Indonesian Journal of Electrical Engineering and Computer Science
Vol. 39, No. 1, July 2025, pp. 681~690
ISSN: 2502-4752, DOI: 10.11591/ijeecs.v39.i1.pp681-690

Smart enterprise architecture framework for developing patent office

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Article Info

Article history:

Received Aug 9, 2024
Revised Mar 13, 2025
Accepted Mar 26, 2025

Keywords:

EA framework
Enterprise architecture
Patent
Patent office
Smart enterprise architecture

ABSTRACT

Technology and communication's impact on daily life makes innovation vital for economic growth, highlighting prizing intellectual property (IP) asset protection and management. Patent office, pivotal custodians of legal frameworks and repositories of IP assets, grapples with significant challenges, and backlogs stemming from escalating patent applications and outdated processes. Patent office encounters the challenge of balancing innovation and IP protection because of the convergence of rapid advancements in technologies, for instance, AI, and blockchain. This research employs a design science research methodology to generate a tailored framework addressing these multifaceted challenges. The proposed smart enterprise architecture (SEA) framework offers a strategic, multidimensional approach to modernizing the patent office. It integrates principles from enterprise architecture, information systems management, and IP law, emphasizing efficiency, scalability, and security. The framework leverages the quadruple helix model, fostering collaboration between government, industry, academia, and civil society to enhance stakeholder engagement and innovation ecosystems. Optimizing patent office functions and adapting to IP management's evolution, the SEA framework integrates technology and organizational goals for a comprehensive approach.

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1. INTRODUCTION

A brief phrase in the digital realm describes the present time when digital technology and communication are everywhere in our daily routines. Innovation thrives as the cornerstone of economic growth, and protecting and managing intellectual property (IP) assets has emerged as pivotal elements in fostering creativity, competitiveness, and sustainable development [1]. In this context, the Patent Office/IPO is critical, acting as a guardian of legal structures, an IP asset repository, and an enabler of innovation ecosystems [2]. The patent office faces the same problem: substantial backlogs. It arises because of the increasing volume of patent applications, limited resources, and outdated processes [3]. As innovation speeds up across industries, applications flood in for patent office, causing delays in vetting, issuance, and enforcement of intellectual property rights (IPRs). This backlog debilitates the rights of creators and inventors and hinders innovation [4]. Technological innovation's rapid swiftness presents opportunities and challenges for patent office. Emerging technologies such as artificial intelligence (AI), the Internet of Things,

and nanotechnology are reshaping traditional notions of IP, blurring the lines between physical and digital assets, and raising novel legal and ethical considerations [5]. The patent office must navigate this complex landscape, balancing the imperative to foster innovation with safeguarding IPRs.

Meanwhile, one endeavor patent office can construct to face these opportunities and challenges in implementing enterprise architecture (EA). EA is a strategic planning and management discipline that aligns an organization's business processes, information systems, technology infrastructure, and human resources with its strategic goals and objectives [6]. Furthermore, EA frameworks are structured approaches or methodologies used to conceive, implement, and manage EA within organizations. These frameworks provide standardized processes, methods, and tools for creating, analyzing, and maintaining EA artifacts [7]. The swift expansion of information and communication technologies (ICT) with IP management has led to visionary approaches to enhance patent office efficiency, effectiveness, and agility. Stakeholders recognize the need for dynamic, adaptive, and intelligent systems capable of addressing contemporary challenges, prompting a re-imagination of traditional models of IP administration. In response, a paradigm shift toward conceptualizing and implementing smart enterprise architecture (SEA) frameworks has gained momentum [8]. The study also takes advantage of the quadruple helix model, a conceptual framework highlighting the interaction between four critical stakeholders in innovation ecosystems: government, industry, academia, and civil society [9]. Integrating the quadruple helix model into the SEA framework involves leveraging the principles of collaboration, innovation, and stakeholder engagement to enhance the effectiveness of EA initiatives. Advanced technologies, including AI for patent examination, blockchain for secure data management, and big data analytics for trend prediction, enhance the patent office's capability to manage increasing volumes of applications [10].

