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Literature Review on the Challenges and Opportunities of Implementing Digital Population Identity (IKD) in Indonesia's Demographic Statistics System

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Abstract
This literature study examines the development, challenges, and opportunities of implementing Indonesia's Digital Population Identity (in Indonesian: Identitas Kependudukan Digital/IKD) and its potential contribution to strengthening the national demographic statistics system. Drawing on national and international publications, government reports, and empirical findings from regional case studies, the review highlights that IKD represents a significant step in modernizing population administration through real-time data updates, system integration, and improved accuracy of civil registration. However, implementation remains constrained by uneven digital infrastructure, low digital literacy, varying administrative capacity, and data security concerns. Comparative insights from Estonia, India, Singapore, and South Korea show that Indonesia faces challenges similar to global digital ID initiatives, particularly regarding interoperability, privacy protection, and governance. Despite these obstacles, the literature indicates substantial opportunities for IKD to enhance demographic statistics through improved accuracy of vital event recording, cross-agency data integration, and the development of big-data-driven demographic analysis. Strengthening infrastructure, capacity building, and inter-agency collaboration will be essential for maximizing the role of IKD in supporting a modern, efficient, and integrated demographic statistical system.

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Keywords: Digital Population Identity; IKD; Demographic Statistics; Civil Registration; Data Integration

Introduction

Population data is one of the fundamental components in national development planning and implementation. Information on population size, age structure, regional distribution, birth rates, mortality rates, and migration forms the basis for the government in formulating public policies in the fields of education, health, economy, and social affairs. The accuracy and completeness of this data greatly determine the quality of national demographic statistics. According to the Central Statistics Agency (BPS), the availability of valid population data plays an important role in supporting the development of development indicators and the evaluation of national program achievements [1].

The development of the population administration system in Indonesia has undergone significant transformation in the last two decades. In the early stages, population registration was carried out manually through physical documents such as ID cards and family cards. Then, the government modernized through the e-KTP Program based on Law Number 23 of 2006 concerning population administration, which was updated with Law Number 24 of 2013 [2, 3]. In the line with the acceleration of national transformation, the Directorate General of Population and Civil Registration (Dukcapil) introduced Digital Population Identity (IKD) as a new innovation that enables the storage and access of identity through an application directly connected to the Centralized SIAK, a national population database [4].

The presence of IKD brings great hope for the modernization of the population registration system and the strengthening of demographic statistic. The digitization of identity enables real-time data updates, cross-agency integration, and minimizes recording errors, inconsistencies, and data duplication. According to the World Bank, integrated digital identity systems can improve the efficiency of public services and the quality of socio-demographic statistical data through sector interoperability [5]. Thus, IKD has great potential to become a more accurate source of data for development planning and statistics compilation.

Unlike Estonia, which has implemented a national digital identity system since the early 2000s, with e-ID being part of public administration and digital services for citizens since 2002 and the e-Residency program since 2014, as well as India, which has developed Aadhaar-based digital identity since 2009, the implementation of Digital Identity (IKD) in Indonesia is still in its early stages, so its effectiveness needs to be assessed. In the implementation process, IKD faces several complex challenges.

From a technological perspective, the distribution of digital infrastructure such as internet access and devices is still not optimal, especially in 3T (underdeveloped, frontier, and outermost) areas [6]. From a social perspective, low digital literacy among the public means that some citizens do not yet understand the benefits and mechanisms of using IKD. In addition, data security and privacy risks are a particular concern, given that digital identities contain sensitive information that could potentially be misused if not protected by strong security standards, as emphasized in a study by the OECD on *digital identity governance* [7].

The government continues to strengthen the IKD system through national digital transformation policies, the implementation of SPBE (Electronic-Based Government System), and cross-agency collaboration. Dukcapil is working with Kemenkominfo, BPS, OJK, and other financial and public service institutions to increase the coverage of IKD activation and expand its use in various public services [8]. These efforts are strategic steps in building a more efficient, transparent, and integrated population data governance system.

However, academic studies on IKD from a demographic statistics perspective remain limited. Most research focuses on aspects of technology, digital security, or public services, while discussions on the contribution of IKD as the main data source for the national population statistics system are still rare. Therefore, a more comprehensive literature review is needed to assess the potential, limitations, and implications of IKD implementation on Indonesia's demographic statistics system.

Through this literature review, we will examine in depth the challenges and opportunities of implementing Digital Population Identity (IKD) in the demographic statistics system in Indonesia and the extent to which IKD can strengthen the accuracy, efficiency, and integration of population data at the national level.

