

The importance of final record data (as built data) of infrastructure built in the Indonesia's new capital

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Abstract. The new capital of Indonesia, which is currently under construction, has several major frameworks that underlie its development vision. One of them is to become a modern city with international standards that is progressive, innovative and competitive in various aspects, such as technology, architecture, urban planning and social issues. Apart from that, IKN will also be equipped with world-class infrastructure and connected to various other international city centers. The infrastructure that is built will then function over a period of time. In the future, this infrastructure will need maintenance, repair, and possibly replacement. These activities often require initial data when the infrastructure was built. If infrastructure repair activities are carried out far from the time of construction, it is often difficult to find the necessary data. This article discusses the importance of having final recorded data (as built data) available for infrastructure that has just been built so that in the future there will be no difficulties in rehabilitation and renovation activities. The study was carried out by taking old infrastructure assessment cases as examples, namely the plan to replace the Ketenger power plant penstock which is 84 years old and the rehabilitation plan for the Pelus River Bridge which is 52 years old. Both are located around a city that is not too big, namely Purwokerto, however, they can be used as a reference in developing the concept of as-built data which can be said to be a development of as-built drawings which have long been known in the world of construction. To support this concept, it is necessary to use the latest technologies such as big data, artificial intelligence, internet of things, virtual reality and other technologies.

1 Introduction

The new capital of Indonesia, as known as Ibu Kota Nusantara (IKN), is under construction on land that initially had few or no man-made buildings. The situation is still natural and will be maintained even though there will be many buildings and infrastructure on IKN land. To keep assets useful, maintenance and monitoring are needed. This article discusses the significance of the availability of built infrastructure data for maintenance, rehabilitation and modification of a structure or building. Two case studies of old structures are taken as examples. During the analysis, there was difficulty in knowing the structure and materials of a building that was built in the past. Visual detection without tools only on visible parts causes doubts in the analysis.

This study conveys an idea for newly built IKN in terms of providing data after a building is completed. The concept is stated in general terms while the details will be future work.

2 Lesson learned 1: an assessment of Ketenger hydropower plant, Banyumas

The first case raised for discussion in this study was the penstock assessment of the Ketenger Banyumas Hydroelectric Power Plant (PLTA). The Ketenger hydroelectric power plant is a legacy of the Dutch East Indies government which was built in 1935 and began operating in 1939 [1]. The hydroelectric power plant, which is on the slopes of Mount Slamet and is included in the administrative area of Baturaden District, Banyumas Regency, has 4 main components as shown in Figure 1, namely pondage, penstock, surge tank, and power house. Even though it is 84 years old, this hydroelectric power plant is still productive in producing electrical power. To maintain the capability of the Ketenger Hydroelectric Power Plant, an assessment will be carried out in 2023, especially on one of the two water distribution pipes from the pondage to the power house, namely penstock pipe 1. The aim of the assessment is to find out the current pipe thickness, the pipe thickness reduction rate, the remaining life of the pipe, discharge capacity and pressure loss, material durability, pipe repair or replacement priority,

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preventing damage and maintaining the penstock so that it remains operational.



(a)



(b)



(c)



(d)

Fig. 1. The main components of the Ketenger Hydroelectric Power Plant: (a) pond, (b) dampening tank, (c) penstock pipe, and (d) power house

To estimate the remaining life of a pipe, the formula can be used:

$$RSL = \frac{t_{actual} - t_{required}}{CR} \quad (1)$$

where

- RSL : remaining service life (years);
- t_{actual} : actual thickness (mm);
- $t_{required}$: minimum required thickness (mm);
- CR : corrosion rate.

The data needed to calculate the corrosion rate value is the nominal thickness of the pipe, the actual thickness of the pipe and the age of the pipe. The following is the equation for calculating the corrosion rate:

$$CR = \frac{t_{previous} - t_{actual}}{T} \quad (2)$$

where

- CR : corrosion rate
- $t_{previous}$: previous pipe thickness (mm)
- t_{actual} : pipe thickness at current inspection (mm)
- t : time interval for collecting nominal and actual thickness data (years)

