Engineering Topology of Ecological Model for Orientation Impact of Sustainability Urban Environments: The Spatial-Economic Modeling

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***Abstract*—**The spatial-economic modeling database is crucial in understanding economic network structures for social development. Sustainability within spatial-economic model focuses on encouraging green businesses to align with Earth's systems. The natural exchange patterns of ecosystems exhibit consistent and periodic cycles to maintain energy and material flows in systems ecology. When network topology influences formal and informal communication to function in systems ecology, ecosystems are hypothesized to influence the basic level of spatial sustainable outcomes (i.e., project compatibility success). These referred instrumentalities impact with various aspects of the second level of spatial sustainable outcomes (i.e., participant social security satisfaction). The sustainability outcomes are modeled using composite structure based on a network analysis model to calculate the prosperity of panel databases for efficiency value from 2005 to 2025. The spatial database structure represents the state-of-the-art of value-orientation impact and corresponding complexity of sustainability issues for collecting a consistent database in approach structure of spatial-economic-ecological model, developing a set of sustainability indicators, enabling quantification impact using value-orientation policy and demonstrating spatial structure reliability. The structure of the spatial-ecological model is established for management schemes from the perspective of pollutants of multiple sources through the input–output criteria. These criteria evaluate the spillover effect to conduct Monte Carlo simulations and sensitivity analysis in a unique spatial structure. The balance within "equilibrium patterns," such as collective biosphere features, is measured using a composite index of many distributed feedback flows. This index has a dynamic structure related to physical and chemical properties for gradual prolongation to incremental patterns. While these spatial structures argue from ecological modeling of resource savings, static loads are not decisive model from an artistic/architectural perspective. The model attempts to unify analytic and analogical spatial structure for the development of urban environments in a relational database, using optimization software to integrate spatial structure where the process is based on the engineering topology of systems ecology.

***Keywords*—**Ecological modeling, spatial structure, orientation impact, composite index, industrial ecology.

I. Introduction

VARIATION of spatial-economic conditions within natural phenomena intersects with spatial-ecological models, influencing inflation from a socio-economic systems [1]. The architecture of resources (i.e., natural or man-made) without topological features focuses on urban environments with all dimensions of various terms and culturally invests to cover the three E's of Environment, Economics, and Ecology to sustain social security of industrial systems [2]-[5]. The first spatial theory of economics model is described by J. von Thünen in "The Isolated State in Relation to Industrial and Political Economy" (Thünen, 1826) [6]. Specific graphic model is introduced in the form of seven concentric rings, where each approximate ring is created to include the previous one and indicates the land use around the industrial center along the "free" economy limits. von Thünen described in his model the interaction of three factors of production placement: the products' prices, domestic land use rent, and distance to the export or import market (Thünen, 1826). The main idea of von Thünen is the denial of absolutely advantageous use of land existence to shape environmental conditions within natural, social, and economic limits [7]. The distance from the "center" introduces the extensiveness of urban environments and increases the value of transportation costs. The cost of output per unit includes the market value of resources as approximately the same in all land systems [8], [9].

The spatial-econometric model is a unique econometric model that can be used to determine the spatial relationship between geographical economic units [10], [11]. According to the spatial correlation analysis described in Exploratory Spatial Data Analysis of Regional Development Zone, the regional development efficiency of Industrial Systems is characterized by obvious spatial autocorrelation. Therefore, a spatial econometric model is constructed using the following formulas to evaluate and analyze efficiency of environmental development of Industrial Structure.

1) Spatial lag model (SAR) [12]:

$$y_{it} = \rho \sum_{j=1}^{n} \omega_{ij}\, y_{jr} + \beta x_{it} + \mu_i + \lambda_i + \varepsilon_{ij}$$

2) Spatial error model (SEM) [13]:

$$y_{it} = \beta x_{it} + u_{tt} + \mu_i + \lambda_i$$

$$u_{tt} = \rho \sum_{j=1}^{n} \omega_{ij}\, u_{ij} + \varepsilon_{it}$$

3) Spatial data model (SDM) [14]:

$$y_{it} = \rho \sum_{j=1}^{n} \omega_{ij}\, y_{jt} + \beta x_{it} + \theta \sum_{j=1}^{n} \omega_{ij}\, x_{ij} + \mu_i + \lambda_i + \varepsilon_{it}$$

In the above formulas, y_{it} represents the explained variable of the region i in the period t, the variable x_{it} represents the

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explanatory variable of the dimension matrix 1 × k, the dimension ω_{ij} is the spatial weight matrix, the total errors are ε_{it} and u_{it} represent the random error term in Gaussian model, and the μ_i, λ_i represent the spatial effect of the region i and time effect λ_i, respectively. The described reasons in Exploratory Spatial Data Analysis of Regional Sustainable Development Level Section are used the inverse distance of spatial matrix to construct the spatial econometric model [15].

The spatial econometric model studies economic activity and factors affecting them to be considered as a subfield or method in economics [16]. The model takes approaches to evaluate different topics, including geographic location of industries, economies of agglomeration (i.e., also known as "linkages"), materials transitions between essential physical and chemical variables, transportation, and international trade. The complexity is regarded as the basic characteristics of development real estate, gentrification, ethnic economies, the core-periphery theory, relationship between the environmental economy and urban environments, (e.g., binding communities into a long term of spatial analysis and culture-environment interaction), for simulation [17].

