The Multidimensional Tourism Carrying Capacity Model for Zanzibar

Abstract

Zanzibar as a tourist destination nation is experiencing strong tourism growth, with high tourism intensity and with high seasonality is bound to be subject to considerable negative effects related to the amount of tourists visiting their area.Therefore, determining the tourism carrying capacity of Zanzibar is thus vital national policy issue to ensure a balance between achieving optimal tourism development without compromising the delicate environmental, economic and social structure. The paper develops and proposes the Multidimensional Tourism Carrying Capacity Model, (MDTCC) to be used assess and establish the tourism carrying capacity of Zanzibar.The paper considers the tourism carrying capacity (TCC), as a national policy target variable and complex function of six interdependent dimensional and subsystems variables, namely, Economy, Ecology or Nature, Social, Culture, Heritage, and Political. In turn, these independent subsystems are defined as complex functions of other endogenous, exogenous factors,parameters, and series of pre-outcomes.The MDTCC is determined according to mathematical rules as there are seven relations;to be determined by the seven endogenous variables as policy target variables.The empirical MDTCC Model is proposed to be used to investigate performances or behaviour of policy target variables given variations of other endogenous, exogenous factors and parameters. The quantitative MDTCC procedures to be adopted in the framework to evaluate each component are based on mathematically valid procedures and techniques associated to the complete ex-ante and ex-post evaluation monitoring processes, through all stages or phases; from the planning stagesto reporting of results from the data and policy analysis.

Key Words: Zanzibar Tourism Carrying Capacity

1.0.Introduction

1.1.Background

Tourism is one of the fastest growing sectors in the global economy, Africa, Zanzibar and for those tourist destination countries which are able to attract tourism businesses; tourism can be a means of accelerating economic growth and providing employment, especially if strong linkages with domestic economy are developed, (Leonard & Carson, 1997 and Denise & Pavol, 2014).

Tourism is a flagship sector, which binds other economic sectors in Zanzibar. It accounted for about 29.2 % of gross domestic product (GDP) and contributes more than $450 million in foreign exchange in year 2022 with the potential for further expansion and subsequent contribution to Zanzibar's economic development. The tourism sector offers employment to a significant proportion of youth, women, as well as employs low skill labor, thus generating employment for families and the poor. Statistical reports indicate a gradual increase in tourism

arrivals to Zanzibar into an up-market and competitive destination for tourists in the Indian Ocean archipelagos tourism, (OCGS and ZCT 2022).

Zanzibar as a small island tourist destination nation is experiencing strong tourism growth, with high tourism intensity (i.e. a high number of arrivals in relation to the number of local residents) and with high seasonality is bound to be subject to considerable negative effects related to the amount of tourists visiting their area. The social, cultural and environmental impacts of tourism in Unguja and Pemba, although more difficult to define given they are not tangible, are just as relevant as the environmental and economic effects. Although tourism has been a positive social economic gain for Zanzibar in creating employment, improved infrastructure and increased revenue, tourism has also led to social stress such as conflict between developers and local communities often over land tenure issues. Other social impacts include changes in the traditional village lifestyle and culture.

1.2. The Tourism Carrying Capacity of Zanzibar

The Revolutionary Government of Zanzibar, (RGoZ), desires to assess the Zanzibar Tourism Carrying Capacity, (ZTCC) as a vital development policy issue to ensure a balance between achieving optimal tourism development without compromising the delicate environmental and social structure of the nation, i.e., sustainable tourism development which refers to tourism that is environmentally, socially and economically acceptable or tourism development within the carrying capacity,(JérômeMassiani and Giovanni Santoro, 2012).The RGoZ plans to undertake a comprehensive study of the prevailing situation, opportunities, challenges as well as economic and social effects of the high inflows of tourists in Zanzibar and the entire tourism attractions of Unguja and Pemba. The ZTCC Study will assess the physical carrying capacity of tourism destinations, as a tool to evaluate whether the current situation is sustainable or not and to determine if a rise in visitor numbers could affect the quality of the environment, the resources available and the quality of public services.

Tourism carrying capacity is multidimensional and it may bedescribed in a lot of different social economic ways, (Josef Zelenka1and Jaroslav Kacetl, 2014, and WTO, 1999). This multidimensionality must be borne in mind inrelation to the character of causes, interconnectivities and effects on the economic, natural and socio-cultural parts of the destination area.According to the purpose of its utilization in management, it is relevant to choosedimensions and their specifications in relation to the appropriately defined area, the type ofphenomena, possibilities of influence and impact monitoring, (ESPON EGTC, 2020).

Capacity to absorb tourism impacts must be perceived as a time-space variable, e.g., inthe case of ecological carrying capacity, its environmental manifestations must be considered in relation tothe local changeability of ecosystems, time changeability (seasons, weather, belated effectsof certain influences) and a suitable size of the area for its determining and utilization(making an average across dissimilar ecosystems), (Denise and Pavol, 2014). On the practical level, many nations wish sustaining benefits to local communities, private sector enterprises and tourists, and destination.However, the prevailing weaknesses, challenges and effects of the tourism carrying

capacity and the importance of tourism to Zanzibar economy as well as the livelihood of the people are unknown and not certain.

1.3. Objective of this Paper

The objective of this paper is to develop, formalize and proposethe Multidimensional Tourism Carrying Capacity,(MDTCC), model, to be used assess and establish the current tourism development status with regards or in relation to a number of key economic, environmental, social, cultural, heritage and political variables and indicators in Zanzibar. The MDTCC model is a comprehensive methodological framework which will contribute to an evaluation and understanding of the concept of Tourism Carrying Capacity (TCC), its practical analysis and measurement and its efficient application in Zanzibar. The MDTCC model will provide guidance that help stakeholders manage acceptable change of basic social economic parameters to achieve sustainable tourism development in Unguja and Pemba.

The MDTCC model for Zanzibar is founded on the multiple-criteria decision-making (MCDM) or multiple-criteria decision analysis, (MCDA) theory, (Hwang and Yoon, 1981). The MDCA allows a multitude of aspects in the socio-economic context of destinations are touched upon and carrying capacity is strongly related to the dimensions of sustainability and its conceptual components (i.e. economy, society and the environment), (ESPON EGTC, 2020). This paper proposes analytical methodology establishing causality between tourism as a sub-sector of the economy and spatial phenomena (flows and concentration) and all these multiple aspects. The analytical methodological approach meets this challenge by allowing for different ways to assess normative borders for carrying capacities, (Denise and Pavol, 2014 and ESPON EGTC, 2020).

