A New Model for Assessing Sustainability of Complex Systems

Integrating LCA and RA for Sustainability

Gayathri Babarenda Gamage

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ABSTRACT

Assessment of sustainability is an essential step in determining if action taken is sustainable. Early research in sustainability assessment was based on reconciling the three pillars (environmental, economic and social) using the weak sustainability model. Today there are numerous indicators (single and composite) for measuring impacts in the three systems (environmental, economic and social) using the strong sustainability model where current thinking emphasises the need for system thinking rather than the reductionist concept of pillars. Most existing indices/methods measure single aspects of sustainability and the more integrated indicators are aimed at national or global level assessments.

A review of existing indicators, methods and models within the context of complex system sustainability showed that no single existing index, method or model was able to assess sustainability of complex systems since most fail to account for complex system characteristics such as system dynamics, interconnections and interdependencies of system components, system's ability to learn and remember, emergence of novel behaviours, co-evolution, etc. However, two analytical methods, Life Cycle Assessment (LCA) and risk assessment (RA), were found to have significant potential for addressing concerns regarding sustainability of complex systems as they were able to account for complex system characteristics. Thus LCA and RA were integrated in a new model to assess sustainability. The model is tested on case study product systems to illustrate applicability, potential issues and areas for improvement.

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LIST OF ACRONYMS

CAS	Complex Adaptive Systems
CBD	Convention on Biological Diversity
CSR	Corporate Social Responsibility
CBA	Cost-Benefit Analysis
CNC	Critical Natural Capital
EF	Ecological Footprint
ESD	Ecologically Sustainable Development
EWI	Ecosystem Wellbeing Index
EDIP	Environmental Design of Industrial Products (Denmark)
EIA	Environmental Impact Assessment
EPI	Environmental Performance Index
ESI	Environmental Sustainability Index
FCA	Full Cost Accounting
FCEA	Full Cost Environmental Accounting
GPI	Genuine Progress Indicator
GRI	Global Reporting Initiative
GWP	Global Warming Potential
GHG	Greenhouse gas
GDP	Gross Domestic Product
HDI	Human Development Index
HWI	Human Wellbeing Index
IFOTIS	In Full, on Time and in Spec
ISEW	Index of Sustainable Economic Welfare
IDEMAT	Industrial Design Materials
IPENZ	Institute for Professional Engineers New Zealand
IPENZ	Institute of Professional Engineers of New Zealand
IPCC	Intergovernmental Panel on Climate Change
IISD	International Institute for Sustainable Development
IIDEX	International Interior Design Exposition
IUCN	International Union for the Conversation of Nature
LCCA	Lice Cycle Costing Assessment
LCA	Life Cycle Assessment
LCC	Life Cycle Costing
LCIA	Life Cycle Impact Assessment
LPI	Living Planet Index
MCA	Multi-Criteria Analysis
NGO	Non-governmental organization
PFC	Perfluorocarbons
PPP	Policies, Plans and Programs
PSI	Product Sustainability Index
REPA	Resource and Environmental Profile Analysis

RA	Risk Assessment
SELCA	Social and Environmental Life Cycle Assessment
SLCA	Social Life Cycle Assessment
SETAC	Society of Environmental Toxicology and Chemistry
SEA	Strategic Environmental Assessment
SAFE	Sustainability Assessment by Fuzzy Evaluation
SPI	Sustainability Performance Index
SD	Sustainable Development
TNS	The Natural Step
TCA	Total Cost Assessment
TBL	Triple Bottom Line
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
WCED	World Commission on Environment and Development
WWF	World Wildlife Fund