Environmental Impact of Sustainability Dispersion of Chlorine Releases in Coastal Zone of Alexandra: Spatial-Ecological Modeling

Mohammed El Raey, Moustafa Osman Mohammed

***Abstract*—**The spatial-ecological modeling is relating sustainable dispersions with social development. Sustainability with spatial-ecological model gives attention to urban environments in the design review management to comply with Earth's system. Naturally exchanged patterns of ecosystems have consistent and periodic cycles to preserve energy flows and materials in Earth's system. The Probabilistic Risk Assessment (PRA) technique is utilized to assess the safety of an industrial complex. The other analytical approach is the Failure-Safe Mode and Effect Analysis (FMEA) for critical components. The plant safety parameters are identified for engineering topology as employed in assessment safety of industrial ecology. In particular, the most severe accidental release of hazardous gaseous is postulated, analyzed and assessment in industrial region. The IAEA-safety assessment procedure is used to account the duration and rate of discharge of liquid chlorine. The ecological model of plume dispersion width and concentration of chlorine gas in the downwind direction is determined using Gaussian Plume Model in urban and rural areas and presented with SURFER®. The prediction of accident consequences is traced in risk contour concentration lines. The local greenhouse effect is predicted with relevant conclusions. The spatial-ecological model is predicted for multiple factors distribution schemes of multi-criteria analysis. The input–output analysis is explored from the spillover effect, and we conducted Monte Carlo simulations for sensitivity analysis. Their unique structure is balanced within "equilibrium patterns", such as the composite index for biosphere with collective structure of many distributed feedback flows. These dynamic structures are related to have their physical and chemical properties and enable a gradual and prolonged incremental pattern. While this spatial model structure argues from ecology, resource savings, static load design, financial and other pragmatic reasons, the outcomes are not decisive in an artistic/architectural perspective. The hypothesis is deployed to unify analytic and analogical spatial structure in development urban environments using optimization loads as an example of integrated industrial structure where the process is based on engineering topology of systems ecology.

***Keywords*—**Spatial-ecological modeling, spatial structure orientation impact, composite structure, industrial ecology.

I. Introduction

SPATIAL ecology is applied to natural resource sciences including, for example, biology, forestry, conservation, agriculture, and environment. In other words, spatial ecology is where geography and ecology intersect for predicting neutral phenomena [1]. The architecture of resources (i.e., natural or man-made) without topological feature is the focus in integration urban environments with various terms of culturally invested to cover all three E's" of Environment, Economics, and Equity to sustain social security of industrial structure projects [2]-[5]. The first spatial theory of ecological model is described by J. von Thünen in "The Isolated State in Relation to Industrial and Political Economy" (von Thünen, 1826) [6]. Graphically, the model is presented in the form of seven concentric circles, where each next circle includes the previous one and indicates the land use of industrial center that "frees" social parameters. Von Thünen describes in his model the interaction of three factors of individual placement: the domestic land use, regional dispersions, and distance to the service facility (von Thünen, 1826). The main idea of von Thünen is the denial of absolutely advantageous use of land existence because environmental conditions depend on natural, social, and atmospheric conditions [7]. The atmospheric conditions integrated in the distance from the "center" causes the extensiveness of urban environments, increases the value of transportation risk, and the hazardous loads of output per unit, although the reliability value of resources is approximately the same in all unit systems [8], [9].

The industrial ecology not only presents a serious support to the workers but to the environmental as a whole. Techniques have been recently developed to identify potential sources of deterioration to assess associated risk. The applications of these techniques to a specific site could help safety authorities to reduce risks and warn the population to exert pressure for upgrading their safety. In Alexandria, an industrial area is chosen as a case study. It is a rapidly developed area with a number of major industries, petrochemical plant, and others. The model predicts dispersion of chlorine releases and other hazardous liquefied gaseous substances. The hypothesis adopted first linear variation for hazards identification as well as analysis, in non-linear analysis, as Failure-Safe Mode and Effect Analysis [10].

The critical components of plant systems are identified for judgment components from failure-safe mode in industrial plant. The most severe conditions with potential off-site consequences are defined as a rupture or break in storage tanks. The meteorological data in the last few years are downloaded

This work is supported in Environmental Department of Alexandria University and the Ministry of Industries. This work is supported as a partial fulfillment part of the Environmental Management Course in Alexandria University.

M. El Raey is with of Environmental Department, University of Alexandria, Institute of Graduate Studies and research, Alexandria, Egypt (e-mail: melraey@alexu.edu.eg).

Moustafa Osman is with Suez Canal Economic Zone, Egypt (e-mail: moustafa.osman@sczone.gov.eg).

from intern meteorological station to be integrated with release dispersion for analysis with statistical computer code. The computer codes are used to depict most probable weather conditions in the area as well as possible severe cracks and draw contour of chlorine gas concentration in downwind direction is then plotted and analyzed with professional computation program (CHEMS-PLUS) [11]. The spatial model present comprises analysis which accounts for the consequences of emissions of chlorine. The transitions between essential social elements are investigated (i.e. physical and chemical variables, commuting time in transportation, international standard, real estate development, gentrification, ethnic economies, the gendered economies variables and core-periphery theory). The relationships between the environment and the economy in urban communities are integrated as long history of spatial analysis with culture-environment for globalization [12].

Limitations on the total capacity of engineering topology of transportation network may arise from the design of access points, junctions or routes. Limitation by access curtail points in residential area is one of great importance in air and sea transport, of lesser importance in rail transport, and of comparative unimportance in road transport where, in general, the total number of access points is extremely high. Junctions are of critical importance in rail and road networks, often imposing capacity constraints far beyond their geographical location. The point is succinctly made of air quality modeling as reference to the network's topology in Fig. 1 [13], [14].

