economy. Lower leakages to economies are assumed to be represented by higher value added multipliers.

Economic Impact Concepts and Measures: Direct, Indirect and Induced Effect Impacts

To estimate the I/O model, the main equations are (Chen *et al.*, 2001)

$$T_n = y_j \times b_{jn} \tag{1}$$

$$M_n = c \times T_n \tag{2}$$

$$M_n = c \times y_i \times b_{jn} \tag{3}$$

$$M_n = (I - A)^{-1} \times T_n \tag{4}$$

where

T_n = a vector of changed final demand
y_j = a vector of total spending in sector j, $j = 1, \ldots, n$
b_{jn} = a value from allocating the j category in travel spending to I/O n sectors
M_n = impact vectors, resulting from final demands changes (i.e. changes in value added, number of jobs etc)
c = the matrix of coefficients (multipliers will be calculated based on the availability of data sets)
$(I - A)^{-1}$ = Leontief inverse matrix (used in I/O); I is the identity matrix; A is the transactions matrix.

Suggested Input Variables of Economic Impact Assessment (EIA)

Based on (1) the availability of existing secondary data sets, (2) the economic structure of selected islands, (3) feasible data collection approaches and (4) the suggestions of previous studies and other considerations, this EIA module will include the following potential variables:

- total number of visitors (non-resident visitors: people who are from outside of the defined study region; for example, each participated island could be seen as one defined study area);
- total spending during the trip within the study area;
- categorized spending, including lodging, food, transportation, recreation, souvenirs and other expenditures;
- length of stay and
- various multipliers (value added, employment etc) for individual industrial and tourism sectors.

Tables 4 and 5 demonstrate the types of visitation and travel spending data sets. The data sets used here were retrieved from Bornholm (Denmark) as variable examples.

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Expenditure per day per person		
	Amount (DKK)	% distribution
Ferry	74.01	12.00
Accommodation	308.95	50.08
Drinks & beverages	100.96	16.37
Shopping	52.79	8.56
Entertainment	6.91	1.12
Souvenirs	11.96	1.94
Transportation on Bornholm	7.9	1.28
Auto repair	12.81	2.08
Attractions	17.75	2.88
Others	22.85	3.70
Total	616.89	100.00

Table 4. Travel spending in Bornholm, 2003

Passengers	1998	1999	2000	2001	2002	2003
Ystad	800	727	803	1040	1116	1156
Sealand	355	370	312	216	231	216
Germany	195	175	177	163	144	129
Poland	12	23	11	36	56	33
Air (CPH)	204	229	216	169	138	130
Passengers, total	1567	1523	1520	1624	1685	1665
Arrivals	1998	1999	2000	2001	2002	2003
Ystad	400	363	401	520	558	578
Sealand	178	185	156	108	116	108
Germany	98	88	89	81	72	65
Poland	6	11	6	18	28	16
Air (CPH)	102	114	108	84	69	65
Arrivals, total	783	761	760	812	842	832
Special events (SE)					20	
Total – SE	783	761	760	812	822	832
Million	1998	1999	2000	2001	2002	2003
Bed-nights	1.66	1.59	1.62	1.61	1.56	1.58
	1998	1999	2000	2001	2002	2003
Arrivals	1.00	0.97	0.97	1.04	1.08	1.06
Arrivals – SE	1.00	0.97	0.97	1.04	1.05	1.06
Bed-nights	1.00	0.96	0.98	0.97	0.94	0.95
Nights/arrivals – SE	1.00	0.98	1.01	0.93	0.90	0.89

Table 5. Visitation trends of Bornholm, 1998–2003

Implementation of EIA

Based on the current available spending profile and visitation of overnight stays, the direct effect can be calculated easily. Detailed multipliers for various industrial and tourism sectors will be needed for indirect and induced calculations. Currently, all participating islands are collecting the above variables and multipliers; therefore, this paper is unable to include the results of total economic impacts. Once the outputs of the EIA are estimated, using the forecasting module and integrating the inflated dollar with

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Method/equation	Definition
	Seasonal autoregressive integrated moving average (SARIMA)
$\Phi_p(B)\vartheta_P(B^S)\nabla^d\nabla_S^D V_t = \Theta_q(B)\Psi_Q(B^S)\varepsilon_t$	V_t = dependent variable (e.g. number of visitors in time t); Φ_p = regression coefficients; B = the backshift operator; S = time period (i.e. when analyzing monthly data, $S = 12$); ∇_S^D = seasonal differencing operator, where $\nabla_S^D = (1 - B^S)^D$; D = degree of seasonal differencing; Θ_q = coefficient, or called weights; $\vartheta_P(B^S)$ and $\Psi_Q(B^S)$ = polynomials in B^S in degrees of P and Q; ε_t = error with white noise ~ iid $N(0, \sigma^2)$.

