The Influence of Intellectual Capital Efficiency on Innovation Performance: Mediated by Environmental Innovations – Conceptual Review

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Abstract. This study aims to explore the mediating role of environmental innovation in the relationships among structural capital, human capital, relational capital, and innovation performance. The methodology used is a structured conceptual framework that combines literature from relevant previous studies to develop and analyze conceptual models. The analysis shows that the three components of intellectual capital have a significant positive effect on innovation performance, both directly and indirectly through environmental innovation. In managing internal resources and integrating environmental innovation, it is important to achieve sustainable competitive advantage. The originality of this study lies in the role of environmental innovation as a mediator that has not been comprehensively explored in prior contexts. The practical implication of this research is the importance of effectively managing the three components of intellectual capital to improve innovation performance, especially in the police force, by implementing various strategies and emphasizing environmental innovation to increase effectiveness, efficiency, and sustainability in the performance of duties and to increase public trust.

Keywords: Structural Capital, Human Capital, Relational Capital, Innovation Performance, Environmental Innovation

1 Introduction

Indonesia is entering an era of increasingly complex global competition. Technological advances are one of the causes of significant transformations in Human Resources (HR) within organizations. Human resources play a vital role. COVID-19 has been one of the causes of the acceleration of digital technology and Artificial İntelligence (AI) [1]. In addition, the pandemic has highlighted the adaptive capacity of organizations that use digital communication and underscored the importance of infrastructure in crisis response. Digitalization in HR processes is very helpful for managing activities, including environmental management, increasing productivity, and managing employee dynamics more effectively [2]. Global competition and technological advances are driving organizational innovation and ensuring long-term sustainability [3].

One organization affected by digitalization is the police force. Digitalization helps the police force to strengthen its control model [4], [5]. In carrying out its duties

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to maintain security and public order and support government programs effectively and efficiently throughout Indonesia, especially in the Special Region of Yogyakarta, the police force needs to achieve competitive excellence. This was conveyed by Inspector General Anwar at the 2025 Technical Working Meeting (Rakernis) of the Indonesian National Police on May 8-9, 2025. This commitment is one of the Indonesian National Police's strategic efforts to maintain security and public order, which can be realized with superior, adaptive, and integrity-driven human resources, thereby becoming the key to maintaining national stability and anticipating potential disturbances to security and public order. This competitive advantage will help the police build public trust and perform their duties better in accordance with Law No. 2 of 2002.

The key to maintaining competitive advantage is innovation that involves a multifaceted approach, integrating several factors, namely technological, organizational, and social [6]. Strategic innovation is significant for long-term success [7]. The ability of police organizations to innovate can help them respond to the challenges of a dynamic environment. Intellectual capital is an important factor in supporting organizational innovation. Intellectual capital reflects the efficiency of intangible resources in creating added value and sustainable innovation [8]. Structural capital includes organizational processes and databases that are important in providing infrastructure that supports knowledge and innovation. Human capital includes individual skills, knowledge, and abilities [9]. Relational capital involves networks managed by the organization [10]. Specifically, in the context of police organizations, the efficiency of intellectual capital is expected to drive innovation performance—both technical and environmental—in response to the organization's sustainable needs and social role [11].

From the preliminary study results, three components of intellectual capital have a positive effect on innovation performance. The importance of intellectual capital efficiency in driving innovation performance is proven by the fact that intellectual capital consists of three components that play an important role in innovation performance [8], [12], [13], [14]. Structural capital, such as team social capital, negatively impacts innovation by increasing task conflict [15], [16]. Structural capital does not have a significant effect on innovation in the absence of other variables [17], [18]. Relational capital needs to be supported by more effective human and cultural capital, while structural capital tends to make a less significant direct contribution to innovation [19]. Without organizational culture, leadership, and relational and structural capital [20] to support it, human capital has a weak relationship with innovation performance.

To address this empirical gap, researchers added a mediating variable—environmental innovations—to examine the impact of ıntellectual capital efficiency (structural capital, human capital, and relational capital) on ınnovation performance. Environmental innovations are important for sustainable development [21]. Environmental innovation in the police force can be facilitated by implementing environmental controls [22] to enable strategic planning and facilitate continuous control [23]. Innovation performance is a multifaceted effort that integrates technological, social, and organizational innovation [6]. This will significantly increase the productivity of the Indonesian National Police by making more accurate and actionable predictions [24].

