



# Sustainable project selection: Optimal project selection considering sustainability under reinvestment strategy

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## ABSTRACT

Reflecting the call being made by the United Nations Environmental Protection and society to adopt innovative approaches to resolve current sustainability challenges, there is a strong need for studies that incorporate sustainability concerns in decision-making processes. Yet the quantitative method of measuring sustainability in project investment practice is still limited. Besides, reinvestment is seldom considered. In light of this, the authors have proposed an integrated novel optimization approach in which sustainability cost is quantitatively quantified and reinvestment strategy is adopted. Our method creates win-win situation which prevents environmental damages and in the meantime efficiently allocates budget and maximizes the investors' income. A case study is presented to illustrate the applicability of the proposed method and the impact of sustainability measure with reinvestment strategy incorporated in project selection decision-making processes. Expected net present value is employed to calculate the return of the project investment. Based on demonstrated optimization results, some significant observations have been got: (1) range of sustainability cost significantly influences investors' objective value and optimal project selection decision. Investors' project selection decision and maximum objective value is obtained at 3% sustainability cost; (2) compared to traditional project selection practices, consideration of sustainability can maximize investors' net profit value; (3) objective value varies with different reinvestment strategies and it is more sensitive with total reinvestment strategy than with partial reinvestment strategy; (4) appropriate use of reinvestment strategy ensures efficient budget allocation to the projects for the effective implementation of project investment without exceeding investors' available capital even when additional 3% cost on sustainability is employed. The results verify the proposed methodology.

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## 1. Introduction

The resource scarcity, tremendous growth of world population and the threat of climate change cause numerous environmental and social problems (WCED, 1987). Sustainable project selection is based on the concept of sustainable development. This concept is defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). In order to broaden the focus on the financial bottom line by businesses to include social and environmental responsibilities, Elkington (1997) introduced “triple bottom line approach”. This approach measures a company's degree of social

responsibility, its economic value, and its environmental impact. Based on this approach, Kaveh et al. (2012) proposed a new framework to enhance the incorporation of sustainable development in business context. Kaveh and Soheil (2013) thus used “the triple bottom line approach” in terms of social, environmental and economic goals to assess the fitness of investment chances in sustainable decision-making.

And thus sustainability issue became more and more important for policy and decision makers worldwide (UNEP, 2013). Increasing regulatory demands due to environmental protection force companies to lower their impacts on the environment by incorporating sustainability issues into their project decision-making strategies (Baumgartner, 2014). Project investment as one of the largest sector with crucial importance to the economic development, has a huge impact on environment and society (Saunila et al., 2018). Therefore, in order to enhance sustainability concerns, this study integrates the issue of Sustainable Project Selection Problem (SPSP) in project

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investment. In a new area, “*Portfolio Decarbonization Coalition*” concept has been established by the United Nations Environment Program (UNEP), which is aimed to drive greenhouse gas emission reductions by mobilizing a critical mass of institutional investors for committing to gradually decarbonize their portfolios (Sullivan et al., 2015). After numerous disclosures and thriving efforts for boosting sustainability concerns in financial sector, the implementation of UNEP report commenced ensuring investors can approach SPSP without harming investment performance. Later on, researchers proposed new studies on investment by focusing on sustainability while categorizing and coding the funding sources for sustainable agriculture investment (DeLonge et al., 2015). Sullivan et al. (2015) emphasized sustainability cost not exceeding but being within the company's available budget. In fact, sustainability practices in investment of project selection is likely to enhance long-term investment performance as it allows investors to reduce the risk of stranded assets as a result of regulation, while also increasing their competitiveness (Tan et al., 2015). Thus, enhancing sustainability incorporation should be a top priority for the investment projects.