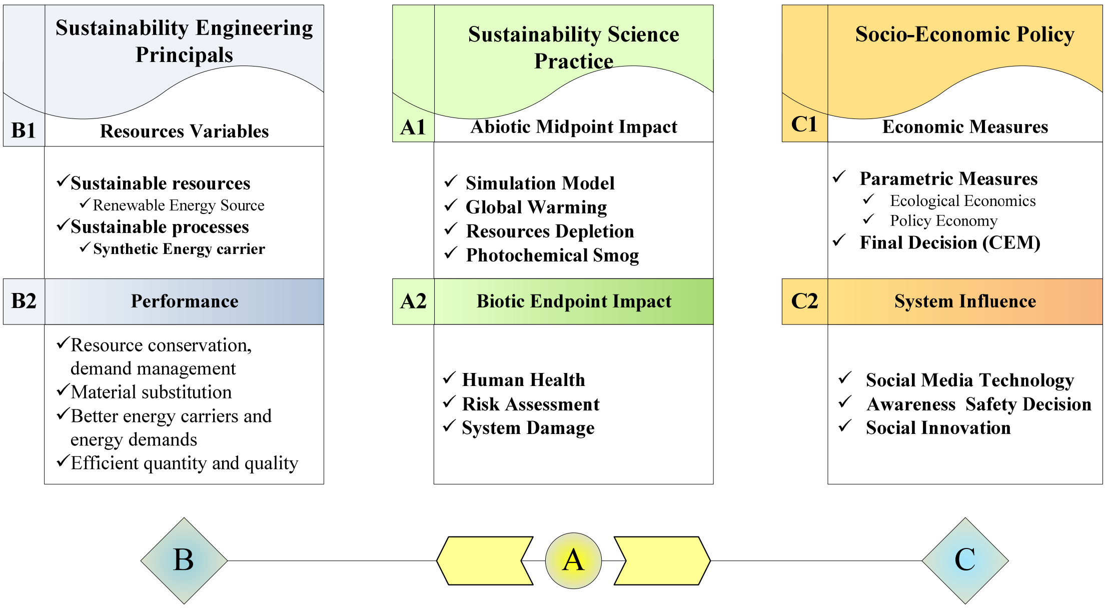

Fig. 1 The design procedure for spatial ecological structure for socio-economic systems [13], [14]

The spatial-ecological model in context, (i.e., conservation energy, material as resources of land, water, and air) [15]-[21], is often a complex incentive between social, economic, aesthetic, technology and systems ecology. The successful outcomes of such a spatial-ecological model require design input from the point of view of practice ecologists and principals engineer at the early process stage of design in which computers have an important role in simulation of the detailed applications. In urban environments, principal engineers provide detailed review with healthy, appropriate and efficient use of spatial data such as open space, natural harmony of construction to reduce CO_2 emissions and volumes of solid waste. Ecologists and engineers both employ iterative multi-stage design procedures, setting conceptual design to progress the final product. There are, however, essential differences in approaches to this discipline in the proposed geophysical object that anthropogenic insertions or integrated industries have a rapid cause of planetary change of impact-orientation systems [22]. The environmental module integrates the selective and collective features of the spatial ecological model for general equilibrium. The standard versions of the model consider both costs and benefits of environmental policy suggestions [23]. Environmental data for the air quality model include data on regional emission of SO_x, NO_x, VOC, and PM_{10}, as well as CO_2. All emissions are calculated on the basis of the fuel used by region and by industry. The completion of this task involves substantial data work described in spatial structure.

In the spatial prediction of socio-economic model, first, ordinary least squares regression is adopted; and then, the Lagrange Multiplier test is performed on the regression results in order to determine whether the model exhibited spatial error, (i.e., model error). The test results of the spatial error model and the robust spatial error model are not significant. However, the two test methods of the spatial lag model passed the significance level of 0.02, indicating that the general panel regression exhibited a spatial lag effect. As the significance of the two spatial lag test methods is significantly higher than that of the spatial error model, the spatial lag model is initially constructed as a preliminary regression analysis of the three models. The spatial lag model indicates that the fixed effects model should be selected. Also, the model tested the optimality of regional fixed effects, time fixed effects, and double fixed effects [24]. This tendency of a systems model responds and maintains changes or perturbations of dynamic-service-orientation systems that are described in a certain function (i.e., regulate temperature, balance acidity and alkalinity, preserve carbon dioxide and oxygen concentration emissions, etc.). On the micro level, this process is often done through centralized regulatory systems such as the hypothalamus in the human body [25]-[30]. The basic components of human behavior are integrated sustainability outcomes and classified into four main categories. These categories indicate considerable points to social security, spatial outcomes in urban environments as in Fig. 2 [31]-[33]:

1. Spatial Economy (Resources Variables).
2. Social life (Social Security Systems).
3. Urban Environments (Orientation Impact).
4. Legislation and Governance (Services-Oriented).

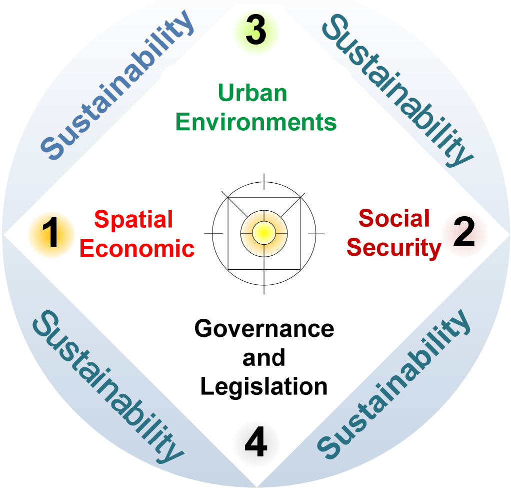

Fig. 2 Essential elements for sustainability [32]

Besides conceptual design of sustainability outcomes, systems ecology tends to be pragmatic in nature (i.e., the choice between an arch and a composite index, spatial structure, between chemical and physical properties with a proper height). These different approaches are typified by the problem of expressing psycho-physiological spatial concern in the mathematic of computers [34]. Yet these differences tend to vanish in some of the integrated process of successful examples and pattern design. It is exemplified as in "algebraic topology" [35]-[37]. Sustainability is also known in urban environments as resources flow (i.e., energy and materials in a protective structure) that are designed in an executive manner and operated, or reused in an ecological resource-efficient manner.

