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Integrated Ecological Assessment of Engineering Projects Based on Emergy Analysis

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Abstract

For a long time, the problems of complex system mechanism of major engineering, such as lack of acknowledge, inconsistence of scale, insufficient quantification and lack of valid direct viewing evaluation tools lead to decision failures of major engineering projects. Under the view of engineering ecology, based on system theory and system ecology, employs system analysis method and ecological network analysis method, activates engineering. Given emergy as the uniform scale, adopting emergy analysis methods, building up emergy evaluation index system of major engineering can realize quantitative assessment of major engineering. Employing the integration of computational experiments methods and emergy analysis methods realizes the numerical simulation of complex system mechanism of major engineering; getting help from the integration of BIM, GIS and Multi-agent technique makes the linguistic expressions of space and analog simulation come true, to emerge ecological evolution. The study of this project, with theoretical significance and using value, converting comprehensive assessment to ecological assessment, provides brand-new theory, methods and decision tools for the evaluation of major engineering projects.

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1. Introduction

Major engineering projects change the regional spatial configurations and have earthshaking effect on the local social, environmental and economic development for its huge investment and large resource

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consumption. While Chinese major engineering constructions have achieved remarkable results, the social disputes and risk caused by a number of major engineering projects and lessons from the failure of projects expose the problem of evaluation theory and method of Chinese major engineering projects. The first case of "walking" in the field of environmental protection in our country, Xiamen PX chemical project, has raised the thinking of the current project decision and evaluation theory. For the quantitative methods of the corresponding dimension are used in the technical, economic and environmental assessment resulting in each part out of touch, current comprehensive evaluations of the project lack of effective rigidity and cannot effectively control subjective human factors. In addition, the environmental and social costs of major projects cannot be quantitatively evaluated effectively resulting in the project evaluation results exaggerating the economic benefits. The evaluation of engineering project is lack of the unified standard of linking engineering, economy, environment and social system and it is difficult to realize the dimensional unification of each part of the system, which becomes formalistic and the bottleneck of the long-term existence of the evaluation. Can we find a unified scale that can connect complex dimension of engineering, economic, environmental and social systems to achieve the quantitative evaluation of engineering projects and control human factor. Is there any tool to show the consequences of major projects in the future? In this paper, the above problems are studied.

Nomenclature

BIM	Building Information Modeling
ENA	Ecological Network Analysis
EYR	Emergy Yield Ratio
ELR	Emergy Loading Ratio
EAR	Emergy Amplifying Ratio
EER	Emergy Exchange Ratio
ESI	Environmentally Sustainable Index
GIS	Geographic Information Systems
USCG	United States Coast Guard

2. Problems in the practice of major engineering projects in China

In the past twenty years, Chinese engineering achievements have attracted worldwide attention, but the environmental and social problems caused by major projects cannot be ignored. Through the investigation of major projects in China, it can be summarized into two categories: The first is composed of major engineering projects that cause social disputes, as shown in Table 1:

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