This study introduces a theoretical framework for developing a SEA tailored to the specific needs and objectives of the patent office. Based on the foundational tenets of EA, information systems management, and IP law, the proposed framework offers a comprehensive and methodical strategy for enhancing patent office efficiency, services, and results in the contemporary digital era. The theoretical framework outlined draws upon established theories, models, and best practices from diverse domains, including EA, innovation management, digital transformation, and legal informatics [11]. Through the synthesis of insights across different domains, we aim to build a comprehensive SEA framework that encompasses technological advancements, organizational strategies, legal considerations, and policy frameworks. This will empower the patent office to navigate complexities and seize opportunities in the evolving landscape of IP management.

2. METHOD

The study employs design science research (DSR) methodology to conceive a SEA framework [12]. As shown in Figure 1, the following figure describes DSR's fundamental phases. These goals and objectives, in turn, drive the design of the service architecture, ensuring alignment of all framework layers with the IP office's overarching strategic intent. Figure 1 illustrates several essential stages: problem identification, artifact design, and evaluation. Problem identification is associated with understanding the specific needs and challenges the patent office faces, such as processing time, accuracy, and security of patent information. After identifying these problems, the next step is to design an artifact - in this case, a comprehensive framework that integrates advanced technologies like AI, blockchain, and cloud computing [13]. This framework strives to streamline operations and enhance data security and decision-making processes within the patent office. The final stage of the DSR methodology involves evaluating the designed framework to ensure it meets the desired objectives and effectively addresses the identified problems through expert considerations. The iterative nature of DSR fosters continuous improvement and ensures the framework remains relevant and effective over time.

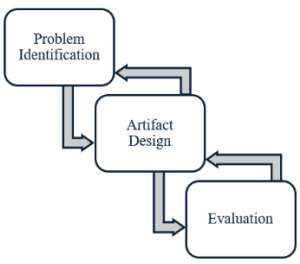

Figure 1. DSR methodology

3. RESULTS AND DISCUSSION

3.1. Related works

The study identified the prevalent EA frameworks obtainable on the market. Previous research has explained corporate strategies, depicted operational workflows, and simulated information systems to oversee assets, enhance organizational frameworks, adapt information strategies, and generate reinvigorated business worth [14]. Effective EA frameworks for the patent office need to address the specific demands of IPR management [15]. Prior research on EA frameworks has emphasized their role in improving organizational agility and efficiency. Zachman's Framework, for instance, provides a classification-based approach, while TOGAF adopts a phased method. Both frameworks have shown success in structuring complex IT environments but lack explicit provisions for government-regulated domains like the patent office [16], [17]. The following are some available options as shown in Table 1.

Table 1. EA framework comparison

Aspect	Zachman framework	TOGAF framework	FEA framework
Focus	Classification of perspectives and interrogatives	Phased approach to enterprise architecture	Segmented architecture framework
Perspective	6 perspectives (What, How, Where, When, Who, Why)	5 architectural domains (Business, Data, Application, Technology, Implementation, and Migration)	6 segments (Performance, Business, Data, Applications, Infrastructure, and Security)
What/Scope	Define scope, purpose, and fundamental concepts	Define vision, scope, and strategic goals	Introduction and performance objectives
How/Business model	Describe business processes, functions, and activities	Analyze business processes and capabilities	Define business processes and functions
Where/System model	Examine information systems, applications, technologies	Identify existing IT systems, data repositories	Assess IT infrastructure and technology landscape
When/ Technology model	Assess timing, sequencing, and dependencies	Assess technological capabilities and standards	N/A
Who/Detailed representation	Specify roles, responsibilities, and structures	Define roles, responsibilities, and organizational structures	Define roles, responsibilities, and organizational structures
Why/Motivation	Articulate underlying motivations, objectives, benefits	Define strategic imperatives, legal mandates	Define performance objectives and benefits
References	[16]	[17]	[18]

From Table 1, the authors determined to implement the federal enterprise architecture framework (FEAF) because its segmented architecture framework offers the patent office a structured and comprehensive approach to EA development. FEAF's segmented framework addresses various critical aspects of IP management, including performance, business processes, data management, applications, infrastructure, and security, ensuring that all dimensions of IP management are analyzed and planned. FEAF aligns with government standards and best practices, making it suitable for patent office operating within government or regulatory environments. The patent office can improve its IPR management by using FEAF's segmented architecture, ensuring interoperability, security, scalability, and flexibility in its IT.

