International Journal on Advanced Science Engineering Information Technology

Vol.15 (2025) No. 3
ISSN: 2088-5334

Comparison between Information Technology Value through Partial Adjustment Valuation and Real Options Approaches

Lukman Abdurrahman [a,*], Muhammad Arif Bijaksana [b]

[a] *Department of Information Systems, School of Industrial and Systems Engineering, Telkom University, Bandung, Indonesia*
[b] *Department of Data Science, Faculty of Informatics, Telkom University, Bandung, Indonesia*
Corresponding author: [*]abdural@telkomuniversity.ac.id

***Abstract*— Information Technology (IT) plays a pivotal role in driving business innovation, operational efficiency, and competitive advantage. However, valuing IT investments is complex due to uncertainties, the intangible benefits, and the long-term nature of many IT projects. Traditional financial metrics, such as Net Present Value and Internal Rate of Return, often fall short of capturing the dynamic nature of IT investments. This paper introduces two advanced approaches to IT valuation: Partial Adjustment Valuation and Real Options Theory. PAV captures the incremental nature of IT adjustments due to organizational inertia or financial constraints, while ROT offers a framework for valuing the flexibility of IT investment decisions under uncertainty. Through an examination of both theories and their application to real-world IT investments, this paper presents a more comprehensive methodology for evaluating IT value in a rapidly evolving technological landscape. Furthermore, this paper applies the theories to three case studies across different industries: cloud computing infrastructure investment, ERP system deployment in a multinational manufacturing firm, and digital platform development for a technology startup. The case studies show that by capturing the incremental nature of IT adoption through PAV and by valuing the strategic flexibility inherent in these projects through ROT, firms can make more informed and adaptable investment decisions. The findings from these case studies underscore the critical importance of embracing a dynamic, flexible valuation framework for IT investments. By integrating PAV and ROT, organizations can optimize their IT capital allocation; here, ROT is at 9-10 compared to PAV at 6-8. Thus, ROT is better.**

***Keywords*— Information technology valuation; IT investment; IT capital structure; strategic decision-making; IT portfolio management.**

Manuscript received 24 Oct. 2024; revised 19 Jan. 2025; accepted 16 Mar. 2025. Date of publication 30 Jun. 2025.

I. INTRODUCTION

The valuation of IT investments is crucial for organizations seeking to leverage digital technologies for sustainable competitive advantage [1], [2]. While traditional valuation models offer clear guidelines for assessing static investments, they often fail to account for the complex and strategic nature of IT projects. As businesses navigate rapid technological advancements, decision-makers require models that allow incremental adjustments and flexibility in response to uncertainties [3].

Partial Adjustment Valuation considers the gradual nature of IT adoption, emphasizing the importance of incremental investment adjustments as organizations seek to optimize their technology deployment. Likewise, Real Options Theory complements PAV by valuing the flexibility embedded in IT investments, particularly the ability to defer, expand, contract, or abandon projects as new information becomes available [4], [5].

Valuing Information Technology (IT) investments is an enduring challenge for organizations across various industries. The need for robust valuation methodologies becomes critical as IT becomes increasingly integral to business operations, from automating routine tasks to enabling strategic digital transformation [6]. The traditional approaches to investment evaluation—such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period—often fall short when applied to IT due to the dynamic nature of technology, the strategic value of flexibility, and the long-term uncertainty that these investments entail [7], [8]. IT investments are rarely static or straightforward; they often require ongoing adjustments, come with the possibility of reconfigurations, and offer opportunities to respond to technological advances or shifts in market conditions [9].

In response to these challenges, more sophisticated valuation models have emerged. Two notable frameworks—Partial Adjustment Valuation (PAV) and Real Options Theory (ROT)—offer deeper insights into the complexities of

IT investment. PAV models IT investments as gradual, acknowledging that organizations rarely move from one state of technological adoption to another without facing frictions such as budget limitations, integration challenges, and learning curves [10]. In contrast, ROT focuses on the flexibility and strategic value of investment decisions. IT projects often provide managers with "options" to adjust courses based on future technological or market developments. These options could involve deferring the project, expanding or contracting its scope, or abandoning it entirely if circumstances change [11].

This paper aims to integrate Partial Adjustment Valuation and Real Options Theory into a unified framework for evaluating information technology (IT) investments. By doing so, it presents a more comprehensive approach for assessing the value of IT in uncertain and dynamic environments. Specifically, this research seeks to address two key questions [12]:

a. How does Partial Adjustment Valuation capture the incremental nature of IT adoption in organizations?
b. How can Real Options Theory enhance the valuation of IT investments by accounting for strategic flexibility and the ability to respond to uncertainty?

Through an exploration of case studies, the paper demonstrates how combining these two theories offers a more robust framework for valuing IT investments, especially in industries where technological change is rapid and the innovation potential is significant [12], [13].

This paper explores how integrating PAV and ROT can provide a more nuanced framework for valuing IT investments. The study is structured as follows: a review of relevant literature and an explanation of research methodology, presentation of case studies, discussion of findings, and conclusions with implications for theory and practice.

II. Materials and Methods

A. Traditional IT Valuation Approaches

Traditional approaches to IT valuation, such as Net Present Value (NPV) and Internal Rate of Return (IRR), focus primarily on financial returns while disregarding strategic flexibility and uncertainties. These models are suitable for projects with predictable outcomes; however, IT investments are often characterized by high uncertainty, long-term horizons, and rapid technological changes. Traditional metrics may undervalue IT by failing to capture non-financial benefits, such as improved organizational agility or strategic positioning [2], [8].

Traditional financial models such as Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period have been widely used to evaluate IT investments. These methods, which originated in capital budgeting, assume that investments yield predictable cash flows over time, allowing for straightforward discounting to present value. The NPV method calculates the present value of all future cash flows, subtracting the initial investment, while the IRR method focuses on finding the discount rate that sets the NPV to zero. Payback Period measures how long it takes for an investment to generate enough cash flow to recover its initial cost [8], [14]. However, as highlighted by Bendall and Stent [23] and [15], this method are often inadequate when applied to IT investments for several reasons.

1) Intangibility: IT projects often produce benefits that are difficult to quantify, such as improved decision-making, enhanced customer satisfaction, or the ability to innovate more quickly.

2) Uncertainty: IT investments are subject to high levels of uncertainty, particularly in terms of technological change and the evolving business environment. Traditional models do not adequately capture the risk of obsolescence or the potential for market disruption.

3) Strategic Flexibility: IT projects often involve multiple implementation phases, allowing firms to adjust, expand, or abandon the project based on performance and market conditions. Traditional methods are ill-suited to capture this flexibility.

Clemons and Hitt [15] have argued that these limitations can lead to underestimating IT's actual value, particularly for projects where future flexibility is critical. The inherent weakness of traditional valuation approaches necessitates the adoption of more sophisticated models that better capture the complex and evolving nature of IT investments.