The minimum pipe thickness required to withstand the pressure can be calculated using the formula:

$$Tr = \frac{P \times D}{2 \times \sigma \times E} + CA \quad (3)$$

where

- Tr : thickness required (cm)
- P : internal design pressure (kg/cm²)
- D : pipe diameter (cm)
- σ : specification minimum yield strength (kg/cm²)
- E : joint factor of riveted connection
- CA : corrosion allowance (cm)

Difficulties come up when determining the rate of corrosion where data on the initial pipe thickness is not found. Therefore, it needs to be measured at the beginning and end of a period. In this case, the pipe thickness was measured in 2020 to get the initial thickness (previous) and 3 years later it was measured again to get the actual (tactual) thickness. Apart from that, difficulties are also experienced in calculating the required pipe thickness where several parameters are needed as shown in Equation 3. In determining pipe pressure, there are differences in information on the elevation of the bottom of the pondage as shown in Figure 2. The elevation will show the amount of hydrostatic pressure so accurate data is needed. Measurements will of course provide this but will add to the cost of the job. Costs also need to be incurred in connection with determining the values of other parameters in equation 3, namely to obtain the values of pipe diameter, steel pipe yield strength, rivet connection factor and corrosion level. The yield strength of steel can be known if the material can be detected so in this work tests have been carried out to obtain this value.



(a)

6. KOLAM TANDO

Luas dasar kolam	:	1.768 m ²
Luas permukaan air	:	3.536 m ²
Isi kolam efektif	:	20.800 m ³
Duga muka air max.	:	5,80 m
Duga muka air min.	:	2,50 m
Elevasi dasar kolam	:	658 m
Harga perolehan	:	Rp 319.073.686,-
Tahun perolehan	:	1939

(b)

Fig. 2. Pondage bottom elevation data: (a) on the information board at the pondage, (b) in the book "Ketenger hydroelectric technical data"

To achieve the assessment objectives, data collection and analysis are carried out. Primary data was collected using field surveys, while secondary data was obtained from various sources and documents. The field survey carried out included measuring pipe thickness (UT thickness), measuring pipe hardness (hardness test), testing pipe materials (Positive Material Identification/PMI), and visual surveys of pipe conditions [2]. Furthermore, from the data obtained, a remaining life assessment (RLA) analysis can be carried out and several recommendations can be produced so that the penstock can function properly.

The remaining life of the pipe can be used as a basis for pipe replacement. Because the pipe age for each section is not the same, pipe replacement can also be carried out in stages starting from the one with the shortest remaining life. The hardness of the pipe can withstand the pressure of water but has entered the plastic deformation phase so that when the steel pipe changes shape due to the applied force, it cannot return to its original condition when the force is removed. Pipe maintenance to maintain penstock function can be carried out with several types of actions.

The difficulties experienced in the analysis before emergency work was carried out were related to the absence of technical data regarding this bridge. This bridge has been functioning for 52 years as stated in the simple inscription attached to the end of the bridge railing (Figure 5a). Apart from that, it is not known exactly when several parts of the bridge and its supporting structures or buildings were built. For example, there is a retaining wall on the west abutment (Figure 5b), hydraulically there are losses if this section is made.

The whereabouts of other data relating to structure are also unknown, which could possibly occur due to several things such as awareness of the importance of

storing data at that time, offices moving, agencies changing names, changes in authorized officials, and so on.

3 Lesson learned 2: Rehabilitation of the Pelus river bridge Purwokerto

A bridge is a structural building that functions to connect two parts of a road that are disconnected because the road crosses a river, irrigation canal, highway, and the like. Bridges were built to increase accessibility and efficiency of transportation in the context of equitable development and improving people's welfare.

The Kali Pelus Bridge, which is on Jalan Senopati, Arcawinangun Village, Banyumas Regency, has a very vital role for the residents of Banyumas Regency. The bridge that connects two parts of this provincial road is one of the main access points between Purwokerto City and Kembaran District. Many Purwokerto and Kembaran communities use this bridge for educational accessibility, health and overall economic activities.

The Kali Pelus Bridge, which was built in 1971, has experienced damage to the lower structure, especially the ground sill, base of the bridge pillars, and river banks on the west and east wings. The flood and landslide incident that occurred on Saturday, January 21 2023, resulted in landslides on the river slopes which resulted in the collapse of three surrounding houses (Figure 3).