Table 6. Equations of time series forecasting methods

visitation forecasts (e.g. using the 2007 spending profile (inflated number) multiplied by 2007 forecast visitation), the forecasts of EIA can be obtained.

Module 3. Trend Analysis and Forecasting Models

Trend analyses and forecasting models offer a basis and in-depth analysis of (1) economic and business planning, (2) product development, (3) inventory and production control and (4) optimization of business processes. Short- and medium-term forecasts can be used to establish strategic marketing plans. Such forecasts can provide valuable information for pricing, seasonal employment and short-term budgeting (Chen *et al.*, 2003). With respect to developing long-run strategic plans and sustaining the existing resources of islands, forecasts can determine future employment, community development, new attractions and facilities/utilities and future needs of infrastructures, businesses and customers.

The suggested forecasting methods in this study will include (1) Naïve 1 (Makridakis *et al.*, 1998), (2) Naïve 2 (Newbold and Bos, 1994), (3) Holt Winter's seasonal double exponential smoothing model (Winters, 1960) and (4) the seasonal autoregressive integrated moving average (SARIMA) model (Box *et al.*, 1994). Forecast accuracy may be assessed using mean absolute percentage error (MAPE) and root mean square percentage error (RMSPE) (Chen *et al.*, 2003). According to Chen's previous forecasting studies (Chen *et al.*, 2001, 2003; Chen, 2005), SARIMA was the best choice for her selected cases.

Seasonal Autoregressive Integrated Moving Average (SARIMA)

The difference between non-seasonal and seasonal time series is that the non-seasonal relationships can be described as those between observations for successive time periods (V_t and V_{t-1}), whereas seasonal relationships are between observations for the same month (V_t and V_{t-12}) or for the same quarter (V_t and V_{t-4}) in successive years. The seasonal autoregressive integrated moving average (SARIMA) model examines the year-to-year relationships for each month or quarter (Box *et al.*, 1994) (Table 6).

Variables for developing and evaluating forecasting models will include (1) overall visitations (historical data sets: monthly, seasonal and/or annual, e.g. 1991–2004), (2) intervention events (particular events that caused the increase/decrease of visitations) and (3) other factors that influence visitations. This paper used the trend data sets of Bornholm's overnight-stay visitation as an example and con-

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Year	Forecasts	Low 95%	High 95%
2004	1562 390	1389 043	1735 738
2005	1543 755	1340 228	1747 283
2006	1536 460	1317 164	1755 757
2007	1527 956	1282 274	1773 637
2008	1518 444	1250 526	1786 362

Table 7. Forecast overnight visitation (2004–2008) within 95% confidence intervals

