Indonesia's Digital Infrastructures for Nuclear Energy Policy Transparency

Full Papers

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Abstract

In increasingly digitized and interconnected nations digital infrastructures (DIs) as a strategic asset present not only great promise but also great perils. There is a lack of DI research attention in the e-government field. This paper examines DIs for nuclear energy policy transparency towards public safety and environmental safety at Indonesia's government agency, BATAN, responsible for nuclear policy compliance, experimental nuclear reactors operation, and radiation risk management. Using website and content analysis we identified salient dimensions of extant DIs including sensors embedded in various environment monitoring systems and real-time radiation dose-related data and radiation warning systems. Despite the public opinion polls BATAN conducts annually on citizens' acceptance of using commercial nuclear power plants for electricity, however, other salient dimensions found in the literature such as website and social media for active forms of citizen engagement and policy transparency on the potential radiation hazards are still lacking at the agency level.

Keywords

Digital infrastructure, nuclear energy policy, policy transparency, citizen engagement, radiation hazards

Introduction

In our increasingly digitized and interconnected nations digital infrastructures (DIs) present not only great promise but also great perils. U.S. President Barrack Obama has underscored the critical importance of protecting America's DIs: "From now on, our digital infrastructure – the networks and computers we depend on every day – will be treated as they should be: as a strategic national asset. Protecting this infrastructure will be a national security priority." (The White House, 2009, p. 1) In Obama's view of DI, it is the backbone that underpins the economy, a strong military and an open and efficient government; comprising broadband networks, wireless networks, massive grids that power the nation, classified military and intelligence networks, and the Internet that provides unprecedented interconnectivity. Despite the recognized importance of DIs as a strategic national asset, however, there is a serious lack of research to examine extant DIs in the e-government context in general and in the nuclear energy policy context in particular. This paper therefore aims to reduce this gap in the literature by raising the following research question: *What dimensions of digital infrastructures are necessary for government to make its national nuclear energy policy transparent to the public towards building high capability for public safety and environmental safety?* We will address this question in a specific research context of the National Nuclear Energy Agency of Indonesia responsible for the nation's nuclear energy policy compliance, policy benefits and risk management of radiation hazards. As part of a larger research project, we adopt a website analysis and a content analysis of the agency's internal documents to identify and examine the agency's DIs. Our analysis and insights learned from this case study on nuclear energy policy transparency will be useful for developing a better understanding of nuclear energy policy benefits and challenges such as its potential impact on public safety and environmental safety.

The remainder of this paper is structured as follows: in the next section we present our literature review. In the third section, we discuss our research methodology used in this paper. In the fourth section, we briefly describe our research background. In the fifth section we present our analysis results. In the final section, we discuss our key results, their policy implications, and conclusions.

Literature Review

Digital Infrastructures

Tilson et al. (2010, p. 748) define DIs as "the basic information technologies and organizational structures, along with the related services and facilities necessary for an enterprise or industry to function". They argue that DIs in the 21st century digitalization initiatives reflect a paradigm shift, because "IT has become deeply socially embedded, is coordinated through diverse sociotechnical worlds and numerous standards, and is most visible during breakdowns (Tilson et al., 2010, p. 749)." They further argue that DIs are the missing research agenda in the information systems (IS) field, when the IS research attention has moved beyond administrative systems and individual productivity tools. A similar paradigm shift seems to have taken place in the e-government research field. While governments create interconnected and decentralized work organizations through the use of information and communication technologies (ICT), citizens can use e-government portals (e.g., a whole-of-government approach) for new levels of integrated public services and can use ubiquitous social media channels operated by government departments and agencies for new forms of social interactions with government. It is important for us to examine DIs as "paradoxes of change and control" (Tilson et al., 2010, p. 749) in decentralized, heterogeneous and distributed platforms and environments, with the emergent foci on service ecologies, new experiences, and new forms of human interaction.

On the one hand, the literature shows positive roles of DIs in supporting and influencing public policies. DIs for the new digital borders of Europe have been built to control unwanted immigration through the interconnection of a network of diverse national databases across the European Union (EU) nations. The DIs include biometric data and digitized application documents of the internationally mobile population for digital registration, identification and traces of temporal and geographical movements of migrants. The DIs aim to support the EU immigration policy for monitoring, detecting and controlling unwanted irregular migration flows (Broeders, 2007). The author concludes that these DIs were "developing into a formidable tool for the surveillance of irregular migrants in Europe" (Broeders, 2007, p. 71). Similarly, a study found a positive association between DI policies of provincial governments in Canada and the emergence of relatively high quality broadband networks (Rajabiun and Middleton, 2013).

On the other hand, while contributions of DIs in transforming public services are found, other studies have not explicitly examined relationships between DIs and public policies. For example, the fundamental transformation of the existing fire governance practices in the British Fire and Rescue Service (FRS) into anticipatory governance were significantly facilitated by the DI newly embedded in the FRS. The DI comprised of data, hardware, software, fiber-optic cables as well as human analysts and organizational processes to make risk projections on fire which shape the FRS strategic decision-making (O'Grady, 2015). Similarly, worldwide customs is transforming from the labor intensive paper work to "e-customs," which effectively facilitates international trade by fully leveraging the emergence of global DIs which include so-called service-oriented auditing; innovative auditing services based on the Service-Oriented Architecture (Bukhsh and Weigand, 2012).