In the context of this study, researchers are interested in exploring how the

influence of intellectual capital efficiency (structural capital, human capital, relational capital) on innovation performance is mediated by environmental innovations among members of the Indonesian National Police (POLRI) in contributing to improving the quality of the organization and sustainable public services. This research is important to provide a basis for the development of POLRI's resources and innovation strategies, with the hope of professionally completing tasks related to environmental sustainability. This study uses a conceptual review as the main approach to explain and integrate various concepts and theories relevant to the topic under investigation. A conceptual review allows for a deep understanding of the rationale and conceptual framework underlying the analysis, thereby contributing significantly to the development of the study [57]. Therefore, this study aims to determine and analyze the positive influence of intellectual capital efficiency on innovation performance, mediated by environmental innovations, using a conceptual review method.

2 Literature Review

2.1 Resource-Based View (RBV)

The Resource-Based View (RBV) theory is a comprehensive theoretical framework. RBV emphasizes the importance of internal and strategic resources [25] to achieve sustainable competitive advantage with VRIN characteristics (valuable, rare, inimitable, non-substitutable). The RBV theory is used because it provides a robust strategic framework for understanding how an organization's internal resources [26], including intellectual capital, become sources of superiority, competitiveness, and sustainable innovation. This theory has ongoing relevance to innovation driven by intellectual models directed at an innovation environment that supports social responsibility, competitive advantage, and sustainability. RBV theory can enhance an organization's innovation capabilities by focusing on the efficient management and utilization of intellectual models.

2.2 Intellectual Capital Efficiency

Intellectual capital efficiency is an important concept for demonstrating intangible human resources [27] to increase company value, environmental performance, and competitive advantage. Intellectual capital efficiency can help regulate organizational practices by understanding and exploring capabilities to achieve goals [28] and benefit society in managing the environment. Intellectual capital efficiency encourages changes in regulations and knowledge, as well as innovations, through research and development. The study adopts three components of intellectual capital, namely structural capital, human capital, and relational capital [27].

2.3 Structural Capital

Structural capital is often considered the backbone that supports human capital and relational capital, routines [29], databases, organizational charts, strategies, and organizational culture [30], driving innovation and efficiency. The dimensions of

structural capital are as follows [31], [32]: (1) Culture in the form of values, norms, and social practices that influence organizational behavior and sustainability [33], (2) Structure greatly influences innovation capabilities [34] and time [35]; rigid structures can hinder collaboration and create various challenges [36], (3) Processes involve several strategies and methodologies as well as adaptation [37], (4) Intellectual & industrial property influences organizational choices, performance, and innovation capabilities [38] to encourage innovation, efficiency, and sustainable growth [8], [39].

2.4 Human Capital

Human capital relates to the skills, knowledge, and experience of each individual [40] that drives innovation, performance [29], [41], and efficiency [42]. Human capital directly influences innovation and the ability to adapt to a rapidly changing organizational environment [29]. The dimensions of human capital are as follows [32]: (1) Values & attitudes are influenced by demographic factors, showing different hierarchies that play a role in job satisfaction [43], (2) Aptitudes include knowledge and skills [44], (3) Capabilities involve the implementation of AI [45], adapting and innovating [46] for success and developing innovation [47].

2.5 Relational Capital

Relational capital consists of relationships and networks that an organization has with external stakeholders (customers, suppliers, and partners) that are well managed [29]. Relational capital becomes an energy that can trigger interactions between internal and external parties [48]. Dimensions of relational capital [32], [49], [50]: (1) Customer relationships, improving organizational performance, innovation, and sustainable competitive advantage require maintaining strong relationships with customers [19], (2) Supplier relationships, which occur between buyers and suppliers, become efficient and adaptive, supported by the implementation of 4.0 technology [51], (3) Shareholder relationships, which play an important role in forming relationships with shareholders to encourage innovation and improve performance by minimizing various risks [18], (4) Ally relationships-community, a concept of utilizing networks to improve performance and innovation [19].

2.6 Innovation Performance

Innovation performance refers to an organization's ability to develop products, services, and processes to improve efficiency and competitiveness. Important components in driving innovation performance are human capital and structural capital [12]. Dimensions of innovation performance [52]: (1) Highlight effectiveness is a measure of the success of programs, activities, or organizations in achieving optimal goals and results [53], and (2) efficiency involves organizational, technological, and institutional factors that play an important role in improving efficiency in innovation performance [54].

2.7 Environmental Innovations

The characteristics of environmental innovation are the introduction of products, processes, services, and organizational changes that are significantly improved to reduce resource consumption. A sustainable environment through ecological progress is a contribution of environmental innovation that benefits the environment, including initiatives to reduce pollution, conserve energy, improve product design, and promote waste recycling [27]. The dimensions of environmental innovations are as follows [27]: (1) Process innovation is facilitated by the integration of industry 4.0 technologies [55] that improve performance through sustainable innovation, and (2) Product innovation is a multifaceted concept involving sustainable integration in product development to improve environmental and organizational performance [56].