(a)



(b)

Fig. 3. Disturbances that occurred on the Purwokerto Pelus River bridge in 2023: (a) landslides on the right bank of the river which endangered residents' houses, (b) failure of the retaining wall on the right bank of the river

To avoid loss of life due to the bridge's increasingly worrying condition, access to the bridge was closed by the Banyumas district government. As a substitute, residents are forced to use circular transportation routes through the Mersi or Sumbang areas to travel from Kembaran to Purwokerto or vice versa. As a result, traffic jams occur on these transportation routes. Therefore, the Regency Government took the initiative to carry out emergency work, namely installing gabions as a temporary replacement for the ground sill which previously existed downstream of the bridge but has been destroyed and washed away by the large discharge of the Pelus River (Figure 4). It is hoped that this emergency ground sill can last until permanent work is carried out which is the authority of the Serayu Citanduy River Region Center.



(a)



(b)

Fig. 4. The ground sill (yellow box) downstream of the bridge was washed away due to large flood discharges (a) and the installation of gabions as emergency ground sills to replace the previous ground sills (b)

The difficulties experienced in the analysis before emergency work was carried out were related to the absence of technical data regarding this bridge. This bridge has been functioning for 52 years as stated in the simple inscription attached to the end of the bridge railing (Figure 5a). Apart from that, it is not known exactly when several parts of the bridge and its supporting structures or buildings were built. For example, there is a retaining wall on the west abutment (Figure 5b), hydraulically there are losses if this section is made.



(a)



(b)

Fig. 5. Marking that the bridge will be 52 years old in 2023 (a) and the presence of a volume of soil with stone masonry for retaining the soil in front of the bridge abutment (b)

The whereabouts of other data relating to structure are also unknown, which could possibly occur due to several things such as awareness of the importance of storing data at that time, offices moving, agencies changing names, changes in authorized officials, etc.

4 Data management of infrastructure final records

Reflecting on the two cases above, data management of facilities and infrastructure needs to be paid attention to. One or two buildings may not require complicated management, but for the entire data of a city, extra management is needed. At this time, data technology has become more advanced, so it is best to apply it when managing infrastructure data, especially those that have been completed at IKN. The development of facilities and infrastructure at IKN continues to be accelerated. One of them is the Sepaku Semoy dam (Figure 6). This dam data is very large if it is stored and preserved in the long term. In the construction phase of this dam, as well as several other projects that are being worked on such as drinking water network systems and highways, the practice of collecting data through work tools connected to the communication network has been practiced. For example, cameras are installed on bulldozers and

excavators to monitor the progress of work, the data of which can then be transferred to devices in the office.