One of the benefits of formalizing an economic modelis to meet the test of the second-generation reforms, an opportunity to refine and provide quantitative guidance to the Tourism Carrying Capacity model, (ESPON EGTC, 2020). The refinement provides for improvement - to delete archaic and install the novel, to introduce more relevant examples and to build on an accepted framework of ideas. The level of analysis is tailored for the modern policy, planning, project, monitoring, controlling and evaluation purposes.

The MDTCC model may assist and form the basis and guidance to the field research surveys for territorial evidence and visualizations in Zanzibar to establish the current tourism development status with regards to a number of key economic, environmental, social, cultural, heritage and political indicators. The model will assist in the projections and suggestions of growth scenarios and provide tentative views with a strategic tourism policy direction that supports the high value, low impact tourism model Zanzibar is striving for. The desired outcome is to define desired conditions and thresholds for tourism growth and associated impacts from tourism that balances.

Comment [u3]: This section should go under the Introduction/Background of the study.

1.4. Format of the Paper

For a systematic presentation, the paper is divided into six main sections. Section 1.0has introduced the background of the Zanzibar tourism carrying capacity, objectives, research methods and approaches. Section 2.0 presents the Multiple-Criteria Decision-Making Theory.

This consists of the multiple-criteria decision-making, different classifications of problems; methods, and main multi-criteria analysis steps.

Section 3.0 reviews the theoretical multidimensional tourism carrying capacity model, subsystems and main components. These subsystems include economic carrying capacity; ecological (nature) carrying capacity; social carrying capacity; culture carrying capacity; heritage carrying capacity and political carrying capacity.

Section 4.0 presents and discusses the theoretical quantitative multidimensional tourism carrying capacity model. This consist of the formal quantitative multidimensional tourism carrying capacity model; overall tourism carrying capacity policy variable; economic carrying capacity, social carrying capacity; culture carrying capacity; heritage carrying capacity;and political carrying capacity and the MDTCCmodel determination and solution

Section 5.0 presents an indicative quantitative MDTCC model arrangement; methods, approaches and processes. Section 6.0 is the conclusion consisting of major issues and recommendation.

> **Comment [u4]:** Is not relevant as it reflects a graduate dissertation write up.

2.0. Literature review

2.1 Theoretical Literature

> **Comment [u5]:** Consider this structure.

2.1.1 Multiple-Criteria Decision-Making Theory

2.1. Multiple-Criteria Decision-Making

> **Comment [u6]:** Consider deleting the title as it appears to be a duplicate of the above sub- title.

Multiple-criteria decision analysis, (MCDA) or multiple-criteria decision-making (MCDM) is a sub-discipline of operational policy research that explicitly considers multiple criteria components, linkages and processes in decision-making systems, (Saaty, 1980 and Keeney,*et al*., 1993). In the policy decision systems, we usually identify, select, use and weigh multiple criteria implicitly and we may be comfortable with the consequences of such policy decisions that are made based on only intuition. On the other hand, when stakes are high, it is important to properly structure the problem and explicitly evaluate multiple criteria, (Charnes, *et al.,* 1978 and Hwang and Yoon, 1981).MCDA is concerned with structuring and solving policy decision, planning and project problems involving multiple criteria, (Charnes, *et al.,* 1978 and ESPON EGTC, 2020). The purpose is to support policy decision makers facing such problems. Typically, there does not exist, a unique optimal solution for such problems and it is necessary to use policy decision maker's preferences to differentiate between solutions.

The difficulty of the development policy problem originates from the presence of more than one criterion or subcomponent, Charnes, *et al.,* 1978 and Hwang and Yoon, 1981). There is no longer a unique optimal solution to an MCDM problem that can be obtained without incorporating preference information. The concept of an optimal solution is often replaced by the set of nondominated solutions. A nondominated solution has the property that it is not possible to move away from it to any other solution without sacrificing in at least one criterion. Therefore, it

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makes sense for the decision maker to choose a solution from the nondominated set. Otherwise, one could do better in terms of some or all of the criteria, and not do worse in any of them. However, the set of nondominated solutions is too large to be presented to the decision maker for his final choice. Hence we need tools that help the decision maker focus on his preferred solutions (and or alternatives). Normally one has to "trade-off" certain criteria for other.

2.2. Different Classifications of MCDM Problems and Solutions

There are different classifications of MCDM problems and solutions. A major distinction between MCDM problems is based on whether the solutions are explicitly or implicitly defined, (Saaty, 1980 and Keeney,*et al*., 1993). Multiple-Criteria Evaluation problems consist of a finite number of alternatives, explicitly known in the beginning of the solution process. Each alternative is represented by its performance in multiple criteria. The problem may be defined as finding the best alternative for a decision maker (DM), or finding a set of good alternatives. One may also be interested in "sorting" or "classifying" alternatives. Sorting refers to placing alternatives in a set of preference-ordered classes (such as assigning credit-ratings to tourism destinations), and classifying refers to assigning alternatives to non-ordered sets (such as diagnosing patients based on their symptoms), (Hwang and Yoon 1981).

In the case of Multiple-Criteria Design Problems, the alternative solutions are not explicitly known. An alternative solution can be found by solving a mathematical model. The number of alternatives is either infinite or not countable (when some variables are continuous) or typically very large if countable (when all variables are discrete), (Charnes, *et al.,* 1978).Whether it is an evaluation problem or a design problem, preference information of DMs is required in order to differentiate between solutions. The solution methods for MCDM problems are commonly classified based on the timing of preference information obtained from the DM.

There are different methods that require the DM's preference information at the start of the process, transforming the problem into essentially a single criterion problem. These methods are said to operate by "prior articulation of preferences." Methods based on estimating a value function or using the concept of "outranking relations," analytical hierarchy process, and some decision rule-based methods try to solve multiple criteria evaluation problems utilizing prior articulation of preferences. Similarly, there are methods developed to solve multiple criteria design problems using prior articulation of preferences by constructing a value function. Perhaps the most well-known of these methods is goal programming. Once the value function is constructed, the resulting single objective mathematical program is solved to obtain a preferred solution, (Charnes, *et al.,* 1978).Some methods require preference information from the DM throughout the solution process. These are referred to as interactive methods or methods that require "progressive articulation of preferences,(Hwang and Yoon 1981).

