

ABSTRACT

Engineering projects face risks over time. The risks generally may come from financial, environmental, technical, social aspects, and so on. Despite that the extreme event scarcely occurred, such event including slope failure may result a catastrophic loss. Given that the risks cannot be fully eliminated, considering the risks in the project evaluation is urgently needed. One common technique to evaluate engineering projects is through discounted cash flow where Net Present Value (NPV) is widely used. However, the existing NPV assumes that the risks are transformed into one single number (i.e., discount rate). Implementing one single discount rate number to represent all the risks in the engineering projects is not realistic due to the various risk characteristics. This paper discusses how the risks should be modelled differently and how we may benefit the proposed approach towards sustainability in the industry. The environmental, social, and governance (ESG) risks represent the sustainability indicator. In this thesis, the environmental and the social risk were assumed as a cost that was deducted from cash flow and modelled through probability concept. On the other hand, the governance risk was identified to macroeconomics and systematic risks that affect the lender's and investor's expected returns, thus weighted average cost of capital (WACC) was reasonably used. Furthermore, to a risk profile was also illustrated through Monte-Carlo simulation technique to see how the project might have possibility to feasible/not-feasible. Thus, the proposed approach enhances the conventional DCF technique by incorporating sustainability perspective through ESG approach risks quantification and uncertainty analysis through Monte-Carlo simulation technique.

Keywords: discounted cash flow; risk modelling; sustainable project evaluation; ESG; Monte-Carlo simulation.

ABSTRAK

Proyek pertambangan menghadapi berbagai risiko seiring waktu, yang umumnya berasal dari aspek finansial, lingkungan, teknis, sosial, dan lainnya. Meskipun kejadian ekstrem jarang terjadi, seperti longsor, dampaknya dapat menyebabkan kerugian yang signifikan. Karena risiko tidak dapat sepenuhnya dihilangkan, penting untuk mempertimbangkannya dalam evaluasi proyek. Salah satu teknik umum untuk mengevaluasi proyek pertambangan adalah melalui teknik *discounted cash flow* (DCF) dengan menggunakan metode *Net Present Value* (NPV). Namun, NPV tradisional mengasumsikan bahwa semua risiko direpresentasikan dalam satu angka diskonto (*discount rate*), yang tidak realistis mengingat karakteristik risiko yang beragam. Pada penelitian ini, risiko-risiko akan dimodelkan secara berbeda dan digunakan dalam mengevaluasi proyek yang berorientasi pada keberlanjutan (*sustainability*). Risiko *Environmental, Social, and Governance* (ESG) digunakan sebagai indikator keberlanjutan. Dalam tesis ini, risiko lingkungan (*environmental*) dan sosial (*social*) dianggap sebagai biaya yang mengurangi arus kas dan dimodelkan melalui konsep probabilitas. Sementara itu, risiko tata kelola (*governance*) diidentifikasi sebagai risiko makroekonomi dan sistematis yang mempengaruhi ekspektasi pengembalian (*return*) pemberi pinjaman dan investor sehingga *Weighted Average Cost of Capital* (WACC) menjadi metode yang digunakan dalam memodelkan komponen tata kelola. Selain itu, profil risiko diilustrasikan melalui teknik simulasi Monte Carlo untuk menilai kelayakan proyek. Dengan demikian, pendekatan ini meningkatkan teknik DCF konvensional dengan mengintegrasikan perspektif keberlanjutan melalui kuantifikasi risiko ESG dan analisis ketidakpastian menggunakan simulasi Monte Carlo.

Kata kunci: *discounted cash flow*, pemodelan risiko, evaluasi proyek berkelanjutan, ESG, simulasi Monte Carlo.