When the infrastructure supports our energy flow to share natural resources with social security in a much higher level of efficiency, there will be a much lower level of pollution and waste. Their objective is tending to create transition to sustainability outcomes in which spatial economic activities respect the limits of global and local service-orientation [38].

II. Quantitative Risk Assessment Procedure for Prediction Orientation Impact

Quantitative Risk Assessment (QRA) as a mathematical analysis tool is used to predict consequence to prevent rare and potentially catastrophic events in the chemical process industry. This can be included in QRA objectives to assess necessary risks related to the industrial process as follows:

1- Identifying accident scenario.
2- Quantifying the frequency of each scenario.
3- Quantifying consequences of each scenario.
4- Evaluating total risk for hazards gases.

The product-orientation is an optimal form obtained using topology and shape optimization structure developed during the last decades with the least square method [39], [40]. The product-orientation does not need the technology, but it has a wide philosophy or paradigm to include feedback-end scenarios like road network topology, high level scenarios like industrial process with services-orientation [41], [42]. The product-orientation topology is also designed to provide the possibility of changing parts of a system without change in physical configurations. These physical properties shift the system from process-oriented to product-oriented, as so the fundamental objective is configured system's middleware platform used in different urban environments [43]. The physical components of midpoint abiotic and biotic variables are described in ecological systems to predict what is beyond "efficiency measures" to indicate systems deviation from volumes of gaseous missions, releases of solid waste. The improvement system predicts topology as variable design aspect of the classified between biotic and abiotic variables in three main categories influence flux motion [44]:

– Generic of physical static and dynamic variables.
– Mitigation to human behavior and systems ecology.
– Regional protective systems.

Several industrial projects have addressed products directly services-oriented in the urban pervasive systems [45]-[48]. For example, in [53], a product-oriented middleware is explored that posed an engineering topology to the incentive process between the product-market and the population-density in the urban environments. These eco-feedback chain systems have revealed that there are three main trends in this spatial data of process-oriented industrial projects: first systems focusing on indicators of the location, second systems focusing on social contexts and third systems focusing on spatial ecological model [49]-[52].

Based on systems topology, the proposed relations between design and orientation impact are directly pervasive system of the urban environments. These relations are providing location-based services and interaction with indicators within a social context (i.e., directly to the individual). In industrial ecology, potential integration of products-orientation topology with the urban environments is developed as new services. These services are providing equilibrium to clarify orchestration services. These different services are integrated with physical configuration to influence orientation of multiple applications depending on the social context. The definition of these services is considered the adjustment and the interaction of the individual with the pervasive system. These conceptual results are derived from the ethnographic analysis and the Precinct Structure Planning (PSP) guidelines to framework indicators in urban environments as quantified by life-cycle analysis models to predict a product-orientation topology [53].

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

The impact-oriented definition of spatial ecological model has other specific outcomes. It not only led to disregarding, misinterpreting or undervaluing the ancestors of scientific ideas, but was expressed in a formal model. The various superficial observations turned on the history of restricted interpretation of socio-economics impact. Investigation of the relationship between orientations of non-linear relations did not receive substantial attention in the majority of the reviewed articles [54]. Time series has limited utilities in aiding management and policy intervention, as in energy-response relations revealed. The comparisons between orientation and allocation served either to validate variable in social model results or compare spatial structure for composite structure approaches. The comparisons between orientation, derived by turning feedbacks in active and passive conditions, show the difference of spatial composite structure implemented to influence land-use applications. The integrated orientation did not provide information about linear or non-linear behaviors in the landscape, but it extends to recommend system policy, such as linearity, in providing spatial data for spatial modeling systems [55].

B. Analysis of Chlorine Dispersion Consequences

The consequences of chlorine gas dispersion, as a toxic airborne material, are identified as the most sever release with potential off-site effects. The chlorine release consequences analysis is difficult to obtain because the exact concentration of chlorine is not known and is not constant [56], however a general assessment is possible. The dispersion of cloud behavior is influenced with meteorological conditions as applied in environmental model.

In order to attain the defined objectives, the structure of the spatial model is selected to quantify the impact through various methods. Those methods are available to estimate the orientation impacts, in spite of being adequate to an extent for a particular purpose with various notes about outcomes. The environmental aspects are increasingly more significant in sustainability. Therefore, spatial model is employed in urban environments to quantify and evaluate the environmental impact during its stable condition lifetime, which includes inventory of extraction raw materials, utilization, end of life, and beyond building life [57], [58].

Once detailed information is loaded, spatial index is created for either bulk or transactional loading of the model for the most efficient access to each column (i.e., data structure). The data abstract the composite structure to describe and unify an analytical approach for environmental management, using simulation software. The internal sorting data of indexes will be built on two, three, or four dimensions of data sets. The default object numbers are two dimensions, but usually the datasets have more than two dimensions. So, the index scales as a keyword to specify the access numbers and build the list factors. While the other information supports geometric explanation in three-dimensional objects, various spatial objects are adopted in query elements using a composite index. These datasets are predicting combination of small taxonomic sample sizes with comparative spatial data for analysis. These spatial objects are associated to understand biomechanical performance in feeding ecology and artificially elevating correlations of such biases. The spatial objects are introduced false positives into interpretation topology of clade-level trends. Considering potential pitfall, recommendations are provided to consider the least square analyses as the best practice to evolutionary questions address both taxon-specific and clade-level trends. Other objects are addressed as examples for a recent model, where the ecological design process is based on optimization topology as investigated in [59].

The lack of spatial independence in ecological data has typically been viewed as a problem that can obscure one's ability to understand the biology of the natural organisms being studied. The spatial structure is intended to define the relationship between different data for obtaining the strategies of sustainability outcomes. The model layers have specific keywords to be used for the literature search: procurement delivery, procurement strategy, procurement method, green building, high performance building, sustainable building, and construction ecology. These limitations of spatial models are related to industry features and composite index where linked to relations one–many or many–one and narrowed down to journals. These relations are specified to the construction ecology and the urban environments. Due to the intensified interest in the subject of sustainability in academic research, open databases such as Google Scholar would have returned literature from large volumes of unpublished papers [60], [61].