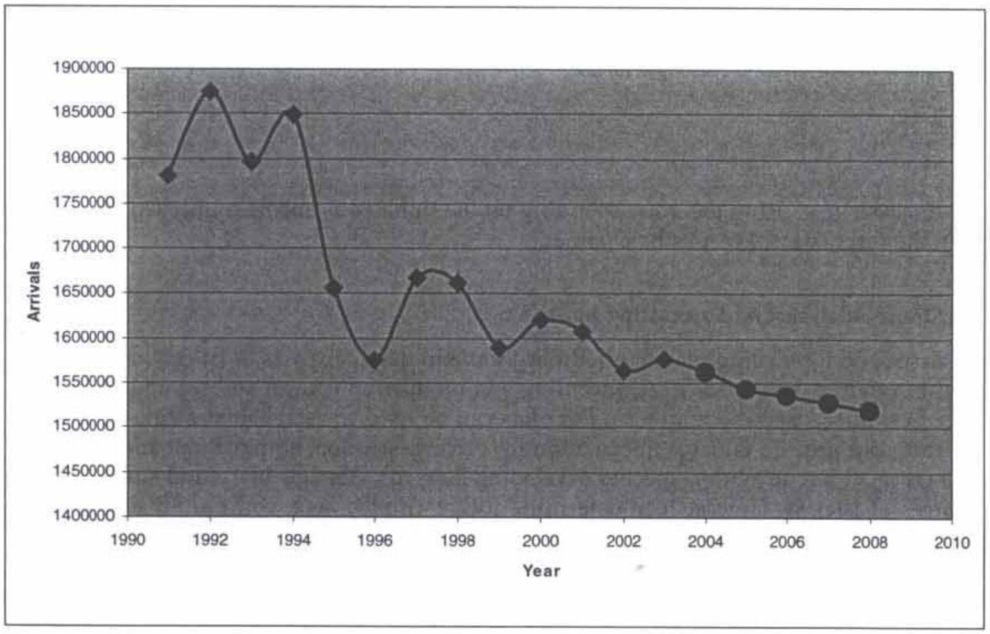

Figure 2. 2004–2008 forecast overnight-stay visitation, Bornholm

structed SARIMA models to estimate the forecasts for the next 5 years. The Bornholm overnight-stay data sets used in this study refer to annual visitation figures (from January 1991 to December 2003). Seasonal autoregressive integrated moving average (SARIMA) models are estimated without intervention effects. The estimation period was January 1991–December 2003. Forecasts were then generated for the following 5 years (2004–2008) (see Table 7 and Figure 2). The results of the Bornholm visitations reveal a declining trend for the next 5 years' predictions.

Modules 4–6. Modules of Accessibility, Seasonality and Alternatives

Accessibility and seasonality related valuables can be analyzed under data mining analyses and sensitivity analyses. The data mining technique provides tourism decision makers with scalable data analysis solutions that drive better insightful decisions faster by revealing patterns, trends and relationships.

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Sensitivity analysis is used to ascertain how a given model output depends upon the input parameters. This is an important method for checking the quality of a given model, as well as a powerful tool for checking the robustness and reliability of its analysis. Therefore, using both data mining and sensitivity analyses, the relationships among the tourist flows, satisfactory levels, the levels of accessibility (physical and programmatic) and seasonality (peak, shoulder and off) can be identified.

Seasonality modeling also includes parameter analysis, sensitivity analysis and cost–benefit analyses. Parameter analysis can estimate population-genetic parameters such as population/visitation size, population/visitation growth rate, recombination rate and migration rates. The technique approximates a summation over all possible genealogies that could explain the observed sample, which may be sequence data. Cost–benefit analysis estimates and totals up the equivalent money value of the benefits and costs to a destination/communication of projects to establish whether they are worthwhile. The valuation of benefits and costs should reflect preferences revealed by choices that have been made. For example, improvements in public transportation frequently involve saving time and budget. The question is how to measure the money value of that time saved. The value should not be merely what transportation planners think time should be worth or even what locals/visitors say their time is worth. The value of time should be that which the public reveals their time is worth through choices involving trade-offs between time and money. The process of evaluating alternatives will be the main vehicles for the qualitative techniques. Variables for the modules of accessibility, seasonality and alternatives will include levels of affluence, mobility, holiday entitlement, the attractions and amenities of destination areas, the relative cost of the visit, time of using transportation, perceptions of decision makers, residents' attitudes and business engagement toward tourism development.

Conclusions

Based on the nature of participating islands and the availability of data sets, finalized variables will be input under the proposed modules. When variables/indicators are identified and retrieved through the process of inventory of data sources, the island tourism multi-dimensional model (ITMDM) will be investigated systematically using available input variables. It will provide more comprehensive results to demonstrate how this heterogeneous group of island regions can be typologized and analyzed through the island tourism multi-dimensional model (ITMDM).

Island project partners may combine modules or use module-by-module step to generate results at various stages. As mentioned previously, integrated simulations include forecasting models, economic impact assessments (EIAs) and geographic information systems (GISs) can be used to project forecasts and demonstrate the level of development mutuality and map sustainable tourism issues. The EIA module may be integrated with the forecasting module to project the future economic benefits of the study region. The outcomes of the accessibility and seasonality modules may be used to generate strategic plans of marketing segments, service engagement and community involvement. Alternative modeling may integrate the output of quantitative analyses (e.g. forecasting, EIA, GIS and segments) with the input of qualitative analyses.

Furthermore, the ITMDM is tailored to the analytical needs of islands in transition, and aims to target tourism managers and planners working at local, regional and national levels. Even not yet fully developed, it is already a starting point for the data collection process, giving access through links and references to in depth information on each topic addressed. In addition, the ITMDM aims to exchange knowledge and practice experience, support the EU Gederi project processes and promote inter-island networks.

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