3.2. Stakeholder in quadruple helix

The study delineates the stakeholders in the EA framework for the patent office, grouping them according to the quadruple helix model [2] as shown in Table 2.

Table 2. Patent office stakeholder in quadruple helix model

Stakeholder	Description	Possible entities
Government	Regulatory bodies responsible for setting policies, laws, and regulations governing IP	Other IP offices, ministry of science and technology, regulatory agencies, WIPO
Industry	Companies and organizations involved in research, development, and commercialization of innovative technologies	Technology companies, pharmaceutical companies, research institutes
Academia	Universities, research institutions, and educational bodies contributing to knowledge creation and innovation	Universities, research institutions, technology transfer offices
Civil society	Non-governmental organizations (NGOs), advocacy groups, and community stakeholders influencing IP policies	IP consultants, consumer protection organizations, community innovation hubs

Table 2 summarizes the stakeholders within the patent office's ecosystem, framed by the Quadruple Helix model [19]. Government entities, including other IP Offices and regulatory bodies, are crucial for establishing the legal framework and policies governing IP. Technology, pharmaceutical companies, and other industry stakeholders drive innovation through research, development, and commercialization. Academia, represented by universities and research institutions, contributes to knowledge creation and technology transfer, fostering collaboration between academia and industry. Civil society organizations, including IP consultants and consumer protection groups, are vital in advocating for balanced IP policies and ensuring community engagement in innovation processes.

3.3. Proposed smart EA framework

Figure 2 illustrates the proposed EA framework for the IP office, which is structured to align the organization's operations with its vision, mission, goals, and objectives. At the top of the framework, the vision and mission provide a clear direction for the organization, guiding the service goals and objectives [17]. These goals and objectives drive the design of the service architecture, ensuring alignment of all framework layers with the IP office's overarching strategic intent.

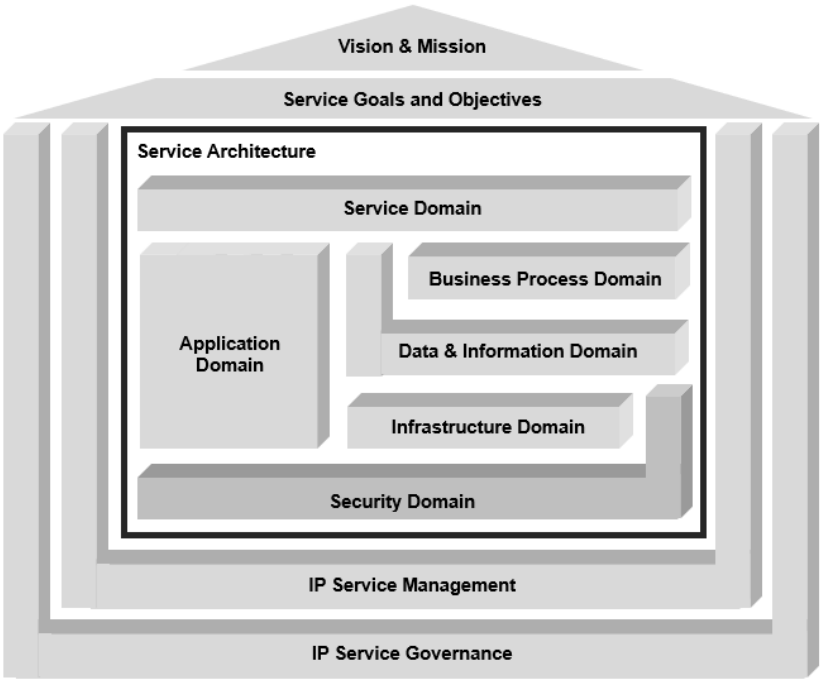

Figure 2. Proposed EA model for developing patent office (Modified from: [6])

Several interconnected domains, each representing a critical aspect of the organization's operations, meticulously divide the framework. The service domain encapsulates the overall service delivery, supported by the application domain, which focuses on the software and applications necessary for service execution [20]. The business process domain ensures all processes are aligned with business goals, while the data and information domain manages the flow and integrity of data across the organization [17]. The infrastructure domain supports these activities by providing the physical and technical infrastructure, and the security domain ensures all operations are conducted within a secure environment, safeguarding the integrity and confidentiality of the IP office's data and processes [21].