Based on the above background, the following questions arise:

1. How has the implementation of Digital Identity (IKD) developed in Indonesia?
2. What are the challenges faced in implementing IKD as part of the population registration system?
3. What are the opportunities for IKD in strengthening the national demographic statistics system?

Method

This study uses a literature review method with a qualitative descriptive approach and secondary statistical analysis. This study employs secondary data and scientific literature as its main sources of information. The secondary data consist of reports from the Directorate General of Population and Civil Registration (Dukcapil) for the period 2023–2025, publications from Statistics Indonesia (BPS), Indonesian Sustainable Development Goals (SDGs) reports, and official government news. In addition, this study draws on national and international scholarly journals focusing on digital identity, population registration, and digital demographic systems. The analysis technique used is qualitative, specifically content analysis of the literature, to identify key opportunities and challenges in the implementation of the Digital Population Identity (IKD). The procedure for this study is as follows: 1) Collecting statistical data and scientific references related to IKD implementation; 2) Grouping data based on themes: technology, infrastructure, social, and security; 3) Presenting and interpreting the results of the study; 4) Drawing conclusions that summarize the challenges and opportunities of IKD implementation in the context of demographic statistics.

Literature Review

1. Basic Concepts

a. Population Registration

Population registration is an official recording system that records vital events such as births, deaths, marriages, divorces, and population movements. This system is the main foundation for compiling demographic statistics and development planning. According to the United Nations, good population registration must include completeness, continuity, and accuracy of recording in order to produce accurate population estimates [9]. In Indonesia, the population registration mechanism is regulated by Law Number 24 of 2013 concerning Population Administration, which emphasizes the importance of data validity in the Population Administration Information System (SIAK) [3].

b. Digital Population Identity (IKD)

Digital Population Identity is the latest innovation in population administration that allows residents' identities to be stored digitally through a mobile application. IKD is directly connected to the centralized SIAK national database, so that data updates can be made in real-time and integrated [4]. In addition to being an identity authentication tool, IKD has great potential to become a source of digital data for compiling big data-based demographic statistics. The implementation of IKD is in line with the government's digital transformation strategy in SPBE (Electronic-Based Government System) and the utilization of population data in cross-agency public services.

2. Previous Studies

A. Digital Transformation of Population Administration in Indonesia

Several studies highlight the digital transformation carried out by Dukcapil, including the implementation of a centralized SIAK, modernization of e-KTP services, and preparation for IKD to improve data integration and public service efficiency [10]. A study in Tangerang Regency, Banten

Province, Indonesia shows that the digitization of population administration can accelerate and facilitate access to public services, despite technical and human resource constraints [11]. An evaluation of the implementation of the IKD application in Ternate City shows the importance of leadership and community readiness in adopting this new technology [12]. In addition, research in Sinjai Regency, South Sulawesi Province, Indonesia found that digitization through SIAK and IKD improves bureaucratic efficiency, but challenges in digital literacy and infrastructure still need to be overcome [13]. At the e-government service level, the Sobat Dukcapil program in Tangerang shows a transformation in services that improves the public experience in population administration services [14]. A study in Aceh also emphasizes that the implementation of IKD provides ease of access, despite facing technical challenges in the field [15].

B. The Use of Big Data and Digital Identity in Development

Several international and national studies discuss how digital identity can be a source of big data for population analysis, population mobility, and policy evaluation [1, 5]. The use of digital identity enables the availability of more up-to-date, integrated, and sustainable administrative data, thereby supporting evidence-based development planning [16, 17]. Empirical studies show that national digital identity systems, such as Aadhaar in India, can improve the quality and reliability of administrative data used in demographic analysis and public policy formulation, especially in developing countries [18, 19]. In addition, the integration of digital identity-based administrative data with official statistical systems also has the potential to strengthen the quality of demographic statistics and the efficiency of national statistics production [20]. However, studies that specifically link Digital Population Identity (IKD) in Indonesia with its use in demographic statistics are still relatively limited.

C. Evaluation of the IKD Pilot Project in Indonesia

Several internal and academic reports have discussed the IKD pilot project in provinces such as Central Java, Bali, and East Kalimantan [21]. Initial evaluation results show that the success of IKD implementation is greatly influenced by the readiness of information and communication technology (ICT) infrastructure, network stability, and human resource capacity at the implementation level, particularly population service officers in the process of activating and assisting the community. Research by Putri and Santoso found that variations in the level of IKD adoption between regions were mainly due to differences in the digital readiness and technological literacy of the community [22]. Meanwhile, Rahman *et al*. emphasized that institutional coordination and regional policy support also play an important role in the sustainability of the IKD pilot project [23]. These findings indicate that although the IKD pilot project has yielded positive initial results, there are still structural and operational challenges that need to be further evaluated before nationwide implementation.

