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Sustainability Impact Assessment of Construction Ecology to Engineering Systems and Climate Change

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Abstract**—**Construction industry, as one of the main contributor in depletion of natural resources, influences climate change. This paper discusses incremental and evolutionary development of the proposed models for optimization of a life-cycle analysis to explicit strategy for evaluation systems. The main categories are virtually irresistible for introducing uncertainties, uptake composite structure model (CSM) as environmental management systems (EMSs) in a practice science of evaluation small and medium-sized enterprises (SMEs). The model simplified complex systems to reflect nature systems' input, output and outcomes mode influence "framework measures" and give a maximum likelihood estimation of how elements are simulated over the composite structure. The traditional knowledge of modeling is based on physical dynamic and static patterns regarding parameters influence environment. It unified methods to demonstrate how construction systems ecology interrelated from management prospective in procedure reflects the effect of the effects of engineering systems to ecology as ultimately unified technologies in extensive range beyond constructions impact so as, - energy systems. Sustainability broadens socioeconomic parameters to practice science that meets recovery performance, engineering reflects the generic control of protective systems. When the environmental model employed properly, management decision process in governments or corporations could address policy for accomplishment strategic plans precisely. The management and engineering limitation focuses on autocatalytic control as a close cellular system to naturally balance anthropogenic insertions or aggregation structure systems to pound equilibrium as steady stable conditions. Thereby, construction systems ecology incorporates engineering and management scheme, as a midpoint stage between biotic and abiotic components to predict constructions impact. The later outcomes' theory of environmental obligation suggests either a procedures of method or technique that is achieved in sustainability impact of construction system ecology (SICSE), as a relative mitigation measure of deviation control, ultimately.

Keywords**—**Sustainability, constructions ecology, composite structure model, design structure matrix, environmental impact assessment, life cycle analysis, climate change.

I. INTRODUCTION

CONSTRUCTION ecology, is a complex subject to predict interaction between physical dynamic and static patterns and practice science and engineering into reality [1]. When construction ecology becomes an obligatory skill in the engineering systems' kit, decisions upon integration of management multidisciplinary knowledge are ultimate goal of sustainability [2]. Constructions as so, engineering systems, are manipulating anthropogenic insertions in natural modeling of erection elements. It promotes a discipline of 'sustainability science' from construction ecology prospective to protect and improve systems diversity. It approaches material processes of quality control and management analogy of ecosystems. It is a system of systems ecology observed from natural erection elements as ecological behavior and operating systems for sustainability. The construction system ecology is emerged for examining whether industries intensively influence equilibrium conditions as 'great force of nature' and outlines some insights beyond sustainability framework of build–environment [3].

Basically, the main purpose of build–environment is designing a control system to provide space to human activities into a natural interdependent framework. These interventions are contributing in global change and extend their effects to influence Earth Systems as recognized in climate change [4]. Significantly, environmental degradation is reflecting deterioration in air, water and soil as destruction of ecosystems when anthropogenic insertions are exerted a 40% of transitions materials. Then, hierarchical operations of natural recovery emerge biosphere system for mitigation or adaptation deviations for recovery. The quantum's observation of material and energy provides management with data to control quality and quantity of anthropogenic insertions that starts in industrial processes and affect Earth's System [5].

Ecosystems as natural self-sustaining predominantly nature models, are cyclic rather than linear; operating in one cycle to circulate in a closed interconnection and preserve mass and energy flux for each other's [6]. The principal of a natural system model design is relied on diverse elements that conduct an autocatalytic recovery analysis in linear based–function. These functions are set lifetime cycle to balance physical static and dynamic patterns and preserve natural interaction of synthetic systems. Thereby sustainability reflects natural states of ecological equilibrium at a multi-disciplinary scale for management ecosystems [7].

Sustainability of constructions' element has categorized ecological industry to relative biotic and abiotic systems. The biotic refers to people beyond the theme of design and extraction of build environment. The resources based on material and energy as its structural processes are abiotic systems observed with "efficient measures". These measures are required for controlling both material extraction and energy conservation to functions as autocatalytic systems or recovery systems in techno sphere. The "efficient measures" are the key element of environmental model for controlling natural diversity of operations and preserve biodiversity based on engineering principals of constructions' ecology [8].

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II. BASICS TO CONSTRUCTION ECOLOGY

Systems ecology is an interdisciplinary field of ecology, taking a holistic approach to the study of ecological systems, especially entire ecosystems. Howard Thomus Odum, 1950 [9] has seen systems ecology as an application of general systems theory related to ecology. It focuses on interactions and transactions within and between physical, biological and ecological systems, especially concerned with the way the functioning of ecosystems influenced by human interventions. It extends the idea of constructions' ecology as a central approach to the other macro system descriptions of complex systems for analysis and deployment model criteria.

The nature of construction system is depending on selection raw materials for post processing and spare energy during operation stages such as: embedded carbon in extraction and translocation materials for building and construction processes as 'induced' energy. Construction ecology extends aspects of idealization thinking in relation to its environmental systems. It simplifies methods of international standards to parse components of midpoint abiotic and endpoint biotic beyond "efficiency measures" and indicate system deviation. This approaches theory, yet "newest synthesis" remains more collectively methods than model for integration miscellaneous systems, take key elements from different perspectives for evaluation of the behavior impact. The theory is providing an innovation discipline, as entails a wide range of interaction to state and regulate recovery processes in systems ecology as common interdisciplinary for equilibrium systems [10].

Construction ecology is influenced and linked to industrial ecology in management processes from open to closed cellular systems, interrelation to quality control. First, it strengthens selection of natural material and renewable energy, second, state resources of CET, in turn, to introduce one further novel concept. It is a potential mode influence nature motion of species during construction processes, for deterioration air and water quality as "a function of other species". The innovation of technology is therefore, inclusion nature cycle influence principal ecological as anthropogenic insertions to interface whether or not impact is formally inclusion to environment. The question for ecology is not whether, when, or even how humans have transformed the biosphere, but rather, why?

There is no question recognized from the scale, rate, intensity, and diversity of anthropogenic insertion that changes biosphere in comparison with those caused by any prior cellular insertion operation. These alter aggregation procedure to distinguish main difference between constructions ecology theory (CET) and standard evolutionary theory (SET) as postulated in the design–control reference and their insights of engineering and EMSs [11]. *Construction Ecology theory* (CET) was first formulated as a revision of evolutionary theory, one of several different theoretical development in the mid–to–late twentieth century that began to explore the variety of ways in which materials interact with their selective environments—others included co–evolution theory [12] and extended phenotype theory [13], [14]. However, a broader application of constructions' peripheral is extend the core idea of integration conceptual frameworks of ecological systems. The effects of ecology extend to protect heredity diversity as focus on modify selection materials for conservation energy not only for the composition and structure, but extend for other diversity species as well Fig. 1 [15], [16].

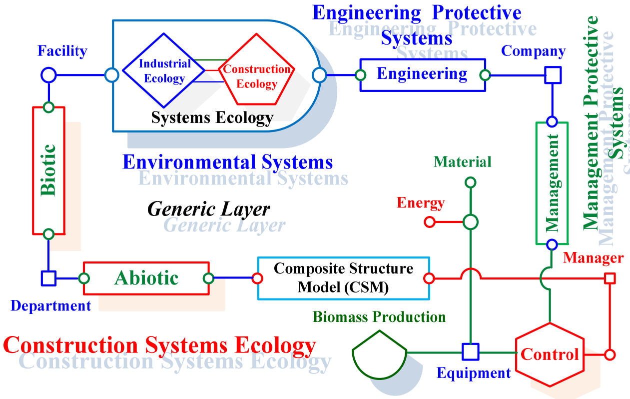

Fig. 1 Construction Systems Ecology Interrelation [15]

First, construction systems affect the distribution of energy and may lead to decline diversity of species. The wider area of the construction, the more stable of ecosystems is, the more safety of natural communities. The more heights of the construction volumes, the more deviation of ecosystems is, the more risk to natural communities (i.e., species diversity, ecosystem diversity) [17], [18]. The natural selection of synthetic structure systems, plate reinforcements or materials, load distribution, internal webs, and the other modified structure of soil are the way to enlarge ecosystems diversity with Earth Loaded System Control (ELSC) without mankind disturbance of infrastructure interventions [19], [20].

The potential value of scientific analysis of engineering systems is to establish ecological construction serve natural ecosystems with buffering zone guarantee the circulation of hydrology with comprehensive prevention of air vagrant. The profound effects of constructions systems are reflecting ideas in multidisciplinary systems that developed to address the consequences concept of construction ecology [21]. In either case, engineering ecosystem does affect other cellular system functions as a system of systems ecology. So, engineering ecosystem is importantly defined so as to exclude competitive and trophic interactions, since the ecological roles of these are already accounted for in existing models and theories. The category of ecosystem engineers is distinguished according to the nature of their systems' effect to environment [22].

Berke [23] distinguishes four main categories for controlling anthropogenic interferences. *Structural engineers* change or create relatively durable structural features of their ambient: beaver dams, termite mounds, coral reefs, and the woody parts of plants are all examples of this sort of engineering structural systems to reduce disturbance and increase the heterogeneity of their ambient. *Mechanical engineer* such as burrowers and excavators disturb and mix materials in their ambient, often producing an increase in uniformity. *Chemical engineers* modify the chemistry of cultivate soil, water, or air through processes such, or by moving or depositing materials to be as respiration or photosynthesis. *Electrical engineers* alter the local patterns of light transmission and distribution loads changing the intensity of light in nearby locations by casting shade or causing light scattering, for example. All of these kinds of ecosystem engineering can be either *allogenic* or *autogenic*, i.e., they could indicate the impact form either effects organisms have on their surroundings, or the aspects of the organisms' own growth and their development [15].

