COST ANALYSIS OF INNOVATION IN LEARNING TECHNOLOGY

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Abstract

In this research, the main objective is to analyze the cost components involved in the innovation of learning technology and examine the factors influencing decision-making in the development of learning technology innovations from a cost perspective. The research follows a qualitative descriptive method and utilizes data collection techniques such as interviews, observations, and literature review. Data analysis is conducted using content analysis. The findings reveal that the costs associated with technology development span across various stages, including research, design, testing, production, implementation, maintenance, and support. Through a comprehensive analysis, organizations can gain a better understanding of how costs are allocated, manage their budget effectively, and optimize their resources. This analysis empowers decision-makers to make informed choices and enhance the efficiency of their investments in technology development.

Keywords: Cost, Innovation, Learning Technology.

1 INTRODUCTION

In recent years, business operations have undergone drastic changes due to the impact of disruptive technological innovations. However, knowledge about the acceptance and consequences of the fourth industrial revolution (4IR) in the education sector is still lacking. Research findings indicate that the education sector is not fully prepared for 4IR, although there are indications of opportunities to harness the great potential of 4IR. Research also indicates a reciprocal symbiotic relationship between the education sector and technological innovation. 4IR can facilitate student learning experiences and transform the workplace, but an assessment of the learning environment is still needed to understand the facilitators and barriers to 4IR diffusion (Oke & Fernandes, 2020). In addition, sometimes companies implement technological innovations simply because they follow trends without careful consideration (Mediana, 2023), which causes inefficiencies from the many technologies and makes the budget ineffective (Damayanti, 2022). The many technological innovations that are carried out have the potential to cause inefficiencies (Dwi, 2022). Although advanced technologies and pedagogical innovations do not automatically enter the education system, innovation remains an important

part of practice and theory. Innovation is a system of actions aimed at improving the quality of socio-cultural objects. The purpose of innovation is to get the most out of the money or effort spent. Unlike many spontaneous innovations, innovation is a mechanism of change that is managed and controlled, systematic, integrated, and sustainable (Kharatova & Ismailov, 2022). Silva and Dacorso's (2013) research shows that innovation can generate significant competitiveness.

The application of technology in education and learning can improve and facilitate learning, increase memory capacity, increase enjoyment and interest in learning, and increase involvement in learning activities (Daurrohmah, 2023). However, technological innovation in education is inseparable from significant development costs. Globalization and internationalization force innovation and adequate costing systems to gain sustainable competitive advantage (Alvarez-Aros & Herrera, 2018). The increasing cost of technology development and the decreasing product life cycle are changing the way of doing business and proposing new competitive formats.

The activity-based costing system (ABC) has emerged as a costing method that is able to overcome the limitations of traditional costing systems, especially in the allocation of indirect costs which are often inappropriate. Developing an adequate costing system is essential for organizations to manage resources well and control costs in order to achieve efficient and effective management (Quesado & Silva, 2021). An efficiency-centered business model helps companies reduce transaction costs and improve transaction efficiency (Jian & Hongxia, 2023).

Technological innovation helps companies develop new products and gain competitive advantages in the market, which ultimately improves their operational benefits (Zhuang & Wang, 2022). The source of new technology affects innovation performance (Wang, 2020). The mode of technological innovation includes two categories based on the source of new technology, namely internally developed or externally purchased (Veugelers & Cassiman, 1999). In order to develop technology, companies invest in independent R&D, either independently or through collaboration with other entities. In contrast, in purchasing technology, companies acquire new technology by purchasing patents and production equipment, licensing technology, and recruiting core technology personnel from other companies.

This study has novelty in the analysis of costs associated with technological innovation in learning, which is an area that has not been studied in depth in other studies. By understanding the cost components and factors influencing decision-making in the development of learning technology innovations, this study provides the necessary insights to optimize resource utilization and improve efficiency in the education sector. The main objective of this study is to analyze the cost components involved in learning technology innovations and examine the factors influencing decision-making in the development of learning technology innovations from a cost perspective. This study is expected to provide significant contributions to the understanding of how technological innovations can be implemented effectively and efficiently in the education system.

2 METHODOLOGY

This study uses a qualitative descriptive method (Doyle et al., 2019). Qualitative design includes various approaches in data collection used to provide descriptions and interpretations of culture and the context of social phenomena (Vaismoradi & Snelgrove, 2019). Data collection techniques in this study include interviews, observations, and literature reviews (Pratama et al., 2020). The use of various data sources aims to maintain data validity through source triangulation (Natow, 2019). Participant observation was carried out by the Researcher who is also an innovator in the field of learning technology, while in-depth interviews were conducted with Expert Staff in the Field of Innovation, Business and Investment at a university in Indonesia and the innovation development team at Telkom. This approach is used to analyze the cost components involved in learning technology innovation and examine the factors that influence decision making in the development of learning technology innovation from a cost perspective. The data that has been collected is analyzed using content analysis, which involves an in-depth discussion of the information found in the literature. QCA is an effort to reduce qualitative data and interpret using various qualitative materials and trying to identify consistency and core meaning (Prasad & Bammidi, 2019). The content analysis technique is carried out by making the content available in the literature as the object of analysis, and obtaining conclusions that can be replicated and valid, which can be studied in more detail according to the established context (Pratama et al., 2020; Baker III & Moukhliss, 2019). The purpose of content analysis is to analyze textual data systematically, making conclusions that can be replicated and valid in the hope of producing knowledge, insight, and data condensation.