C. Gas Dispersion Model

Since the chlorine gas density is greater than air, dispersion is adopted within the framework of Gaussian plume model. The basic assumption is that, the plume is naturally buoyant. Therefore, the plume can be treated as “elevated source”; but for light conditions, the plume can remain close to ground, thereby causing toxic concentrations to occur over a wide area. So, for the purpose of safety assessment, the rise will be neglected. Through the use of Pasquill-Gifford [62] coefficients and Hosker graphs [63], the difficulties of the surrounding terrain and non-uniform emission rate of gas cloud can be overcome. Various physical conditions are applied to CHEMS-PLUS [11] code to assess hazards associated with the discharge of pressurized liquid chlorine from a storage system. The evaluation depends on the specified parameters of source emission area, vapor pressure, atmospheric conditions and other data obtained from Chemical Industry Systems (CISs) identification. Since these parameters cannot be controlled at the accidental time, different scenarios are predicted to reveal the “worst case” consequence of vapor toxic hazard that occurs at the following conditions:

- 1.4-inch crack hole in diameter,
- 12 ATM release pressure,
- stable atmospheric condition (slow speed of surface wind).

Under these circumstances, the plume is found to disperse over an area approximately 5.8 x 2.5 km^2 along the downwind direction. This confirms that residents within industrial area will be exposed to toxic effects in any local leakage accident. The concentration contours are found to be in "cigar" shaped with the axis of the cigar pointing downwind from the source emission point.

D. The Air Dispersion and Urban Effect

The model is specified total area for evacuation over concentration limits as 30 ppm. The maximum concentration determined variations in different stability classes for both rural and urban areas and reveals where dispersion in the urban area spreading over a wider area than that for rural areas; the plume concentration is higher in the urban areas than rural areas. An important observation is that, local greenhouse affects the plume in wider dispersion areas through the urban area or high rise-built zones.

III. GIS Data Visualization the Impact

This section discusses the relation or elements as the model has specific locations, (i.e., GIS visualization software). In this context, the GIS software is applied to merge conventional data as services-oriented databases and the basic map as shape files created by the Mapping Inequality Project [64]. The mapped outcomes boundaries are extended to encompass the associated urban environments. Provinces which had partial overlap with a conventional database (SQL) are labeled as 100%; the overlapping grade is because the basic map of negative space often reflects non-residential areas (e.g., disturbance is overlapped to predict major changes in the biological functions of the ecosystems). These criteria are reflected in the temporary change in external parameters that break the passive feedback flows in the linear systems (e.g., fire, wind storms, earthquakes, floods, or human behavior impacts on the environment such as acid rains) [65]. Several factors are influencing social security for sustainable development. The ecological model selected the corresponding input–output indexes that affect the level of regional green economic development, and then introduced the undesirable outputs. These resources facilitate integration of databases, such as the merging of tax assessment records with land parcel boundary files or demographic data with place or area boundary files, and the conversion of non-spatial to spatial databases via geocoding or address matching [66].

The economic model has related spatial dispersion to control emergence breed of theory, as new economic geography or geographical economics. These parameters are tailored in new dimension broadly aims to analyze the role of geography and location in economic phenomena. The spatial economic analysis is increasingly being supported by the emergence of analytical methods, with an inverse structure of models and techniques of spatial data analysis and data visualization (GIS) [67]. Spatial structure is also becoming increasingly recognized as a valuable sub-discipline among mainstream econometricians. The impact can be mapped with GIS system for visualization of basic data and overlay each parameter to determine buffer zone around hot spots. The boundaries of micro-scale spatial analysis are expanding to include developing countries, as spatial structure is made available because of technical advances in global positioning system (GPS) and remotely-sensed data collection and infrastructural enhancements at established research sites [68], [69].

The numerical model is followed by stress, deformation and shear-slip failure-safe analysis for geological sequestration of carbon dioxide (CO_2). The spatial structure is built on an open-source object–oriented code, and results are compared to the analytical solutions. Once solutions are mapped in columns of database system as conventional product with the primary function, in tables for retrieving data that requested with other applications—which may run either on the same platform or across a network topology. The pressure and deformation fields solutions are derived from a typical geological sequestration scenario in previous analysis. The virtual result of shear-slip failure-safe analysis is presented based on the numerical results, where the potential precinct failure-safe is identified from relevant information for prediction of the maximum sustainable injection rate or pressure. These proposed terms of current geophysical force are classified into their "deviation equilibrium" in which anthropogenic insertions in industry have a rapid change cause of failure-safe mode or planetary systems change [70]-[72].

IV. Chlorine Risk Assessment

Topology optimization methods offer a spatial simulation model for ecologists and engineers as a regular basis for the selected structure's initial form, particularly in developments of simulation software of this approach. It is a branch of systems science, or operational framework design of industrial systems to be sustainable and interdependent with the natural ecosystem. It is an emerging environmental indicator with spatial factors to balance anthropogenic insertion and ecological systems. Industrial ecology is applied for determined structure for the following objectives [73]:

- Conservation of energy and material.
- Optimization of product life cycle and process.
- Control of ecological impact on the natural system.
- Improvement of system performance.
- Short term innovation for product quality.

The industrial ecology has emerged in modeling selective or collective parameters for design and control pollution as waste. These fields approach the transition sustainability outcomes to control our spatial structure and provide limits and constraints of social security. The industrial ecologists can predict dynamics behavior of anthropogenic insertions from ecosystem behavior [74].

A. The Sustainability of Urban Environments

The influence of ecological community has stated that environmental management system stimulates as a green development to invest in environmental technology, for innovation. The offset cost and effect are leading to enhance the level of development; thus, environmental regulation has an incentive effect on sustainable development. However, according to the constraint theory, environmental regulation will increase the production cost of enterprises and affect the development of green economic and technological efficiency. In this context, the hypothesis model is used for utilization rate of industrial structure as a proxy variable of environmental governance. In relative development of the urbanization level, social objects are indicated for continuous development of the local economy and improved resource and energy utilization efficiency. The urbanization rate is expressed as the ratio of permanent urban residents to the total population. There is a positive correlation between the urbanization level and development efficiency.