In the spatial econometric of air quality model, ordinary least squares regression is first adopted and the Lagrange Multiplier spatial analysis is performed on the spatial regression analysis in order to determine whether the model exhibited spatial error. The results of the spatial error or the robust spatial error are not significant. However, the two spatial lag models passed the significance level of 0.02, indicating that the general panel regression exhibited a spatial lag effect. Although spatial lag model method is significantly higher than the spatial error model, the spatial lag model is initially constructed with the preliminary regression results as the basis models for spatial autocorrelation and spatial interpolation analyses. The spatial lag model indicates that the selected fixed effects model should be optimality reviewed with regional fixed effects, time fixed effects, and double fixed effects [18]. These system measures of dynamic-service-orientation in systems ecology respond to maintain changes or perturbations to model a certain function (i.e., to regulate system temperature, balance acidity and alkalinity, reduce carbon dioxide emissions and preserve oxygen concentration in ambient air dispersion, etc.). On the micro level, the process or service-orientation is often done through capital regulatory systems such as the hypothalamus in the human body [19]-[24]. These orientations of micro-levels are described behavior of integrated spatial sustainability outcomes to be classified into three main stages to indicate considerable points of social security and economy measures in urban environments as in Fig. 1, [25]-[27]:

1. Sustainability engineering principals.
2. Sustainability science practice.
3. Socio-economic policy.

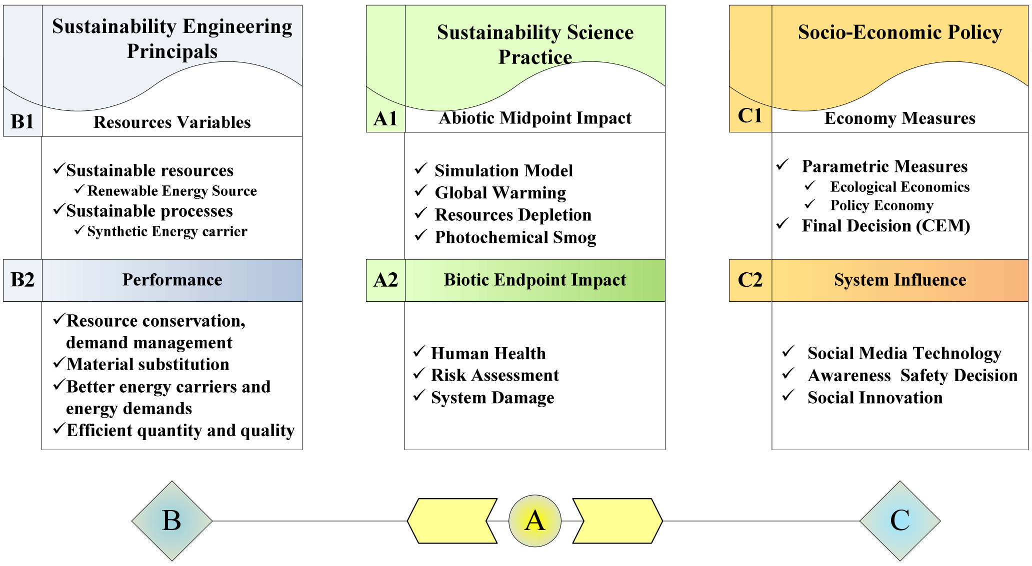

Fig. 1 Coverage of sustainability engineering principals, science practice and socio-economic policy [25]-[27]

Besides conceptual design, systems ecology and its potential address geo-problems in nature; the concept of nature-based solutions are mentioned in the World Bank Portfolio [28]. The concept emerged from the search for innovative solutions to manage natural systems in an attempt to balance the benefits for both nature and society (i.e., the choice between an arch and a composite index, chemical and physical variables of spatial structure in a proper distances and specific heights). These approaches have specific weights to analyze the problem for expressing psycho-physiological concern in the mathematic of computers [29]. These natural-based structures tend to become the most successful model of integrated process and pattern design, as in "algebraic topology" [30]-[32].

Sustainability outcomes are known in urban environments as natural resources flow (i.e., basic energy and materials in a protective structure). The designed manner is operated, or reused in an ecological resource-efficient manner. These points of spatial economies are representing both the rate of investment and transitions data framework which influence market. The spatial economy reflects the relative age of people who form managerial elites [33], [34], across the distributed employee center for simulation ecosystems production and interacting consumption, acquiring complex knowledge points for evaluating fewer process functions [35].

In reality, sustainability has "spatial organization" [36, p.69] as materialized by the advances in these two network topologies. The spatial data are reflected in the agglomeration of specific-global-economic activities [37]. In engineering applications, the relationship between system response and inputs is often available through computer simulation models, such as finite element analysis (FEA) and computational fluid dynamics (CFD) models. Since physics simulation models are computationally intensive, a crucial issue in reliability analysis is how to predict reliability with fewer function evaluations, (i.e., fewer runs of the expensive physics simulations) [38], [39].

Sustainability outcomes in reviewing ecological models are relatively innovative disciplines aiming to integrate sustainability of nature, rather than against it, to develop solutions towards resilient, resource-efficient, and green economies for human communities [40]. When the composite structure of infrastructure supports our energy flow to share natural resources with social security efficiency (i.e., considered administratively efficient), pollution during the design and construction phase will be reduced to lower levels, such as CO_2 emissions, to reduce the environmental impact from building construction. Recently, attentions to integrate composite structure of systems ecology to design, develop, and operate systems for the regional geographic phenomena and their evolutions are understood. The main objective is to create a transition to sustainability outcomes in which spatial economic activities respect the limits of regional and local service-orientation [41].