Multiple criteria design problems typically require the solution of a series of mathematical programming models in order to reveal implicitly defined solutions. For these problems, a representation or approximation of "efficient solutions" may also be of interest. This category is referred to as "posterior articulation of preferences," implying that the DM's involvement starts posterior to the explicit revelation of "interesting" solutions.The MCDM problem can be

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represented in the criterion space or the decision space. Alternatively, if different criteria are combined by a weighted linear function, it is also possible to represent the problem in the weight space, (Hwang, and Yoon, 1981).

2.3. Multi-Criteria Analysis

All multi-criteria analysis (MCA) approaches make the options and their contribution to the different criteria explicit, and all require the exercise of judgement. They differ, however, in how they combine the data and information. Formal MCA techniques usually provide an explicit relative weighting system for the different criteria, (Charnes, *et al.,* 1978). The main role of the techniques is to deal with the difficulties that human decision-makers have been shown to have in handling large amounts of complex data and information in a consistent way.MCA techniques can be used to identify a single most preferred option, to rank options, to short-list a limited number of options for subsequent detailed appraisal, or simply to distinguish acceptable from unacceptable possibilities.As is clear from a growing literature, there are many MCA techniques and their number is still rising. There are several reasons why this is so: [1] there are many different types of decisions which fit the broad circumstances of MCA; [2] the time available to undertake the analysis may vary; [3] the amount or nature of data available to support the analysis may vary; [4] the analytical skills of those supporting the decision may vary, and [5] the administrative culture and requirements of organisations vary. Multi-criteria analysis establishes preferences between options by reference to an explicit set of objectives that the decision making body has identified, and for which it has established measurable criteria to assess the extent to which the objectives have been achieved. In simple circumstances, the process of identifying objectives and criteria may alone provide enough information for decision-makers.

3.0. Theoretical Multidimensional Tourism Carrying Capacity Model

3.1. Multidimensional Carrying Capacity Systems

Tourism carrying capacity (*or capacity tout court)*is a multifaceted and multidimensional concept,(JérômeMassiani and Giovanni Santoro, 2012). Middleton and Hawkins (1998) define carrying capacity as a measure of the limit beyond which an area may suffer from the adverse impacts of tourism. Chamberlain (1997) defines it as the level of human activity an area can accommodate without the area deteriorating, the resident community being adversely affected, or the quality of visitors experience declining. Clark (1997) and Frederic (2021) define carrying capacity as a certain threshold level of tourism activity beyond which there will be damage to the environment, including natural habitats

World Tourism Organization defined tourism carrying capacity as "the maximum number of persons which could visit a location within a given period, such that local environmental, physical, economic, and socio-cultural characteristics are not compromised, and without reducing tourist satisfaction, (WTO, 1999). The tourism carrying capacity may entail the maximum abundance of species,(e.g., tourists, locals) that can be sustained within a given habitat (e.g., tourist destinations, common places and attractions), (Lohmann and Panosso, 2017). When an ideal population is in equilibrium with the carrying capacity of its environment, net flows; the

birth and death rates are equal, and size of the population does not change, (Castellani *et al*, 2007). Populations larger than the carrying capacity are not acceptable, sustainable, and will degrade their habitat. In nature, however, neither carrying capacity nor populations are ideal; both vary over time for reasons that may be complex and in ways that may be difficult to predict. This suggests the use of the Multiple-criteria decision-making (MCDM) or multiple-criteria decision analysis, (MCDA) in analyzing tourism carrying capacity.

When identifying carrying capacities for tourism using the Multidimensional Tourism Carrying Capacity Model (MTCCM), the subsystems will depict territorial characteristics and external influences on the specific territory have to be identified and captured,(JérômeMassiani and Giovanni Santoro, 2012). These MTCCMissues include [1] tourism intensity and concentration in territorial terms and in time; [2] tourism flows into and within the destinations and the consequences in terms of causal loops that refer to user conflicts and the opportunity costs connected to them – on the territorial conditions of the destination – in economic, political, social and environmental terms, (ESPON EGTC, 2020).

It is noted that MTCC system is never simple and static. It varies over time and space in response to complex environmental changes, perhaps associated with climatic change, technological development or the successional development of ecosystems. More rapid changes in carrying capacity may be caused by disturbances of the habitat occurring because of a rains, fire or windstorm, or because of a human influence such as over fishing, pollution, or the introduction of a non-native competitor, predators, or diseases. Carrying capacity can also be affected by overpopulation, which leads to excessive exploitation of resources and a degradation of the habitat's ability to support the species. Of course, birth and death rates of a species must respond to changes in carrying capacity along with changes in other factors, such as the intensities of disease or predation. The collection of all such dimensional state vectors at a point constitutes the total state vector at the point. The following sections 3.2 – 3.7 suggest that the notion of carrying capacity is inclusive and multidimensional in the context including economic, ecological, social, culture, heritage and political systems and fact that, for all species, there are environmental limitations to the sizes of human populations that can be sustained, (Castellani*et al*, 2007).

3.2.Economic Carrying Capacity

The *first* MTCCMcomponent or subsystem the "economic", or "engineering" or "technical" definition, according to which potential output represents the maximum amount of output that can be produced in the short run with the existing stocks of inputs such as capital equipment, machineries and technologies. Thus, a standard definition of economic capacity utilization is the (weighted) average of the ratios between the actual output of firms and the maximum that could be produced per unit of time, with existing inputs. Output could be measured in physical units or in market values, but normally it is measured in market values. However, as output increases and well before the absolute physical limit of production is reached, most firms might well experience an increase in the average cost of production—even if there is no change in the level of equipment used.

The MTCCM considers that the biophysical properties of a finite earth and the realities of economic inputs, transformationsand outputs determining the economic carrying capacity of our societies, (Castellani*et al*, 2007). The most widely used concept of capacity is the maximum potential production of an output or group of outputs by a producing unit, firm, or industry, given technology, capital stock and other factors of production. To optimally utilize a capacity constrained integrated industrial systems, based on the group technology concept, loading and scheduling models for optimal utilization of the processing capabilities of an integrated manufacturing system consisting of a set of heterogeneous workstations are developed. In these models either the maximum tardiness or the make span is minimized while; the total production quantity of each part or product type equals the total demand quantity during the planning time horizon; each part requires a single aggregated stage of operation; job splitting is allowed; and the processing priorities of all the jobs during the planning time horizon is specified based on a desirable arbitrary dispatching rule.

Economic carrying capacity takes the form of maximum social global welfare derivable from the sustainable throughput activities and flows of the ecosphere. These are fleshed out by development of a welfare return curve plotted as a function of economic scale; the latter is measured by entropic throughput. The primary thrust of the argument is that not only are economic scales that exceed throughput sustainability definitionally impossible to maintain in the long run, but because of declining welfare, they are not even desirable in the short run.