B. The Environmental Management and Social Security

Environmental management became well-known after atmospheric chemist and Nobel laureate Paul Crutzen popularized it in 2000, and it extends beyond just anthropogenic climate change. It is a more specific term used to describe our current geological era. Biodiversity can be viewed as the relative diversity and distribution of ecosystems in biogeography. The model reflects the similar influence of invasive species that have been introduced either on purpose (i.e., crops, livestock) or accidentally [75]. The main profile of the simplified spatial index is partitioning, because this composite index type eliminates the need for most, if not all, index partitioning management operations. The system will support the provided databases as all Oracle Database base tables partitioning column for including inter dimension to:

– state intervention to determine and stabilize land supply for competing uses,
– transaction costs in land exchange and utilization, and
– imperfect market competition arising from excess surplus situations and differences in security characteristics.

An additional category is urbanization land with relatively small development potential that estimated coefficients of all land attributes in the model (road frontage, proximity to urban centers, population growth, land restrictions and year of sale) are significant. However, their individual implicit value differs across different land categories. The effects of urbanization and spatial economic transformation are expected in the spatial data and further examined via a moving correlation analysis using composite price indexes constructed from a longer set of sales data.

V. Framework Model of Industrial Ecology

The question is how industrial ecology is expanding for modeling system diversity within the biotic and abiotic variables as autocatalytic resources [76]. The natural optimization of energy, natural resources and the environment is providing stability in rectification failure of generic systems contributing to the state of anthropogenic insertions. In order to mitigate the impact of construction components along their life cycle, systems have emerged for encouraging use of environmentally-friendly materials, implementation of techniques and to save resources and reduce volume of waste. The improvement of indoor environment [77] through construction materials is utilized in mansions as domestic (vernacular) elements, which are integrated into the modeling theories. These types of material do not have any harmful effect on the environment, because when buildings are demolished, there is confidence in a quick resumption of material to nature unlike current construction. For instance, Sialk hills are a good example of sustainable outcomes that were made about 7000 years ago. It can be named as a sustainable complex. Although it is being demolished these days, it never pollutes the environment due to using proper material [78]. Unlike, if the current buildings are demolished, it can provide different pollution. It can be named as a sustainable complex. The recognition of the need to attain sustainable development in urban environments has led to increased interest in the discourse of sustainability considerations as one of the important roles of outcomes. The concept of sustainability outcomes is situated within the extensive framework of knowledge on construction ecology performance or project eco-feedbacks.

In literature, the terms project eco-feedback, project outcomes and project objectives are inextricably linked. Reference [79] defines project outcome as the extent to which an operation’s major relevant objectives have been achieved. Reference [78] equates project success as a favorable outcome. According to [80], project outcome is often referred to loosely as project success (or failure). Thus, understanding the analysis of the perceived performance is aligned with project objective then matching a favorable outcome for orientation [81], [82].

The general concept of relations between industrial ecology and Earth's systems rests on the importance of maintaining or improving conditions of the natural life cycle and human health via the urban environments. The factors contain a grounding of fact-based knowledge in raw materials (e.g., classification, production, qualities and uses) with the development of design frameworks that enable environmental and health criteria to be set project components. These components are providing the knowledge to enable ecologists and engineers to select or collect a number of building materials for any project, in any location, culture or date for resource conservation [83], [84].

VI. Conclusion

Based upon applications of QRA for chlorine dispersion in the storage system, the risk of an accidental release in the current chlorine storage system (CIS) is deemed acceptable, despite the potentially large consequences associated with the release at 200 ppm chlorine concentration level. This conclusion is made after consideration of the large liability the company will be exposing itself and the proximity of the population to the plant. The severe consequences occur at the following conditions: 1.4-inch crack diameter, 12 ATM release pressure and stable atmospheric condition [85].

The selection of routing decisions must avoid high-accident locations, highly populated corridors, or congested areas, including highway reconstruction sites where traffic concentration is expected to be heavy. Typically, the objective of routing decisions is to minimize the level of exposure caused by given shipment or collection of shipments. Potential actions include restrictions on transport during peak hours or through heavy employment areas during the daytime and heavy residential areas during the night. It may also be appropriate to avoid time periods when schools are either beginning or ending. Benefits of QRA are many. The most obvious one is a reduction of personal injuries. However, concomitant with that is improved plant on stream time and reliability. This increases production and provides reliable services to customers. Fewer and shorter outage also reduce emergency maintenance costs and the inefficiencies that occur because of emergency conditions [86].

REFERENCES

[1] Perla J, Tonetti C and Waugh M E, (2021) "Equilibrium Technology Diffusion, Trade, and Growth", American Economic Review, Vol. (111)(1): pp. 73-128, 2021.

[2] Rajput S P S, Datta S, (2020) "Sustainable and Green Manufacturing–A Narrative Literature Review", Mater. Today Proc., 2020.

[3] Couckuyt D, Van Looy A, (2019) "Green BPM as a Business-Oriented Discipline: A Systematic Mapping Study and Research Agenda", Sustainability, Vol.11: pp. 4200, 2019.

[4] Kumar, R, Singh S P, Lamba K, (2018) "Sustainable robust layout using Big Data approach: A key towards industry 4.0", J. Clean Prod., Vol. 204: pp. 643–659, 2018.

[5] Lai K H, Wong C W Y, (2012) "Green Logistics Management and Performance: Some Empirical Evidence from Chinese Manufacturing Exporters", Omega Vol. 40: pp. 267–282, 2012.

[6] Johann Heinrich von Thünen, (1826) "Der isolirte Staat in Beziehung auf Landwirtschaft und Nationalökonomie", Wirtschaft and Financial, 1826. https://www.biodiversitylibrary.org/page/21988453. Accessed 16 May 2023.

[7] Heinrich Wiskemann: Die antike Landwirtschaft und das von Thünen'sche Gesetz. Aus den alten Schriftstellern dargelegt. Hirzel, Leipzig1859. https://www.deutsche-digitale-bibliothek.de. Accessed 16 May 2023.