II. Procedure for Prediction Orientation Impact

The service-orientation has optimal forms when reliability of network topology is shaping optimization tools during the last few years with finite elements method [42], [43]. The service-orientation does not require simulation within technology beyond life cycle, but it has a wide philosophy or paradigm to include feedback-end scenarios. This end design paradigm is applied to business process with web services [44], [45]. The designed service topology is providing the possibility of changing parts of system software without change in physical configurations. The service-orientation inherits a small number of principles from earlier paradigms, including object-oriented programming, component-based software engineering, and open distributed processing. These collective physical and chemical properties are integrated with composite structure to shift the pervasive systems from an object-oriented to services-oriented approach, with the fundamental objective of configuring the system's middleware platform to be used in different urban environments [46].

The physical components of the midpoint impact are described in the mitigation layer of ecological systems to predict what is beyond "efficiency measures" and indicated system deviation. The generic layer is improved according to the improvement system topology and design aspect between biotic and abiotic variables for the three main classes influencing flux motion [47]:

- Generic physical static and dynamic variables,
- Mitigation of human behavior and systems ecology,
- Recovery of protective systems.

Several industrial projects have directed their products directly towards object-oriented approaches in urban pervasive systems [48]-[51]. For instance, as described in [44], an abstraction layer encapsulates services closer to object-oriented middleware to influence the physical environment and engage in an engineering topology incentive process between product-market and population-density in urban environments. However, despite the extensive application of formal methods, it often occurs quietly worldwide. Therefore, when discussing research results and academic theory, the main focus of this hypothesis is the evolution of the impact of formal methods in industry. These eco-feedback chains have revealed at three main trends in the spatial data of object-oriented industrial projects: first, systems focus on indicators of location; second, systems focus on social contexts; and third, systems focus on approaches to spatial economic structure [52]-[55].

Based on other systems, engineering topology proposes relations between design services and their orientation impact, directly linked to urban environments (i.e., land use planning). These relations are based on services' interaction with indicators. When a social context (i.e., directly to individual) is integrated with ecology, the potential integration of object-orientation with urban environments is developed as an improvement of services-orientation systems. These oriented services provide equilibrium and clarify the orchestration of services. These different services are integrated with the physical configuration to influence the orientation of multiple applications depending on the social context. The services are considered for adjusting the interaction of individuals with pervasive systems. This Precinct Structure Planning (PSP) is derived from ethnographic analysis and builds sensitive objects based on middleware to approach physical guideline indicators in urban environments. These objects observe the behavior of their surrounding environment and are quantified in the model through life-cycle analysis, predicting the topology of a service-orientation [56].

A. Orientation Impact from the Perspective of Spatial-Ecological Model

The impact-oriented definition of the spatial ecological model has other specific outcomes. It is not only leading to disregarding the ancestors of scientific ideas but is also expressed in a formal model that makes various superficial observations on the history of economic thought interpretation of economic indicators. Investigation datasets are proposed for implementation architecture of geographic modeling and simulation systems and discuss the module composition for the relational orientations of non-linear analysis. This addresses the diversity of geographic problems to receive substantial attention in the majority weights of the reviewed indicators [58]. A time series database consists of an ordered sequence of values of a variable at equally spaced time intervals. It is used to collect utilities over an optimized time for aiding the management structure of spatial data and policy intervention (e.g., the limited sequence of data points revealed the energy-response in relation to systems ecology). The comparisons between orientation and allocation served either to validate model results or compare the spatial structure approach used in industrial ecology. The comparisons between orientations, derived through turning feedbacks in active and passive conditions, influence the difference in implemented spatial structure and its use in land-use applications. These integrated orientations did not provide information about linear behaviors in the landscape but rather focused on systems social policy for recommendations, such as linearity in providing spatial data for spatial modeling systems [59].