A. Sustainability Framework Systems Ecology

Sustainability as a basis resource of framework provides entities for efficient control of systems ecology with design. It has multidisciplinary elements of inputs–outputs mode based on potential factors of socio–economic concerns (i.e., specific technologies, social, political and cultural dimensions) that are not found in any systems' context. It influences development targets and highlights references for integration design aspects and practice control solutions as synergy across a number of environmental concerns in conservation energy. It requires innovation to balance systems' operation constraints to local, regional and global scales. The main methods and techniques applied in construction ecology are summarized in:

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

Clearly, basic concept of integration is indicated to improve conventional engineering systems and unified ecosystems for recovery performance. These have independent descendent resources to inherit viable elements of construction ecology for integration design and operation with other independent systems as material balance and conservation energy. Fig. 2 illustrates sustainability framework of major constructions' ecology element [21].

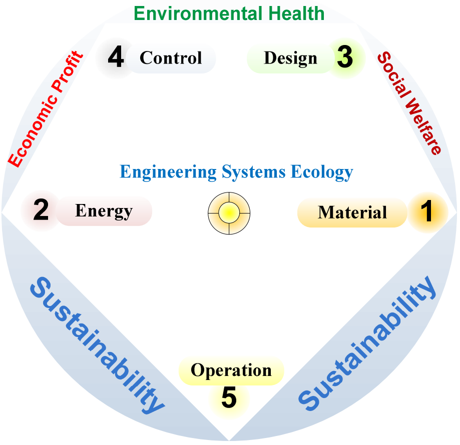

Fig. 2 Sustainability Framework Systems Ecology [21]

Sustainability is an emergence direction attracted decision makers to set elements and criteria supporting common sectors in government. These achieve their planning goals in:

- Social progress that meets equity with quality of life respecting religious value.
- Efficient protection to the man-made environment.
- Prudent use of natural resources.
- Balance layers of high and stable levels of economic growth with employment investment.

The main elements are related urban systems to control energy flow through built–up environment. The interventions are responding to element that interactive analogous of design and upgrade a pilot model of conventional engineering system. While intervention scale of infrastructural is depending on structure category (i.e., such as bridges, furnaces, and sulfur scrubbers etc…), sustainability is integrated as framework model (i.e. life cycle assessment, material balance, energy conservation, etc…) to unified socio–economic parameters of systems ecology and prediction behavior impact [25].

B. Systems Spatial Architectural and Boundary

Ecological engineering are introduced by Odum et al. [26] for utilizing natural energy sources as the predominant input to manipulate controlling processes, and conservation material of environmental systems. Consider a simple model of object motion with interactive architecture: a vertical motion between main segments "A" and "B" in linear dimensional axis and steady state conditions. The motions is reflecting change in object relation to basic axis directions [δx, δy, δz] while reflecting changes in object relation to time (t) and speed (v) as a function of mass (m). The motion between ecosystem segments is function of parallel (or concurrent), sequential (or dependent) and coupled (or interdependent) motion that is restricted analogous to force (f) inducing volicity change (δv) with time (δt) for a particle of mass (m). On other word, the species flux with motion force induce changes in speed and mass per volume in specific time as described in Newton's second law [27].

$$f = m \times a \tag{1}$$

Replacing acceleration rate "a" with vertex speed and space displacement in "δx, δy, δz" directions and constant time "t", when multiplication equation by $\left(\frac{\delta t}{\delta t}\right)$ and integration it reveals:

$$f = 8\, m \times \left(\frac{v^3}{\delta x.\delta y.\delta z}\right) \times \delta t \tag{2}$$

where, (m) is the mass for the object velocity (v), in response time (t).

In derivation of (2), a few empirical facts is replaced for predicting vertical analogues to Newton's equation of motion $m\ a = f\ \left(\left(m \times \frac{\delta v}{\delta t}\right) \times f\right)$is appraised spatial integrity of environmental systems within relative time and control volume [28]. The design analysis is classified its physical elements into main categories influence flux motion (i.e., physical static and dynamic pattern, human and systems ecology and technology). The segments predict object motion in hierarchal levels to integrate vertex node in forms and boundary as so, control system variables. The node is assigned to main segment influence flux motion as reflected in:

(A) Upper–front segment contains anthropogenic or generic of microsystem levels,
(B) Median–recovery segment contains mitigation facility at regional mesoscale levels.
(C) Baseline–environmental ecosystem or universe layer for protection of the unique characteristic from unexpected insertions into the systems ecology (e.g., front, generic and recovery of ecosystems).

These main segments connected in detail to describe what dimensions described from a techno–mathematics or techno–mathematical literacies [29]. Hoyles et al. [30] detail interaction of techno–mathematics for system layer's A, B, and C as analysis flux motion at reference axes ($\delta x, \delta y, \delta z$) in hierarchy levels as predicted in Fig. 3.

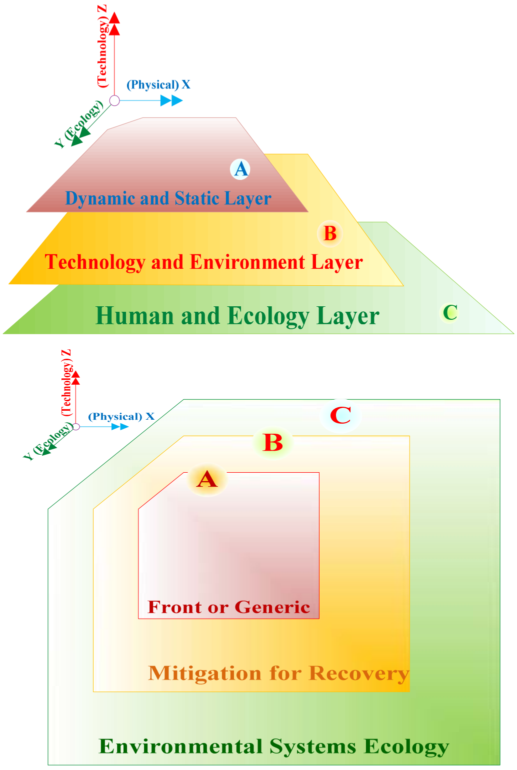

Fig. 3 Physical Interaction of Ecosystem Mode [30]

Stewart [31] related changes of object motion to energy and material flow between segments layer. The nature of environmental model is an iterative method used to classify the baseline of particle motion between segments and function as a system of system ecology. In design stage, the model provides flexible components, but consistent to control the attribute of dataset and integrate scope objective of product, In generic layer, variables are controlled in mesoscale levels to prodice operations between segments A, B and C for effective control critical deviations. These levels are attributed to universe layer to control energy flows as a partial development of project Life Cycle Analysis [32]. The model is extending to complete a full scope of segments architecture with the basic modular process of flux motion for conservation material and balance energy flow for resources recovery. These can be used to integrate mathematic model to Life Cycle Analysis (i.e., point's source emission and release model) at various stages to evaluate processes deviations and reflect mitigation processes for approval or reject the project components from design stage as so, an initial screening procedure of environmental impact assessment [33].

III. MANAGEMENT LIFE CYCLE DESIGN MODEL

In civil engineering systems, construction performance has delivered a long lifespan to be considered as time-dependent. Therefore, a consistent design approach has to comply with the desired performance not only at the initial stage when the system is in erection state, but during its expected Life–Cycle. These developments are perceived to be the heart of transition a Life–Cycle oriented design philosophy towards engineering. The aspects of life–cycle engineering models are validated with special focus on Life–Cycle Analysis design, inspection, monitoring, assessment, maintenance and rehabilitation for evaluation structural damage processes. The stages extend to structures cost of infrastructures interventions as Life–Cycle Cost and performance of special structures as Life–Cycle Oriented for engineering System and computation tools [34].

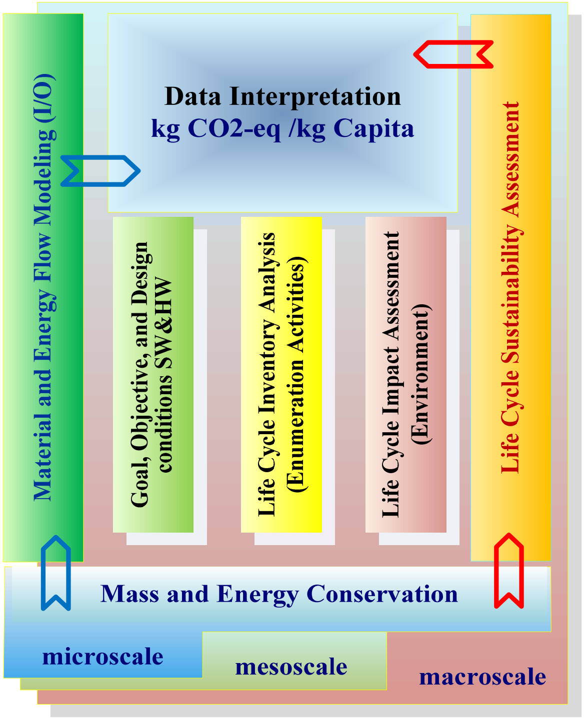

Fig. 4 Principals of CSM Based Sustainability Life Cycle Analysis [36], [37]

Svanström et al. [35] practice application model for interpretation data and analyze how each condition are

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separately defined after the other through Life Cycle Analysis with Sustainability Impact Assessment Model. The proposed model enables fast feedback on the proposed interventions at residential and business agglomerations in the different scale and allows full control on any stage with simulation process as abstract in Fig. 4 [36], [37].