[8] Henry Ludwell Moore, (1895) "Von Thünen's Theory of Natural Wages", G. H. Ellis, 1895. https://doi.org/10.1215/9780822385646-016. Accessed 16 May 2023.

[9] H. Schumacher-Zarchlin, (1875) "Der isolirte Staat in Beziehung auf Landwirtschaft und Nationalökonomie", Wiegant, Hempel and Parey., 1875. DOI: https://doi.org/10.5962/bhl.title.24798. Accessed 16 May 2023.

[10] Joun Yuan, "A Strategy to Establish a Reliability Model with Dependent Component through FMEA", Reliability Engineering, 11(1985) 37-48.

[11] CHEMS-PLUS, Arther D Little, Inc Cambridge, Massachusetts 02140, Version 1.0 July, 1988.

[12] Fujita M and Krugman P (2004) "The New Economic Geography: where now, and to where", Papers in Regional Science 83(1): pp. 139-164, 2004.

[13] Gayatri A and Bennett L L, (2001) "Valuing Open Space and Land-Use Patterns in Urban Watersheds", Journal of Real Estate Finance and Economics, Vol. 22(2-3): pp. 221-237.

[14] Geoghegan J, Wainger L and Bockstael N E, (1997) "Spatial Landscape Indices in a Hedonic Framework: An Ecological Economics Analysis Using GIS", Ecological Economics. Vol. 233: pp.251- 64, 1997.

[15] Edwin H W Chan, Queena K Qian, Patrick T I Lam, (2009) "The Market for Green Building in Developed Asian Cities- The Perspectives of Building Designers", Energy Policy, Vol. 37: pp.3061-3070, 2009.

[16] Chinese National Standards (GB/T 50378-2006), "Evaluation Standard for Green Building", Beijing, China Building Industry Press, 2006.

[17] US global change research program, (2009) "Global Climate Change Impacts in the United States", 2009.

[18] Wang W, Zmeureanua R, Rivard H, (2005) "Applying multi-objective genetic algorithms in green building design optimization. Building and Environment Vol. 40(11): pp.1512–25, 2005.

[19] Thormark C, (2006) "The effect of material choice on the total energy need and recycling potential of a building", Building and Environment, Vol. 41(8): pp. 1019–26, 2006.

[20] Wang W, Zmeureanua R, Rivard H, (2005) "Applying multi-objective genetic algorithms in green building design optimization", Building and Environment, Vol. 40(11): pp.1512–25. 2005

[21] Aste N, Angelotti A, Buzzetti M, (2009) "The influence of the external thermal inertia on the energy performance of well insulated buildings", Energy Build, Vol. 41(11):1181–7, 2009.

[22] Sokolowski J A, Banks C M, (2009) "Principles of Modeling and Simulation", John Wiley & Son. p. 6, 2009. ISBN 978-0-470-28943-3.

[23] Zeigler B P, Praehofer H and Kim T G, (2000) "Theory of Modeling and Simulation: Integrating Discrete Event and Continuous Complex Dynamic Systems", Elsevier, Amsterdam, 2000.

[24] Irwin E G, Bell K P and Geoghegan J, (2003) "Modeling and Managing Urban Growth at the Rural-Urban Fringe: Evidence from a Model of Residential Land Use Change", Agricultural and Resource Economics Review, Vol. 32(1): pp. 83-102, 2003.

[25] Naqi A and Jang J G, (2019) "Recent Progress in Green Cement Technology Utilizing Low-Carbon Emission Fuels and Raw Materials: A Review", Sustainability, Vol. 11: pp. 537, 2019.

[26] Tong H H, Yao Z Y, Lim J W, Mao L W, Zhang J X, Ge T S, Peng Y H, Wang C H, and Tong Y W, (2018) "Harvest green energy through energy recovery from waste: A technology review and an assessment of Singapore", Renew. Sust. Energ. Rev., Vol. 98: pp. 163–178, 2018.

[27] Ahn D G, (2016) "Direct Metal Additive Manufacturing Processes and Their Sustainable Applications for Green Technology: A Review", Int. J. Precis Eng Manuf-Green Technol. Vol. 3: pp. 381–395, 2016.

[28] Purohit D, and Malvi B, (2019) "Review on Green Technology for Sustainable Development", Am. J. Eng. Res. (AJER), Vol.8: pp. 296–300, 2019.

[29] Jeong Y J, Kang I, Choi S K, and Lee B H, (2018) "Network Analysis on Green Technology in National Research and Development Projects in Korea", Sustainability, Vol.10: pp. 1043, 2018

[30] Mukhtarova K, Trifilova A, and Zhidebekkyzy A, (2016) "Commercialization of Green Technologies: An Exploratory Literature Review", J. Int. Stud., Vol. 9: pp. 75–87, 2016

[31] Matsebula F, Mnkandla E, (2016) "Information systems innovation adoption in higher education: Big data and analytics", In Proceedings of the 2016 International Conference on Advances in Computing and Communication Engineering (ICACCE); IEEE: Durban, South Africa, 2016; pp. 326–329, 2016.

[32] Patel D, Kellici S, and Saha B, (2014) "Green Process Engineering as the Key to Future Processes", Processes Vol. 2: pp. 311–332, 2014.

[33] Cheng C C J, Yang C, and Sheu C, (2014) "The Link between Eco-Innovation and Business Performance: A Taiwanese Industry Context", J. Clean. Prod., Vol. 64: pp. 81–90, 2014.

[34] Wang L, Lu K, Liu P, Ranjan R, and Chen L, (2014) "IK-SVD: Dictionary Learning for Spatial Big Data via Incremental Atom Update", Comput. Sci. Eng, Vol. 16: pp. 41–52, 2014.

[35] Brown, Ronald, Higgins, Philip J, Sivera, and Rafael, (2011) "Nonabelian Algebraic Topology: Filtered Spaces, Crossed Complexes, Cubical Homotopy Groupoids, European Mathematical Society Tracts in Mathematics, Vol. 15, European Mathematical Society, ISBN 978-3-03719-083-8, archived from the original on 2009-06-04,

[36] Maunder C R F, (1970) "Algebraic Topology", London, Van Nostrand Reinhold, ISBN 0-486-69131-4.