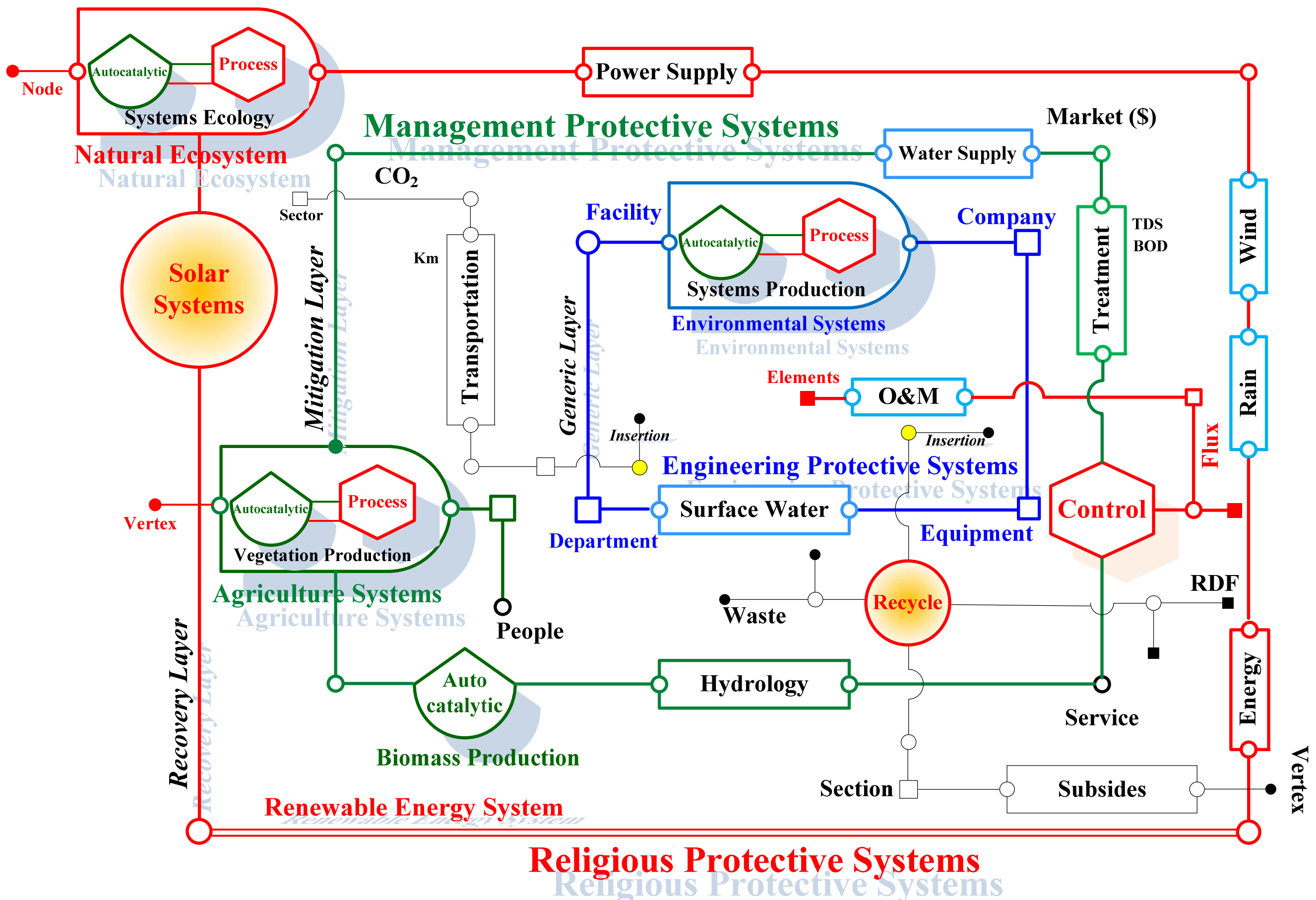

Fig. 2 The concept of orientation impact to the spatial ecological model [57]

B. Composite Index of Spatial Structure

In order to achieve the defined objectives, the structure of the spatial data model is selected to quantify the impact through various methods. These methods are available to predict the orientation impacts, despite being adequate for a particular purpose with various indications to outcomes. These environmental aspects are increasingly significant in sustainability spatial outcomes. Therefore, regional geographic simulation is employed in urban environments to quantify and evaluate the market impact on the economic factors during its stable condition lifetime. The model resources which include the cost of raw materials and technology utilization beyond life cycle can directly affect the analysis capability of modeling and simulation systems for various geographic phenomena and processes in different regions [60], [61].

The composite index results are related to the principles of engineering indicators and environmental phenomena, playing a more significant role in equilibrium structure. Energy is related to mass flow, increasing compactness without simultaneous attention to the mass-space ratio. Adequate provision does not necessarily lead to increased energy for environmental resilience, but also detract from environmental development. These illustrate the practical implications of the index findings, while relative scenarios are recommended for action plans and contribute to enhancing the environmental resilience of the composite index indicators. The proposed globally applicable framework gives urban planners a better understanding of the environmental resilience implications of spatial structure [62].

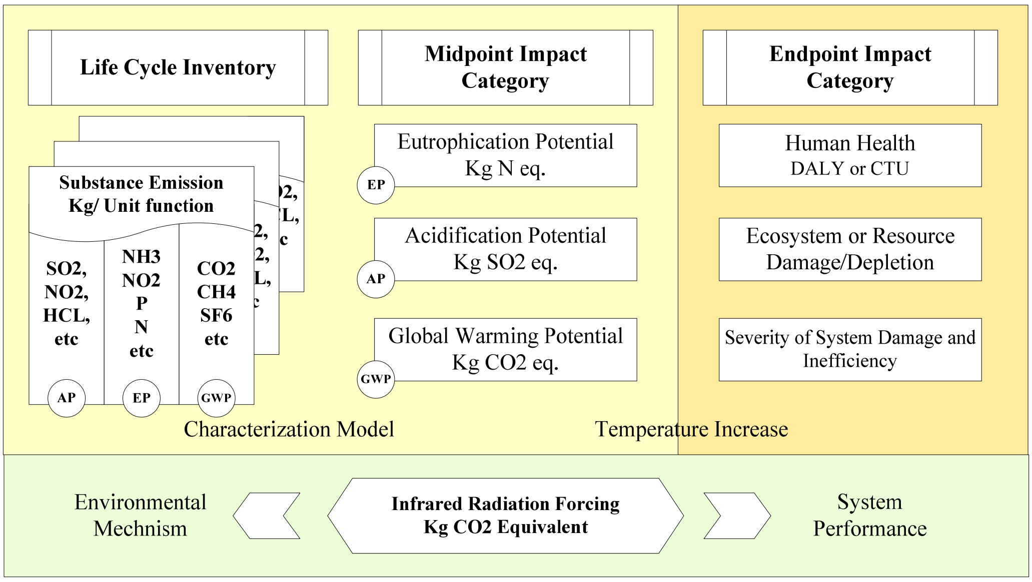

Fig. 3 The elementary process in relation to orientation impact [60]

TABLE I
SPATIAL STRUCTURE OF ENVIRONMENTAL MANAGEMENT SYSTEMS [65]