3. Digital Identity Implementation in Various Countries

A. Estonia – e-ID and X-Road Platform

Estonia is often referred to as the country with the most advanced digital identity in the world. The e-ID system is used for almost all public services, including health, taxation, education, and national statistics. All data flows through the X-Road platform, which enables secure data exchange between government agencies [24]. The advantages of the Estonian system are its interoperability, transparency, and very high level of encryption-based security. Its relevance to Indonesia is the need to build an integrated cross- agency data architecture so that IKD can be utilized to its full potential

B. India – Aadhaar System

Aadhaar is the world's largest digital identity system with over one billion users. The system uses biometrics (iris, fingerprints, facial photos) and generates a unique identification number (UID) for each resident [25]. Aadhaar has been used as the basis for social assistance programs, public service verification, and SIM card registration. Its advantages are scalability and efficiency, while its challenges include privacy and data security issues. This comparison is important because Indonesia has a large population and geographical complexity similar to India.

C. Singapore – Singpass and National Digital Identity (NDI)

Singpass is an application-based digital identity system that allows citizens to access more than 2,000 government and private services. The Singaporean government developed NDI (*National Digital Identity*) to expand the use of digital identity in economic transactions, healthcare, and the private sector [26]. The success of Singpass lies in the high level of digital literacy among the population and the equitable distribution of ICT infrastructure. This comparison shows the importance of public readiness in adopting IKD in Indonesia.

D. South Korea – Resident Registration System

South Korea has had a digital-based resident registration system integrated with public services since 1968. The government uses the Resident Registration Number (RRN) as a unique identifier for various purposes, including population statistics, health services, and tax administration. Digital transformation is carried out through the Digital Government Act, which encourages data connectivity between ministries [27]. The South Korean model emphasizes the importance of data consistency and privacy protection in national digital identity.

Results and Discussion

1. Implementation of Digital Identity (IKD) in Indonesia: Literature Review

The implementation of Digital Identity (IKD) in Indonesia shows quite progressive developments in efforts to modernize national population administration. A few studies at the regional level describe this progress, although the level of adoption is uneven. Research by Syafitri *et al*. in Riau Province, Indonesia, reveals that the readiness of human resources (HR) among officials is a key determinant of the successful implementation of IKD [28]. Officials who are proficient in information technology are able to manage the activation process effectively. Meanwhile, Asmaniah *et al*., through a study in Padang City, West Sumatra Province, Indonesia, emphasized the importance of digital governance in ensuring the smooth running of IKD-based administrative services, including system reliability, service consistency, and integration with the national database [29].

Findings from various regions show a consistent pattern. Implementation in Nganjuk Regency, East Java Province, Indonesia [30], Lembata Regency, East Nusa Tenggara

Province, Indonesia [31], Sukabumi Regency, West Java Province, Indonesia [32], and Kuningan Regency, West Java Province, Indonesia [33] faced limitations in network infrastructure and low digital literacy among the community. These challenges have implications for the slow activation of IKD in these regions. In contrast, research by Zafira & Reviandani in Surabaya City, East Java Province, Indonesia, and Humdiah in Bukittinggi City, West Sumatra Province, Indonesia, shows higher adoption rates thanks to technological support, intensive socialization, and more established administrative capacity [34, 35].

Overall, national literature reviews show that the implementation of IKD has been dynamic, but its success rate is highly dependent on the readiness of infrastructure and human resource competencies in the regions. These conditions need to be considered in analyzing the use of IKD for demographic statistics.

2. Challenges in IKD Implementation: National and International Perspectives

This section discusses the challenges of IKD implementation from a national and international perspective based on the latest literature review.

A. Challenges of Implementation Based on National Studies

Literature reviews in Indonesia identify several key challenges in IKD implementation, namely:

1. **Limitations of Digital Infrastructure:** Regions that still experience limited internet access, particularly 3T (underdeveloped, frontier, and outermost) areas, face difficulties in activating and utilizing Digital Identity (IKD) optimally. This condition is reflected in studies in Nganjuk Regency, East Java Province, Indonesia, and Lembata Regency, East Nusa Tenggara Province, Indonesia, which show that limitations in telecommunications infrastructure and digital connectivity are major obstacles to the implementation of IKD at the regional level
2. **Low Digital Literacy Among the Community:** Several studies indicate that public understanding of the functions of the IKD remains limited. The lack of digital literacy hinders public acceptance and participation [28, 29].
3. **Data Security and Privacy Risks:** The increase in fraud cases exploiting Digital Identity (IKD) highlights the need to strengthen data security and personal information protection [36].
4. **Limitations in Civil Servant Competence:** Variations in the technological competence of officials between regions have a direct impact on the quality of Digital Identity (IKD) services, particularly in the process of data activation and updating. Several studies show that regions with low human resource readiness tend to experience obstacles in the implementation of IKD, as found in studies in Riau Province and Padang City [28, 29].