An environmental system impact is a proportionally common perception of cause and effect; large scale stimuli cause large effects, whereas small stimuli cause only small effects. This is only true, when the system of interest is linear to close cellular equilibrium state. The system's scale is coupled to the effects when referred to *microsystem:* it reflects the most immediate and direct development impacts including: systems material, energy and chemical interaction. The *mesosystem* is defined as microsystems intra–connection within all other facility. When recovery process referred to *macrosystem*, the conservative system of material and energy culture is reflected the 'induce' interactions of *macrosystem* within ecosystems. While system scale is determined by successive generation for controlling operation to be induced, communities' development or culture changes of ecosystem is determined by product life–time for defining socio-economic dimension of system distribution and consumption as a unique characteristic of sustainability [37]. However, several methods in civil engineering design are analyzing elements influence modeling systems, with special focus on management environmental impact assessment EIA. In design civil engineering systems, Composite Structure Model (CSM) is applied to numerous methods and techniques to determine environmental impacts of development projects. The quantification process is inferred into context as a great extent of sustainability impact Life Cycle Analysis (LCA) and environmental management systems (EMSs) as modified to be applied in construction systems ecology to predict species diversity based on scientific methods. The model is relied on practice science to validate methods of industrial systems control and introduce interventions analysis using model forms composite structure model as interrelated in [38]:

- Industrial metabolism,
- Urban footprint (unique characteristic),
- Input – output model (energy balance),
- Life cycle assessment (gate to gate analysis),
- Design for environment (sustainability),
- Pollution prevention (material recovery), and
- Product life extension (composite model).

The model predicts systems ecology in segments levels and based on broadly integration practice measures of a Composite Structure Model (CSM). The model is prediction system intervention as a midpoint impact using other methodologies in sequential layer for prediction end point impact as in Fig. 5 [39].

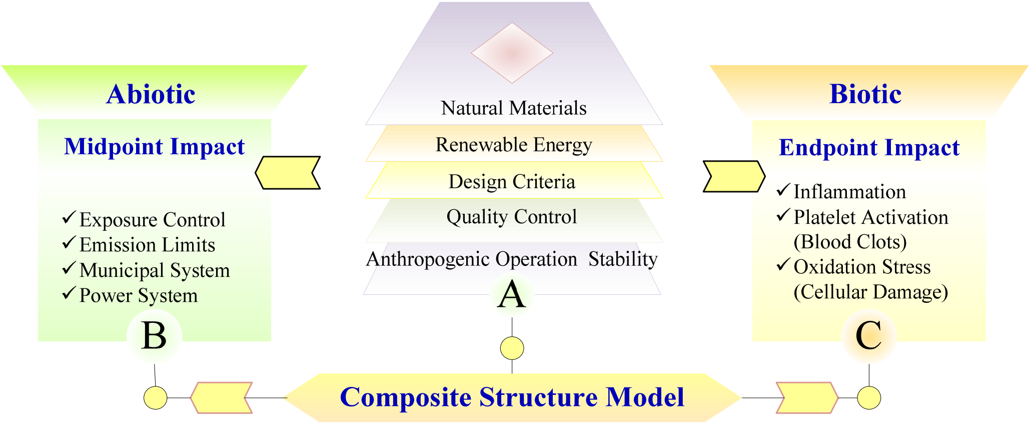


Fig. 5, Management Methods for Prediction Impact [36]

Among other unified techniques for virtual equilibrium, Composite Structure Model (CSM) is introduced in a variety of contexts to distinct system feasibility and evaluate life cycle of insertions in a systematic prediction of structural dynamics other dynamic patterns of model for evaluation impact [39]

IV. ENGINEERING COMPOSITE STRUCTURE MODEL

Engineering systems ecology model is relied on bridging the Scientific's understanding as a key environmental issue and relevant engineering topics' need of available information that influence basic solutions [40]. Construction Systems Ecology reflects a stand–in experience to management normalization of abiotic midpoint categories, or focuses on the ambient quality and quantity targets of endpoint biotic damage categories. So, ecological engineers did determine appropriate assembly keys for mitigation phenomenon such as global warming and other acidification potential categories (acid drainage) or much more relevant impacts for evaluations recovery performances of site specific systems [41].

While Mitsch and Jorgensen [42] wrote that ecological engineering is designing societal services such that they benefit society and nature, Odum [43] reflected ecological engineering as self-organizational properties. Since engineering systems are in the early stage for management mathematical modeling, systems ecology can be viewed in three connected dimensions of mathematics, technology, and problem–context, as unified activity or, where instance "language and mathematics could be predicted as the supreme modeling tools", and variables are relating to main terms of analysis [44] as using:

- *Graphical interfaces,* to define generic interrelation between management and engineering of construction systems ecology [42].
- *Interactive matrix,* to examine categories into systems as composite structure reflects design stage interactive to construction and operation stages.

These hybrid approaches are starting initial engages to graphic and mathematic schema and build documentation for sustainability life cycle analysis. It is considered a subsequent step of graphical interface to define supplement and validate mathematics of systems interrelations. The hidden object is improving systems' performance of mathematical modeling for management technology product outcomes [46]. The management and engineering systems are determined for mathematic analysis to contain all objects under ecological terms and conditions that applied in design as operation stages as unified element of Composite Structure Model in CSMs [47].

A. Graphical Interface Layers' System Flow

In fact, Odum suggested that the first step in simulation modeling is beginning into draw energy flow diagrams for representing a coscise way to visualization the universe layer, describing systems mathematically, and developing programs for simulating their dynamic behavior impact. Thinking on the behavior impact from CSMs stand point, is tracing elements interrelation in systems ecology as reality. In general systems theory, understanding simulation to a whole system and the full parts interaction must be used in a common denominator that reflects all the flows and expresses processes together to ensure continued flow and reliable supply of energy [48].

In Fig. 6, [49] the diagram of interaction consequence layer "protective systems" goes into main segment boundaries of flux motions. The flux boundaries have an autocatalytic unit based on "solar receptors" from a source–limited flow as external energy inflow. The energy circuit is renewable but limited to mass production unless the quantity or energy growth equal to the amount that is consumed by product for a steady state conditions. The autocatalytic unit with materials (example: nutrients) have iterative components that being exponential between segments layer as constant energy source to bound state of energy. The bound state is affected by both cycling of energy flow and by available materials (i.e. nutrient as renewable sources). The energy flow model is introduced for single process predicting various operation conditions between segments as energy flow as being operated by various kinds of elements as scalar of natural ecosystems for resources recovery [50].

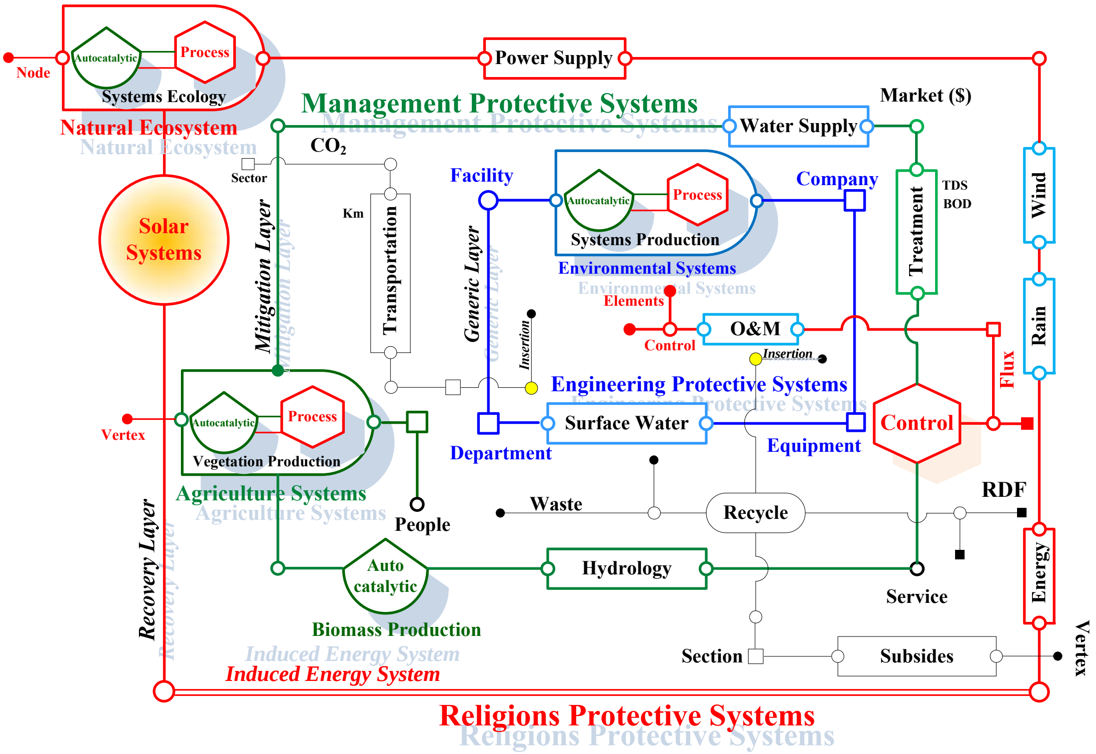


Fig. 6 Energy Flow Model Predictive Systems Boundary [49]

The model is used to build major segment of anthropogenic insertion blocks. First segment illustrates how engineering protective systems in generic layer is interpreted in segment (A) where language and mathematics are attributing passive analogs for elimination synthetic processes and control their effects in later maintenance, then apply digital simulation in computer systems later. Energy flow is growth to connect autocatalytic unit for mitigation their effects in median segment (B). The boundary that is not being replaced is used for controlling recovery processes. This initial feedback from storage growth is based on a religion protective system that is uncountable as attributed to universe layer in third segment (C). The autocatalytic is characterized as well as the natural flow from available energy accumulation left to right or vies versa, remain an integral part of Odum's religious strategy. It considered for providing self-maintenance unit (i.e., photosynthesis, green metabolism process, etc...) to protect unique characteristics of processes as a partial consequence of "nature's strategy" in ecosystems [51].