B. Partial Adjustment Valuation (PAV) Theory

Grounded in macroeconomic adjustment models, PAV was initially developed to explain the slow adjustment of capital stock to optimal levels. As applied to IT, Caballero and Engel [16] suggests that firms adjust their IT investments gradually due to frictions such as budget constraints, technical knowledge gaps, and changing business needs. PAV is particularly relevant for industries with rapidly changing technology landscapes, where IT adoption cannot occur instantaneously [10], [16].

Partial Adjustment Valuation (PAV) explains the slow adjustment of capital stock to its optimal level due to frictions such as financial constraints, time delays, or organizational inertia. Caballero and Engel [16] and Abel and Blanchard [17] were among the first to formalize the theory of partial adjustment, where firms are assumed to adjust their capital investments gradually rather than instantaneously, even when faced with profitable opportunities.

When applied to IT investments, PAV suggests that firms could not adopt new technologies at once but it could make incremental adjustments over time due to a variety of factors, including [10], [18]:

1) Budget Constraints: IT projects often require significant upfront investment, and annual budgets or cash flow limitations may constrain firms.

2) Technical Challenges: Integrating new IT systems with legacy systems is often complex and requires a phased approach, as seen in large-scale enterprise resource planning (ERP) projects.

3) Learning Curves: Employees and IT staff may require time to adapt to new systems and processes, delaying full implementation.

By modelling IT adoption as a series of gradual adjustments, PAV provides a more accurate reflection of how firms invest in and deploy new technologies over time. As

Caballero and Engel [16] discussed, the value of IT investments cannot be fully realized in a single period; instead, firms make a series of adjustments toward an optimal level of IT capital stock. This model is beneficial in environments where technology changes rapidly, and firms must constantly adapt to new developments [10], [16], [18].

C. Real Options Theory (ROT)

Real Options Theory, derived from financial options, offers a way to value flexibility in investment decisions. Lagunas and Bakht [19] highlights that ROT allows firms to treat investments as "options" that can be expanded, delayed, or abandoned depending on future market conditions. In the context of IT, real options provide a framework for decision-makers to respond dynamically to technological changes, uncertainties, and evolving business requirements [19], [20].

Real Options Theory (ROT), originally developed by Bloch [21] for financial options, was later extended to capital investments by Ahmadi and Bratvoid [12]. The core idea behind ROT is that investments, particularly those characterized by uncertainty and irreversibility, can be viewed as a series of options. Just as financial options give the holder the right but not the obligation to buy or sell an asset in the future, real options give managers the right to make strategic investment decisions at various times [23].

In the context of IT, real options provide a framework for valuing flexibility in decision-making. As noted by Lagunas and Bakht [19], IT investments often present several types of real options: growth, deferral, and abandonment options. Growth options are the ability to expand an IT system as demand increases or as technology evolves. Deferral options is the flexibility to delay an IT investment until more information is available, or conditions are favorable. Abandonment options are the option to abandon or scale down an IT project if it becomes unprofitable or technological advancements make it obsolete.

Moreover, Real options allow managers to make decisions incrementally and respond to uncertainties, particularly in environments where technology and market conditions are evolving rapidly. As Sizova et al. [24] note, the ability to defer, expand, or abandon IT projects adds significant value beyond what traditional NPV or IRR models can capture. ROT thus provides a powerful tool for assessing IT investments where flexibility and the ability to respond to new information are critical.

D. Integration of PAV and ROT

The combination of PAV and ROT offers a unique approach to valuing IT investments, recognizing both the gradual adjustment process and the flexibility of IT projects. As suggested by Almansa et al. [20], integrating these theories can better capture IT investments' uncertainty and evolving nature.

Integrating Partial Adjustment Valuation and Real Options Theory presents a unique and robust framework for valuing IT investments. Almansa et al. [20] and Ali and Rafique [28] argue that combining these two approaches allows for a more comprehensive understanding of the complexities inherent in investment decisions. While PAV accounts for the gradual nature of IT investment and adoption, ROT emphasizes the strategic flexibility and value of waiting for new information. Together, these theories provide a framework that captures the operational realities of IT investment and the strategic opportunities that IT projects often entail [8], [12].

E. Research Methodology

This paper employs a qualitative research methodology focusing on case studies to explore the application of Partial Adjustment Valuation and Real Options Theory in real-world IT investments. Case studies are chosen from industries undergoing significant IT-driven transformation, including retail, manufacturing, and technology startups. The research methodology consists of three key stages [3], [25], [26], [27], [28]:

1) Data Collection:

Data was collected through semi-structured interviews with IT managers, financial analysts, and project stakeholders in the selected case study firms. These interviews provided insights into the decision-making processes, the incremental nature of IT investments, and the strategic flexibility considered during project execution. Key themes explored in the interviews include the initial rationale for the IT investment. The phased or gradual nature of the IT project deployment. Strategic decisions related to expanding, deferring, or abandoning parts of the IT project.

Secondary data, such as financial reports, project documentation, and internal presentations, were analyzed to assess the economic valuation of the IT investments. These documents provided quantifiable metrics, such as cost savings, revenue generation, and cash flow projections, which were critical for applying both Partial Adjustment Valuation and Real Options Theory.

2) Framework Application

The case studies were analyzed through two theoretical lenses: Partial Adjustment Valuation (PAV) and Real Options Theory (ROT). In Partial Adjustment Valuation (PAV), each IT investment was modelled as a gradual adjustment toward an optimal level of IT capital. The PAV framework was used to assess how companies managed the incremental nature of their IT adoption, considering the constraints they faced, such as technical challenges, budget limitations, or market uncertainties. Real Options Theory (ROT) was applied to identify and value the strategic options available to the firms during their IT investment processes. Key real options, such as deferral, expansion, and abandonment, were evaluated for each case to understand how the firms' flexibility in decision-making added value to the project.

3) Comparative Analysis: A comparative analysis was conducted across the three case studies to identify standard IT investment valuation and decision-making patterns. The analysis focused on understanding how the combination of PAV and ROT provided a more robust framework for valuing IT investments than traditional methods. The comparative analysis also examined how industry context (e.g., manufacturing vs. technology startups) influenced the application of these valuation models.

4) Validity and Reliability: To ensure the validity and reliability of the findings, the case studies were triangulated with quantitative data and expert opinions. Cross-case comparisons were made to identify recurring themes and

ensure that the findings were not context-specific but relatively applicable across different types of IT investments. By incorporating qualitative insights from interviews and quantitative financial data, the research methodology provided a comprehensive view of how Partial Adjustment Valuation and Real Options Theory can be applied to IT investment valuation.