In tourism sector, economic carrying capacity is the threshold limit (capacity) beyond which tourism growth becomes economically unacceptable; this situation may rise from two conditions: a) when tourism businesses interfere with other social economic activities obstructing their development, b) when the presence of a great number of tourists makes the destination no more desirable, comfortable and attractive and causes a contraction in tourism demand, (Leonard J. Lickorish and Carson L. Jenkins, 1997 and Lohmann and Panosso, 2017). Important variables and indicators measuring economic carrying capacity include; E_1=Economic revenues, e.g., export earnings, GDP, government revenues from the tourism sector; E_2=Number, types and quality of tourists in a given time; E_3=Tourism infrastructure systems and facilities, e.g. accommodations & transportation, E_4= Human Resource Capacity, employment in particular youth and female gender employment, *and*E_5= Tourism images and attractions.

3.3.Ecological Carrying Capacity

The *second*MTCCMcomponent is the ecology. In ecology, carrying capacity is defined as a 'species' average population size in a particular habitat and particular time. The species population size is complex function and limited by environmental factors,needs and requests, (Xiangrong Yan, 2022). If these needs are not met and satisfied, then the population will decrease until the resource rebounds. Carrying capacity of individuals that an environment / nature can sustain over time without destroying or degrading the environment, is determined by a few key factors such as food availability, air, water, and space. These natural or ecological limiting factors can be further broken down into abiotic or biotic limiting factors.

Abiotic factors are non-living physical and chemical elements in the ecosystem, such as sunlight, temperature, soil, water, and oxygen. Biotic factors are living or once-living organisms in the

ecosystem, such as food, disease, and predators. In tourism sector, ecological carrying capacity is the maximum use that the biota or the physical processes of an area can withstand before becoming unacceptably and or irreversibly damaged. As any use of an ecosystem induces change, the decision as to what level of use will cause unacceptable change is to a large extent subjective. For example, when talking about the physical or ecological type, it means the acceptable level of mass in places like parks, city streets, forests, swimming pools, forests, etc. When the tourism population is at carrying capacity, there is no fluctuation in the entry and or exits rates. We can also look at factors that determine ecological carrying capacity in terms of their density-dependence. Density-dependent limiting factors make the per capita growth rate decrease as thepopulation increases. Density-dependent limiting factors tend to be biotic, including factors such as food and disease. As such, the per capita growth rate of the panther population may shrink or level off.

Density-independent limiting factors are factors that affect the per capita growth rate regardless of how dense a population is and include factors such as a flood, drought and habitat destruction. While food and water supply, habitat space, and competition with other species are some of the limiting factors affecting the carrying capacity of a given environment, in human populations, other variables such as sanitation, diseases, and medical care are also at play. Often, some variables are not equitably distributed among human populations with some consuming more than others, and with affluence on the rise globally, human carrying capacity is neither static nor easy to calculate, (Lohmann and Panosso, 2017).

In tourism sector, the natural, physical (or ecological) carrying capacity is the threshold limit beyond which nature of a destination are damaged by tourism. Physical carrying capacity of a destination is thence determined through the analysis of its environmental components (for example, tourism resources quantity and availability, water quantity and quality, limits for air pollutants concentrations) and through the analysis of the facilities required by both tourists and residents: saturation limits for existing facilities (for example, sewage treatment plants, waste treatment plants) and limits for new facilities construction, (Norbert Vanhove, 2005 and (Xiangrong Yan, 2022).Important variables and indicators measuring ecological (natural environment) carrying capacity will includeN_1=air quality,N_2=water quantity and quality,N_3= sanitation, sewage treatment plants, waste treatment plants,N_4=forestry, fisheries, animals and vegetation, *and* N_5=land, infrastructure, beaches, sand and soil quantity and quality.

3.4.Social Carrying Capacity

The *third*MTCCM component is the social carrying capacity. In the tourism sector, the social carrying capacity (SCC) is defined as the optimal levels of consumption that can be absorbed by an area without an unacceptable decline in the quality of the visitor experience and /or without an unacceptable negative impact on the community in the area, (Leonard and Carson 1997 and Mohamad; *et al* 2021).The SCC is the level of use for a given site, beyond which the users' quality of experience decreases or is no longer acceptable. The two subcomponents of SCC are (i) the acceptable quality of visitor experience before seeking alternative destinations (i.e. the ability to carry tourist psychology) and (ii) the level of tolerance of the host population to the presence of tourists (i.e. the psychological carrying capacity of the population). From Zanzibar point of view social carrying capacity is the threshold beyond which social aspects of the host communities are badly influenced and damage by tourism activities and life's quality of residents

is no more granted; this situation may also lead to conflicts between tourists and resident populations, generating social tensions, (Lohmann and Panosso, 2017).

SCC issues consist of various complex sentiment or attitude indicators related with such as encounters, congestions, conflicts, noises and satisfactions, (Mohamad; *et al* 2021). In many cases evaluations describe the subjective count of the number of others seen by the individual assessments, the level of congestion is a negative subjective assessment of the number of people observed or the number of gatherings with others, groups or activities too many. Both of these values are highly subjective and depend on the number of people consulted, interviewed and the results can be completely biased and the report cannot reveal the maximum acceptable level of use.

The paper considers the SCC of a tourist site as indicator of residents' visitors' perception of crowding, intended as the maximum number of visitors (MNV) tolerated. In case of conflict between the residents' MNV tolerated and the visitors' MNV tolerated, the policy-makers have to mediate.We consider the case in which the residents' SCC(r) is lower than the visitors; SCC(v), and the site SCC(s) is the result of a compromise between these two aspects of the SCC. This can be measured by making reference to two criteria of choice: the utility maximization criterion and the voting rule, (Mohamad; *et al* 2021). The use of one method rather than the other depends on the data and information available about the community or individual preferences on crowding. Assuming that individual preferences are known, a maximization model for the computation of the site SCC(s) is conceived. It represents the case in which the residents' SCC(r) is the limiting factor.

Because a local policy-maker maximizes the welfare of residents, in this model visitors are represented by those residents whose welfare wholly depends on the tourism sector, while the social costs due to crowding are borne by those residents who are partially or totally independent from tourism, (Mohamad; *et al* 2021). Nevertheless, in practice, the individual preferences about crowding are not always known. In this case, the MNV tolerated can be computed by applying the majority voting rule. It is shown that, under certain conditions, the optimum number of visitors, obtained through a maximization model, is equal to the MNV tolerated by the majority of voters.Important variables and indicators measuring social carrying capacity will includeS_1= acceptable quality of visitor experience,S_2= level of tolerance of the host families, communities and population,S_3= level of tolerance of the religious leaders,S_4=state or government institutional systems, andS_5=level of tolerance of the global tourist organizations, agencies.