[37] Tammo tom Dieck, (2008) "Algebraic Topology", EMS Textbooks in Mathematics, European Mathematical Society, ISBN 978-3-03719-048-7

[38] Erl T, (2005) "Service-Oriented Architecture: Concepts, Technology and Design", Prentice Hall, July 2005.

[39] Haldar Achintya, and Mahadevan Sankaran, (2000) "Reliability Assessment Using Stochastic Finite Element Analysis", John Wiley & Sons. ISBN 978-0471369615

[40] Tseng, Z Jack, (2021) "Rethinking the use of finite element simulations in comparative biomechanics research", PeerJ vol. 9 e11178. 7 Apr. 2021, doi:10.7717/peerj.11178

[41] Georg Jung, Tiziana Margaria, Ralf Nagel, Wolfgang Schubert, Bernhard Steffen, and Horst Voigt, (2007) "SCA and jABC: Bringing a Service-Oriented Paradigm to Web-Service", IEEE Computer, IEEE Press, November 2007.

[42] Richmond B G, Wright B W, Grosse I, Dechow P C, Ross C F, Spencer M A, Strait D S, (2005) "Finite Element Analysis in Functional Morphology", Anatomical Record, Part A, Discoveries in Molecular, Cellular, and Evolutionary Biology, Vol.283: pp.259–274. 2005.

[43] Vuong Q –H, (2021) "The Semiconducting Principle of Monetary and Environmental Values Exchange", Economics and Business Letters, Vol. 10 (3): pp. 284–290, 2021. doi:10.17811/ebl.10.3.2021.284-290.

[44] Bernardi E, Carlucci S, Cornaro C, Bohne R A, (2017) "An Analysis of The Most Adopted Rating Systems for Assessing the Environmental

Impact of Buildings", Sustainability. 2017 Jul 13; Vol. 9(7): pp.1226 Layer of flux modeling (from the previous paper)

[45] Ankur Gupta, Cristian Borcea, Achir Kalra, Quentin Jones, Liviu Iftode, (2009) "MobiSoC: a middleware for mobile social computing: Challenges, Design, and Early Experiences", Mobile Networking Applications, Springer, 2009.

[46] Bilandzic M, Foth M, and A de Luca, (2008) "CityFloks: Designing Social Navigation for Urban Mobile Information Systems", DIS 2008, ACM Press, February 2008.

[47] Hansen F A, and Gronbaek K, (2008) "Social Web Applications in the City: A Lightweight Infraestructure for Urban Computing", HT 2008, ACM Press, June 2008.

[48] Kjeldskov J, and Paay J, (2006) "Public Service Computing: Making the Invisible Visible", IEEE Computer, IEEE Press, September 2006.

[49] Daniel S, Tsoulfas G, Pappis C, and Rachaniotis N, (2004) "Aggregating and evaluating the Results of Different Environmental Impact Assessment Methods", Ecological Indicators, Vol. 4 (2): pp. 125–138, 2004. doi:10.1016/j.ecolind.2004.01.003.

[50] Hitzschky K, and Silviera, J, (2009) "A proposed impact assessment method for genetically modified plants (As-GMP method)", Environmental Impact Assessment Review, Vol. 29 (6): pp. 348–368, 2009. doi:10.1016/j.eiar.2009.02.006.

[51] Peche R, and Rodriguez E, (2009) "Environmental impact Assessment procedure: A new approach based on Fuzzy logic", Environmental Impact Assessment review, Vol. 29: pp. 275–283, 2009.

[52] Cotton Roger, Emond D. Paul, and John Swaigen (ed.), (1981) "Environmental Impact Assessment", Environmental Rights in Canada. Toronto, Ontario: Butterworths, 1981.

[53] Margaria T, Steffen B, Reitenspieß M, (2005) "Service-Oriented Design: The Roots", In: Benatallah B, Casati F, Traverso, P (eds.) ICSOC 2005. LNCS, Vol. 3826: pp. 450–464. Springer, Heidelberg (2005).

[54] Lynn Govaert, Emanuel A. Fronhofer, S_ebastien Lion, Christophe Eizaguirre, Dries Bonte, Martijn Egas, Andrew P. Hendry, Ayana De Brito Martins, Carlos J Melián, Joost A. M. Raeymaekers, Irja I. Ratikainen, Bernt-Erik Saether, Jennifer A. Schweitzer and Blake Matthews,(2018) "Eco-evolutionary Feedbacks-theoretical Models and Perspectives", Function Ecology, Vol. 33(1): pp.13-33, 2018. https://doi.org/10.1111/1365-2435-13241.

[55] Aström K J, and Murray R M, (2008) "Feedback Systems: An Introduction for Scientists and Engineers", Princeton University Press: Princeton, NJ, USA, p. 1, 2008.

[56] Raymond F. Boykin, Raymond A. Freeman and Reuven R. Levary, "Risk assessment in chemical storage facility" Man. Sci., 30(4), April, 1984,512-17.

[57] Gard P T, (2001) "Fast and Innovative Delivery of High-Performance Building: Design-Build Delivers with Less Owner Liability", Strategic planning for energy and the environment, 2004 Apr 1, Vol. 23(4): pp7-22, 2004.

[58] Martin H, Lewis T M, Petersen A, (2016) "Factors affecting the choice of construction project delivery in developing oil and gas economies", Architectural Engineering and Design Management, 2016 May 3, Vol. 12(3): pp.170-88, 2016.

[59] Naoum S, Egbu C, (2015) "Critical Review of Procurement Method", Research in Construction Journals, Procedia Economics and Finance, 2015 Jan 1, Vol. 21: pp. 6-13, 2015.

[60] Awadh O, (2017) "Sustainability and Green Building Rating Systems: LEED, BREEAM, GSAS and Estidama Critical Analysis", Journal of Building Engineering, 2017 May 31; Vol. 11: pp. 25-9, 2017.

[61] Herazo B, Lizarralde G, (2015) "The influence of Green Building Certifications in Collaboration and Innovation Processes", Construction Management and Economics, 2015 Apr 3; Vol. 33(4): pp.279-98, 2015.