III. Results and Discussion

A. Case Study 1: Cloud Computing Infrastructure Investment

A global retail firm invested heavily in cloud infrastructure to enhance operational efficiency. Initially, the project was evaluated using traditional NPV and IRR models. However, applying PAV, the firm recognized that its gradual migration to the cloud, constrained by budgetary limits and integration challenges, was not fully captured in traditional models. Real Options further highlighted the value of scalability, offering flexibility to expand services as customer demand increased [29], [30].

Overview: RetailCo, a global retail firm, embarked on a large-scale migration to cloud infrastructure to enhance operational efficiency and scale its e-commerce capabilities. Initially, the firm relied heavily on on-premise servers and outdated IT systems, which were increasingly costly and slow to maintain. A transition to cloud infrastructure was seen as essential to handle the firm's growing data needs and fluctuating demand, especially in peak shopping periods such as Black Friday and holiday seasons [29], [30].

The initial valuation of the cloud infrastructure project used traditional Net Present Value (NPV) and Internal Rate of Return (IRR) models. While providing a straightforward financial analysis, these models failed to capture the ongoing nature of the cloud migration process. The traditional models treated the IT investment as a lump sum expense followed by cash inflows. However, in practice, the migration occurred gradually over several years due to technical complexity, budget constraints, and the need for integration with existing systems [28].

Using Partial Adjustment Valuation (PAV), the firm modelled the transition as a gradual adjustment process. PAV acknowledged that RetailCo could not immediately switch to cloud computing at the optimal investment level due to organizational constraints, such as the capacity of their IT team to implement the migration, budgetary limitations, and risk management concerns. The firm's investment pattern followed a phased approach, spreading investments over time. The gradual adjustment accounted for the learning curve and the need to pilot smaller segments before full-scale implementation [28].

In PAV, the firm's IT capital stock (cloud infrastructure) adjusts incrementally toward the optimal level over time. The PAV model reflected RetailCo's progressive investments, starting with basic cloud services and expanding to advanced data analytics, AI, and machine learning capabilities as the firm became more comfortable with the technology and as cost savings from earlier phases materialized [3], [7].

Real Options Theory (ROT) further enriched the valuation by capturing the flexibility inherent in RetailCo's cloud investment decisions. As cloud services offer modularity and scalability, the firm had several real options available, such as [20], [31]:

a. Expansion Option: As RetailCo's e-commerce platform grew, they could dynamically increase their cloud capacity to meet higher demand.
b. Deferral Option: If cloud migration encounters issues or market conditions deteriorate (e.g., a financial downturn reduces the budget), the firm can defer further investment without abandoning the project.
c. Abandonment Option: If the cloud infrastructure fails to deliver the expected results, RetailCo can abandon migration and revert to a hybrid model or explore alternative technologies.

These options provided significant value by allowing the firm to adapt to changing conditions, mitigating risks and enhancing long-term returns. The real options framework showed that while the initial NPV might have appeared modest, the value of having strategic flexibility increased the overall value of the IT investment [28].

B. Case Study 2: ERP System Deployment in a Multinational Manufacturing Firm

A multinational manufacturing firm implemented an ERP system to improve supply chain management. The deployment occurred in phases, allowing the firm to adjust its investment over time based on operational feedback. PAV captured the incremental nature of the investment, while ROT allowed the firm to assess the option of halting or delaying further deployment depending on early performance outcomes.

1) Overview: A multinational manufacturing firm, ManuCorp, implemented a new Enterprise Resource Planning (ERP) system to improve its supply chain management and integrate global operations. The ERP system promised substantial long-term benefits, including real-time data sharing, streamlined workflows, and reduced operational inefficiencies. However, the rollout of the ERP system across multiple countries and business units was a highly complex and phased process, taking several years to complete.

2) Traditional Valuation Approach: The project was initially evaluated using financial metrics like payback period and Internal Rate of Return (IRR). These metrics focused on the cash inflows expected from cost savings and efficiency improvements once the ERP system was fully operational. However, the phased nature of the project and the uncertainty about the time it would take for the system to be fully functional across all regions was not adequately captured in these static financial models [8], [19], [32].

3) Partial Adjustment Valuation (PAV) Application: The gradual nature of ERP implementation was well-suited to Partial Adjustment Valuation. ManuCorp's investments in ERP technology were not made all at once but through incremental, region-by-region deployments. PAV captured this dynamic by modelling the firm's IT investment as a progressive adjustment toward the optimal capital stock level. The phased implementation allowed ManuCorp to adjust its approach based on lessons learned from earlier rollouts. For example, the first phase revealed integration issues between the ERP system and existing legacy systems, leading to adjustments in subsequent phases [3], [32]. PAV also

reflected the time lag in realizing the full benefits of the ERP system. As the system was rolled out across various regions, the firm adjusted its level of investment, integrating feedback from early adopters and modifying the pace of deployment accordingly [32].

4) Real Options Theory (ROT) Application: In applying Real Options Theory, the firm identified several options within its ERP deployment [6], [33]:

a. Staging Option: ManuCorp's decision to roll out the ERP system in stages rather than as a single, significant investment was a real option. This approach allowed the firm to mitigate risk by gaining information about the system's performance in one region before committing to additional regions.
b. Deferral Option: If the ERP system encountered significant challenges in early rollouts, ManuCorp could defer further implementation. This flexibility allowed the firm to pause the project, correct any issues, and proceed later, thereby reducing the risk of a costly failure.
c. Abandonment Option: In the event of a complete failure or if a better alternative emerged, the firm retained the option to abandon the ERP implementation, though this was considered a last resort given the sunk costs.

The combination of PAV and ROT demonstrated that the value of the ERP system was not merely in the immediate cost savings but in the flexibility to adjust the investment as more information became available, reducing the overall risk [12].

C. Case Study 3: Digital Platform Development for a Technology Startup

A technology startup launched a digital platform that connected users with on-demand services. The firm initially invested modestly, with plans to scale the platform as the user base grew. PAV accounted for the firm's gradual investment as resources allowed, at the same time, ROT provided insight into the timing of additional investments and the flexibility to pivot the business model if the platform did not perform as expected [1], [5], [11].

1) Overview: TechConnect is a technology startup that developed a digital platform to connect service providers with customers in real time. The platform, which facilitated on-demand services, initially targeted a niche market but had the potential for scalability into multiple sectors, including healthcare, education, and professional services. TechConnect's strategy was to launch the platform with minimal features, gather user feedback, and expand based on demand and performance [2].

2) Traditional Valuation Approach: The initial investment was evaluated using fundamental Discounted Cash Flow (DCF) analysis. The financial projections relied heavily on highly uncertain assumptions about user growth and platform adoption rates. The traditional valuation approach provided a static view of expected cash flows but did not account for the strategic flexibility that the startup could exercise as the market evolved [15].