The autocatalytic path with feedback of a system accelerates input–production–designs that are self–organized for maximum recovery performance [52]. The model is unified segment elements to simulate the composite behavior of energy inflow, outflow and losses of system. The language is tracing "picture mathematics" of each symbol interpolated as rigorously and mathematically defined in drawing. Thus, it's possible to view the complexity of the modern world through systems diagrams to synthesize pattern and process into predictable model. The system model breakdown processes into three mean categories as segment of layers A, B and C separate to quantify the impact or the influenced ecosystems in each layer. The impact factor is interpreted as *critical*, *safe* or *threshold* value beyond or below (un)desired effects occurs. Fig. 6 illustrates some of the interrelation to obtain equation or mathematic solution for simulations systems impact as described in [53]:

$$Impact = \sum Errors$$
$$I_r = ax + by + cz = \sum e_s \tag{3}$$

where I_r, is the reflected impact in the decline of energy systems due to slop of process deviation as a result of product dispersed or misplaced and social limited culture. The generic segment analysis is based on the presence of a dataset (x, y, z), in which (z) and (y) are the dependent variable and (x) is the independent variable.

$$X_r = a_{21}x_1 + a_{22}x_2 + \cdots + \cdots + a_{2m}x_m = 1.0 \tag{4a}$$

$$Y_r = b_{21}y_1 + b_{22}y_2 + \cdots + \cdots + b_{2m}y_m = 1.0 \tag{4b}$$

$$Z_r = c_{21}z_1 + c_{22}z_2 + \cdots + \cdots + c_{2m}z_m = 1.0 \tag{4c}$$

where a_{ij}, b_{ij} and c_{ij} are *regression coefficients* (indicating the slope of the line segments x, y, z); X_r, Y_r and Z_r are the expected ratio value for rational impacts in three dimension as (predicted impact) of x, $\mathbf{y}$ and $\mathbf{z}$ for a certain value of I_r; e_s is *regression constants* for sum of errors (indicating the intercept at the **y**-axis) [54].

B. Matrix Integration Scheme

The main matrices are classified for numerical analysis according to its physical patterns of protective systems. It exchanges element scalar information pieces (parameters) as required for starting a certain action. In each protective system, variables of independent coverage are partitioned into intervals and line segment to fit each hypothesis one. The simple linear model concerns to determine relation between main independent variables. The relation between social issues and design stage is interpreted in ***social matrix***. While economic profits and execution construction is part stage of the whole interaction as in ***economic matrix***. The human ecology based on environment parameters and operations stages is considered as a unite function together for evaluation the impact as in ***environmental matrix*** in Fig. 7 [55].

Sträßer [56] and Rodrigues [57] inferred optimization to protective components that related to main systems of constructions ecology theory. So, project stages are predicting systems information into correspondence parameter that issues along vertical and horizontal axis that contains main stages interactive matrices [58]:

- Planning and design stage related to social issues
- Construction in executive workplace depends on economics reform in terms and references
- Operation for Production refered to monitoring environmental conditions for modeling systems.

These variables are providing insights as a square matrices (i.e. a matrix with equal number of rows and columns) with (m) rows and (n) columns for non-zero elements, where 'm" is the number of nodes and 'n" is the number of edges. The rows and columns indicate a flow through terms: upstream activities in relation to a critical load process precede downstream activities for design, construction and operation stages [59].

V. THE LINEAR ANALYSIS MODEL

Elementary, composite structure is related sequential indicators in simple approach of linear model to predict relationship between individual variables in construction systems [55]. It reflects the usage of systems in a simple simulation segment of virtual model, as in design structure matrices (DSMs), dependency structure matrix, dependency source matrix, dependency map, interaction matrix, incidence matrix, precedence matrix, and others based in the literature [61].

In regression analysis, the researcher specifies an empirical model detect a relation between the values of two or more variables that contain random variation [62]. The variables are independent or explanatory values (X) split up into classes or segments. For each segment, regression has a confidence analysis to be yield the value of variable that is dependent or response variable (Y) and behaves in different form of various segments. So, the inclusion of variable is useful when the independent variables, clustered into different groups, exhibit different relationships between the variables in these regions. Otherwise, the boundaries between segments are breakpoints (i.e. as mean threshold values) for elimination overwhelmed processes. So, the segmented linear regression is considered segmented regression whereby the relations in the intervals are obtained by linear regression [63].

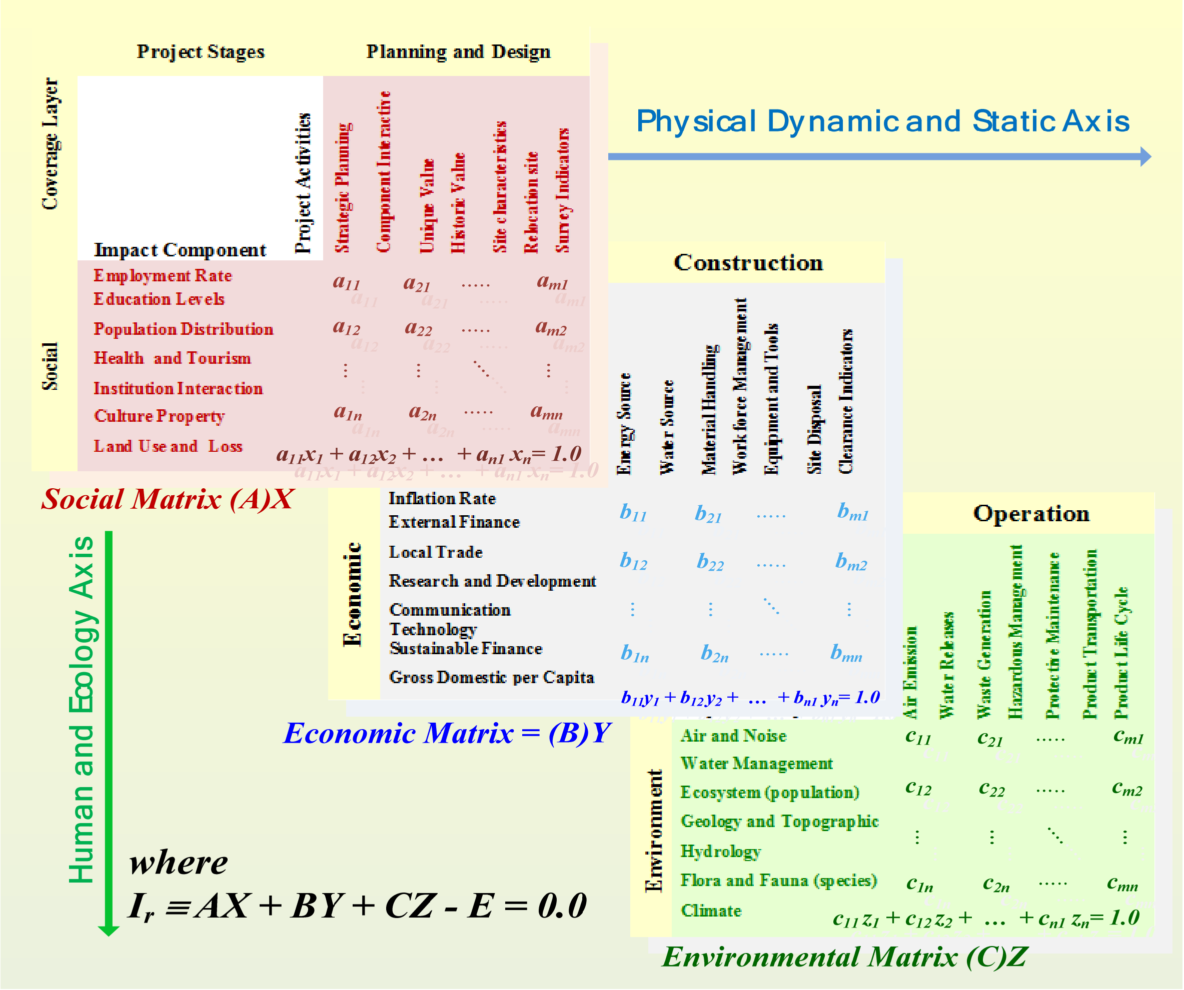


Fig. 7 Matrices Based Composite Structure Model [55]

The linear regression analysis is provided to predict the threshold limit of proposed action by probability function and binary matrices (i.e. a matrix populated with only zeros and ones). Both are matrices predicting the presence or absence of relationship between pairs of elements for system modeling. Thus, composite structure matrix is represented by two main matrices, one is containing probabilities of anthropogenic insertions information within value relations while breaking data values from analysis information in the other matrix to reflect the system interrelation and quantify the impacts [64].

A. CSMs Based Object Interpolation

This section describes the concepts of multi regression analysis and its underlying least squares fitting in vector-matrix format. In initial stage, the model decomposes components along vertical and horizontal axes. These are physical static and dynamic patterns in relations to its human-ecology and based on monitoring technology systems' insertion. Static element is representing architecture based on object-operation parameters as one independent variable (X), while human-ecology as sustainability inferred to social culture, economic and environmental parameters as one independent variable (Y). These variables are presented in a square matrix within *n* row and *m* column along main axis of label X and Y. Assume that due to some approximation in probability matrix A, a symmetric preconditioner considered for simpler iteration as illustrated in block Fig. 8 [65]. First, consider the physical interaction between protective boundary systems is **closed** (that means system is capable of recovery and mitigates the impact as, no waste is produced form export or import factors) and that all elements of product are used, system with linear equations can be expressed in matrix form [66]:

$$AX = Y \tag{5}$$

For the following equation:

$$a_{11}x_1 + a_{12}x_2 + \cdots + \cdots + a_{1m}x_m = y_1 \tag{6a}$$

$$a_{21}x_1 + a_{22}x_2 + \cdots + \cdots + a_{2m}x_m = y_2 \tag{6b}$$

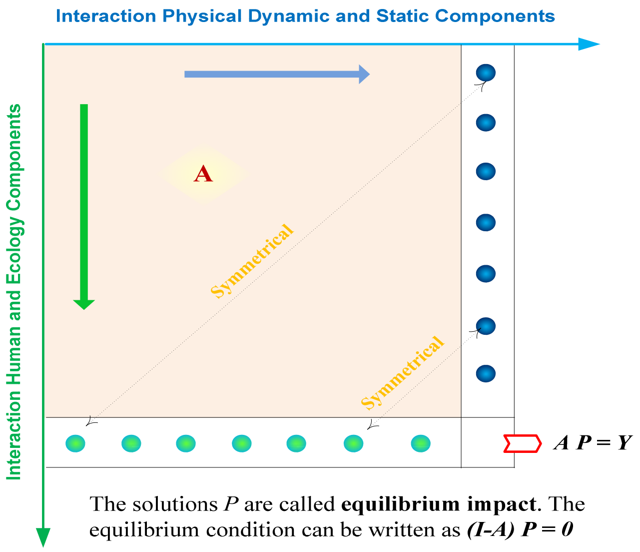
$$a_{n1}x_1 + a_{n2}x_2 + \cdots + \cdots + a_{nm}x_m = y_n \tag{6c}$$

Given two variables $i = (1,2,\dots,n)$ and $j = (1,2,3,\dots,m)$, let a_{ij} present the probability of the total annual output of project dependable variable *j* that is respond independence variable *i* .