3 Methodology

This study uses a conceptual review to explain theories and develop new interpretations based on the existing systematic literature [57]. According to several experts, a conceptual review can help identify shortcomings in previous research and lay the foundation for future empirical studies [58]. The literature used covers the period 2020-2025 and was collected from official websites, including Google Scholar, Scopus, etc. The result of this approach is a conceptual framework that can be tested in subsequent studies. This framework aims to answer several questions: (1) Does structural capital have a positive effect on innovation performance? (2) Does human capital have a positive effect on innovation performance? (3) Does relational capital have a positive effect on innovation performance? (4) Does structural capital have a positive effect on environmental innovation? (5) Does human capital have a positive effect on environmental innovation? (6) Does relational capital have a positive effect on environmental innovation? (7) Do environmental innovations have a positive effect on innovation performance? (8) Do environmental innovations mediate the positive effect of structural capital on innovation performance? (9) Do environmental innovations mediate the positive effect of human capital on innovation performance? (10) Do environmental innovations mediate the positive effect of relational capital on innovation performance?

4. Results & Discussion

4.1 The Positive Influence of Structural Capital on Innovation Performance

Structural capital is key to ıntellectual capital efficiency, which significantly influences innovation performance and strategic development. It impacts resource management and efficient processes, thereby improving organizational outcomes [10]. The adoption of 4.0 technology aims to increase intellectual capital as the basis for technological advancement. RBV theory states that structural capital plays an important role in improving innovation performance through collaborative innovation [18], [59], [60] to achieve competitive advantage. This is supported by the Knowledge-Based View (KBV) theory [61] and the Intellectual Capital Based View (ICBV) theory [8]. Therefore, if a certain threshold is reached, the higher the structural capital, the higher

the innovation performance [12], [14]. In conclusion, structural capital positively influences innovation performance.

4.2 The Positive Influence of Human Capital on Innovation Performance

Human capital, which includes skills, education, and experience, plays an important role in driving innovation within organizations and improving performance. Human capital significantly influences innovation performance [62]. The aspects needed to support this are education, R&D, and strategic HR management, which significantly contribute to product and process innovation [63]. HR skills and education are important in driving innovation. RBV theory states that HR is an important resource for enhancing organizational innovation [63], [64], [65], [66]. This is supported by KBV theory [61], [65], [67] and ICBV theory [8], [68]. Therefore, the higher the quality of human capital, the greater the organization's ability to create sustainable Innovation to improve performance [62]. In conclusion, human capital has a positive influence on innovation performance.

4.3 The Positive Influence of Relational Capital on Innovation Performance

Relational capital facilitates collaboration with stakeholders to drive innovation performance. This concept is helpful for service-oriented organizations [69]. Relational capital significantly influences innovation performance [18]. Several studies show that RBV theory supports the positive influence of relational capital on innovation performance [70], [71], [72]. This is supported by the Knowledge-Based View (KBV) theory [18], [61] and the Intellectual Capital Based View (ICBV) theory [73]. Therefore, the higher the quality of relational Capital, the greater the organization's ability to collaborate with external parties to create sustainable innovation to improve performance [62]. In conclusion, relational capital positively influences innovation performance.

4.4 The Positive Influence of Structural Capital on Environmental Innovations

This concept covers organizational assets related to ecological protection, namely information systems, regulatory compliance, and innovation culture. In relation to environmental innovations, structural capital forms initiatives that increase human resource efficiency, foster a culture of sustainability, and improve relevant information [27], [13]. The structural model has a positive influence on environmental innovation [74], [75], [76], [77]. RBV theory supports the idea that structural capital positively influences environmental innovation, which supports sustainable product development [76], [61], [14], [60]. This is supported by the ICBV theory [11]. Therefore, the higher the quality of structural capital, the greater the organization's ability to create environmental innovation that provides resources to address environmental challenges. In conclusion, structural capital has a positive influence on environmental innovation.

4.5 The Positive Influence of Human Capital on Environmental Innovations

Human capital is recognized as an important asset for every organization. Human capital is an important factor in driving environmental innovations focused on environmental protection [78]. RBV theory emphasizes the strategic importance of internal resources that positively affect environmental innovation [79], [80]. This is supported by KBV theory [81] and ICBV theory [14]. In conclusion, human capital has a positive effect on environmental innovation.