Layer No.	Layers Structure of Spatial Data	Model Consideration
1	Economic	Consider Economic Effects and Benefits of Market.
2	Social	Consider Human and Societal Interests in Outcomes
3	Ecological	Consider Effect on Nature and Earth
4	Time	Consider Long Term Effect to Increase Product life-cycle.
5	Values	Understands Sustainability as A Normative Evaluation Concept
6	Geographical	Consider Both Local and Global Location Effects
7	Performance	Consider Failure Effects and Non-Performance A Waste of Resource and Energy
8	Participation	Consider Including and Participation of Stakeholders
9	Emissions	Consider Reducing Emission in Landfill by Incineration
10	Waste Reduction	Consider Reducing and Prevention of Waste by Recycle and Treatment
11	Transparency	Open and Proactive Sharing of Information with Decision Maker
12	Accountability	Willing and Available to be Held Accountable for Decisions and Actions
13	Cultural	Consider Respecting Differences in Social Cultures and Values
14	Risk reduction	Reducing and Avoiding Certain Risks
15	Political	Consider Recognizing Differences in Interest of Decision Maker
16	Reliability	Consider the Failure Effect in System
17	Maintainability	Consider the Periodical Response to Systems Failure-Safe analysis

A composite index of spatial structure can be integrated from the standpoint of ecology, conservation resource, static load of applied design, and financial data with a number of other environmental pragmatics. The rationale behind prospective decisive materials in spatial structures and analogical structures includes metaphoric interpretation of context. Spatial structure can also be extended to a panel data framework. Specifically, main objective of the composite index is introduced in a general maximum entropy formulation for a class of spatial data structure with the aim of developing a composite index. In the present application of the real-time data collection method, data are investigated for the dynamics and complex interactions between selected and collective dimensions that represent the main measures of intangible assets of social panel [63], [64].

Once spatial data are completed into the relational database either in bulk or transactional loading, a spatial index (i.e., a spatial R-tree index) will be created on each geometry column in the tables for the most efficient access to the spatial data. The spatial data in composite structure describe an attempt to unify analytic and analytical dataset as environmental management tools for setting simulation model. Spatial indices can be built structure in two, three, or four dimensions of datasets. The default number of dimensions is two, but since data usually have more than two dimensions, the index parameters specify the number of dimensions on which to build the spatial index. This supports three-dimensional geometries, using a composite index to explain various combinations of dimensionality in query.

The model predicts combinations of small taxonomic sample sizes in datasets for comparative spatial data analyses performance, which can artificially elevate correlations. Such biases introduce false positives into interpretations of clade-level trends. These issues are considered potential pitfall, and least square analyses are recommended to address taxon-specific and clade-level evolutionary equations. These equations are used as examples of a recent method where the ecological modeling design is based on optimization topology, as mentioned in [66].

The lack of spatial independence indicators in ecological data has been viewed as a problem obscure one's ability to understand the biology of the natural organisms being analyzed. The spatial data structure defines relations between variables for obtaining the model of sustainability outcomes. In other words, integrating technology with local history, geography, culture, and socio-economic and political contexts will produce diversified locations where urbanism employs diverse environments. The urbanism data contain levels of specific information integrated with their locations for specific keywords obtained from the spatial outcomes. These data are used to address various aspects of procurement and delivery in in construction ecology, including procurement delivery in the short-term, investigating procurement strategy, and selective procurement methods for green buildings and high-performance sustainable construction. The limitation of spatial data is related to indices and other data structures, particularly how it links relations (i.e., one–many or many–one) and narrows down to specific journals. Spatial data collected through physical real-life locations like towns, cities, and islands often involve complex link relations. These data include physical features, represented by raster data structures, which are the simplest form of representing special information in construction ecology and urban environments. Due to the intensified interest in the subject of sustainability, the academic research, open-source databases such as Google Scholar returned literature from large volumes of unpublished papers [67], [68].

III. Main Features of Topological Systems

Systems topology offers a spatial simulation for ecologists and engineers as a basis for the selection structure's forms, particularly in developments of software of this approach. This approach can depict as a branch of systems science, or operational framework systems of industrial ecology. The systems topology has sustainable and interdependent components with the natural ecosystem. It is an emerging environmental indicator with spatial variable to balance anthropogenic insertion of ecological systems. Industrial ecology is applied to structures to achieve the following objectives [69]:

- Sustainable conservation energy and material flows.
- Reclamation product life cycle and optimization.
- Modeling ecological impact to control system.
- Development of system performance.
- Innovation resources for product quality.

Industrial ecology has emerged in recent years as a system approach to material and energy flows through industrial systems. These innovative resources in the model facilitate the reuse or recycling of materials and energy in society and manage their exchanges (i.e., extraction and emissions) in nature. The transition of spatial outcomes respects the limits and constraints of social security. Thus, industrial ecologists can predict the dynamics of anthropogenic insertions by analyzing the mass balance and energy flow of ecosystems in the context of climatic changes [70].

A. The Sustainability of Urban Environments

An ecological community hypothesis model posits that environmental management stimulates businesses to invest in environmental technology, leading to innovations that offset cost effects and enhance the level of development. Thus, environmental regulation can incentivize sustainable development. However, according to the constraint theory, environmental regulation can increase production costs for enterprises, potentially affecting economic and technological efficiency. In this context, the hypothesis used the comprehensive utilization rate of industrial waste as a proxy variable of environmental governance of businesses. Relative development of the urbanization levels is indicated in the continuous development of local economy and improved resource reclamation for energy utilization, which can increase the efficiency. The urban environment is expressed as the ratio of permanent urban residents' density to the total population. These reflections have positive correlation between urbanization level and systems efficiency. Urban spatial structures are shaped by dynamic market factors interacting regulations, primary infrastructure investments, and funds. They are usually the unintended result of unforeseen consequences of policies and security regulations.