A special notation has been devised for the entries of a matrix.

If (A) is an $(n \times m)$ matrix, and if the (i, j)-entry of A is denoted as a_{ij}, then A is displayed as:

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1m} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2m} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & a_{nm} \end{bmatrix}, \quad X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_m \end{bmatrix}, \quad Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ \vdots \\ y_n \end{bmatrix}$$



The solutions *P* are called **equilibrium impact**. The equilibrium condition can be written as ***(I-A) P* = *0***

Fig. 8 The Model of Social Matrix [65]

This is a system of homogeneous equations for a number of linear independence equations more than numbers of unknown or total number of zeros less than unknown variable. So, next section will use approximation for optimization (X) and then invert (A) using condition distribution of response variable closer to Gauss's formulation of 1821 [67] including Gauss-Markov theorem to obtain solution for (Y) by multi regression analysis combined with its underlying least squares fitting in vector–matrix format.

B. Linear Multi Regression Analyses

Standard linear regression models are broadly a number of hypotheses that the predictor variables, the response variables and their relationship are weighted [68]. The linear regression model is fitted when identifying relationship between a single predictor variable x_j with the response variable y while other predictor variables in the model are "held fixed". Clearly, the interpretation variable (b_j) is the expected with correspondence in (y) for a one-unit change in (x_j) when the other covariates are held fixed—that is, reflected in the value of the partial derivative of (y) with respect to (x_j). In contrast, the *marginal effect* of (x_j) on (y) is evaluated using a simple linear regression relating only (x_j) to (y); this result is the total derivative of (y) to (x_j). Generally these make the estimation more complex and time–consuming. This extension is known as *multiple linear regressions*, or *multivariable linear regression*. The vector–valued predictor variables denoted with a capital *X*. The linear multi regression analysis is fitting the response variable to the group of predictor variables as illustrated in Fig. 9 [69].

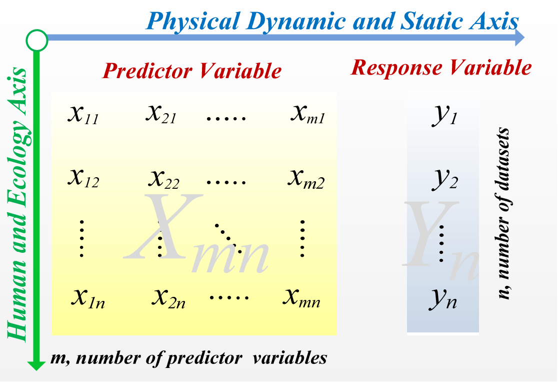


Fig. 9 Multi regression analyses dataset [69]

Multiple regressions are one of the most common statistical methods used in quantitative independence variables. These variables are X_i's and *Y's* which represent the predictor variables (x_{i*} data) and response variables ($y*$ data), respectively. * is a wild card, Y is estimated from the multi regression model and b_i [b_o, b_1, ……. b_m] are the regression coefficients. This is as so to identify the regression coefficient such that the estimated value Y from (7) best explains the true value y in the given dataset as a multi regression model refers to [70]:

$$Y = b_o + b_1 x_1 + b_2 x_2 + \cdots + \cdots + b_m x_m \tag{7}$$

To avoid the problems associated with absolute value calculations, the square of the errors (E) is minimized instead. This is known as the least squares method. Numerically, we identify [b_o, b_1, ……. b_m] such that the expression:

$$E \equiv \sum_{i=1}^{n}(y_i - Y_i)^2 = \sum_{i=1}^{n}\left(y_i - (b_o + b_1 x_{1i} + b_2 x_{2i} + \cdots + \cdots + b_m x_{mi})\right)^2 \tag{8}$$

In this case, the regression equation is that of a surface, and the error E defined in (8) can be calculated as the distance between the flat surface and the data points, projected onto the y-axis.is minimized. Since E is a function of [b_o, b_1, ……. b_m], this problem is equivalent to minimizing E; that is:

$$\frac{\delta E}{\delta b_o} = 0 \Leftrightarrow -1 \times 2 \sum_{i=1}^{n}\left(y_i - (b_o + b_1 X_{1i} + \cdots + b_m X_{mi})\right)$$
$$\Leftrightarrow n b_o + b_1 \sum_{i=1}^{n} x_{1i} + b_2 \sum_{i=2}^{n} x_{2i} + b_m \sum_{i=m}^{n} x_{mi} = \sum_{i=1}^{n} y_i \tag{9}$$

where the first equivalence is derived from the chain rule of differentiation [66].

$$\frac{\delta E}{\delta b_1} = 0 \Leftrightarrow -\sum_{i=1}^{n} x_{1i} \times 2 \sum_{i=1}^{n}\left(y_i - (b_o + b_1 x_{1i} + \cdots + b_m x_{mi})\right) = 0$$
$$\Leftrightarrow b_o \sum_{i=1}^{n} x_{1i} + b_1 \sum_{i=1}^{n} {x_{1i}}^2 + b_2 \sum_{i=1}^{n} x_{1i} x_{2i} + b_m \sum_{i=1}^{n} x_{1i} x_{mi} = \sum_{i=1}^{n} x_{1i} y_i \tag{10}$$

$$\frac{\delta E}{\delta b_m} = 0 \Leftrightarrow -\sum_{i=1}^{n} x_{mi} \times 2 \sum_{i=1}^{n} \left(y_i - (b_o + b_1 x_{1i} + \cdots + b_m x_{mi})\right) = 0$$
$$\Leftrightarrow b_o \textstyle\sum_{i=1}^{n} x_{1i} + b_1 \sum_{i=1}^{n} x_{1i} x_{mi} + b_2 \sum_{i=1}^{n} x_{2i} x_{mi} + b_m \sum_{i=1}^{n} x_{mi}^2 = \sum_{i=1}^{n} x_{mi} y_i \qquad (11)$$

Summarizing (9)-(11) and expressing in a vector–matrix format, we get:

$$X^T X\, b = X\, Y \qquad (12)$$

where

$$X = \begin{bmatrix} 1 & 1 & 1 & & 1 \\ x_{11} & x_{12} & x_{13} & \dots & x_{1n} \\ a_{21} & a_{22} & a_{23} & \dots & x_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & x_{m3} & \cdots & x_{mn} \end{bmatrix}, \quad Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}, \quad b = \begin{bmatrix} b_o \\ b_2 \\ \vdots \\ b_m \end{bmatrix}$$

Equation (12) is known as the characteristic equation of the least squares method. Solving (12) for b gives:

$$b = [X^T X]^{-1} X\, Y \qquad (13)$$

Thus, we have shown that [b_0, b_1, ……. b_m] is the over determined solution of (13). So, it will need optimization for exact soulution.

C. Least Square Solution

It is common to apply the ordinary least squares method to minimize the residuals (vertical distances between the points of the data set and the fitted line) and to find an approximate solution to overdetermined systems. This hypothesis reflects the accuracy of sample points measured by the sum of squared residuals passing through a line or flat surface for a solution aim to make this sum is fitting smaller as possible. The idea of least–squares analysis is independently formulated by the Adrain [71]. The future analysis will widen a range of theory depends on errors detections as in statistics to determine least squares in different segment as stand–determining system for more exact and reliance solution of each independent implementation [67].

The solution via variation methods leads to set (n) numbers of linear equations exist, each has (m) unknowns, as shown below. To solve this set of simultaneous equations, we must obtain the unknown numbers $x_1, \ldots, x_m$.

$$a_{11}\, x_1 + a_{12} x_2 + \cdots + \cdots + a_{1m} x_m = b_1 \qquad (14a)$$

$$a_{21} x_1 + a_{22} x_2 + \cdots + \cdots + a_{2m} x_m = b_2 \qquad (14b)$$
$$\vdots$$

$$a_{n1} x_1 + a_{n2} x_2 + \cdots + \cdots + a_{nm} x_m = b_2 \qquad (14c)$$

Consider:

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} & \cdots & a_{1m} \\ a_{21} & a_{22} & a_{23} & \cdots & a_{2m} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & a_{n3} & \cdots & a_{nm} \end{bmatrix}, \quad X = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ \vdots \\ x_m \end{bmatrix}, \quad b = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ \vdots \\ b_n \end{bmatrix}$$

Here, if m > n, i.e., if the number of unknowns exceeds the number of equations, the system permits an infinite number of solutions, and is hence referred to as indeterminate. As should be familiar from junior-school algebra, a unique solution is obtained only *when* $m = n$. Solutions to (14) are then obtained as in [73]:

$$b = AX \Leftrightarrow X = A^{-1} b \qquad (15)$$

How do we tackle the situation in which more equations exist than unknowns i.e., m < n? We adopt the least squares method, expressing (14) as (the reader should confirm this carefully):

$$A^T\, b = [A^T\, A]\;\; X \qquad (16)$$

A^T^ is called the adjoint matrix of **A**. The adjoint is the transpose of the conjugate complex of **A**. For a matrix of real numbers; the adjoint and transpose are identical. (16) is easily the solution of which can be written with the normal equations solved as:

$$X = [A^T\, A]^{-1}\, A^T\, b \qquad (17)$$

This is the least square solution. The matrix $\boldsymbol{[A^T A]^{-1}\, A^T}$, called the generalized inverse matrix, reduces to the standard inverse when $m = n$. This relatively simple problem has been dealt with some detail to illustrate some or processes used in solving systems of equations. This formula is an approximate solution when no exact solution exists, and it gives an exact solution when one does exist [74].