3) Partial Adjustment Valuation (PAV) Application: TechConnect's investment followed a gradual adjustment model. Instead of making a significant upfront investment in fully developing the platform, the startup invested incrementally, launching an MVP (minimum viable product) with limited features. The PAV model recognized this gradual scaling of the platform. The initial investments were minor, reducing the risk of launching the full version immediately. As the platform gained traction and the firm gathered feedback from early users, subsequent investments were made to improve functionality, add new features, and expand to additional markets [3], [22]. The PAV model accounted for the startup's constrained resources and the need to validate its business model through incremental stages. Over time, TechConnect adjusted its platform investment as it approached its optimal level of technological infrastructure and user base [18].

4) Real Options Theory (ROT) Application: TechConnect's digital platform investment presented multiple real options [16], [20], [30], [34]:

a. Expansion Option: As the user base grew, the firm could expand the platform into additional sectors (e.g., healthcare and education), leveraging its existing technology and infrastructure.
b. Deferral Option: If adoption rates were slower than expected, TechConnect could defer further investment in new features or market expansions until market conditions improved.
c. Deferral Option: If adoption rates were slower than expected, TechConnect had the flexibility to defer further investment into new features or market expansions until market conditions improved.
d. Abandonment Option: If the platform does not gain sufficient market traction, the firm could pivot or abandon the project altogether, reducing potential losses.

Real Options Theory highlighted the strategic importance of TechConnect's flexible decision-making process. Rather than committing all resources upfront, the firm's ability to adapt its investment decisions based on market conditions significantly enhanced the platform's long-term value [4], [11], [33].

D. Discussion of Case Studies

The case studies reveal several key insights. PAV highlights gradual adoption: IT investments are rarely one-time, lump-sum expenditure. Organizations often adjust their investments incrementally as they gather more information and gain experience with technology. This was particularly evident in the phased deployment of ERP systems and cloud migration [32].

ROT adds value through flexibility. Real Options provide a framework for understanding the strategic value of IT investments beyond immediate financial returns. In each case, the flexibility to expand, defer, or abandon investments based on changing market conditions was critical to maximizing the value of IT [31].

Traditional models are insufficient. Traditional valuation models like NPV and IRR failed to capture the full complexity of IT investments. These models often undervalued the strategic benefits and flexibility that PAV and ROT accounted for [8], [28], [35]. The case studies presented offer crucial insights into the effectiveness of Partial Adjustment Valuation

(PAV) and Real Options Theory (ROT) in assessing IT investments:

PAV reflects real-world incrementality. In each case, PAV proved superior to traditional models in capturing the gradual nature of IT investment. Whether it was the cloud infrastructure, ERP deployment, or digital platform, each investment unfolded in stages rather than as a single, all-encompassing financial commitment. Traditional NPV or DCF models failed to account for this incremental approach, often underestimating the cost and time needed for IT adoption. The phased nature of these investments is often due to practical constraints—whether technical, organizational, or financial [9], [10].

ROT captures flexibility and strategic value. Theory applied across all three cases, illuminated the inherent flexibility in IT projects, which traditional financial models often miss. The ability to scale services dynamically in cloud computing represented significant strategic value. For the ERP system, the ability to defer or pause implementation reduces risks associated with the system's complexity. In the digital platform case, the expansion option allowed TechConnect to scale into new markets as demand grew. By incorporating ROT, organizations can make better-informed decisions in the face of uncertainty, capturing the full value of flexibility [36], [37].

Synergy of PAV and ROT. PAV and ROT provide a comprehensive framework for valuing IT investments. PAV captures the reality of gradual investment adjustments over time, while ROT enhances this framework by emphasizing the strategic value of flexibility. This synergy is potent in fast-changing technology environments, where businesses must adapt to unforeseen circumstances and leverage new opportunities.

Traditional models fall short. In all cases, traditional models such as NPV and IRR provided a limited perspective. These models failed to capture the staged investments and strategic flexibility that were critical to the projects' success. Traditional methods often underestimated the long-term value and strategic importance of IT investments by focusing purely on static cash flows. Including PAV and ROT addresses these shortcomings, providing a more realistic and strategic valuation [12].

The following discussion expands upon the three case studies presented in the paper, emphasizing how Partial Adjustment Valuation (PAV) and Real Options Theory (ROT) enhance the understanding and valuation of IT investments in complex, uncertain environments. Each case illustrates the practical implications of these theories in different industries and highlights the lessons learned about investment valuation in information technology.

Furthermore, in this section, we delve into the application of Partial Adjustment Valuation (PAV) and Real Options Theory (ROT) to the valuation of IT investments in three different contexts: Cloud Computing Infrastructure Investment, ERP System Deployment in a Multinational Manufacturing Firm, and Digital Platform Development for a Technology Startup. These case studies highlight the strengths of these valuation frameworks in capturing the complexities of IT investments, particularly in environments characterized by high uncertainty, the need for strategic flexibility, and the incremental nature of technology adoption. Traditional financial models such as Net Present Value (NPV) and Internal Rate of Return (IRR) fail to fully capture the strategic options and phased investments present in these scenarios, which PAV and ROT address more comprehensively [10], [12].

1) Case Study 1: Cloud Computing Infrastructure Investment

A large financial services firm sought to invest in a cloud computing infrastructure to replace its on-premises systems, aiming to improve scalability, cost-efficiency, and flexibility. The investment required a multi-year transition, during which the firm had to phase out its legacy systems while gradually moving to a cloud-based infrastructure. Given the uncertainty surrounding regulatory issues, security concerns, and technological advances in cloud solutions, the firm needed a valuation method beyond static approaches like NPV [28].

Application of Partial Adjustment Valuation (PAV): The cloud computing infrastructure investment was not made as a single large outlay but rather in stages. The firm adopted a hybrid cloud approach, moving specific non-critical applications to the cloud in the first phase and leaving more sensitive operations on-premises until later in the process. This allowed the firm to evaluate the cloud's performance and security before committing fully. The PAV model captured the following critical aspects [3], [26], [35]:

Incremental Adoption: The firm started with small, low-risk workloads in the cloud, planning to progressively migrate more critical applications based on performance evaluations and evolving regulatory requirements. PAV modelled this phased investment, accounting for the gradual adjustment of IT infrastructure.

Adjustment Frictions: Transitioning to cloud computing was met with various frictions, such as the need for employee retraining, security upgrades, and dealing with evolving data compliance regulations. These frictions were critical in determining the pace at which the firm could adopt cloud technology, and PAV allowed for a more accurate reflection of these operational barriers.

Application of Real Options Theory (ROT): Real Options Theory played a significant role in helping the firm navigate the uncertainties associated with cloud adoption. The firm's management understood the value of maintaining strategic flexibility in an environment where cloud technologies and regulatory frameworks constantly evolve.