4.6 The Positive Influence of Relational Capital on Environmental Innovations

Relational capital refers to a company's association with clients and platforms for sharing information and participating in environmental protection. Relational capital has a significant effect on environmental innovations [27]. A strong network can strengthen the benefits of relational capital in environmental innovation [20]. Several theories explain that positive relational capital influences environmental innovation [76], [20]. These results are consistent with RBV theory [82], [20], KBV theory [61], [70], and ICBV theory [13]. In conclusion, relational capital has a positive influence on environmental innovation.

4.7 The Positive Influence of Environmental Innovations on Innovation Performance

Environmental innovations significantly influence innovation performance by improving environmental outcomes, including green innovations that can enhance sustainability and competitive advantage for organizations. RBV theory supports the idea that environmental innovations have a positive impact on innovation performance [83], [84], [56]. KBV theory [85] and ICBV theory [86] explain that a strong framework for understanding environmental innovation is driven by knowledge management, which positively influences organizational performance. In conclusion, environmental innovation has a positive effect on innovation performance.

4.8 The Positive Influence of Environmental Innovations in Mediating Structural Capital on Innovation Performance

Optimizing structural capital integrates environment-based innovations that drive improvements in organizational innovation performance. Structural capital significantly influences knowledge absorption capacity and, in turn, improves innovation performance, with environmental innovation acting as a mediator [13], [87]. RBV theory proves that environmental innovation can mediate the relationship between the structural model and innovation performance [14], [83], [84], [86]. This is supported by KBV theory [56], [13] and ICBV theory [88]. In conclusion, environmental innovation mediates structural capital towards innovation performance.

4.9 The Positive Influence of Environmental Innovations in Mediating Human Capital on Innovation Performance

Human resources contribute significantly to innovation performance, with environmental innovations mediating this effect most substantially. Organizational resources, namely human capital and environmental strategy, are important in achieving competitive advantage. Tori RBV provides similar results [14]. Meanwhile, KBV theory [89] and ICBV theory [86] explain that, in utilizing human resources, it is important to encourage environmental innovation to improve innovation performance. The conclusion is that environmental innovation mediates the effect of human capital on innovation performance.

4.10 The Positive Influence of Environmental Innovations in Mediating Relational Capital on Innovation Performance

Relational capital derived from relationships with external partners plays an important role in enhancing organizational innovation capabilities [72] by mediating environmental innovation [14]. RBV emphasizes that environmental innovation mediates and has a strong effect on relational capital's performance-innovation support for sustainable development [84], [14], [20]. This is supported by KBV theory [90] and ICBV theory [88]. In conclusion, environmental innovation mediates relational capital towards innovation performance.

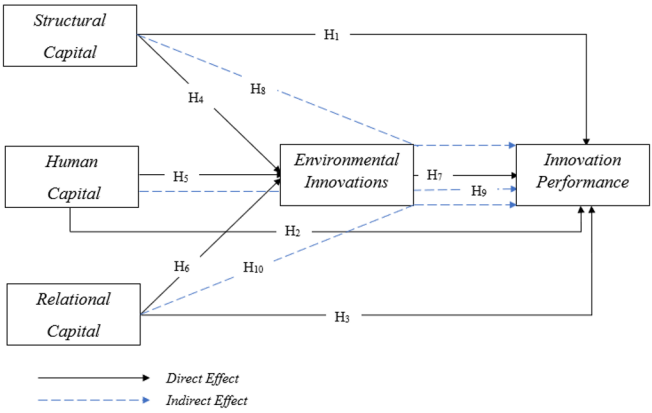

Fig. 1. Conceptual Framework

Figure 1. Conceptual framework obtained from discussions and integration of previous research. The conceptual study of intellectual capital —structural capital, human capital, and relational capital —has a positive effect on innovation performance, both directly and indirectly. This aligns with the RBV's view of the importance of internal and external resources for enhancing sustainable advantage. Environmental innovation serves as a mediator, thereby enhancing the positive influence of structural capital, human capital, and relational capital on innovation performance.

5 Conclusion

This conceptual study comprehensively describes the relationships among intellectual capital efficiency with innovation performance mediated by environmental innovation. Structural capital, human capital, and relational capital have a significant positive influence on innovation performance in police organizations. The importance of environmental innovation as a mediating variable strengthens the relationship between intellectual capital and innovation performance. The existence of excellent human resources, strong internal systems and procedures, and robust external networks will help the Indonesian National Police improve its capacity for sustainable innovation. The results of this study align with RBV theory, which emphasizes that strategic internal resources with high value can create sustainable competitive advantage. Therefore, environmental innovation is key to supporting the improvement and sustainability of organizational innovation performance, especially in police organizations facing increasingly complex global challenges. Recommendations for further research include exploring moderating variables and testing them across other public organizations to strengthen the generalizability of findings and support effective innovation policies.

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