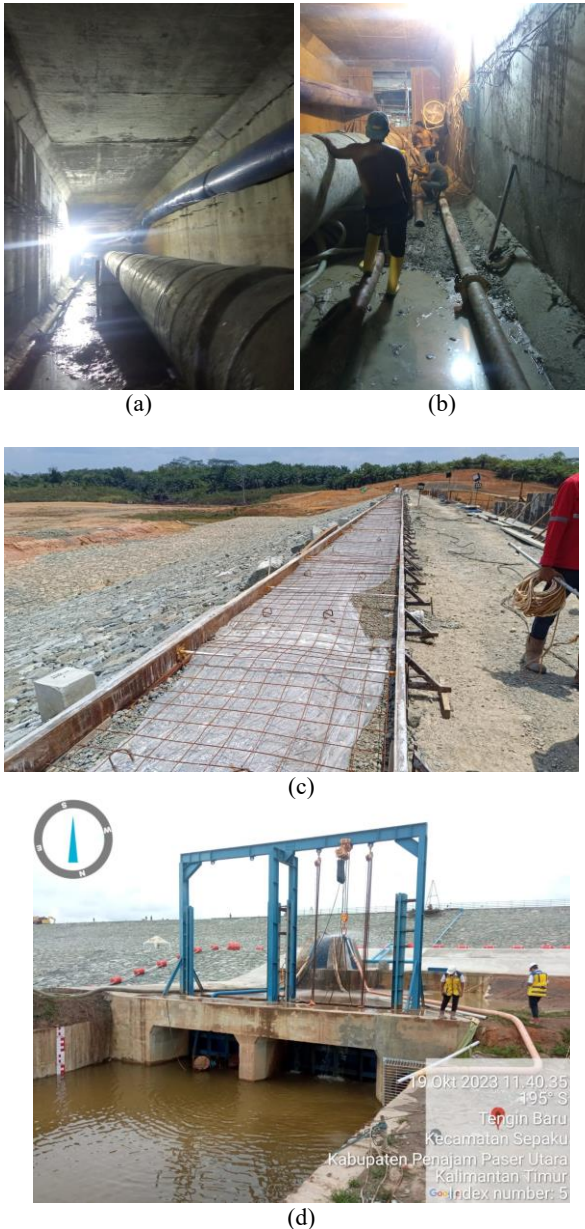


Fig. 6. Water distribution pipe from the dam intake to the IKN settlement (a and b). Top of the Sepaku Semoy dam and intake water gates (c and d)

Three types of technology that are often mentioned are big data, artificial intelligence (AI) and the internet of things (IoT). Big data is defined as data with larger volumes, more variety, and faster processing speeds. Big data, in its most basic form, is a more extensive and intricate collection of data, particularly from new data sources [5,6,7,8]. Artificial intelligence, on the other hand, is the study of creating machines with human-like thought processes. He is capable of actions deemed "smart." Large volumes of data can be processed by AI technology in a manner not possible by humans. Artificial Intelligence aims to mimic human abilities in pattern recognition, decision-making, and judgment. [9,10,11]. Meanwhile, the term IoT, or Internet of Things, refers to a collective network of connected devices and technologies that facilitate communication between devices and the cloud, as well as between the

devices themselves [12,13]. The relationship between these three technologies is depicted in Figure 7.

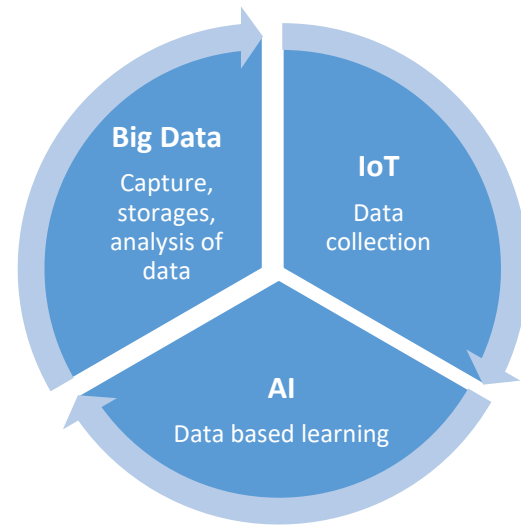


Fig. 7. The relationship between big data, internet of things and artificial intelligence

Applications of artificial intelligence (AI) and big data complement one other well. Large data inputs are necessary for AI applications to be successful. With previously unthinkable approaches, artificial intelligence (AI) is now assisting enterprises in using their data as a tool to impact organizational decision making. The outcomes of machine learning models improve with the amount of data we feed them.

Big data is becoming a very popular idea for resolving difficult technical issues. The discipline of civil engineering has been significantly impacted by big data analysis among other engineering specialties. The abundance of data offered by new test and monitoring technologies is causing a true revolution in the operation and maintenance of civil engineering systems today. It is often known that big data plays a crucial role in this transition. Big data technology is crucial for handling vast amounts of data, but it hasn't been successfully implemented in civil engineering information systems yet. In the area of civil engineering, this thematic edition of automation in construction aims to examine the key advancements and uses of contemporary big data tools and techniques. A number of advances in science have made it possible to successfully apply big data analytics to solve difficult challenges in the field. [4].

Big data has transformed traditional operational procedures in the construction industry, resulting in more automated processes. The availability of digital tools and technology for planning and carrying out building projects has significantly advanced the construction sector throughout the past 20 years. Industry investment in big data and related technologies has emerged from the potential to model building structures and determine their function before the technology is constructed.

Big data is being used extensively in the construction sector. It's still difficult to figure out how big data may benefit the building sector. Every construction project produces additional data, thus it's critical to evaluate and arrange the information as needed. Big data has the

potential to significantly improve a number of important aspects of the construction sector, including productivity, waste minimization, safety, competitive advantage, and pollution control. The construction industry is susceptible to big data accumulation and storage issues because of the size of 3D modeling files and the volume of daily data produced by wearable technology. [5].