B. The Environmental Management and Social Security

The environmental issues related to climate change and the Anthropocene have garnered widespread attention since the atmospheric chemist and Nobel laureate Paul Crutzen popularized the term in 2000. The purpose of this model is to understand the current geological epoch, biodiversity, and biogeography of ecosystem. The spatial indicators allow the comparison of cities' structures and the monitoring of the evolution of individual cities' spatial organization over time. When management arises from environmental and social concerns, limited spatial data have been introduced around the globe either on deliberately (e.g., monitoring ozone depletion and the climatic impacts of biomass burning such as crops or livestock) or accidentally as pathogenic insertions [71]. The main objective of spatial data query is simplified in the spatial index for partitioning, eliminating the need for most, if not all, index partitioning management operations. Full support is provided based on Oracle Database query of partitioning models, including:

- The impact of state intervention to stabilize land supply for competing uses.
- The database structure for relational exchange transaction costs in land use for utilization.
- Deficient market competition accidently arising from excess surplus situations and differences in security characteristics.

The urbanization land categories are relatively small and the estimated development coefficients are obtained from all land attributes in the model (i.e., road frontage, proximity to urban center, population growth, land restrictions, and year of sale). However, their individual implicit value differs across different land-use systems. The spatial econometrics exercise is inconclusive in identifying the type and degree of spatial preference in the present dataset. The urban effect of spatial economic indicators is reviewed for exchange transformation within the spatial data structure for further examination. The model correlation has emerged regional areas using composite price in indexes constructed from a longer set of sales analyses of relational database systems for social security.

IV. Framework Model of Industrial Ecology

The question is how industrial ecology is expanding model systems diversity within biotic and abiotic variables as autocatalytic processes [72]. The natural optimization of energy flow, natural resources, and urban environments is providing stability in rectifying failure-safe generic systems to accommodate anthropogenic insertions. In order to mitigate the impact of construction ecology along its life cycle, material balance has emerged as a key characteristic in urban places. Population growth and economic activities are encouraging the use of environmentally friendly materials. The improvement of the indoor environment [73] through the use of sustainable construction materials is evident in the domestic vernacular architecture, as supported by modeling theories. These materials are efficient and do not negatively impact urban environments. When buildings are characterized by environmental, technological, economic, and institutional systems, there is confidence in the rapid resumption of materials back into nature, supporting sustainable construction [74]. Once detailed information about indicators to attain sustainability in urban environments is loaded, spatial index has led to intersect the discourse of sustainability as a crucial outcome. The sustainability outcomes are clearly defined, measurable, and realistic, and based on knowledge of construction performance or project eco-feedbacks. In the literature, the terms project eco-feedback, project outcomes and project spatial data are inextricably linked to spatial model. Reference [75] defines objective of outcome, as the extent to which an operation's major relevant information has been achieved. Reference [74] equates project success as a favorable outcome. According to [76], project outcome is often referred to loosely as project success (or failure). Thus, if the analysis indicates that the project's performance is aligned with its objective, it can be concluded that the project has a favorable outcome or is on the right track, as discussed in [77].

A. Case Studies

Social, economic, and environmental unity are at the core of developing urban environments. There is a high degree of harmony between human behavior and urban environments. When urban environments and morphology of data structure of urban environments are designed to reduce energy consumption and carbon emissions, particularly in industrial regions, two aspects are reflected in systems: moderate land-use and ecological data [78]. The nature of land-use data is helpful in promoting mixed-use development, reducing travel distances, and bringing about a sustainable multiplier effect of "who gets what, where, when, and how" [79]. In order to use the model in social policy, it is important to incorporate the ability to framework modeling tools for the effective policy issues. It is crucial to decide whether the range of potential policy scenarios is in the stage of developing the model or the model structure evaluates sources of impact [80] and interface design for eco-feedback performance is crucial. When the model conducted empirical roles using a prototype eco-feedback interface, the data statistically show an inverse correlation between user engagement (measured as logins) and energy consumption. The relationship between the performance basis of spatial data and the analysis of design components (biological, economic, sociological, environmental ethics, and planning) is statistically corroborated to historical comparison incentives that drive design components in higher engagement and thus reductions in energy consumption. The analysis raises performance questions regarding the efficiency of various eco-feedback components in eliciting energy saving [81].

Another important property is improving energy efficiency is the enhancement of conservation thermal inertia (or thermal mass). While thermal inertia walls may not necessarily have good insulation properties air behavior provides better indoor temperature to stand point of delaying and reducing the impact of temperature and changing conditions of indoor environments. Thermal walls are constructed from materials with high thermal inertia, to prevent heat penetration from entering indoors by storing it during the day-time and releasing it during the night-time when the temperature cools down. Simulation outcomes from multiple action scenarios indicate reductions in total energy consumption when comparing the baseline of subsequent. Spatial process outcomes reveal that behavior changes in response to actions impacting energy systems. For example, changes in cooling systems levels will require users to adapt by accepting action for energy efficiency measures over their preferred cooling set points for comfort [82]. This adaptation is necessary to achieve significant energy efficiency improvements while maintaining indoor comfort.