3.5.Culture Carrying Capacity

The *fourth*MTCCMcomponent or subsystem is culture. Culture is an umbrella term which encompasses the social behaviour, institutions, and norms found in human societies, as well as the knowledge, beliefs arts, laws, customs, capabilities and habits of the individuals and groups. Culture is often originated from or attributed to a specific region or location. Humans acquire, adopt, and change culture through travelling, movements and learning processes of enculturation and socialization, which is shown by the diversity of cultures across societies. Additionally, cultural ideas may transfer from one society to another, through diffusion or

acculturation. In diffusion, the form of something (though not necessarily its meaning) moves from one culture to another. Stimulus diffusion" (the sharing of ideas) refers to an element of one culture leading to an invention or propagation in another. "Direct borrowing," on the other hand, tends to refer to technological or tangible diffusion from one culture to another

A cultural norm codifies acceptable conduct in society at certain particular point of time; it serves as a guideline for behavior, dress, language, and demeanor in a situation, which serves as a template for expectations in a social group. Accepting only a monoculture in a social group can bear risks, just as a single species can wither in the face of environmental change, for lack of functional responses to the change. In the practice of religion, analogous attributes can be identified in a social group.

Cultural change, or repositioning, is the reconstruction of a cultural concept of a society. Cultures are internally affected by both forces encouraging change and forces resisting change. There are different ways in which cultural change can be brought about, including growth, movements, development, evolution, involution, renovation, reconception, reform, innovation, revivalism, revolution, and other ways. Cultures are externally affected via contact between societies such as through tourism. Many countries including Zanzibar and UNESCO attempt to preserve culture universal and cultural heritage. Cultural universal are found in all human societies. These include expressive forms like art, music, ritual, dance, religion, and technologies like tool usage, cooking, shelter and clothing. The concept of material culture covers the physical expressions of culture, such as technology, architecture and art, whereas the immaterial aspects of culture such as principles of social organization (including practices of political organization and social institutions), mythology, philosophy, literature (both written and oral), and science comprise the intangible culture heritage of a society.

When used as a count noun, a "culture" is the set of customs, traditions, and values of a society or community, such as an ethnic group or nation. Culture is the set of knowledge acquired over time. In this sense, multiculturalism values consisting of peaceful coexistence and mutual respect between different cultures inhabiting in Zanzibar. Important variables and indicators measuring cultural carrying capacity will include; C_1=Social behaviour, institutions (e.g. family and friendship relationships) and norms; C_2= Changes in cultural practices,C_3= Islamic norms and practices,C_4= Cultural universal (e.g.; art, music, ritual and taarab dance); $andC_5$= Multiculturalism values including peaceful coexistence and mutual respect.

3.6.Heritage Carrying Capacity

The *fifty* MTCCMcomponent or subsystem is heritage. Tourists visiting heritage cultural and historical resources is one of the largest, most pervasive, and fastest growing sectors of the tourism industry in Zanzibar. Heritage consists of tangible and intangible heritage assets of a group or society orcountry that is inherited, owned, managed and enjoyed from the past generations(Timothy, 1997, Timothy and Boyd, 2003 and González and Medina, 2003). Not all heritages of past generations are "heritage"; rather, heritage is a product value of selection by society.The deliberate act of keeping cultural heritage from the present for the future is known as preservation or conservation, (Timothy, 1997).Aspects and disciplines of the preservation and

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conservation of tangible culture include museology, archival science, conservation; art conservation; archaeological conservation; architectural conservation; film preservation; phonograph record preservation and digital preservation. Preserved heritage has become an anchor of the global tourism industry, a major contributor of social economic value to local communities, (Timothy and Boyd, 2003 and González and Medina, 2003).

People visit heritage places to enhance learning, satisfy curiosity and feelings of nostalgia, grow spiritually, relax, get away from home, spend time with loved ones, or "discover themselves", (Timothy, 1997). Heritage properties include the physical or "tangible" cultural heritage, such as artworks. These tangible" cultural heritagesare generally split into two groups of movable and immovable heritage. Immovable heritage includes buildings (which themselves may include installed art such as organs, stained glass windows, and frescos), large industrial installations, residential projects or other historic places and monuments. Moveable heritage includes books, documents, moveable artworks, machines, clothing, and other artifacts, that are considered worthy of preservation for the future. These include objects significant to the archaeology, architecture, science or technology of a specified culture.

Intangible heritage consists of non-physical aspects of a particular culture, more often maintained by social customs during a specific period in history. This includes the ways and means of behavior in a society, and the often formal rules for operating in a particular cultural climate. These may include social values and traditions, customs and practices, aesthetic and spiritual beliefs, artistic expression, language and other aspects of human activities. The significance of physical artifacts can be interpreted as an act against the backdrop of socioeconomic, political, ethnic, religious and philosophical values of societies.

"Natural heritage" is also an important part of a society's heritage, encompassing the countryside and natural environment, including flora and fauna, scientifically known as biodiversity, as well as geological elements (including mineralogical, geomorphological, paleontological, etc.), scientifically known as geodiversity. These kinds of heritage sites often serve as an important component in a country's tourist industry, attracting many visitors from abroad as well as locally. Heritage can also include cultural landscapes (natural features that may have cultural attributes). Aspects of the preservation and conservation of natural heritage include rare breeds; conservation and heirloom plants.

Important variables and indicators measuring heritage carrying capacity will include $H_1=$ Tangible culture (museology; archival science, art conservation),$H_2=$ Cultural intangibles (e.g., folklore and oral history),$H_3=$ Swahili language preservation, $H_4=$ Natural heritage (e.g., rare breeds; conservation and heirloom of plants),$H_5=$Digital heritage (e.g. physical objects such as documents which have been digitized for retention and artifacts).

3.7.Political Carrying Capacity

The *sixth*MTCCMcomponent or subsystem is politics. Politics is the set of social economic systemic ideas, issues and aspects associated with policy making decision systems in groups, countries, states or other forms of power relations among individuals and nationals, such as the

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setting and distribution of resources, sectors or actors. These may be used positively in the context of a "political solution" which is compromising and nonviolent, or descriptively as "the art or science of government", but also often carries a negative connotation. The political system can be designated as the interactions through which values are authoritatively allocated for a society. Each political system is embedded in a society with its own culture, heritage, social and they in turn shape their societies through public policy. The interactions between different political systems with states are the basis for global politics and major determinants for sustainable economic development. The political governance is the manner in which state power is exercised in the management of a country's economic and social systems and resources for sustainable development.