Option to Expand: As the initial phases of cloud adoption proved successful, the firm retained the option to expand its cloud infrastructure by moving more mission-critical applications to the cloud. The ROT framework allowed the firm to evaluate this option by recognizing the value of waiting for further information on security protocols and regulatory changes.

Option to Abandon: In case of unforeseen issues, such as escalating costs or insurmountable security risks, the firm had the option to abandon cloud infrastructure investment and revert to an upgraded on-premises solution. This option was valuable as it allowed the firm to mitigate downside risks.

Key Insights: The combination of PAV and ROT provided the firm with a dynamic, flexible framework to evaluate its cloud computing infrastructure investment. PAV allowed the firm to model its phased migration process, while ROT

captured the value of maintaining strategic options, such as expanding cloud usage or abandoning the project if risks materialized. This approach provided a much richer evaluation than traditional methods, which would have failed to consider the firm's incremental adoption and strategic flexibility in response to future uncertainties [38].

2) Case Study 2: ERP System Deployment in a Multinational Manufacturing Firm

A multinational manufacturing firm invested in an enterprise resource planning (ERP) system to streamline its global operations and integrate various functional areas, including supply chain management, finance, and human resources. The deployment was a massive, multi-year project with substantial capital outlays and high implementation risks. The firm faced challenges associated with organizational change management, data integration across subsidiaries, and customizing the ERP system to meet diverse regulatory requirements across countries [32].

Application of Partial Adjustment Valuation (PAV): The ERP system deployment occurred over multiple stages, reflecting the complexity of the project and the need for gradual integration. The firm first piloted the system in its headquarters before rolling it out across its regional offices and subsidiaries. PAV was instrumental in capturing the following factors [32]:

Phased Investment: The firm adopted a phased approach to ERP deployment, starting with core functions and incrementally adding modules as the system proved effective. This allowed the firm to mitigate risk and spread the capital outlay over several years, aligning with PAV's focus on gradual adjustment.

Adjustment Frictions: The deployment faced numerous frictions, including technical difficulties in integrating legacy systems, resistance from employees unfamiliar with the new technology, and country-specific customization requirements. These frictions delayed full adoption and increased costs, which PAV helped to model more accurately than a traditional NPV analysis.

Application of Real Options Theory (ROT): Given the scale and complexity of the ERP project, ROT was vital in valuing the firm's strategic options throughout the deployment process. The uncertainty regarding regulatory changes, employee adoption rates, and the future evolution of ERP technology required a flexible approach.

Option to Defer: The firm could delay the deployment of certain ERP modules in specific regions if unforeseen technical challenges or cost overruns occur. This deferral option allowed management to adjust the deployment schedule based on local conditions and emerging regulatory requirements.

Option to Expand: Once the ERP system was successfully deployed at headquarters, the firm could expand it to include advanced analytics and integrate additional subsidiaries and business units. This option was particularly valuable in ensuring the ERP system could grow with the firm's future needs.

Key Insights: Integrating PAV and ROT provided the multinational manufacturing firm with a comprehensive framework for managing its ERP system deployment. PAV captured the incremental investment strategy, and the frictions associated with organizational change, while ROT helped the firm value the flexibility of deferring or expanding different aspects of the project. These approaches provided management with a more dynamic tool for decision-making, reflecting the complexities and risks of such a large-scale IT investment more effectively than static financial models [6].

3) Case Study 3: Digital Platform Development for a Technology Startup

A technology startup focused on developing a digital platform that integrated various applications for small and medium-sized enterprises (SMEs) to manage business processes. Given the high level of uncertainty in market demand, competition, and technological feasibility, the startup faced significant challenges in managing its capital investment and the development timeline [11].

Application of Partial Adjustment Valuation (PAV): The startup adopted an agile development methodology, releasing the platform in stages to allow for incremental improvements based on user feedback. This approach aligned well with the principles of PAV, which focuses on gradual adjustments toward an optimal IT investment strategy [3], [10], [18]:

Incremental Development: The startup released an initial version of its platform with essential features and gradually added more complex functionalities as market feedback and resources allowed. PAV captured the startup's decision to invest in stages rather than committing to a full-scale platform build-out.

Adjustment Frictions: The firm faced resource constraints, evolving market requirements, and technical challenges in integrating new features. These frictions influenced the timing and scale of each development phase, and PAV allowed the startup to model these adjustments effectively.

Application of Real Options Theory (ROT): ROT was crucial for the startup, as it faced high uncertainty regarding future competition, technological trends, and market adoption rates. The flexibility to pivot or expand the platform based on external factors was central to its success.

Option to Pivot: The startup could pivot its business model or platform design based on market feedback. This option allowed the firm to adapt to changing customer needs and competitive pressures without fully committing to an initial strategy.

Option to Expand: As the initial platform gained traction, the startup retained the option to expand its offering by developing new features or integrating third-party applications. The value of this expansion option was critical in enabling the startup to scale its platform as demand increased.

Key Insights: The combination of PAV and ROT provided the technology startup with a flexible, adaptive framework for managing the development of its digital platform. PAV captured the incremental nature of the development process, while ROT helped the startup value the strategic flexibility to pivot or expand the platform based on market conditions. This approach enabled the startup to manage uncertainty more effectively and optimize its IT investment strategy [12].

4) Conclusion of Case Study Discussion:

Across these three case studies, Partial Adjustment Valuation (PAV) and Real Options Theory (ROT) demonstrate their superiority over traditional financial models

by addressing the phased nature of IT investments and the strategic value of flexibility. In each case, the integration of PAV and ROT provided firms with more robust frameworks for managing uncertainty, making incremental investments, and adapting to changing market and technology conditions. These models are beneficial in the context of modern IT investments, where technological advances and market dynamics necessitate a flexible, dynamic approach to capital allocation and strategic decision-making [8], [9], [12].

Furthermore, the integration of Partial Adjustment Valuation (PAV) and Real Options Theory (ROT) provides a more dynamic and flexible approach to valuing IT investments than traditional methods. Here's an explanation of their effectiveness and advantages:

a. Recognition of Managerial Flexibility. PAV and ROT account for managers' ability to adjust their strategies in response to uncertainties or new information. Traditional methods like Net Present Value (NPV) or Internal Rate of Return (IRR) typically assume static decision-making, which may undervalue IT investments that involve significant uncertainty and evolving conditions. ROT, in particular, emphasizes the value of deferring, expanding, contracting, or abandoning projects, which aligns well with IT investments that often require incremental development or scaling [6].
b. Adaptation to Uncertainty. IT investments are characterized by high uncertainty in costs, benefits, and technological advancements. ROT models uncertainty explicitly, treating it as an opportunity rather than a risk, while PAV integrates adjustments over time as conditions become more apparent. This combined approach provides a structured way to incorporate risk and opportunity into valuation, resulting in more realistic assessments [6].
c. Time-Phased Investment Consideration. PAV models gradual changes and adjustments over time, reflecting that IT investments are often phased rather than fully committed upfront. By incorporating ROT, this approach evaluates the value of incremental investments or staged developments, which traditional methods might miss [6].
d. Strategic Value Assessment. IT investments often deliver strategic, non-monetary benefits such as competitive advantages, process improvements, or customer satisfaction. ROT captures the strategic value of flexibility in investment, allowing decision-makers to respond to market or technological shifts. PAV further supports this by modelling partial adjustments that align with long-term strategic goals [11].
e. Better Reflection of Real-world Dynamics. The combination of PAV and ROT reflects how IT projects are managed in practice. Decisions are rarely binary but involve adjustments based on iterative feedback. Unlike static valuation methods, this integrated approach accommodates IT projects' iterative, adaptive nature (see Table 1 [6]).