B. The Reliability Based Sensitivity Analysis

In general, the sensitivity and uncertainty analyses are relatively limited within a computable sustainable equilibrium model. The analysis often involves only a limited set of parameters and examines a relatively small range of variations. However, spatial data from ecological models, combined with a series of time interval for ecological improvement in industrial ecology, can enhance eco-feedbacks, eco-structure, and eco-technology performance [83]. The purpose is not only addressing common ecological problems in industrial regions but also to tackle the largest regional climate and energy crisis. The systemic sensitivity analysis performed in two stages: one from basic simulations and one from a representative subset of parameters. The output indicators used in our analysis include the absolute change in social security indicator (measured as equivalent variations of the spatial structure model) and the absolute change in the gross domestic production indicator. In the present model, an attempt has been made to develop a time-varying reliability and sensitivity analysis for a random parametric structural system under stationary or non-stationary conditions, incorporating uncertainty into the structural parameters. An approach for evaluating the response of the random vibrations is proposed by combining Gaussian parameters within the dimension reduction point to establish a stochastic process for reliability-based sensitivities, with respect to the mean and variance of the random structural parameters. These stochastic processes are analyzed based on system reliability utilizing the core function method. The processes of reliability and sensitivity analysis of the random dynamic system are presented in Fig. 4 [84].

The main idea of the process has been performed on nonlinear structures' reliability analysis in the following stages:

(1) Gaussian process [85] is combined by the stochastic process to estimate a series of time-dependent deterministic functions multiplied by Gaussian random parameters, which are dispersed at the Gaussian integral points.
(2) The precise integration is moderated to solve the differential equations of random structures subjected to each expansion deterministic function.
(3) Combining point estimate method with the moments of each response under the series of deterministic functions is calculated.
(4) Considering the Gaussian random parameters produced in the model expansion, the moments of the structure's random response are calculated.
(5) Moment method is used to estimate the reliability and sensitivities of a determined spatial structure [86].

Based on fuzziness and uncertainties, an evaluation method using the cloud model was developed to evaluate the sustainable development level of the economic zone from environmental perspectives. A numerical method was investigated to address time-dependent reliability and sensitivity issues involving random structures and stochastic processes simultaneously. Data are collected from control indicators, supplemented and obtained using the means method. The aim of this postulated structure is to define reliability analysis, parametric reliability, sensitivity analysis, and global reliability sensitivity (GRS) analysis, particularly in the context of extremely rare failure-safe events.

- Efficiently indexing spatial structure in the GRS indices are determined, and weights of the total effect index are also interpreted, the fixed effect of randomly individual input variables aggregated on the safe-failure surface.
- Secondly, a method, denoted as AK-MCMC [87], is developed for adaptively approximating the failure-safe surface with a learning active improvement of Kriging surrogate model as dynamically updated Monte Carlo algorithm or Markov Chain Monte Carlo [88] populations.
- Thirdly, the AK-MCMC procedure combined with the quasi-optimal importance sampling procedure extended for estimating the failure-safe probability, the PRS and GRS indices. For estimating the GRS indices, two new important sampling estimators are derived.

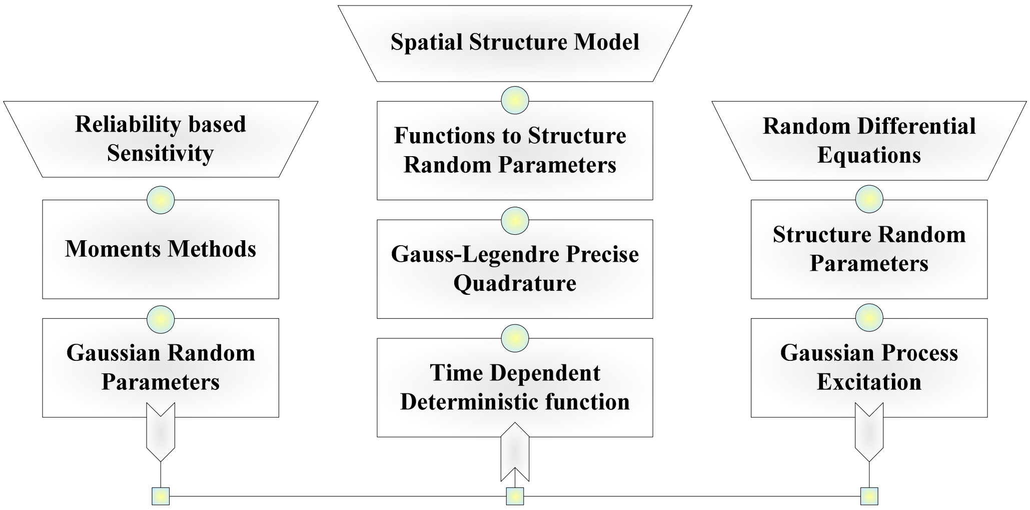

Fig. 4 Flow diagram of solution process [84]

The AK-MCMC procedure is applied to such a combination as the classical AK-MCS and Subset Simulation (SS) for effective events. Results of this example are shown to accurately and robustly estimate the extremely small failure-safe probability (e.g., 1e-9), as well as the related PRS and GRS indices with several dozens of function calls.

V. The Linear Spatial Model

In its simplest form, the composite structure index involves sequential indicators within a straightforward linear model aiming to predict the relationship between individual variables in construction ecology [89]. This approach reflects the utilization of various systems within a basic simulation segment of a virtual model, such as Design Structure Matrices (DSMs), Dependency Structure Matrix, Dependency Source Matrix, Dependency Map, Interaction Matrix, Incidence Matrix, Precedence Matrix, and others outlined in the literature [90].