Political carrying capacity is the optimal ability of state systems to mobilize and utilize resources from a population given their levels of social economic development. Efficient and effective state systems are able to meet or exceed their desiredinstitutional capabilities and inefficient governments may fail to reach their expected extraction levels. This measure of efficiency also represents the ability of a political system to implement a set of policy choices (e.g., tourism policies) politically capable governments will be able to change or influence policy-pursuing their political and economic goals while preserving tourism sector development and stability.

State carrying capacity is the level of government ability to govern and accomplish policy goals, either generally or in reference to specific aims. A state that lacks governance capacity is defined as a fragile state or, in a more extreme case, a failed state. Higher state capacity has been strongly linked to long-term economic development, as state capacity can establish law and order, private property rights, and external defense, as well as support development by establishing a competitive market, transportation infrastructure, health and mass education. States must be able to create the [1] political space to address the extent to which the necessary coalitions or political settlements and solutions can be attained; [2] resource mobilization capacity to generate resources for investment and social development and [3] allocate resources to productive and welfare-enhancing sectors.

Good political capacity and governance indicate how public institutions conduct affairs and manage resources and guarantee the realization of all forms of rights in a manner essentially free of abuse and corruption and with due regard for the rule of law. The good political governance within the democratic institutions creates avenues for all to participate in policymaking either through formal institutions or informal consultations. They also establish mechanisms for the inclusion of multiple social groups in decision-making processes, especially locally. Important variables and indicators measuring political carrying capacity include; P_1= Government or State Capacity and tolerance, P_2= Democratic Institutions and Political Freedoms; P_3= Efficient Public Service Delivery, P_4= Peace, Health, Safety and Security, $and P_5$= Cross cutting policy issues such as poverty reduction, anti-corruption and gender policy measures.

4.0.Multidimensional Tourism Carrying Capacity Model

4.1.The Formal Multidimensional Tourism Carrying Capacity Model

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There are various measuring methods and approaches of the tourism carrying capacities. For measuring carrying capacity, single (*simple*) and multiple (*complex*) approaches have been proposed and developed in several contexts, which served as an inspiration for the development of the methodology at hand, (Lohmann and Panosso, 2017 and ESPON EGTC, 2020). Given that any tourism activity impacts a destination, there has been later a shift in the understanding of thesesystemic concepts, including socio-cultural systems, activities and parameters as to how much impact is acceptable in relation to the conditions of an area at a particular point of time.

This paper has the view that there is no single component, subsystem, determinant or and denominator for carrying capacity – a multitude of aspects in the socio-economic context of destinations are required, identified, reviewed and suggested, (Castellani*et al*, 2007 and Frederic, 2021). The carrying capacity is strongly related to the various dimensions of sustainability and its conceptual components (e.g., economy, society and the environment). There are several ways of capturing the carrying capacity along the different dimensions (social, economic and environmental). This paper proposes to use the Multidimensional Tourism Carrying Capacity (MDTCC) Model.That is, the MDTCC model is the best methodological approachesallowing different and interdependent components and ways of assessing normative borders for tourism carrying capacities, (ESPON EGTC, 2020).

4.2.Multidimensional Tourism Carrying Capacity Policy Variable

The paper considers the Multidimensional Tourism Carrying Capacity (*MDTCC*), as a policy target variable. Let us define the overall*TCC*variable as a complex function of six interdependent policy dimensional variables, components or subsystems variables within the MDTCC Model, namely, [1] Economy, (*E*), [2] Ecology or Nature, (*N*), [3] Social, (*S*), [4] Culture, (*C*); [5] Heritage, (*H*) and Political (*P*). These independent components or subsystems are complex functions of endogenous, exogenous factors parameters, and series of pre-outcomes. The paper suggests optimal *MDTCC*structures and outcomes pathway as a set of desired conditions relevant to a given field of action, which are placed diagrammatically in logical relationships to one another, connected and that posit causality, (Denise and Pavol, 2014). Outcomes along the MDTCC systems are also preconditions to outcomes above them. Thus, early outcomes must be in place for intermediate outcomes to be achieved; intermediate outcomes must be in place for the next set of outcomes to be achieved; and so on. An outcome solutiontherefore represents the change logic and its underlying set of conditions and assumptions, which are spelled out in the rationales given for why specific connections exist between outcomes and in the theory narrative.We formalize theMDTCC model whereby we define overall or total *TCC*target policy variable as a linear function of variables *E, N, S, C, H* and *P as follows;*

1      $TCC = \omega_1 E + \omega_2 N + \omega_3 S + \omega_4 C + \omega_5 H + \omega_6 P$

$$TCC = w_1 E + w_2 N + w_3 S + w_4 C + w_5 H + w_6 P \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.1$$

Whereby we define,
TCC as overall tourism carrying capacityvariable as simple and linear function of;
E is economic carrying capacity,
N as ecological or natural environment carrying capacity,
S as social carrying capacity,

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C as cultural carrying capacity
H as heritage carrying capacity, *and*
P as political carrying capacity.

Whereby the generalparameters and weights defined and restricted as follows:

$$0 \leq \varpi_i \leq 1 \quad whereby \quad \sum_{i=1}^{n} \varpi_i = 1$$

4.3. Economic Carrying Capacity, (*E*)

Economic carrying capacity is the threshold limit (capacity) beyond which tourism growth becomes economically unacceptable; this situation may rise from two conditions: a) when tourism businesses interfere with other social economic activities obstructing their development, b) when the presence of a great number of tourists makes the destination no more comfortable and attractive and causes a contraction in tourism demand, (Lohmann and Panosso, 2017).

$$2 \quad E = \omega_{11}E_1 + \omega_{12}E_2 + \omega_{13}E_3 + \omega_{14}E_4 + \omega_{15}E_5$$

Whereby this first subsystem or components include;

E as Economic carrying capacity defined as a linear and simple fuction of;
E_1=Economic revenues, e.g., export earnings, government revenues from the tourism sector
E_2=Number, type and quality of tourists in a given time,
E_3=Tourism infrastructure systems and facilities, e.g. accommodations & transportation,
E_4= Human resource capacity, employment in particular youth and female gender employment, *and*
E_5= Tourism images and attractions.