To confirm that the least squares coordinates equal the sum of squares of the distance from the straight line, consider the best-fit line to the provided dataset is:

$$a_{i1} X_1 + a_{i2} X_2 = b_i \qquad (18)$$

The equation of the straight-line perpendicular to (18) which passes through the least squares solution (X_1^{LSS}, X_2^{LSS}) with careful choice of direction vector, is expressed as

$$-a_{i2} X_1 + a_{i1} X_2 = -a_{i2} X_1^{LSS} + a_{i1} X_2^{LSS} \qquad (19)$$

Since the base of the perpendicular line $(X_1^P, X_2^P)$is the intersection between (18) and (19), and (18) and (19) can be solved simultaneously,

$$X_1^P = \frac{a_{i2}^2 X_1^{LSS} - a_{i1} a_{i2} X_2^{LSS} + a_{i1} b_i}{a_{i1}^2 + a_{i2}^2}$$
$$X_2^P = \frac{-a_{i1}^2 a_{i2}^2 X_1^{LSS} + a_{i1} a_{i2} X_2^{LSS} + a_{i2} b_i}{a_{i1}^2 + a_{i2}^2} \qquad (20)$$

Hence, the length of the perpendicular line is:

$$l_i^{\,2} = (X_1^{LSS} - X_1^P)^2 + (X_2^{LSS} - X_2^P)^2$$
$$l_i^{\,2} = \left[\frac{a_{i1}^2 X_1^{LSS} + a_{i1} a_{i2} X_2^{LSS} - a_{i2} b_i}{a_{i1}^{\,2} + a_{i2}^{\,2}}\right]^2 + \left[\frac{a_{i1} a_{i2} X_1^{LSS} + a_{i2}^{\,2} X_2^{LSS} - a_{i2} b_i}{a_{i1}^{\,2} + a_{i2}^{\,2}}\right]^2$$

$$l_i{}^2 = \frac{a_{i1}{}^2(a_{i1}X_1^{LSS} + a_{i2}{}^2X_2^{LSS} - b_i)^2}{[a_{i1}{}^2 + a_{i2}{}^2]^2} + \frac{a_{i2}{}^2(a_{i1}X_1^{LSS} + a_{i2}{}^2X_2^{LSS} - b_i)^2}{[a_{i1}{}^2 + a_{i2}{}^2]^2}$$

$$l_i{}^2 = \frac{\left(a_{i1}X_1^{LSS}+a_{i2}{}^2X_2^{LSS}-b_i\right)^2}{a_{i1}{}^2+a_{i2}{}^2} \tag{21}$$

Therefore, the sum of squared errors is:

$$S = \sum_{i=1}^{5} l_i{}^2 = \sum_{i=1}^{5} \frac{\left(a_{i1}X_1^{LSS}+a_{i2}{}^2X_2^{LSS}-b_i\right)^2}{a_{i1}{}^2+a_{i2}{}^2} \tag{22}$$

In the general case with m unknowns and n equations, the sum of squared errors becomes:

$$S = \sum_{i=1}^{n} \frac{\left(\sum_{j=1}^{m} a_{ij}\, X_j^{LSS}-b_i\right)^2}{\sum_{j=1}^{m} a_{ij}{}^2} \tag{23}$$

Similarly, from (9)-(11) in the multi regression analysis, we set $\frac{\delta S}{\delta X_j^{LSS}} = 0$ (where j is an integer such that (j ≤ m) to obtain (16) and (17). Fig. 10 illustrates the relationship between the flat surface described by (7) and the plotted dataset. In this case, the regression equation is that of a flat surface, and the error E defined in (8) can be understood as the distance between the flat surface and the data points, projected onto the y-axis.

As explained above, multi-regression analysis and least squares solutions principally share a common basis, and the reader has probably understood that both concepts are based on the least squares method [75].

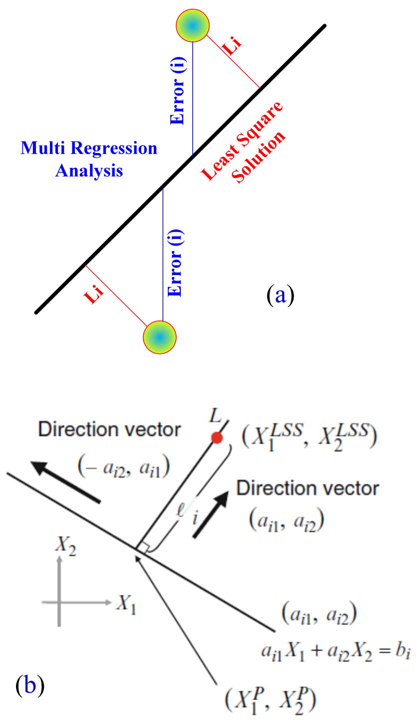


Fig. 10 Difference in geometric interpretation between multi-regression analysis (a) and the least squares solution (b) [74]

VI. CONCLUSION

Ecology of constructions' peripheral does remain discretely integrated despite their obvious mutual relevance. Such integration poses serious challenges: evolutionary mechanics' and ecologists' conceptualizations of the dynamic world -and the models and theories based upon them- are conceptually incompatible. The interaction mechanism of electric and mechanic interfaces to environmental systems by ecologists (ecosystem engineering theory) have limited data to set a gap bridge for separating frameworks, but conceptual integration of sustainability has achieved so far limited. Other integration extension responds to theory *-composite structural models-* now promises to achieve a potential integration of ecological conceptual sustainability frameworks. Construction ecology theory, as initially formulated, elucidate dispersed points about raises adverse philosophy about how to select and integrate idealized thinking in models of complex phenomena, which can be addressed with the mathematic developed by biologists, engineers scientists and philosophers on the interblent strategies in model-building of the complex systems [76]. The model appraises critical areas for integration LCA with physical features of subsystems components. However, no life cycle impact assessment phase is included in the large scales for evaluation energy conservation from artificial insertion flows (i.e., lighting and cooling systems of indoor system to compare natural conditions of an equivalent outdoor system). Therefore, the paper is not really exploring many possibilities within the short time frameworks that typically available in planning processes of an SLCIA. It implements a framework in terms of upgrading LCA model to demonstrate systems ecology by both abstract data and by collection procedures from available plants according to recommendation scale of different environmental systems [77].

Eventually, the basic architecture of construction ecology, from prospective terms of ecosystems and systems ecology is emerging control features to eliminate synthetic operations and balance the adverse impact control in a natural ecosystem [78]. This basic concept is referring engineering all of these terms as broadly applied in design as CSM that integrates Odum diagram with interactive matrix for evaluation the impact of constructions ecology. Due to the complexity of environmental systems, various computer–aided simulation models based in mathematics are still in progress as so, digital computer systems are required for effective management that help decision makers to reach their final decision. The result is an opening up of new pathways for conceptual analysis change, empirical investigation of methodology and reconsideration as only just begun for integration modeling and engineering management systems [79].

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during final analysis of environmental impact assessment.

REFERENCES

[1] UE: Public Policy Initiatives to Promote the Uptake of Environmental Modeling Systems in Small and Medium-Sized Enterprises. Final report of the best project expert group January 2004.

[2] Robert K H, “*Tools and Concepts for Sustainable Development, how do they relate to A General Framework for Sustainable Development, and to each other*”, Journel of Clearner Production, Vol. (8): pp. 12, 2001.

[3] Howard Thomas Odum, (1999), “*Material Circulation, Energy Hierarchy, and Building Construction*”, Paper for the 1999 Rinker Eminent Scholar Workshop on Construction Ecology and Metabolism. Center for Construction and Environment, University of Florida, Gainesville. 1999

[4] Ellis E C, (2011), “*Anthropogenic Transformation of the Terrestrial Biosphere*”. Proceedings of the Royal Society A: Mathematical, Physical and Engineering Science, Vol. (369): pp.1010–1035, 2011.

[5] Steffen W, Grinevald J, Crutzen P, and McNeill J, (2011), “*The Anthropocene: Conceptual and Historical Perspectives*”, Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, Vol. (369): pp. 842–867, 2011.

[6] Zalasiewicz J, Crutzen P J, and Steffen W, (2012), “*The Anthropocene*”, Pages 1033–1040 in F. M. Gradstein, J. G. Ogg, M. Schmitz, and G. Ogg, editors, “*The Geologic Time Scale*”, 2012. Elsevier Science, Oxford, UK. 2012

[7] Smith B D and Zeder M A, (2013), “*The Onset of the Anthropocene*”, Anthropocene, Vol. (4): pp. 8–13, 2013.

[8] Anthony D. Barnosky, Elizabeth A. Hadly, Jordi Bascompte, Eric L. Berlow, James H. Brown, Mikael Fortelius, Wayne M. Getz, JohnHarte, Alan Hastings, Pablo A. Marquet, Neo D. Martinez, Arne Mooers, Peter Roopnarine, Geerat Vermeij, John W. Williams, Rosemary Gillespie, Justin Kitzes, Charles Marshall, Nicholas Matzke, David P. Mindell, Eloy Revilla and Adam B. Smith, (2012), “*Approaching a State Shift in Earth’s Biosphere*”, Nature, Vol. (486): pp. 52–58, 2012.