Regression analysis, on the other the hand, involves specification of an empirical model to detect a relationship between the values of two or more variables that contain random variation [91]. The variables are independent or explanatory values (X) split up into classes or segments. For each segment, regression undergoes a confidence analysis to yield the value of the dependent or response variable (Y), which behaves differently across various segments. Therefore, the inclusion of variables becomes valuable when the independent internal and external variables are clustered into different groups to demonstrate diverse relationships between variables within these regions. Otherwise, the boundaries between segments act as breakpoints (such as mean threshold values) to eliminate overwhelmed processes. Segmented linear regression is then employed to establish the relationships of variables in the intervals defined by these regions [92].

Linear regression analysis is utilized to predict the threshold limit of proposed actions through probability functions and binary matrices (i.e. matrices populated with only zeros and ones). These matrices predict the presence or absence of relationships between pairs of elements for system modeling. Thus, composite structure matrix is represented by two main matrices: one containing probabilities of anthropogenic insertions information within value relations, while the other matrix breaks down data values from the analysis information to reflect the system's interrelation and quantify the impacts [93].

VI. The Multispectral Sustainability Outcomes

The updated procedure of quantitation process is developed at several stages to form sustainability results as an integral part of the numerical model. In ecology, imbalance refers to the deviation of systems or the inability of an ecosystem to respond to perturbations or disturbances by resisting damage and subsequently recovering. Several factors needed to be addressed and resolved before any other modeling can proceed. The transition to sustainability resilience represents is an economic process over time, wherein the economy shifts from a state of equilibrium to unstable production and consumption patterns, indicating perturbations and disturbances in capacity, including stochastic events, including inflation in economy, fire, flooding and windstorm in ecology.

Spatial planning processes are of paramount importance for deriving policy conclusions, necessitating the incorporation of variables into spatial models, often referred to as reuse allocation within a temporal dimension. The recursive dynamics approach is actualized in the current version of the sustainability modeling resilience tool. This resilience model employs cross-boundary entropy procedure to derive social balance within regions of accounting matrices. Consequently, the social accounting matrix serves as the objective of the model to be developed and implemented for composite structure as integrated spatial-economic data.

This ecological model represents the state-of-the-art in different areas of economy, health, social as environmental parameters. The model can assist policy makers in making informed decisions regarding short and long-term sustainability policies.

A. Economic Sustainability Outcomes

While sustainability depends on the balance between the three pillars of environmental, social, and economic, environmental sustainability focuses on maintaining the quality of the environment, social sustainability strives to ensure human rights and equality, and economic sustainability is crucial for maintaining the natural, social, and human capital required for the quality of living standards. In sustainability, the definition of economic model means different variables to different groups of people [94]; the quantitative model is designed to refine spatial data of economic outcomes for regional and neighborhoods. These conventional approaches often rely on empirical settings and invoke the law of large numbers. Concerns also include maintaining economic factors in the future [95], [96]. Other viewpoints emphasize providing financial resources for technical advances required in environmental complexity to overcome radical changes in growth paradigms and resource technology. In environment issues, this aspect is elevated to achieve compatibility by involving local businesses in the systems ecology. The market provides regional models by building feedback for minimizing waste. Once a quantitative economic model is determined for urban environments, infrastructure investments in land-use planning are developed for future decisions.

Quantitative spatial models share similarities with earlier theoretical literature on economic geography and envision modeling spatial outcomes. The growing concerns about economic data are evident in the spatial structure, offering tremendous potential insights. However, if policy-makers rely on these data to inform their decision-making, researchers must ensure that they reliably capture relevant features of the data and perform well in making counterfactual predictions [97], [98]. According to [97], the spatial outcome performance of economic sustainability includes employment and marketing relations. These relationships reflect a conventional continuum of individual relations for improving performance not only in pre-event data but also in predicting uncorrelated events with the observed changes in spatial data flows.

VII. Conclusion

In conclusion, the integration of economic influences encompasses a diverse set of factors in both the short and long terms. Economies effects are directly linked to market sizes, which expand with the creation of free trade areas and customs unions. Reduced costs and commodity prices stimulate internal and external demand growth, leading to innovation and overall economic acceleration. The spatial modeling using indicators of ecological models aims not only to provide neutral solutions to ecological problems in industrial region but also address larger regional climate and energy crises.

The integrated topology into systems ecology has a curial effect on sustainable outcomes in terms of energy and materials. Eco-topologies significantly impact urban environments, as illustrated in the ecological models' previous sections. Modifications bridge the gap between the external forces, which are replaced by outcomes, and internal external forces reflected in technological changes for technology adoption for environmental resilience.

Overall, the efficiency sustainability in urban areas in the province shows fluctuating measures, with most cities exhibiting medium to high levels of green development efficiency. According to spatial correlation analysis of sustainable development levels in the province, various cities exhibited spatial aggregation, with some showing higher values of sustainability efficiency than others. Among the factors influencing the level of spatial economic development, the industrial structure and digital improvements play a significant role. Urbanization at the macro-level shows relatively significant positive correlations with the regional economic development levels, while sustainability energy at the macro-level indicates significant negative correlations with green development efficiency. Environment management and scientific and technological development have significant influences on ecological modeling. Considering the various spatial effects, economic efficiency and composite structure of urbanization have positive effects on local green development in long-term plan.

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