Whereby the specific parameters and weights defined and restricted as follows

$$0 \leq \varpi_{ij} \leq 1 \quad whereby \quad \sum_{i=1}^{n} \varpi_{ij} = 1$$

4.4. Natural, Physical (Or Ecological) Carrying Capacity

Natural, physical (or ecological) carrying capacityis the threshold limit beyond which nature of a destination are damaged by tourism. Physical carrying capacity of a destination is thence determined through the analysis of its environmental components (for example, tourism resources quantity and availability, water quantity and quality, limits for air pollutants concentrations) and through the analysis of the facilities required by both tourists and residents: saturation limits for existing facilities (for example, sewage treatment plants, waste treatment plants) and limits for new facilities construction, (Norbert Vanhove, 2005).

$$3 \quad N = \omega_{21}N_1 + \omega_{22}N_2 + \omega_{23}N_3 + \omega_{24}N_4 + \omega_{22}N_5$$

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Whereby this second subsystem or component is dedefined to include;
N_1=air quality,
N_2=water quantity and quality,
N_3= sanitation, sewage treatment plants, waste treatment plants,
N_4=forestry, fisheries, animals
N_5=land, infrastructure, beaches, sand and soil quantity and quality

Whereby the specific parameters and weights defined and restricted as follows;

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

4.5. Social Carrying Capacity

The social carrying capacity (SCC) is defined as the maximum level of consumption that can be absorbed by an area without an unacceptable decline in the quality of the visitor experience and without an unacceptable negative impact on the community in the area. The two components of SCC are (i) the acceptable quality of visitor experience before seeking alternative destinations (i.e. the ability to carry tourist psychology) and (ii) the level of tolerance of the host population to the presence of tourists (i.e. the psychological carrying capacity of the population).

$$4 \qquad S = \omega_{31}S_1 + \omega_{32}S_2 + \omega_{33}S_3 + \omega_{34}S_4 + \omega_{35}S_5$$

Whereby this third subsystem or component include;

S= the overall social carrying capacity
S_1= acceptable quality of visitor experience,
S_2= level of tolerance of the host families, communities and population,
S_3= level of tolerance of the religious leaders,
S_4=state or government institutional systems such as the ZTC
S_5=acceptable quality and level of tolerance of the global tourist organizations and agencies

Whereby the specificparameters and weights defined and restricted as follows

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

4.6. Culture Carrying Capacity

When used as a count noun, a "culture" is the set of customs, traditions, and values of a society or community, such as an ethnic group or nation. Culture is the set of knowledge acquired over time. In this sense, multiculturalism values consisting of peaceful coexistence and mutual respect between different cultures inhabiting in Zanzibar.

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5 $\quad C = \omega_{41}C_1 + \omega_{42}C_2 + \omega_{43}C_3 + \omega_{44}C_4 + \omega_{45}C_5$

Whereby this fourth subsystem or component include;

C= overall cultural carrying capacity
C_1= Social behaviour, institutions (e.g. family and friendship relationships) and norms
C_2= Changes in cultural practices,
C_3= Islamic norms and practices,
C_4= Cultural universal (e.g.; art, music, ritual and taarab dance); and
C_5= Multiculturalism values including peaceful coexistence and mutual respect

Whereby the specific weights for this variable are defined and restricted as follows:

$$0 \leq \varpi_{ij} \leq 1 \quad \textit{whereby} \quad \sum_{i=1}^{n} \varpi_{ij} = 1$$

4.7. Heritage Carrying Capacity

Zanzibar heritage is what the country has inherited from the past, to value and enjoy in the present, and to preserve and pass on to future generations. Zanzibar heritage comprises of: the tangible - our historical sites, buildings, monuments, objects in museums, artefacts and archives. It is something that is handed down from the past, as a tradition: a national heritage of honor, pride, and courage. It is something that comes or belongs to one by reason of birth; an inherited lot or portion: a heritage of poverty and suffering

6 $\quad H = \omega_{51}H_1 + \omega_{52}H_2 + \omega_{53}H_3 + \omega_{54}H_4 + \omega_{55}H_5$

Whereby this fifth subsystem or component include;

H=overall heritage carrying capacity
H_1= Tangible culture (museology; archival science, art conservation),
H_2= Cultural intangibles (e.g., folklore and oral history),
H_3= Swahili language preservation
H_4= Natural heritage (e.g., rare breeds; conservation and heirloom of plants),
H_5=Digital heritage (e.g. physical objects such as documents which have been digitized for retention and artifacts)

Whereby the specific parameters and weights defined and restricted as follows

$$0 \leq \varpi_{ij} \leq 1 \quad \textit{whereby} \quad \sum_{i=1}^{n} \varpi_{ij} = 1$$

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4.8. Political Carrying Capacity

Politics is exercised on a wide range of social economic entities, levels, from clans and tribes of traditional societies, through modern local governments, companies and institutions up to sovereign states, to the international level. *Political carrying capacity tells us about the ability and capability of national systems, actors and entities to ensure attainment of good social and economic governance.*

$$7 \qquad P = \omega_{61}P_1 + \omega_{62}P_2 + \omega_{63}P_3 + \omega_{64}P_4 + \omega_{65}P_5$$

Whereby this sixth subsystem or component include;

P= Overall political carrying capacity
P_1= Government or State Capacity
P_2= Democratic Institutions and Political Freedoms
P_3= Efficient Public Service Delivery
P_4= Peace, Health, Safety and Security
P_5= Cross cutting policy issues such as Poverty Reduction, Anti-corruption and Gender policy measures

Whereby the specific parameters for this variable and weights defined and restricted as follows

$$0 \leq \varpi_{ij} \leq 1 \qquad whereby \qquad \sum_{i=1}^{n} \varpi_{ij} = 1$$

4.9. The MTCC Model Determination and Solution

Box 1 presents the formal theoretical MDTCC Model. The analytical *MDTCC* model is determined according to mathematical modelling rules since we have seven relations; 1 - 7, to determine the values of seven endogenous variables *TCC, E, N, S, C, H,* and *P* as policy target variables. In turn these determine the overall tourism carrying capacity as vital to ensure a balance between achieving optimal tourism development without compromising the delicate environmental and social structure of the nation, i.e., sustainable tourism development that is environmentally, socially and economically acceptable or tourism development within the carrying capacity. That is, the government needs to ensure that a balance is maintained between the number and activities of tourism and the capacity of the resources system to support activities without impairment, degradation or depletion of the resources that make development possible, (ESPON EGTC, 2020).