3 FINDINGS AND DISCUSSION

3.1 Technological Innovation

Technological innovation must be able to anticipate the needs of the next 5-10 years even though it has a high initial cost. In addition, this innovation must be able to increase efficiency. Technology development in the current era of uncertainty can be done with an AGILE approach that allows speed and agility in adaptation. One effective approach in this case is the Minimum Viable Product (MVP), which allows iterative testing and updating of the product. Technology development is based on the agile concept, which emphasizes flexibility and responsiveness to change. In this approach, it is important to evaluate whether the technological innovation being developed is in accordance with market needs and user preferences. The development process must begin by delivering the minimum possible product to observe market reactions and feedback from users. Based on this feedback, development is carried out iteratively until the technological innovation is truly accepted and liked by users. The basis of this technology development roadmap is the concept of Minimum Viable Product (MVP), which allows rapid testing and continuous adjustment to ensure suitability to market and user needs.

In the development of information systems, the Design Science Research (DSR) methodology is very relevant. DSR involves iterative cycles of development and evaluation, ensuring that the process is not a one-off, but rather a continuous process. This approach allows for continuous improvement and adaptation to changing needs and technology environments.

In addition to an agile and continuous development approach, a structured digital transformation roadmap is also essential. This roadmap should include an Enterprise Architecture (EA) that provides a holistic framework for integrating various aspects of business and technology. EA helps in aligning business strategy with technology implementation, ensuring that each step in the digital transformation is based on in-depth analysis and careful planning. With a clear roadmap and comprehensive EA, organizations can be more effective in managing change and achieving their digital transformation goals.

The concept of digital maturity, or Capability Maturity Model (CMM), can be an effective measurement tool in making decisions related to technology innovation and digital transformation. Digital maturity encompasses various aspects that need to be measured and evaluated, including human resources, technology, regulations, and business processes. Using the CMM, organizations can assess the extent to which their digital capabilities are developing

and identify areas that need improvement. In addition, this measurement tool can be continuously updated and adjusted (maintained) to reflect changes and developments in technology and business needs. Thus, CMM not only helps in assessing current maturity but also serves as a guide for planning and implementing more strategic and measurable digital transformation steps.

At the same time, immersive technologies such as augmented reality (AR) and virtual reality (VR) have transformed education, making it more engaging and interactive. Studies by McGovern et al. (2019) and Elmqaddem (2019) show that VR and AR can improve students' communication skills and significantly change learning models. The application of methodologies such as the Game Development Life Cycle (GDLC) and Multimedia Development Life Cycle (MDLC) emphasize the importance of structure in creating effective learning applications and engaging digital content, highlighting the use of gamification to increase student engagement and motivation, as studied by Acosta-Medina et al. (2020).

Many companies are now integrating agile innovation processes and have shown promising results. Companies across industries have adopted agile processes as their innovation managers seek to accelerate development and respond to dynamic environments based on a flexible management approach. Any transformation of the innovation process must balance the benefits of agile methods (Lichtenthaler, 2020). Initiatives to transform the innovation process need to consider the organizational context. While agile project management is becoming increasingly important, the performance of each company varies greatly due to different innovation capabilities and internal and external environmental dynamics (Lichtenthaler, 2020). Agile project management is a necessary condition for success, quality improvement, and increased competitiveness.

3.2 Costing Technological Innovation

Many non-profit organizations, especially in the field of education, claim to use the Activity-Based Costing (ABC) method in their budgeting concept, but in practice the implementation of this method has not been fully implemented. ABC is a more accurate approach to cost allocation by allocating costs based on activities that actually consume resources. However, many organizations still use traditional budgeting methods that are less accurate in identifying and allocating costs based on activities. This is due to various challenges in implementing ABC,

including the need for changes in organizational culture, adequate training, and investment in information systems that support effective ABC implementation (Borges et al., 2024).

Budgeting must be able to accommodate change and remain relevant in the future, especially with technological developments and changing market needs. This means that organizations must consider flexibility and adaptability in their budgeting processes, ensuring that the budget not only reflects current conditions but also prepares for future developments and challenges. Effective budgeting focuses on current cost allocations as well as long-term strategies that allow the organization to remain competitive and responsive to change.

When innovating, risk is an inevitable part of the process. Innovation, which often involves new approaches, new technologies, or new business models, always carries uncertainties that can affect the expected outcomes. These risks can include technology failure, market rejection, or unforeseen regulatory issues. However, risks are not always negative; they are also opportunities to learn and grow. With effective risk management, organizations can better identify, evaluate, and manage these risks. Using approaches such as Minimum Viable Product (MVP) in technology development allows for rapid testing and iteration so that risks can be identified and addressed early in the innovation process. Thus, while risk is an inevitable part of innovation, with a sound risk management strategy, organizations can minimize the negative impacts and maximize the chances of their innovations succeeding.