B. Challenges from an International Perspective

International research results provide a broader context for national challenges. Studies on centralized digital identity systems highlight the high security risks if the system is not equipped with adequate multi-layered protection features and encryption mechanisms. This is an important concern given that IKD is directly connected to the national database.

Research by Gonzales, Roberts, and Leigh on Unpacking Digital ID Systems' Early Policy Process shows that developing countries often face problems such as low digital inclusiveness, weak data governance, and suboptimal integration between institutions [37]. These findings are relevant to Indonesia, which is still in the process of harmonizing systems between the Population and Civil Registration Agency, the Central Statistics Agency, the Ministry of Communication and Information Technology, and the private sector.

In addition, the study Digital Identities and Verifiable Credentials emphasizes that strong authentication mechanisms, such as verifiable credentials and multi-level authentication, are important in reducing the risk of digital identity theft [38].

Thus, the challenges faced by Indonesia are in line with global experiences, particularly in terms of security, data governance, and equitable access to technology.

3. Opportunities for IKD in Strengthening Indonesia's Demographic Statistics System

After identifying national and global challenges, the next discussion focuses on the opportunities for implementing Digital Identity (IKD) to strengthen the demographic statistics system. Despite facing a number of challenges, national and international literature shows that IKD offers great opportunities for the development of Indonesian demographic statistics [28, 39].

A. Real-Time Data Access and High Accuracy

Digital identity systems enable real-time updates of population data. This can reduce the time lag between demographic events and their recording, thereby improving the accuracy of demographic statistics. International studies show that countries that implement digital identity systems are able to significantly improve the efficiency and accuracy of population data collection [39, 40]. In the Indonesian context, the use of IKD has the potential to accelerate the updating of population data, which has been facing delays in recording.

B. Cross-System and Institutional Integration

International literature, such as Building Digital Identity Systems: A Systematic Review, shows that digital identity can serve as the main link between data across government agencies through single identity-based integration [39]. In Indonesia, the potential for integration between IKD and the Central Statistics Agency (BPS), BPJS, the Ministry of Communication and Information Technology, and the private sector can strengthen the consistency and validity of population data across sectors [1, 41].

C. Efficiency of Administrative Services and Reduction of Data Errors

Empirical studies in the cities of Bukittinggi and Surabaya show that the use of IKD can accelerate the identity verification process, reduce data duplication, and minimize administrative errors in population administration [34, 35]. This administrative service efficiency has a direct implication on improving the quality of population statistics recording, especially in managing basic demographic data.

D. Foundation for Big Data and Modern Demographic Analysis

Global digital identity technology studies confirm that digital

ID systems can be the main foundation for the development of population big data and modern demographic analysis [38, 42]. With the integration of IKD, Indonesia has the potential to develop predictive analysis on population dynamics, internal migration, productive age structure, and projections of public service needs based on more accurate and up- to-date data. In addition to these opportunities, IKD has a strategic role in strengthening the recording of births and deaths, which has been a weak point in Indonesia's vital statistics system. Through the integration of digital identity based on the Population Registration Number (NIK), health facilities can report births and deaths digitally, which are directly connected to the Dukcapil database. This mechanism has the potential to accelerate the issuance of certificates and updates to residency status, while reducing recording errors due to manual processes [41].

Efforts to strengthen civil registration and vital statistics (CRVS) through IKD are in line with the recommendations of the United Nations Statistical Division (UNSD) regarding the importance of a universal, accurate, and timely vital registration system. Improving the quality of CRVS contributes directly to the achievement of Sustainable Development Goals (SDGs) indicators, particularly Goal 16.9 on legal identity for all and Goal 17.18 on increasing the capacity of countries to produce high-quality data. Thus, IKD not only functions as an administrative instrument, but also as a systemic foundation for the transformation of Indonesia's demographic statistics towards a more modern, integrated system that is responsive to national development planning needs [1, 43].