5) Challenges:

While highly effective, integrating PAV and ROT has some challenges:

a. Complexity: These methods require sophisticated modelling, which can be resource-intensive.
b. Data Requirements: Accurate estimation of volatility, option values, and adjustment parameters can be difficult.
c. Understanding: Managers and stakeholders may require training to effectively interpret the results.

TABLE I
COMPARISON WITH TRADITIONAL METHODS

Aspect	Traditional Methods	PAV+ROT
Flexibility	Low	High
Treatment of Uncertainty	Limited (via discount rate)	Explicit and integral to valuation
Strategic Value Capture	Minimal	High
Phased Investments	Difficult to model	Natural and inherent in the approach
Complexity	Low	Higher but provides deeper insight

Therefore, integrating PAV and ROT offers a robust framework for valuing IT investments, particularly in environments with high uncertainty and the need for strategic flexibility. While more complex than traditional methods, this approach provides a nuanced valuation that aligns closely with real-world investment scenarios, making it highly effective for modern IT project management and decision-making (see Table 1).

Moreover, we generated hypothetical data to create a meaningful analysis comparing Partial Adjustment Valuation (PAV) and Real Options Theory (ROT). This data illustrates the strengths and applications of both methods in valuing IT investments under different scenarios. We then use a table to present the data and provide an analysis, accompanied by graphs and explanatory paragraphs [6].

Assumptions, which can be seen in Table 2 [12] are as follows:

a. We compare IT projects regarding flexibility, adaptability to uncertainty, strategic value capture, and overall investment value.
b. Data points are rated on a scale of 0 to 10, where 10 represents the highest level of performance.

TABLE II
COMPARISON OF PAV WITH ROT

Methods	Flexibility	Adaptability to Uncertainty	Strategic Value Capture	Investment Value (ROI)
Partial Adjustment Valuation (PAV)	7	6	7	8
Real Options Theory (ROT)	9	10	9	9

6) Graphical Representation:

We created a radar chart to visualize these metrics and analyze the differences. Let us generate the chart (see Fig. 1). There was an issue with aligning the labels for the radar chart. Let us fix it and regenerate the graph [12].

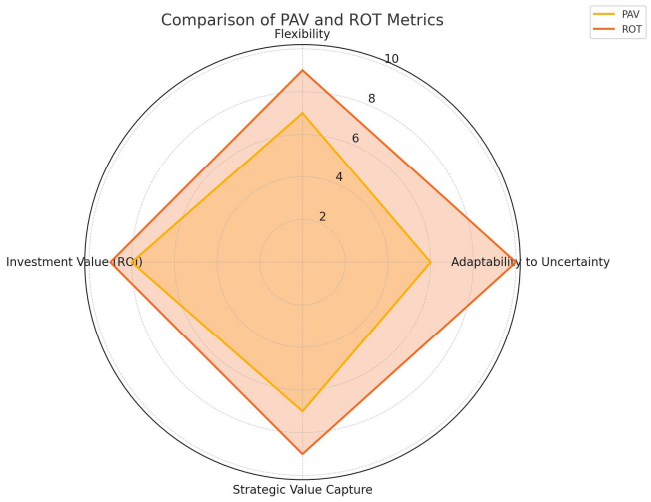

Fig. 1 Comparison of PAV and ROT metrics

The radar chart above compares Partial Adjustment Valuation (PAV) and Real Options Theory (ROT) across four key metrics: flexibility, adaptability to uncertainty, strategic value capture, and investment value (ROI). ROT scores higher due to its inherent design for decision-making under uncertainty, which allows for deferring, expanding, or abandoning investments. While moderately flexible, PAV primarily models adjust over time, resulting in a lower score [12].

Adaptability to Uncertainty: ROT excels by explicitly incorporating uncertainty into its valuation framework, making it a powerful tool for IT investments in volatile environments. Meanwhile, PAV captures uncertainty indirectly through gradual adjustments, which is less effective in highly uncertain scenarios.

Thus, ROT performs better again, directly quantifying strategic options such as market entry or scaling. PAV provides value but is limited in addressing broader strategic scenarios. Therefore, in terms of Investment Value (ROI), both methods offer strong performance, with ROT slightly outperforming due to its ability to leverage opportunities under uncertain conditions fully.

So, it can be concluded the Real Options Theory (ROT) is more suitable for IT investments where uncertainty and strategic flexibility are significant factors. Meanwhile, the Partial Adjustment Valuation (PAV) is effective for scenarios with moderate uncertainty and where gradual adjustments over time are sufficient. The combined use of both methods could provide a comprehensive valuation framework, leveraging the strengths of each approach [6], [12]. Also, both Partial Adjustment Valuation (PAV) and Real Options Theory (ROT) are valuable tools for ensuring the recognition of the full value of IT investments, addressing both short-term and long-term considerations. Here's how they contribute:

7) Short-Term Value Recognition:

In the Partial Adjustment Valuation (PAV): Gradual Resource Allocation, PAV models the dynamic adjustments in resource allocation over time, aligning investments with immediate operational and market conditions. In addition, Speed of Adjustment, by factoring in the speed at which a company can adjust to changes (e.g., technological adoption or market trends), PAV ensures the investment's immediate contributions are not undervalued. Also, in Risk Management, incremental investments can mitigate short-term uncertainties, avoiding significant upfront commitments while capitalizing on immediate opportunities.

Meanwhile, in the Real Options Theory (ROT), in Strategic Flexibility, the ROT emphasizes the value of decisions such as delaying, scaling, or abandoning projects, which helps to protect investments in the face of short-term market volatility or technological disruptions. Likewise, in Initial Exploration Value, the ROT highlights the worth of initial investments that provide learning opportunities, ensuring early-stage initiatives are recognized for their potential to unlock future gains [20], [39].

8) Long-Term Value Recognition:

The Partial Adjustment Valuation (PAV): Sustained Optimization, meaning that by incorporating ongoing adjustments over time, PAV aligns the investment trajectory with evolving business goals and external conditions, ensuring long-term relevance. Also, Path Dependency, the model captures the compounding benefits of initial investments that pave the way for future enhancements, ensuring that long-term returns are recognized and quantified.