[62] Pasquill, F., "Atmospheric Diffusion", 2nd Edition, Wiley, New York, 1974

[63] Hosker R. P., IAEA_SM_181-19, Vienna, 1974, 291-309.

[64] Su J G, Apte J S, Lipsitt J, Garcia-Gonzales D A, Beckerman B S, de Nazelle A, Texcalac-Sangrador J L, Jerrett M, (2015) "Populations Potentially Exposed to Traffic-Related Air Pollution in Seven World Cities", Environ. Int. 2015, Vol.78: pp. 82–89, 2015. https://doi.org/10.1016/j.envint.2014.12.007

[65] Lesage J P and Pace R K, eds. (2004) "Spatial and Spatiotemporal Econometrics", Advances in Econometrics, Volume 18, Oxford, England: Elsevier Publishing, 2004.

[66] Karner A A, Eisinger D S, Niemeier D A, (2010) "Near-Roadway Air Quality: Synthesizing the Findings from Real-World Data", Environ. Sci. Technol. 2010, Vol. 44 (14): pp. 5334–5344, 2010. https://doi.org/10.1021/es100008x.

[67] Lesage J P, (2004) "A Family of Geographically Weighted Regression Models," in Anselin, Florax, and Rey (eds.), Advances in Spatial Econometrics Berlin: Springer-Verlag, pp.241-264, 2004.

[68] Staal S.J., Baltenweck, I., Waithaka, M.M., de Wolff, T., and L. Njoroge. 2002. "Location and Uptake: Integrated Household and GIS Analysis of Technology Adoption and Land Use, With Application to Smallholder Dairy Farms in Kenya", Agricultural Economics, Vol. 27: pp. 295-315, 2002.

[69] Ohnsorge F L, Stocker and Some M Y, (2016) "Quantifying Uncertainties in Global Growth Forecasts", Policy Research Working Paper 7770, World Bank, Washington, DC, 2016.

[70] Steiner Achim, (15 December 2020) "The Next Frontier: Human Development and the Anthropocene", UNDP. Retrieved 16 December 2020.

[71] Ehlers, Eckart, Moss C, Krafft Thomas, (2006) "Earth System Science in the Anthropocene: Emerging issues and problems", Springer Science Business Media. ISBN 9783540265900.

[72] Dixon Simon J, Viles Heather A, Garrett, Bradley L, (2018) "Ozymandias in the Anthropocene: The City as an Emerging Landform", Area. Vol. 50: pp. 117–125, 2018 doi: 10.1111/area.12358. ISSN 1475-4762

[73] Jensen P D, (2011) "Reinterpreting Industrial Ecology", Journal of Industrial Ecology, Vol. 15 (5): pp. 680–692, 2011. doi:10.1111/j.1530-9290.2011.00377.x. S2CID 9188772.

[74] John Ehrenfeld, (2004) "Can Industrial Ecology be the Science of Sustainability?", Journal of Industrial Ecology, Vol. 8 (1–2): pp. 1–3, 2004.

[75] Vincent Julian F V, Bogatyreva Olga A, Bogatyrev Nikolaj R, Bowyer Adrian, Pahl Anja-Karina, (21 August 2006) "Biomimetics: its Practice and Theory", Journal of the Royal Society Interface, Vol. 3 (9): pp. 471–482, 2006. doi:10.1098/rsif.2006.0127. PMC 1664643. PMID 16849244.

[76] Masterman J, (2001) "An Introduction to Building Procurement Systems", Routledge; 2003 Sep 2

[77] Robinson H, Symonds B, Gilbertson B, Ilozor B, editors. "Design Economics for the Built Environment: Impact of Sustainability on Project Evaluation", John Wiley & Sons; 2015 Jun 15.

[78] Naoum SG, and Egbu C (2016) "Modern selection criteria for procurement methods in construction: A state-of-the-art literature review and a survey", International Journal of Managing Projects in Business. 2016 Apr 4; Vol. 9(2): pp309-36, 2016.

[79] Buntaine M T, Parks B C, (2013) "When Do Environmentally Focused Assistance Projects Achieve Their Objectives? Evidence from World Bank post project evaluations", Global Environmental Politics. 2013 May; Vol 13(2): pp. 65- 88, 2013.

[80] Chan A P, Chan A P, (2004) "Key performance Indicators for Measuring Construction Success Benchmarking: an International Journal", 2004 Apr 1; Vol. 11(2): pp. 203-21, 2004.

[81] Liu AM, Walker A, (1988) "Evaluation of Project Outcomes", Construction Management & Economics, 1998 Mar 1; Vol. 16(2): pp, 209-19, 1988.

[82] Erik Cohen, David F. Aberle, Leopoldo J. Bartolomé, Lynton K. Caldwell, Aristide H. Esser, Donald L. Hardesty, Riaz Hassan, H. Dieter Heinen, Jiro Kawakita, Olga F. Linares, Partha Pratim Majumder, Albyn Knight Mark and Harald Tambs-Lyche, (March, 1976) "Environmental Orientations: A Multidimensional Approach to Social Ecology", Current Anthropology, Vol. 17 (1): pp. 49-70, (22 pages), Published By: The University of Chicago Press.

[83] Volker Grimm and Steven F Railsback, (2012) "Pattern-oriented modelling: a 'multi-scope' for predictive systems ecology", 19 January 2012. https://doi.org/10.1098/rstb.2011.0180

[84] Bamgbade J A, Kamaruddeen A M, Nawi M N M, Adeleke A Q, and Maruf Gbadebo Salimon, (2019) "Analysis of some factors driving ecological sustainability in construction firms", Journal of Cleaner Production, Volume 208, 20 January 2019, Pages 1537-1545 https://doi.org/10.1016/j.jclepro.2018.10.229

[85] Stamatelatos M.G., Evlerline C.J., Ligon D.M., "Risk Assessment for Selection of a Chemical Munitions Disposal Alternative", Reliability Engineering 27 (1990) 179-212.

[86] Technica Report, "Risk Assessment for Acute Exposure", Proposal for Technica by Environmental Resources Limited April, 1984.