4. Comparison of National and International Literature

The following table summarizes the differences in perspectives between national and international literature on digital identity:

Table 1: differences in perspectives between national and international literature on digital identity

Aspects	National Literature	International Literature
Main Focus	Implementation of IKD at the regional level, human resource readiness, socialization, infrastructure	Global digital ID model, system architecture, data privacy and security
Research Approach	Case studies, descriptive analysis	Comparative surveys, technical studies, systematic reviews
Key Challenges	Internet networks, digital literacy, human resource limitations	Data privacy, interoperability, risk of data leakage.
Key Opportunities	Public service efficiency, administrative acceleration	Big data integration, verifiable credentials, multi- factor authentication
Relevance to Demographic Statistics	Improved accuracy of population registration	Provision of real-time population data for modern demographic analysis

Discussion

The findings in this study indicate that the implementation of IKD in Indonesia is still in a transitional phase between a conventional population administration system and an integrated digital identity system. The results of the national literature review show that there are disparities in the level of adoption between regions, which are influenced by factors such as digital infrastructure, human resource capacity, and the level of digital literacy of the community. This condition indicates that digital transformation in population administration is not only technical in nature but is also greatly influenced by social and institutional readiness at the local level.

When compared to international literature, the challenges faced by Indonesia show a pattern similar to other developing countries. Issues of data security, privacy protection, digital inclusiveness, and system interoperability are universal challenges in the implementation of national digital identity. However, international literature also emphasizes that countries that have successfully overcome initial challenges through strengthening regulations, data governance, and cross-agency integration are able to utilize digital ID as strategic infrastructure for statistical systems and development planning. This reinforces the argument that the challenges of implementing IKD in Indonesia are not permanent structural obstacles, but rather part of a transformation process that can be managed gradually.

From a demographic statistics perspective, the results of the study show that IKD has significant potential to improve the quality of population data, particularly through increased accuracy, timeliness, and consistency of data. The integration of IKD with the civil registration and vital statistics (CRVS) system has the potential to reduce underreporting of vital events such as births and deaths, which has been a weakness of Indonesia's demographic statistics system. With a digital identity-based recording mechanism, the process of updating demographic data can be carried out more efficiently and in a standardized manner, thereby supporting the provision of more reliable statistics for population analysis.

Furthermore, this discussion emphasizes that IKD not only functions as a population administration tool, but also as a foundation for the development of a modern demographic data ecosystem. The use of IKD as a basic data source opens up opportunities for big data integration, predictive analysis, and the compilation of demographic statistics that are more responsive to social and economic dynamics. Thus, strengthening the implementation of IKD has strategic implications for achieving national development goals and meeting international standards, including Sustainable Development Goals (SDGs) indicators related to legal identity and the availability of quality data.

Conclusion and Recommendations

1. Conclusion

Based on the results of the literature review, the implementation of Digital Population Identity (IKD) in Indonesia shows significant progress as part of the transformation of population administration. IKD has great potential in supporting the strengthening of the demographic statistics system, particularly through real-time data updates, improved accuracy in recording vital events, and data integration across systems and institutions.

Various challenges still need to be overcome in order to optimize the use of IKD. These challenges include limited

digital infrastructure in a number of regions, particularly in 3T areas; low digital literacy among the population; variations in the competence of civil servants; and data security and privacy issues that require the strengthening of national digital identity governance. International findings show that the challenges faced by Indonesia are in line with global issues related to interoperability, data privacy, and the governance of centralized digital ID systems.

Nevertheless, this study confirms that there are enormous opportunities for utilizing IKD as the foundation of a demographic statistics system. The integration of IKD with public service systems and statistical agencies has the potential to improve the quality of civil registration and vital statistics (CRVS), support big data-based demographic analysis, and accelerate the provision of comprehensive, accurate, and timely population data. With strengthened policies and cross-institutional collaboration, IKD can become a key pillar of national demographic statistics modernization.

2. Recommendations

Strengthening the implementation of Digital Identity (IKD) requires the support of equitable information and communication technology infrastructure, especially in areas with limited connectivity. In addition, improving the digital literacy of the community is an important factor in encouraging the optimal acceptance and utilization of IKD. These efforts need to be supported by increasing the capacity of the apparatus through continuous technical training, including understanding related to population data management and digital system security, so that IKD-based administrative services can run more effectively and professionally.

On the other hand, data security and privacy protection must be a primary concern in IKD development, through the implementation of multi-layered authentication systems, data encryption, and the strengthening of national digital identity governance. Cross-agency collaboration, especially between Dukcapil, BPS, Kemenkominfo, and other relevant institutions, needs to be continuously strengthened to ensure data interoperability and consistency. The integration of IKD with the Civil Registration and Vital Statistics (CRVS) system also needs to be accelerated so that vital events can be recorded in real-time and support the provision of accurate, up-to- date, and relevant demographic statistics for national development planning.

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