At the framework's foundation, IP service management and governance ensure that the architecture is effectively managed and governed. IP service management focuses on the operational management of the services provided by the IP office, ensuring they meet the needs of stakeholders [22]. IP service governance provides oversight and control mechanisms to ensure that services are delivered in compliance with relevant standards and regulations. These layers ensure that the IP office's EA framework is robust, secure, and aligned with its strategic goals.

3.4. Expert review

The research canvassed an expert who is the information system division manager of the intellectual property office of Malaysia (MyIPO). The following interview summary: the IP Office must commit to enhancing operational efficiency and effectiveness through technology, especially by adopting smart EA. Improved operational services and processes rely on adopting innovative technologies like cloud computing, AI, and machine learning [21]. In addition, it focuses on data governance, compliance, and security aspects in the transition to smart EA. Ensuring IP data is protected and processed by high security and privacy standards is essential [23]. There is also a necessity for a user-centric approach to designing new systems and services by improving the user experience for applicants, inventors, and other stakeholders through technology and system integration, as well as prizing change management and stakeholder engagement. The transition to smart EA may need more support from internal stakeholders. Therefore, a precise strategy is needed to overcome such resistance through continuous engagement, communication, training, and feedback [24].

The author also interviewed experts from the directorate general of intellectual property (DGIP) in IT planning and standardization. Several vital points emerged regarding the current IT infrastructure and challenges supporting patent management. The IT infrastructure is adequate for basic administrative tasks but needs improved data access speed, analytical capabilities, and security to support more efficient patent management [25]. Key challenges include gaps between existing technology and advanced analytical needs, consistent interoperability standards, and data security issues. Implementing NIST and ISO security standards is essential to protect patent data and increase stakeholder trust [26]. Experts view an integrated data architecture as crucial for improving patent management efficiency by reducing redundancy and ensuring data consistency. Expectations for the new EA include greater flexibility and scalability, allowing for adjustments to changing business and technology needs [27]. It uses open standards and protocols to ensure interoperability and conduct thorough testing. It also conducts security audits to ensure compliance with international standards. Essential features in the analytics and machine learning system include the ability to process big data, detect patterns and trends, and provide accurate predictions regarding patent disruptive potential. It measures the success of EA implementation through increased operational efficiency, decreased patent processing time, and compliance with security and interoperability standards [7].

3.5. Enhancement proposed EA model

Figure 3 represents the vision of a patent office encapsulating its aspirational long-term goals, reflecting its commitment to fostering innovation, protecting IPRs, and contributing to economic growth and societal development. Complementing this, the mission of a patent office articulates its core purpose and functions, outlining its commitment to granting and enforcing IPRs, providing accessible services to creators and innovators, and promoting a culture of respect for IP [28]. A patent office's service goals and objectives outline its commitment to delivering high-quality services to stakeholders and the broader community. It aims to support innovation, encourage creativity, and contribute to domestic and international development by striving to achieve these service goals.

The business layer comprises essential functions, such as preparing policy drafts for patent management, implementing these policies, facilitating appeal commissions to address disputes, providing technical guidance and supervision to ensure quality and compliance, and managing administrative and home affairs [29]. Organizing these functions within the EA framework improves the patent office's efficiency, transparency, and stakeholder satisfaction, while complying with regulations and international best practices.

In the service layer of an EA framework tailored for patent office, critical functions revolve around providing comprehensive patent-related services to stakeholders [30]. These services encompass patent filing and administration, ensuring efficient processing and management of patent applications, patent search and dissemination, facilitating access to patent information, and promoting transparency. Functionalities, such as the Patent Prosecution Highway and ASPEC initiatives, aim to expedite patent examination processes and enhance international cooperation [31]. Services like the patent marketplace and valuation contribute to fostering innovation ecosystems by enabling commercializing patented inventions [32]. Patent work sharing and global services initiatives promote collaboration among patent office worldwide, streamlining procedures and reducing duplication of efforts. Patent infringement monitoring ensures protecting IPRs, while consultation and drafting services support inventors and innovators in navigating the patent system [33]. Internal-related services are vital in supporting the effective delivery of these patent services, ensuring internal operations run to meet stakeholder needs.