Relatively, scholars studied sustainability in project selection from different aspects. For example, Kaveh and Soheil (2013) employed sustainability criteria as economy, society and environment in multiple criteria decision-making approach for sustainable project selection. Vargas (2015) proposed new project selection approach considering sustainability criteria as society, environment and economy for globally distributed projects. Sánchez (2015) on the other hand, proposed a conceptual framework for sustainable project portfolio selection problem based on the eco-impact analysis. Nevertheless, previous studies did not consider quantitative measure of sustainability in project selection. Thus, this study undertakes quantitative sustainability measurement in traditional project selection practices. Quantitative sustainability measurement is crucial since it enables to create win-win situation for both investor and sustainability in project selection. Considering reinvestment strategy, Meng and Siu (2011) investigated an optimal reinsurance and dividend problem of an insurance company with the presence of reinvestment strategies. Tewari et al. (2015) identified the call premium in nonconvertible bond as an effective contracting provision to address reinvestment risk and credit rating improvements. However, these studies did not consider sustainability while identifying reinvestment strategies. Moreover, in literature and practice, quantitative sustainability measure with simultaneous consideration of reinvestment strategy which enables more efficient budget allocation in project selection has not been studied yet. Reflecting the call being made by UNEP and society to adopt innovative approaches to resolve current sustainability challenges (Sullivan et al., 2015), this study attempts to narrow the above mentioned research gap by enhancing sustainability practices through proposing a novel integrated optimization approach.

The objective of this study is to propose a novel sustainable project selection approach that considers sustainability and reinvestment strategy. The authors believe that the approach creates win-win situation by preventing environmental damages and in the meantime efficiently allocating budget to maximize the investors' income. This study contributes to the existing literature by (i) simultaneously incorporating sustainability and reinvestment to construct novel optimization model; (ii) present a new sustainability measure in project selection; (iii) apply real case analysis to verify the robustness of the proposed model.

The structure of the paper is organized as follows. In section 2, a brief review of the traditional project selection and evolution of sustainability in project selection practices is provided. Section 3

outlines the methodological approach employed. Optimization model development is provided in section 4 to implement sustainable project selection under reinvestment strategy. In section 5, the evaluation of the novel optimization model is demonstrated in investment banking industry. Additionally, to check the robustness of the model, sensitivity analysis is performed in this section relatively. Overall results and discussion is presented in section 6. Finally, the paper is concluded in section 7.

## 2. Literature review

There are a variety of project selection methods. Traditional project selection used to focus only on net present value without consideration of sustainability. However, as discussed in Introduction section, incorporation of sustainability into project selection can enhance companies' competitiveness and value, and thus has attracted more and more attention. This section first presents a literature review on study of traditional project selection, and then on evolution of sustainability in project selection and finally research motives and objectives behind sustainability.

### 2.1. Traditional project selection

While reviewing the literature in earlier studies of project selection, it is revealed that most of the past researchers in this field employed exact values to estimate project parameters. For example, Weingartner (1963) made a major contribution to project selection problems by being the first to introduce mathematical programming method into the field. Later on, in order to model steadily imprecise estimations of experts towards indeterminate quantities, Liu (2010) founded an uncertainty theory and refined it based on four axioms. To the present, uncertainty theory has been widely used to handle optimization problems that involve uncertainties. For instance, Huang (2010) employed uncertainty theory to propose a theory on uncertain portfolio selection. Zhang et al. (2011) applied uncertainty theory in solving multinational project selection problem. On the other hand, Padhy and Sahu (2011) proposed methodology based on real option analysis for evaluating the value of case projects and used exact project parameters in selection. Since real life situations are complex and tied with uncertain events, then making decision only based on exact parameters is unrealistic. Hence, scholars studied imprecise project selection problem by employing probability theory. For example, Shakhshi-Niaei et al. (2011) employed Monte Carlo simulation for implication of two-phase framework under randomness subject to real world constraints for project selection problem. Liu and Wang (2011) discussed project selection problems with time dependent resource constraints. However, there are situations in real life that require innovative solution when few historical data exist. Hence, scholars applied fuzzy set theory in project selection problems (Tsao, 2012). Later on, Huang and Qiao (2012) discussed implication of risk index on multi-period portfolio selection, and simultaneous project selection and scheduling with investment uncertainty. Since then, researchers developed variety of models in order to increase the applicability of the new evolved models in practice, thus proposed software project scheduling optimization with algorithms (Xiao and Tang, 2013). Flores et al. (2014) proposed a mathematical model for planning investment in energy sources, which was applied in real industrial case. Dutra et al. (2014) proposed combined economic – probabilistic model for project selection and provided stochastic analysis of expected returns for projects. As proven, unlike uncertainty theory, probability theory helps to achieve favorable outcome on probability distributions, once there is sufficient historical data.

Consequently, based on uncertain theory, Huang and Zhao

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