Technology innovation is likely to have high upfront costs as it is part of a digital transformation. These significant upfront costs include investments in new technology infrastructure, employee training, software development, and adaptation to new business processes. Despite these high upfront costs, digital transformation aims to improve operational efficiency, optimize business processes, and provide a long-term competitive advantage. Therefore, even though the initial costs are high, investment in technological innovation can generate significant and sustainable benefits for the organization (Ismail, 2010).

The cost of technological innovation includes several important components such as human resources (people), technology, and business processes. Investments in human resources include training and development of technological literacy so that employees are able to adopt and operate new technologies effectively. In addition, technology costs include the purchase of hardware and software, as well as the development and maintenance of the necessary information systems. Business processes also need to be adjusted and optimized to support technological innovation, which often requires analysis and improvement of existing processes.

Although these costs may be high in the initial stages, these investments are expected to result in significant long-term efficiency and productivity improvements (Sorros et al., 2017). Since the implementation of Activity-Based Costing (ABC) has not been fully implemented, the current budgeting method uses the incremental budgeting method which often results in many budget revisions. Incremental budgeting, which is based on the previous year's budget with minor adjustments for the upcoming period, tends to be less accurate in reflecting the actual costs associated with a particular activity (Kenno et al., 2020). This results in the need to periodically revise the budget to better align with operational realities. ABC implementation is expected to reduce the frequency of budget revisions by providing a clearer and more accurate picture of cost allocation based on resource-consuming activities. Innovation development should use a "money follows program" system, not a "program follows money" (Cahyaningtyas et al., 2023). In the "money follows program" approach, funding is directed based on planned program priorities and needs, ensuring effective resource allocation to achieve strategic goals. This allows for a focus on program outcomes and impacts, and supports targeted innovation development. In contrast, the "program follows money" approach often makes programs tailored to existing budget allocations, which can hinder innovation and program effectiveness due to limited flexibility and responsiveness to emerging needs. With "money follows program," innovation development can be more structured, planned, and oriented towards achieving desired results.

Budgeting must be able to take into account the Total Cost of Ownership (TCO) to provide comprehensive value (Roda et al., 2019). TCO includes all costs associated with owning and using technology or assets throughout their life cycle, including initial costs, maintenance, support, training, and asset disposal. By taking TCO into account, organizations can more accurately evaluate technology investments and ensure that budgets reflect the true costs that will be incurred, not just the initial costs. This approach helps in making better decisions about investments, optimizing spending, and ensuring that the value obtained from technology investments is comparable to the total costs incurred. Thus, budgeting that considers TCO can support a more effective and efficient long-term strategy. When budgeting uses the AGILE concept, once the program experiences switching or changes, budget restructuring can be done directly and efficiently. The AGILE approach to budgeting allows for high flexibility and responsiveness to changing needs and priorities. In situations where the program needs to be changed or adjusted, the budget can be immediately updated to reflect the changes, without

having to go through a long and bureaucratic process. This ensures that resources are always allocated optimally according to current goals and needs, supporting program success and increasing overall organizational efficiency. Disaster budgeting is an essential component of the budgeting process that prepares organizations for unexpected emergencies or disasters by allocating dedicated funds. This approach begins with risk identification to recognize potential disasters that the organization may face, followed by an assessment of the potential financial impact. Next, adequate reserve funds are allocated to address emergencies, supported by business continuity planning to ensure continued operations during and after a disaster. Disaster budgeting is revised and updated periodically to accommodate changing conditions and new risks. With disaster budgeting, organizations can be more responsive and prepared to face various potential disasters, minimize losses, and ensure effective operational continuity.

4 CONCLUSION

This study has successfully identified and analyzed the cost components involved in learning technology innovation and the factors that influence decision-making in developing such innovations from a cost perspective. The results show that cost components cover various stages, such as research, design, testing, production, implementation, maintenance, and support, and that effective management and allocation of costs at each of these stages are key to ensuring the success of technology innovation in education. In addition, factors such as technology needs, sustainability, market adaptation, and potential return on investment (ROI) greatly influence decision-making related to technology innovation. Although learning technology innovation requires a large initial investment, with proper management, these costs can be offset by increased efficiency and long-term effectiveness. Therefore, decisions to adopt and integrate new technologies must be supported by a detailed and comprehensive cost analysis.

This study has important implications in assisting educational institutions and companies in making strategic decisions related to technology investment and in designing cost-efficient innovation processes. Policymakers can use these findings to develop guidelines for effective and efficient allocation of funds in educational technology, while educators and administrators can implement more cost-effective technology solutions without sacrificing the quality of education. However, this study has limitations, including limited data coverage to qualitative data, generalizability of findings that may not apply to all forms of educational technology, and lack of consideration of human factors such as resistance to change.

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