The data layer plays an essential role in managing patent-related information. Structured and unstructured data encompass diverse data types, including patent documents, legal texts, and correspondence, requiring robust storage, organization, and retrieval systems [34]. Compliance with World Intellectual Property Organization (WIPO) standards ensures interoperability and alignment with global best practices in patent data management. Data exchange mechanisms facilitate the seamless sharing of patent-related information with international partners and stakeholders, fostering collaboration and harmonization efforts

[34]. A data warehouse is a centralized repository for storing and analyzing patent data, supporting informed decision-making and strategic planning. Big data analytics capabilities enable patent office to extract valuable insights from vast amounts of patent-related data, facilitating trend analysis, predictive modeling, and strategic intelligence [23].

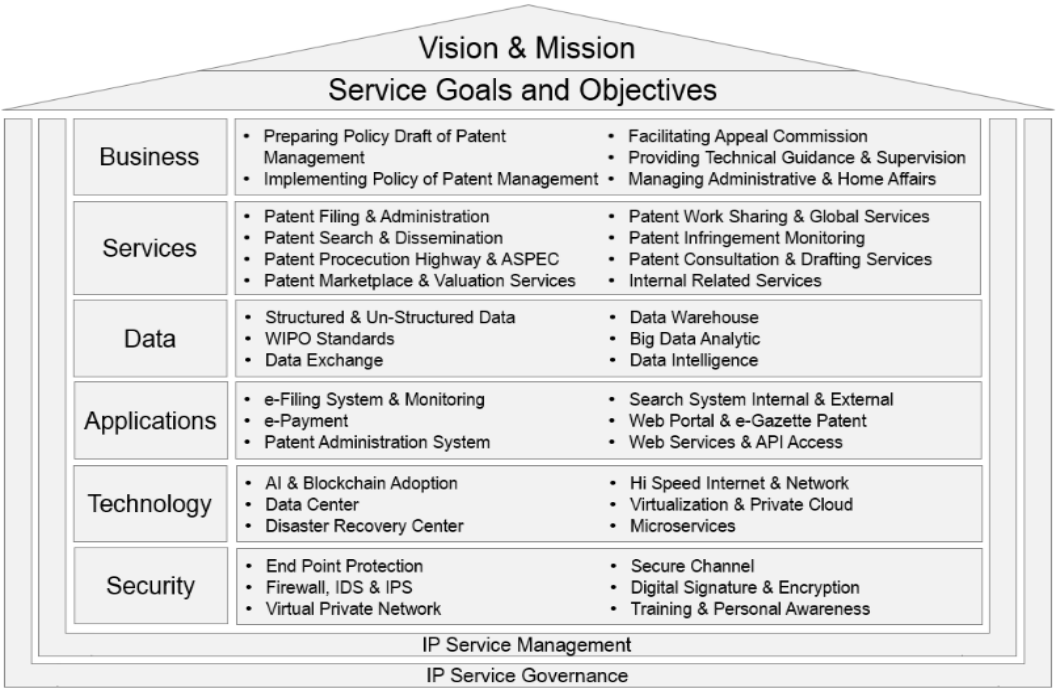

Figure 3. EA framework model for developing patent office

The application layer has critical functionalities focused on providing efficient and user-friendly digital platforms and applications to support patent-related processes and services [34]. E-filing and monitoring tools streamline patent application submission, making the process more accessible and reducing administrative burdens. Integrating e-payment capabilities simplifies fee transactions, improving financial management and user experience. The patent administration system centralizes and automates various administrative tasks, optimizing workflow efficiency and ensuring regulatory compliance [35]. Internal and external search systems enable comprehensive patent searches, facilitating examination processes and promoting transparency. Web portals and e-gazettes provide convenient access to patent-related information and publications, enhancing stakeholder engagement and knowledge dissemination. Web services and API access facilitate interoperability and integration with external systems, enabling seamless data exchange and collaboration with international partners [36].

The technology layer is pivotal in supporting the digital transformation and innovation-driven objectives of patent management. Adopting AI and blockchain technologies enhances efficiency and transparency in patent-related processes, facilitating prior art search, examination, and rights management. Robust data center infrastructure ensures secure and reliable storage and processing of patent-related data, supporting the scalability and resilience of IT systems [30]. Disaster recovery centers provide contingency measures to mitigate the impact of potential disruptions, ensuring continuity of operations, and data integrity. High-speed internet and network connectivity enable seamless communication and collaboration among internal and external stakeholders, promoting agility and responsiveness in patent administration. Virtualization and private cloud environments offer flexibility and cost-effectiveness in deploying and managing IT resources, optimizing resource utilization and scalability. Microservices architecture enables modular and agile development of patent-related applications and services, enhancing flexibility, scalability, and interoperability [37].