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Box 1: Formal Quantitative Multidimensional Tourism Carrying Capacity Model

1    $TCC = \omega_1 E + \omega_2 N + \omega_3 S + \omega_4 C + \omega_5 H + \omega_6 P$

2    $E = \omega_{11}E_1 + \omega_{12}E_2 + \omega_{13}E_3 + \omega_{14}E_4 + \omega_{15}E_5$

3    $N = \omega_{21}N_1 + \omega_{22}N_2 + \omega_{23}N_3 + \omega_{24}N_4 + \omega_{22}N_5$

4    $S = \omega_{31}S_1 + \omega_{32}S_2 + \omega_{33}S_3 + \omega_{34}S_4 + \omega_{35}S_5$

5    $C = \omega_{41}C_1 + \omega_{42}C_2 + \omega_{43}C_3 + \omega_{44}C_4 + \omega_{45}C_5$

6    $H = \omega_{51}H_1 + \omega_{52}H_2 + \omega_{53}H_3 + \omega_{54}H_4 + \omega_{55}H_5$

7    $P = \omega_{61}P_1 + \omega_{62}P_2 + \omega_{63}P_3 + \omega_{64}P_4 + \omega_{65}P_5$

On the practical level, the government wishes sustaining benefits to local communities, private sector enterprises and tourists, and destination Zanzibar in general because it gives guidance on tourism planning and it set the maximum number of tourists visiting Zanzibar led to saturation and, in turn, results in a poorer quality of tourist experience.

5.0.Indicative Empirical MDTCC Model Arrangement, Approaches and Processes

The paper proposes to the RGoZ to use the MDTCC Model to quantify, qualify and determine the tourism carrying capacity of Zanzibar as a vital development policy issue to ensure a balance between achieving optimal tourism development without compromising the delicate environmental and social structure of the nation, i.e., sustainable tourism development which refers to tourism that is environmentally, socially and economically acceptable or tourism development within the carrying capacity, (Jérôme Massiani and Giovanni Santoro, 2012).

The Zanzibar policy researchers may adopt a simple quantitative framework that has been known to provide guidelines for conducting a comprehensive and reliable evaluation of the MDTCC model. The paper proposes to use an evaluative scoring method. Evaluative scoring is the process of combined evaluation research and awarding numbers (usually), or symbols to represent the level of performing entities (e.g., qualitative views on the tourist firms performances at different stages) (Swift, 2006). The most common method is by adding up the

number of correct answers on an evaluation, and assigning a number that correlates to respective performances. Higher numbers reflect optimal tourism carrying capacity levels. As a rule, marking applies to entity level oftourism carrying capacity levels, not to overall achievement in a course, (Swift, 2006).

The government research team may conduct field evaluation survey(s) for assessment, territorial evidence and visualizations in Zanzibar to establish the current tourism development status with regards to a number of key environmental, social, cultural, and economic indicators, (Sharma, 2016). The field research team may use different data and information collection methodologies and approaches to obtain necessary baseline data on the tourism sector in Zanzibar.

They may collect, combine and integrate secondary or existing tourism sector and service research reports, findings, results and or design and conduct specific field research surveys. The technical team may conduct field surveys consultations, stakeholder's analysis, focus group discussions, in-depth interviews and meetings with key selected implementing agencies and stakeholders. The main study research method may include non-experimental, classical or rapid appraisal methods involving consultations and interviewing many stakeholders at every levels and time. Both structured or non-questionnaires may be used to collect more quantifiable data and information. It is important to interview and consult all important stakeholders, representatives, leaders and key individuals on key issues.

The main policy researchers may evaluate the analyze data and information and then project and suggest growth scenarios based on the model, (Jérôme Massiani and Giovanni Santoro, 2012 and Sharma, 2016). The advantages and disadvantages of each scenario and provide tentative views with a strategic tourism policy direction that supports the high value, low impact tourism sector is striving for. The collected data and information may be analyzed using generic computer softwares including Statistical Package for Social Science (SPSS), STATA and MS Excel.

Data and policy analysis will involve statistical investigations of performances or behaviour of endogenous or policy target variables [1] Economy, (*E*) [2] Ecology or Nature (*N*), [3] Social (*S*), [4] Culture (*C*); [5] Heritage, (*H*) and Political (*P*) during the sample period or over time (Chiang, 1984). The policy researchers may conduct data and policy analysis. *Analysis of data* is a process of inspecting, cleansing, transforming and modelingdata with the goal of discovering useful information, suggesting conclusions, and supporting decision-making.

The quantitative MDTCC Model considers both stock and flow variables as measuring indicators of tourism carrying capacity levels. That is, the time derivative of a flow variable is used to measure performances of endogenous variables determined in this model. The growth rate of (*TCC*) is the time derivative of the flow of output divided by output itself. We will distinguish between quantities that are stocks and those that are flows. These differ in their units of measurement (Glenn, 1987). A *stock* variable is measured at one specific time, and represents a quantity existing at that point in time, which may have accumulated in the past. A *flow* variable is measured over an interval of time. Therefore, a flow would be measured *per unit of time* (say a year). Flow is roughly analogous to rate or speed in this sense (Robinson, 1982 and Glenn, 1987). The analyzed data can be presented in tables, graphs and charts followed with report

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writing. Report writing can be based on the data presented in the tables, graphs and charts in order to provide verbal descriptions for the observed findings on the MDTCC model.

6.0. Conclusion

This paper formalized the MDTCC model by determining major variables, assumptions, scope and uses of value for TCC-Studies, (ESPON EGTC, 2020). Also, the paper articulates its corresponding non-parametric quantitative MDTCC model and showed its model determination, use and results of the model. The MDTCC model framework developed in this study is consistent with existing approaches commonly used by public and private organizations to monitor; control and evaluate tourism carrying capacity models. The quantitative model procedures to be adopted in the framework to evaluate each component are based on mathematically valid techniques. These procedures are associated to the four evaluation research phases or activities: input, data collection, data analysis, and reporting.

The proper implementation of these procedures and techniques provides reliable assessments of the tourism carrying capacity. The procedures and techniques adopted are associated to the complete ex-ante and ex-post evaluation monitoring processes, through all stages or phases; from the planning stage through the reporting of results from the data and policy analysis. Robust non-parametric techniques are developed and proposed to address the specific needs in the MDTCC system. The implementation of Quantitative MDTCC has been the most important adopted technique that makes the proposed MDTCC to be very practical and reliable. The proposed framework introduces and presents several contributions to the body of knowledge of Tourism Carrying Capacity Model.

> **Comment [u9]:** The results (model identification) are not related to similar studies to show its feasibility.

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> **Comment [u10]:** Country

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