[9] Howard Thomas Odum, (1950), “*The Biogeochemistry of Strontium: With Discussion on the Ecological Integration of Elements”,* A Dissertation presented to the Faculty of the Graduate School of Yale University in Candidacy for the Degree of Doctor of Philosophy, Said that: “*It is postulated that there is a natural selection of the possible systems that’s entail mechanisms of maintaining stability. If this postulate is applied for recovery all of nature in equilibrium conditions, the resulting proposition is that nature is as a whole in a steady state or is in the most possible stable performance form and constitutes one big entity. This does not necessarily contradict evolutionary changes in the earth's history since these changes may be part of a larger steady state system”,* Odum pp.6–8, 1950. Accessed in July 2017. http://onlinelibrary.wiley.com

[10] Schoener, Thomas W, (2011), “*The Newest Synthesis: Understanding the Interplay of Evolutionary and Ecological Dynamics*”, Science Vol (331) (6016): pp. (426–429), 2011.

[11] Jiang Z G, (1996), “*Conservation Biology*”, Zejiang Science and Technology. 132 – 142, 1996.

[12] Janzen, Daniel H, (1966), “*Coevolution of Mutualism between Ants and Acacias in Central America*”, Evolution Vol. 20(3): pp. 249–275, 1966

[13] Dawkins, Richard, (1982), “*The Extended Phenotype*”, New York: Freeman, 1982

[14] Dawkins, Richard, (2004), “*Extended Phenotype – But not too Extended*”, (*A reply to Laland, Turner and Jablonka*), Biology and Philosophy, Vol. 19(3): pp. 377–396, 2004

[15] Jones, Clive G, John H Lawton, and Moshe Shachak, (1994), “*Organisms as Ecosystem Engineers*”, Oikos Vol. 69(3), pp. 373–386, 1994.

[16] Jones, Clive G John H Lawton, and Moshe Shachak, (1997), “*Positive and Negative Effects of Organisms as Physical Ecosystem Engineers*”, Ecology, Vol. 78(7): pp.1946–1957, 1997.

[17] Jonathan W Moore, (2006), “*Animal Ecosystem Engineers of Streams*”, BioScience, Vol. 56(3): 237–246, 2006. https://doi.org/10.1641/0006-3568(2006)056(0237:AEEIS]2.0.CO;2.

[18] Cole R J, Rousseau D, Theaker G T, (1993), “*Building Environmental Performance Assessment Criteria (BEPAC)*”, Vancouver: BEPAC Foundation; 1993.

[19] Berardi U, (2012), “*Sustainability Assessment in the Construction Sector: Rating Systems and Rated Buildings*”, Sustainable Development vol. 20(6):411–24, 2012.

[20] USGBC (United States Green Building Council) LEED – Leadership in Energy and Environmental Design, (1999), “*Green Building Rating System*”, version 1.0. US Green Building Council; 1999.

[21] Trabucco D, Wood A, Popa N, Vassart O and Davies D, (2015), “*Life Cycle Assessment of Tall Building Structural System*”, Council on Tall Building and Urban Habitat: Chicago, 2015

[22] Cuddington, Kim, Will G Wilson, and Alan Hastings, (2009), “*Ecosystem Engineers: Feedback and Population Dynamics*”, American Naturalist, Vol. 173(4): pp. 488–498, 2009.

[23] Sarah K Berke, (2010), “*Functional Groups of Ecosystem Engineers: A Proposed Classification with Comments on Current Issues*”, Integrative and Comparative Biology, Vol. 50(2): pp. 147–157, 2010. https://doi.org/10.1093/icb/icq077

[24] Laland, Kevin N, Kim Sterelny, John F, Odling-Smee, William Hoppit, and Tobias Uller, (2011), “*Cause and Effect in Biology Revisited: Is Mayr’s Proximate-Ultimate Dichotomy Still Useful*?”, Science, Vol. 334 (6062): pp.1512–1516, 2011

[25] Goodland, R, and Sadler B, (1996), “*The Analysis of Environmental Sustainability: From Concepts to Applications”*, International Journal of Sustainable Development, Vol (3): pp. (2-21), 1996.

[26] Howard Thomas Odum, et al. (1963), “*Experiments with Engineering of Marine Ecosystems*”, in: Publication of the Institute of Marine Science of the University of Texas, Vol. (9): pp. 374–403, 1963.

[27] Blunt M and Rubin B, “*Implicit Flux Limiting Schemes for Petroleum Reservoir Simulation* ”, 2nd European conference on mathematics of oil recovery, Arles, France, © Dominique Guerillote, and Olivier Guillon (Editors) and Editions Technip, pp. (131-138), September 11–14, 27rue Ginoux, 75015 Paris, 1990. Available on:https://books.google.com.eg

[28] Rahim Aguejdad, Thomas Houet, and Laurence Hubert-Moy, “*Spatial Validation of Land Use Change Models Using Multiple Assessment Techniques: A Case Study of Transition Potential Models*”, Environ Model Assess DOI 10.1007/s10666-017-9564-4, Received: 17 December 2015 /Accepted: 1 June 2017 Springer International Publishing AG Switzerland, 2017.

[29] Wilson A G, “*A Statistical Theory of Spatial Distribution Models*”, Transport Res; Vol. 1(3): pp. (253–269), 1967.

[30] Hoyles C, Wolf A, Molyneux–Hodgson S and Kent P. (2002), “*Mathematical Skills in the Workplace*”, London: The Science, Technology and Mathematics Council. 2002. Retrieved from http://eprints.ioe.ac.uk/1565/1/Hoyles2002MathematicalSkills.pdf

[31] Fotheringham A Stewart, Brunsdon Chris and Charlton Martin, (2002), “*Geographically Weighted Regression: The Analysis of Spatially Varying Relationships*”, (Reprint ed.), Chichester, England: John Wiley, 2002. ISBN: 978-0-471-49616-8

[32] Benjamin S Blanchard, and Walter J Fabrycky, (2010), “*Systems Engineering and Analysis*”, (5th ed.) New Jersey: Prentice Hall International Seiries in industrial and systems engineering, Pages 800, 2006. ISBN-13: 978-0132217354

[33] U S Green Building Council, (2013), “*Materials and Resources Credit: Building Life Cycle Impact Reduction*”, LEED Reference Guide for Building Design and Construction, http://www.usgbc.org,guide/dbc

[34] Jaap Bakker, Dan M. Frangopol, Klaas van Breugel, (2016) “*Life-Cycle of Engineering Systems: Emphasis on Sustainable Civil Infrastructure: Proceedings of the Fifth International Symposium on Life-Cycle Civil Engineering (IALCCE 2016)*”, 16-19 October 2016, Delft, The Netherlands, 438 Pages, CRC Press, ISBN 9781138028470 - CAT# K26754, 2016

[35] Magdalena Svanström, Sara Heimersson, Gregory Peters, Robin Harder, David I'Ons, Anders Finnson and Jesper Olsson, (2017) “*Life Cycle Assessment of Sludge Management with Phosphorus Utilisation and Improved Hygienisation in Sweden”*, ©IWA Publishing Water Science and Technology (0273-1223), Vol. 75 (2017), 9: pp. 2013-2024. available Online, wst2017073; doi**:** 10.2166/wst.2017.073

[36] Dayong Wu, Changwei Yaun, Wesly Kumfer, and Hongchao Liu, “*A Life-Cycle Optimization Model Using Semi-Markov Process for Highway Bridge Maintenance*”, Applied Mathematical Modeling, Volume (43) March, pp. 45–60, 2017

[37] Macklin S, Lyon D, and Bisset R, (2002), “*How to Embed Social Impact Assessment into Management Systems–the Development of Shell’s Integrated Impact Assessment Guidelines”,* Paper presented to the Annual Conference of the International Association of Impact Assessment, The Hague, The Netherlands, 2002.

[38] Andrea Titi and Fabio Biondini, (2012), "*Validation of Diffusion Models for Life Cycle Assessment of Concrete Structures*", Third International Symposium on Life Cycle Civil Engineering (IALCCE 2012), Vienna, Austria, October 3-6 in: Life Cycle And Sustainability of Civil Infrastructure Systems, Strauss A, Fragopol DM, Bergmeister (Eds.), CRC Press/Balkema, Taylor &Frances Group, London, UK, 2013.

[39] Barone G and Frangopol D M, (2014a), "*Life Cycle Maintenance and Deterioration Structure by Mulit–Objective Optimization Involving Reliability, Risk, Availability, Hazard and Cost*", Structural Safety, Vol (48):pp. 40–50, 2014.

[40] Schirmer P, Van Eggermond M and Axhausen K W, (2013), "*Measuring Location in Residential Location Choice: An Empirical Study on the Canton of Zürich*", In: 13th International Conference on Computers in Urban Planning and Urban Management, Utrecht, the Netherlands, 2–5 July 2013. Berlin, Germany: Springer. 2013.

[41] Sadler B, (2002), "*From Environmental Assessment to Sustainability Appraisal*?" Environmental Assessment Yearbook 2002, Institute of Environmental Management and Assessment, Lincoln and EIA Centre, University of Manchester, pp. (145–152), 2002.

[42] Mitsch W.J. and Jorgensen S.E. (1989), "*Introduction to Ecological Engineering*" In: W.J. Mitsch and S.E. Jorgensen (Editors), Ecological Engineering: An Introduction to Ecotechnology, John Wiley & Sons, New York, pp. 3–12, 1989.

[43] Howard Thomas Odum, (1994), "*Ecological and General Systems: An Introduction to Systems Ecology*", (Revised edition of Systems Ecology, 1983, Wiley, New York) University Press of Colorado, pp. 644, 1994.

[44] Noss R and Hoyles C, (2011), "*Modeling to address Techno-Mathematical Literacies in Work*", In G. Kaiser, W. Blum, R. B. Ferri, & G. Stillman (Eds.), Trends in teaching and learning of mathematical modelling, New York, NY: Springer, (pp. 75–78), 2011.