The security layer is essential for safeguarding sensitive IP data and ensure compliance with regulatory requirements [16]. End-point protection mechanisms defend against malware and unauthorized access to devices and networks, mitigating security risks at the user level. Firewalls, intrusion detection

systems (IDS), and intrusion prevention systems (IPS) provide network-level defense against cyber threats, monitoring and blocking suspicious activities to prevent unauthorized access or data breaches [22]. VPNs provide secure remote access to patent systems and data, ensuring data confidentiality and integrity during transmission. Secure channels and encryption technologies protect sensitive communications and data exchanges, ensuring confidentiality and authenticity [30]. Digital signatures enhance document integrity and authentication, supporting the legal validity of patent-related transactions and communications. Cybersecurity awareness initiatives, including training and personal development programs, cultivate a culture of employee preparedness to identify and mitigate security risks [38].

IP service management encompasses the strategic planning, implementation, and optimization of IP management services. It includes patent filing, examination, enforcement, and trademark and copyright registration services [6]. IP service governance focuses on the overarching principles, policies, and standards governing the delivery and management of IP services. It involves defining roles and responsibilities, establishing service level agreements (SLAs), and ensuring compliance with regulatory requirements and best practices [39]. The smart terms of EA from the discussion above lie in integrating innovative technologies and innovative approaches across different layers of the EA framework tailored for patent office. For instance, adopting AI and blockchain technologies in the technology layer enhances efficiency and transparency in patent-related processes, facilitating tasks such as prior art search, examination, and rights management [29]. Moreover, big data analytics within the data layer allow the patent office to derive valuable insights from the vast amount of patent data, supporting trend analysis, predictive modeling, and strategic decision-making.

4. CONCLUSION

Implementing the FEAF is a strategic choice for patent office seeking structured and comprehensive approaches to EA development. FEAF's segmented EA addresses critical aspects of IP management, ensuring alignment with government standards and best practices. Leveraging FEAF enables patent office to enhance their capabilities in managing IPRs while ensuring interoperability, security, scalability, and flexibility in IT systems and processes. Our analysis of stakeholders within the patent office's ecosystem, framed by the Quadruple Helix model, highlights the dynamic interplay between government entities, industry stakeholders, academia, and civil society organizations in shaping IP policies and fostering innovation.

Future research could explore several avenues to build upon this study. First, conducting longitudinal studies to assess the SEA framework's impact on patent office key performance indicators (KPIs) like processing times, backlog reduction, and user satisfaction would provide valuable empirical evidence. Second, there is a need for comparative studies across regions, examining how cultural, economic, and technological factors influence the framework's implementation. For example, patent office in developing countries may face additional barriers such as limited IT infrastructure or skilled personnel, requiring adaptations to the SEA framework. Third, integrating emerging technologies, such as quantum computing or IoT-enabled patent tracking systems, could offer innovative solutions to challenges in patent search and enforcement. Addressing the socio-technical challenges in transitioning to smart systems, such as resistance to change among stakeholders or legal uncertainties in blockchain adoption, would ensure smoother implementation and sustainability.

This study underscores the transformative potential of a SEA framework for patent office. Modernizing IP management and enhancing stakeholder collaboration and innovation ecosystems is achieved by this framework, which combines structured EA methodologies (such as FEAF), innovative technologies, and the quadruple helix model. Implementing this framework can help patent office navigate the complexities of the digital era, reduce backlogs, improve service delivery, and foster global competitiveness. As technology and innovation evolve, patent office must continue to adapt, ensuring they remain at the forefront of protecting and promoting IP.

ACKNOWLEDGEMENTS

The University of Bina Nusantara completely supports this research. The authors also express sincere appreciation for the valuable insights and guidance provided by the reviewers, which have enhanced the quality of the presentation.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

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Harjanto Prabowo		✓				✓		✓	✓	✓	✓	✓		
Agung Trisetyarso	✓		✓	✓			✓			✓	✓		✓	✓
Haryono Soeparno					✓		✓			✓		✓		✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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