Artificial intelligence has the potential to be a useful tool in the construction industry for tracking the flow of damaged and used resources automatically. It can also be used to analyze and manage the supply of technical resources and building materials for construction sites. With artificial intelligence, you may quickly choose the best option available at a given level. Making the best selections in the shortest amount of time for various production scenarios is essential to maximizing the efficiency of construction production.

5 Conclusion

Each infrastructure has a certain lifespan. Its performance can decrease over time so that at some point it requires an evaluation or assessment to assess whether action is needed on the infrastructure. IKN can be a good example in sustainable development. Currently, during the construction phase, it is the right time to do various things, one of which is recording all the details of the structure and infrastructure that have been completed. Even though there are design documents and shop drawings, there are often differences between what is planned and what is built. And even though there is a final recorded image (as built drawing), not necessarily all the data is covered. Likewise, data storage also needs to be managed. Data needs to be inherited, and management also needs to be inherited.

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References

1. R. Hariyanto, A.S Soeroyo, D. Aripin (1985). *Data-data Teknik PLTA Ketenger*. PLN, Banyumas
2. Sucofindo Team. (2023). *RLA Penstock 1 PLTA Ketenger*. P.T. Sucofindo (Cabang Cilacap), Cilacap
3. Technical Team Unsoed. (2023). *Technical Study of the Feasibility of the Kali Pelus Bridge, Jalan Senopati, Arcawinangun Village, Banyumas Regency*. Banyumas Regency Public Works Department, Purwokerto (in Bahasa Indonesia).

4. A.H. Alavi, A.H. Gandomi. (2017). *Big data in civil engineering. Automation in Construction*, 79(), 1–2. doi:10.1016/j.autcon.2016.12.008
5. H.S. Munawar, F. Ullah, S. Qayyum, D. Shahzad. 2022. "Big Data in Construction: Current Applications and Future Opportunities". *Big Data Cogn. Comput.*, 6, 18. <https://doi.org/10.3390/bdcc6010018>
6. M. Bilal, Oyedele, O. Lukumon, J. Qadir, K. Munir, S.O. Ajayi, O.O. Akinade, H.A. Owolabi, H.A. Alaka, M. Pasha. (2016). "Big Data in the construction industry: A review of present status, opportunities, and future trends". *Advanced Engineering Informatics*, 30(3), 500–521. doi:10.1016/j.aei.2016.07.001
7. N. Garyaev & V. Garyaeva. (2019). "Big data technology in construction". *E3S Web of Conferences* (Vol. 97, p. 01032). EDP Sciences.
8. M. Sun & J. Zhang. (2020). "Research on the application of block chain big data platform in the construction of new smart city for low carbon emission and green environment". *Computer Communications*, 149, 332-342.
9. S. Bang & N. Olsson. (2022). "Artificial intelligence in construction projects: a systematic scoping review".
10. Y. Pan & L. Zhang. (2021). "Roles of artificial intelligence in construction engineering and management: A critical review and future trends". *Automation in Construction*, 122, 103517.
11. K. Tan. (2018). "The framework of combining artificial intelligence and construction 3D printing in civil engineering". *MATEC web of conferences* (Vol. 206, p. 01008). EDP Sciences.
12. V.B. Chandanshive & A.M. Kazi. (2017, March). "Application of Internet of Things in Civil Engineering construction projects-A State of the Art". *Proceedings of the 11th INDIACom, 4th International Conference on Computing for sustainable global development* (Vol. 4, pp. 1836-1839).
13. A. Ghosh, D.J. Edwards & M.R. Hosseini (2021). "Patterns and trends in Internet of Things (IoT) research: future applications in the construction industry". *Engineering, Construction and Architectural Management*, 28(2), 457-481.
14. I. Susanti *et al.* (2023). "Application and Analysis of Remote Sensing for the Initial Baseline of the Quantitative Comfort Index in Ibukota Nusantara (IKN) and Its Surroundings". In: Basit, A., *et al.* Proceedings of the International Conference on Radioscience, Equatorial Atmospheric Science and Environment and Humanosphere Science. INCREASE 2022. Springer Proceedings in Physics, vol 290. Springer, Singapore. https://doi.org/10.1007/978-981-19-9768-6_78