While the Real Options Theory (ROT) in Future Opportunities explicitly values the optionality embedded in IT investments, such as the ability to expand into new markets, integrate emerging technologies, or adapt to regulatory changes. Additionally, in Strategic Positioning, by treating uncertainty as a source of potential value, ROT ensures long-term strategic benefits are not overlooked, such as gaining a competitive edge or building innovation capacity. Also, in the Lifecycle Perspective, the ROT acknowledges that the value of IT investments evolves, particularly as market conditions and technology landscapes shift, see Table 3 [20], [27].

Therefore, the PAV and the ROT ensure that the full value of IT investments is recognized by addressing both short-term operational benefits and long-term strategic opportunities. PAV focuses on aligning investments with current realities, while ROT values the flexibility to respond to uncertainty and capitalize on future possibilities. Their integration provides a holistic framework that captures the complexity and potential of IT investments in dynamic environments [35], [40].

TABLE III
COMPLEMENTARY IMPACT OF PAV AND ROT

Aspect	PAV	ROT	Combined Impact
Immediate Value	Models incremental adjustment	Capture immediate flexibility	Balances short-term gains with strategic foresight
Risk Mitigation	Aligns with operational realities	Values adaptability to uncertainty	Minimizes downside risks while preserving upside potential
Strategic Value	Focuses on gradual improvement	Quantifies strategic options	Recognizes both incremental and transformative value
Uncertainty Handling	Adjusts over time	Proactively leverages uncertainty	Comprehensive management of known and unknown risks.

IV. Conclusion

The integration of Partial Adjustment Valuation and Real Options Theory provides a more sophisticated and flexible approach to IT investment valuation. While traditional models focus on financial returns, PAV captures the gradual nature of IT investments, and ROT emphasizes the value of strategic flexibility. Together, these models offer a more comprehensive framework for understanding the true value of IT in an uncertain and rapidly evolving business environment [7], [41], [40]. As organizations continue to invest in digital technologies, adopting advanced valuation methodologies like PAV and ROT can lead to better-informed decisions, maximizing the long-term value of IT investments [12]. In conclusion, the integration of Partial Adjustment Valuation and Real Options Theory provides a robust and flexible approach for valuing IT investments, particularly in scenarios characterized by uncertainty and gradual adoption. As demonstrated in the case studies, these models capture both the incremental nature of IT adoption and the strategic value of flexibility, providing a more comprehensive framework than traditional methods. For organizations investing in IT, adopting PAV and ROT can significantly improve decision-making, ensuring that the full value of IT is recognized in both the short and long term [7], [9].

Acknowledgment

We thank the Faculty of Industrial Engineering, Telkom University, Bandung, and the Directorate of Research and Community Service, Telkom University, Bandung, Indonesia for supporting this research.

References

[1] S. K. Ermaya, H. N. L. Ermaya, A. Saefudin, and A. W. Gunawan, "Business intelligence, strategy innovation, and digital value creation for business performance on digital creative industries," *Int. J. Bus. Soc.*, vol. 26, no. 1, pp. 80–100, 2025, doi: 10.33736/ijbs.9548.2025.

[2] Y. Ze and O. K. Loang, "Strategic flexibility in investment portfolios," in *Unveiling Investor Biases That Shape Market Dynamics*, pp. 251-272, Dec. 2024, doi: 10.4018/979-8-3693-9380-2.ch010.

[3] W. T. Lin, Y. H. Chen, and S. S. Jhang, "The effects of unemployment and inflation rates on the business value of information technology and economic performance: The partial adjustment valuation approaches," *Asia Pac. Manage. Rev.*, 2023, doi:10.1016/j.apmrv.2022.12.005.

[4] N. Marques, L. M. Sanchez, L. Brandao, and C. B. Pinto, "Valuation of infrastructure projects: Review of the real options literature," *Transp. Res. Rec.*, vol. 12678, no. 5, 2024, doi:10.1177/03611981231188372.

[5] D. Nguyen and Q. Tran, "Strategic flexibility in healthcare: An exploration of real options," *J. Econ. Stud.*, vol. 51, no. 9, pp. 177–199, 2024, doi: 10.1108/JES-10-2023-0605.

[6] P. Scandizzo and O. Knudsen, "The new normalcy and the pandemic threat: A real option approach," *J. Risk Financ. Manage.*, vol. 17, no. 2, p. 72, 2024, doi: 10.3390/jrfm17020072.

[7] A. Garad, H. A. Riyadh, A. M. Al-Ansi, and B. A. H. Beshr, "Unlocking financial innovation through strategic investments in information management: A systematic review," *Discov. Sustain.*, vol. 5, no. 1, 2024, doi: 10.1007/s43621-024-00542-6.

[8] K. C. Fitzgerald and F. Marimuthu, "Enhancing financial decision-making: Real options complementing the net present value technique in the financial services sector," *Int. J. Environ. Sustain. Soc. Sci.*, vol. 5, no. 5, pp. 1395–1407, 2024, doi: 10.38142/ijesss.v5i5.1125.

[9] A. Azghoul and O. Al-kasasbeh, "The moderating role of information technology infrastructure in the relationship between fintech adoption and organizational competitiveness," *Invest. Manage. Financ. Innov.*, vol. 21, no. 2, pp. 155–166, 2024, doi: 10.21511/imfi.21(2).2024.12.

[10] F. Zafary, "Implementation of business intelligence considering the role of information systems integration and enterprise resource planning," *J. Intell. Stud. Bus.*, vol. 10, no. 1, pp. 59–74, 2024, doi:10.37380/jisib.v10i1.563.

[11] A. Davalas, C. P. Beretas, M. Tsiogka, and A. Angelaki, "The strategic importance of cybersecurity for tech startups in a digital world," *Univ. Lib. Eng. Technol.*, vol. 1, no. 2, pp. 14–25, 2024, doi:10.70315/uloap.ulete.2024.0102003.

[12] R. Ahmadi and R. B. Bratvoid, "An exposition of least square Monte Carlo approach for real options valuation," *J. Pet. Sci. Eng.*, vol. 222, no. 3, p. 111230, 2023, doi: 10.1016/j.petrol.2022.111230.

[13] D. Wang, M. Zhou, D. Han, X. Wu, W. Mao, and Y. Hu, "The effectiveness of revocable pre-commitment strategies in reducing decision-making impulsivity," *Soc. Cogn. Affect. Neurosci.*, vol. 19, no. 1, 2024, doi: 10.1093/scan/nsae093.