[45] Noss, R, Bakker A, Hoyles C and Kent, P, (2007), "*Situating graphs as workplace knowledge*", Educational Studies in Mathematics, Vol. 65(3): pp.367–384, 2007.

[46] Eva Jablonka and Uwe Gellert, (2007), "*Mathematisation–Demathematisation*: *Social, philosophical and educational ramifications*", Rotterdam-Taipei: Sense Publishers, pp. 1-18, 2007. ISB: 90 8790 011 2.

[47] Felix Müller, Broder Breckling, Fred Jopp, and Hauke Reuter, (2011), "*What Are the General Conditions under which Ecological Models can be Applied*", In Journal of Modeling Complex Ecological Dynamics, Springer, pp. 13–14, 2011. ISBN: 978–3–642–05028–2

[48] Odum Eugene Pleasants, (1969), "*The Strategy of Ecosystem Development*", Science 164 (April 18): 262–270, 1969

[49] Odum, H.T., Odum, E.C, (2000), "*Modeling for All Scales, an Introduction to System Simulation*", Academic Press, San Diego, CA, pp.458, 2000.

[50] Howard Thomas Odum, (1972a), "*Use of Energy Diagrams for Environmental Impact Statements. In: Tools for Coastal Management*", Proceedings of the Conference February 14–15, 1972, Marine Technology Society, Washington DC, pp. 197–213, 1972

[51] Howard Thomas Odum, (1972b), "*An Energy Circuit Language for Ecological and Social Systems: Its Physical Basis*", In: Patten, B. (Ed.), Systems Analysis and Simulation in Ecology, Academic Press, New York, Vol. (2): pp. 139–211, 1972.

[52] Howard Thomas Odum, (1983), "*Systems Ecology: An Introduction*", Wiley, New York, pp. 644, 1983.

[53] Joshua Millspaugh and Frank Thompson (2008), "*General Principles for Developing Landscape Models for Wildlife Conservation: Models for planning wildlife conservation in large landscapes*", Academic Press, Pages 720, 2008. ISBN: 9780123736314.

[54] Golushko S K, (2017), "*Mathematical Modeling and Numerical Calculation of Composite Structures*", IOP Conference Series: Journal of Physics: Conf. Series 894 (2017) 012021 doi :10.1088/1742-6596/894/1/012021, IOP publication Ltd available at internet site: http://iopscience.iop.org/article/10.1088/1742-6596/894/1/012021/pdf

[55] Shukla J B, Hallam T G, and Capasso V, (1987), "*Mathematical Modeling of Environmental and Ecological Systems*", Volume 11, Elsevier Science, 1st October 1987. ISBN: 9780444597687

[56] Sträßer, R, Damlamian, A and Rodrigues J F, (2012), "*Educational Interface Between Mathematics And Industry (ICMI-ICIAM-Study 20)*", Pre proceedings of ICME12, The 12th International Congress on Mathematics Education, (pp. 7863–7874), July 8-15, Seoul, Korea, 2012

[57] Rodríguez E, Bosch M and Gascón, J, (2008), "*A Networking Method to Compare Theories: Metacognition in Problem Solving Reformulated Within the Anthropological Theory of the Didactical*", ZDM, 40(2), 287–301, 2008.

[58] Eager E A, (2012), "*Modeling and Mathematical Analysis of Plant Models in Ecology*", (2012). Dissertations, Theses, and Student Research Papers in Mathematics, University of Nebraska, Lincoln, 2012. available at: http://digitalcommons.unl.edu/mathstudent/34

[59] Winsløw C, (2011), "*Anthropological Theory of Didactic Phenomena: Some Examples and Principles of Its Use in the Study of Mathematics Education*", In. Bosch M, Gascón J., Ruiz Olarría A., Artaud M., Bronner A, Chevallard Y, Cirade G, Ladage C and Larguier M, (Eds.), "Un panorama de TAD, CRM Documents 10", Bellaterra (Barcelona): Centre de Recerca Matemàtica, pp. 117-138, 2011.

[60] Suro–Prez V, and Journel A. G, (1990) "*Stochastic Simulation of Lithofacies: An Improved Sequential Indicator Approach*", 2nd European conference on mathematics of oil recovery, September 11-14, Arles, France. © Dominique Guerillote, and Olivier Guillon (Editors) and Editions Technip, pp. 3-10, 27rue Ginoux, 75015 Paris 1990. Available on https://books.google.com.eg

[61] Fotheringham A S, and Wong, D W S, (July 1, 1991). "*The Modifiable Areal Unit Problem in Multivariate Statistical Analysis*", Environment and Planning A, Vol. 23 (7): pp.1025–1044, 1991. doi:10.1068/a231025

[62] Oosterbaan R J, Sharma D P, Singh K N and Rao K V G K, (1990), "*Crop Production and Soil Salinity: Evaluation of Field Data from India by Segmented Linear Regression*", In: Proceedings of the Symposium on Land Drainage for Salinity Control in Arid and Semi-Arid Regions, February 25th to March 2nd, 1990, Cairo, Egypt, Vol. 3, Session V, pp. 373 – 383, 1990.

[63] Ritzema H P, Chapter 6 in: (ed., 1994), "*Frequency and Regression Analysis: Drainage Principles and Applications*", Publ. 16, pp. 175–224, International Institute for Land Reclamation and Improvement (ILRI), Wageningen, The Netherlands. ISBN 90–70754–33–9, 1994

[64] Spandaw J, (2011), "*Practical Knowledge of Research Mathematicians, Scientists and Engineers about the Teaching of Modelling*", In. Kaiser G, Blum W,. Borromeo Ferri, R and Stillman G, (Eds.), "Trends in teaching and learning of mathematical modelling" pp. 679–688). New York: Springer.

[65] Espedal M S, Ewing R E, and Russell T F, (1990), "*Mixed Methods, Operator Splitting, and Local Refinement techniques for Simulation on Irregular Grids*", 2nd European conference on mathematics of oil recovery, September 11-14, Arles, France. © Dominique Guerillote, and Olivier Guillon (Editors) and Editions Technip, pp. 37-345. 27rue Ginoux, 75015 Paris, 1990. Available on https://books.google.com.eg

[66] Philip N Klein, (2013), "*Coding the Matrix: Linear Algebra through Computer Science Applications*", Newtonian Press, 2013 ISBN 061585673X, 9780615856735-530 pages, 2013.

[67] Johann Carl Friedrich Gauss, (1832) "*Theoria Combinationis Observationum Erroribus Minimis Obnoxiae*", (1821/1823).

[68] Johansen T, and Winther R, (1990), "*Mathmatical and Numerical analysis of a Hyperbolic Systems Modeling Solvent Flooding*", 2nd European conference on mathematics of oil recovery, September 11-14 Arles, France. © Dominique Guerillote, and Olivier Guillon (Editors) and Editions Technip, pp. 219-234. 27rue Ginoux, 75015 Paris, 1990. Available on https://books.google.com.eg

[69] Armstrong J Scott (2012), "*Illusions in Regression Analysis*", International Journal of Forecasting (forthcoming). 28 (3): 689. doi:10.1016/j.ijforecast.2012.02.001, 2012

[70] Seibold D R, and McPhee R D, (1979), "*Commonality Analysis: A Method for Decomposing Explained Variance in Multiple Regression Analyses*", Human Communication Research, Vol. (5): pp.355-365. 1979. DOI:10.1111/j.1468-2958. Google Scholar CrossRef

[71] Robert Adrain, (1808), "*Research Concerning The Probabilities of the errors which Happen in Making Observations*", The Analyst, or Mathematical Museum, Vol. (I), Article XIV, pp 93–109, Philadelphia: William P. Farrand and Co., 1808.

[72] Aldrich J, (1998), "*Doing Least Squares: Perspectives from Gauss and Yule*", International Statistical Review, Vol. 66 (1): pp. 61–81, 1998. doi:10.1111/j.1751-5823.1998.tb00406.x, 1998.

[73] Tofallis C, (2009), "*Least Squares Percentage Regression*", Journal of Modern Applied Statistical Methods, Vol. (7): pp. 526–534, 2009. SSRN 1406472

[74] Lai T L, Herbert Robbins, and Wei C Z, (1978), "*Strong Consistency of Least Squares Estimates in Multiple Regressions*", PNAS, Vol. 75 (7): pp. 3034–3036, 1978. https://doi.org/10.1016/0047-259X(79)90093-9

[75] Hermitte T, and Guerillot D, (1990), "*Data Structure and Algorithms for Adaptive Mesh Refinement*", 2nd European conference on mathematics

of oil recovery, September 11-14, Arles, France. © Dominique Guerillote, and Olivier Guillon (Editors) and Editions Technip, pp. 271-280, 27rue Ginoux, 75015 Paris, 1990, Available on: https://books.google.com.eg.

[76] Howard Anton and Chris Rorres, (2010), "*Elementary Linear Algebra*", (10th ed.), John Wiley and Sons, Inc. Pages 792, 2005. ISBN-13: 978-0470559925.

[77] Richard L. Jr. Branham, (1990), "*Scientific Data Analysis: An Introduction to Overdetermined Systems*", Springer, pages 237, 1990. ISBN-13: 978-1461279815

[78] Michel Loreau and Grigoris Kylafis, (2008), "*Ecological and Evolutionary Consequences of Niche Construction for Its Agent*", Ecology Letters, Vol. 11(10): pp. (1072–1081), 2008. DOI: 10.1111/j.1461-0248.2008.01220.x

[79] Charles J Kibert,, Jan Sendzimir, and Bradley Guy G, (2003), "*Construction Ecology: Nature as a Basis for Green Buildings*", Technology and Engineering, Construction, General, Routledge, 2003 ISBN: 1134508301, 9781134508303 - 336 pages.