[14] J. C. Livisaca, P. F. Siguenza, R. Guaman, and A. M. G. Municio, "Key drivers of ERP implementation in digital transformation: Evidence from Austro-Ecuadorian," *Admin. Sci.*, vol. 15, no. 6, p. 196, 2025, doi: 10.3390/admsci15060196.

[15] E. K. Clemons and L. M. Hitt, "Poaching and the misappropriation of information: Transaction risks of information exchange," *J. Manage. Inf. Syst.*, vol. 21, no. 2, pp. 87–107, 2004, doi:10.1080/07421222.2004.11045802.

[16] R. J. Caballero and E. M. Engel, "Explaining Investment Dynamics in U.S. Manufacturing: A Generalized (S,s) Approach," *Econometrica*, vol. 67, no. 4, pp. 783–826, 1999, doi: 10.1111/1468-0262.00053.

[17] A. Abel and O. Blanchard, "An intertemporal model of saving and investment," *Econometrica*, vol. 51, no. 3, pp. 675-692, 1983, doi:10.2307/1912153.

[18] S. K. Mohan, G. K. Barathy, and A. Jalan, "Enterprise data valuation - A targeted literature review," *J. Econ. Surv.*, early access, 2025, doi:10.1111/joes.12705.

[19] A. J. M. Lagunas and M. N. Bakht, "Process mining, modeling, and management in construction: A critical review of three decades of research coupled with a current industry perspective," *J. Constr. Eng. Manage.*, vol. 150, no. 11, pp. 1-23, 2024, doi:10.1061/jcemd4.coeng-14727.

[20] J. M. L. Almansa, J. T. Fernandez, and A. M. S. Perez, "Digital transformation and real options: Evaluating the investment in cloud ERP," *Eng. Econ.*, vol. 34, no. 4, pp. 397-411, 2023, doi:10.5755/j01.ee.34.4.30678.

[21] D. Bloch, "A review of The Pricing of Options and Corporate Liabilities," *Wilmott*, vol. 2023, no. 126, 2023, doi:10.54946/wilm.11152.

[22] M. Benaroch and R. J. Kauffman, "A Case for Using Real Options Pricing Analysis to Evaluate Information Technology Project Investments," *Inf. Syst. Res.*, vol. 10, no. 1, pp. 70–86, 1999, doi:10.1287/isre.10.1.70.

[23] H. B. Bendall and A. F. Stent, "Maritime investment strategies with a portfolio of real options," *Marit. Policy Manage.*, vol. 34, no. 5, pp. 441-452, 2007, doi: 10.1080/03088830701585183.

[24] N. D. Sizova, O. Starkova, G. Solodovni, and N. Dolgova, "Development of a computer model for evaluating the alternative options of an investment and construction project under conditions of uncertainty and risk," *J. East.-Eur. J. Enterp. Technol.*, vol. 6, no. 3, pp. 66-76, 2019, doi: 10.15587/1729-4061.2019.184376.

[25] R. G. Fichman, "Real Options and IT Platform Adoption: Implications for Theory and Practice," *Inf. Syst. Res.*, vol. 15, no. 2, pp. 132–154, 2004, doi: 10.1287/isre.1040.0021.

[26] J. E. Smith and R. F. Nau, "Valuing Risky Projects: Option Pricing Theory and Decision Analysis," *Manage. Sci.*, vol. 41, no. 5, pp. 795–816, 1995, doi: 10.1287/mnsc.41.5.795.

[27] M. I. M. Wahab, C. G. Lee, and P. Sarkar, "A real options approach to value manufacturing flexibilities with regime-switching product demand," *Flex. Serv. Manuf. J.*, vol. 35, no. 3, pp. 1-32, 2022, doi:10.1007/s10696-022-09450-1.

[28] M. Ali and Q. Rafique, "Strategic integration of real options for enhanced valuation and optimization in mining project planning under uncertainty: A comprehensive review," *Int. J. Proj. Manage.*, vol. 6, no. 2, pp. 26-50, 2024, doi: 10.47672/ijpm.2004.

[29] A. Polyviou, N. Pouloudi, and W. Venters, "Cloud computing adoption decision-making process: A sensemaking analysis," *Inf. Technol. People*, vol. 37, no. 6, 2023, doi: 10.1108/itp-02-2022-0139.

[30] R. Guo, A. Tafti, and R. Subramanyam, "Internal IT modularity, firm size, and adoption of cloud computing," *Electron. Commer. Res.*, vol. 25, no. 1, pp. 319-348, 2023, doi: 10.1007/s10660-023-09691-8.

[31] E. Dimanchev, S. E. Fleten, D. Mackenzie, and M. Korpas, "Accelerating electric vehicle charging investments: A real options approach to policy design," *Energy Policy*, vol. 181, no. 12, p. 113703, 2023, doi: 10.1016/j.enpol.2023.113703.

[32] K. Daniil, "Accounting identification and valuation of financial instruments," *Scientia Fructuosa*, vol. 160, no. 2, 2025, doi:10.31617/1.2025(160)06.

[33] S. Lombardo, S. Israel, and D. Wood, "The environment-vulnerability-decision-technology framework for decision support in Indonesia," in *Proc. IEEE Aerosp. Conf.*, 2022, doi:10.1109/aero53065.2022.9843544.

[34] G. B. Benitez and M. J. R. F. Lima, "The real options method applied to decision making - an investment analysis," *Braz. J. Oper. Prod. Manage.*, vol. 16, no. 4, pp. 562-571, 2019, doi:10.14488/bjopm.2019.v16.n4.a2.

[35] W. T. Lin and C.-Y. Chiang, "The impacts of country characteristics upon the value of information technology as measured by productive efficiency," *Int. J. Prod. Econ.*, vol. 132, no. 1, pp. 13–33, 2011.

[36] D. Hatzinikolaou and D. Hatzinikolaou, "Modeling aggregate investment under financial constraints," *Empir. Econ.*, vol. 68, no. 2, pp. 759-781, 2024, doi: 10.1007/s00181-024-02661-5.

[37] B. Kogut and N. Kulatilaka, "Operating Flexibility, Global Manufacturing, and the Option Value of a Multinational Network," *Manage. Sci.*, vol. 40, no. 1, pp. 123–139, 1994, doi:10.1287/mnsc.40.1.123.

[38] Y. Xue and X. Yun, "The optimal performance target of valuation adjustment mechanism agreement with real options perspective," *PLOS One*, vol. 17, no. 11, p. e0277509, 2022, doi:10.1371/journal.pone.0277509.

[39] M. A. Vogel, "Leveraging information technology competencies and capabilities for a competitive advantage," Ph.D Dissertation, Univ. Maryland, College Park, MD, USA, Maryland, College Park, MD, USA, 2005

[40] A. R. Hevner, S. T. March, and J. Park, "Design science in information systems research," *MIS Quart*, vol. 28, no. 1, pp. 75–105, 2004, doi:10.2307/25148625.