Critical DI Protection and Nuclear Reactor Plants

The protection of the DIs for nuclear reactor plants has received the renewed and heightened global attention in the immediate aftermath of the 2011 nuclear reactor meltdowns at the Fukushima Daiichi Nuclear Power Plant (F1) in Japan. It was the worst nuclear accident due to high radioactive release (rated 7 on the International Nuclear Events Scale) since the Chernobyl disaster in 1986 (IAEA, 2015a). On

March 11, 2011, a massive earthquake (magnitude 9.0) and subsequent enormous tsunamis struck F1 in the Tohoku region of northeastern Japan. As F1 suffered the loss of all power that resulted from the tsunamis, three buildings housing nuclear reactors were seriously damaged from hydrogen explosions. In one building, the nuclear reactions became out of control and all three reactors' fuel rods were irreversibly damaged (The Sydney Morning Herald, 2011). In response to this enfolding disaster, the evolving DIs included the deployment of mobile rescue robots with sensors to carry out surveillance missions which could be monitored both by the F1 control room and the TEPCO headquarter command and control center in Tokyo. However, prior to the deployment of the new DI, the TEPCO and government were required to resolve various technical issues on sensors, hardware reliability, communication functions, and the ability of the robots' electronic components to withstand radiation (Nagatani et al., 2012).

The protection of DIs which sustain the operation of nuclear power plants is critically important, since there is a total of 442 nuclear reactors worldwide as of February 2016 (IAEA, 2016). The U.S. leads with 99 reactors in operation, which is followed by France's 58 and Japan's 43. Of the 442 reactors worldwide, 86 reactors (nearly 20%) are located in Asia (Japan, China, Korea, India, and Pakistan) characterized by the natural disaster hazards and the geopolitical tensions.

Nuclear Energy Policy Transparency and Citizen Engagement

There are many examples of the impact of DIs on nuclear energy policy and transparency. For instance, Japan traditionally held all the decision-making powers at the top-tier government bureaucrats, virtually overlooking outside input and scrutiny. Kotler and Hillman (2000) further described the Japanese citizens as unchallenging towards their government because they saw bureaucrats as the policy experts, resulting in no demand for government transparency and accountability. This propensity to trust government all changed, however, when Japan experienced a series of nuclear accidents within a 10-year period under the government push for the nuclear power nation. The Japanese citizens began to question the competence and integrity of the very same authorities they once trusted to be able to handle public safety and environmental safety. Not even the release of internal investigations and reports calmed their fears (Kotler & Hillman, 2000). Public opinion polls (conducted by Japanese newspapers) found that over one-half of the Japanese population felt unsafe in regards to radiation hazards of nuclear power, and there was a demand for government to review its nuclear energy policies to prevent other public safety and environmental security threats in the future (Kotler & Hillman, 2000). The nuclear events did, however, stress the importance of active citizen engagement and government transparency. In fact, the government did make attempts to open itself up to more input from its citizens. For example, the government advisory council ("shingikai") meetings changed its closed-door procedures policy to allow the public to attend and have the opportunity to make comments in person and online. The emergence of the Internet at the time also allowed for the government to post information to educate the public on nuclear policy issues, enabling citizens to monitor their actions as never before (Kotler & Hillman, 2000).

After the Fukushima Daiichi Nuclear Power Plant disaster in 2011, however, the Japanese government was not fazed by the concerns of other countries on their nuclear policy procedures despite confirming 15,000 deaths and 3,000 still missing (Benz, 2013). It was no surprise that other countries started to question whether Japan was capable of protecting the safety of its citizens. The advocacy of strong regulation, transparency in energy policy actions and procedures, and the willingness to inform citizens may help solve this problem. Benz (2013) stressed that public involvement in nuclear policy is indispensable because the public act as overseers of public health and safety (from a third party point of view) of government nuclear regulators and operators.

In the U.S., lessons were also taken from the Three Mile Island and Chernobyl nuclear incidents as well. O'Connor and van den Hove (2001) argued that public trust in government was deeply affected by these accidents, especially after numerous attempts by government to cover-up or hide the inconvenient truths. This led to a new kind of demand from societies of their government in terms of nuclear policy transparency. The public in these countries were generally concerned about their health and the environment, and they demanded that they had the 'right to know' information about both radiological emergencies as they are occurring and how government is preventing them in the first place (O'Connor & van den Hove, 2001). Nuclear disasters and other energy-related accidents have made it clear that stakeholder involvement and input should be promoted throughout the entire process and not just be reactionary to a nuclear accident, and that these established lines of communication will lead to a better accident response in the long run (O'Connor & van den Hove, 2001). When the public participates in nuclear policy matters, transparency will be brought to the process and it will lead to solutions that are more likely to be accepted by all stakeholders (O'Connor & van den Hove, 2001). With Obama's push for open government in 2009, the United States Department of Energy (DOE) created its own open government plan to enable citizens a better look at how it implements energy policy on a day-to-day basis. The use of social media has also been on the forefront of their push for more transparency, allowing DOE to engage the public and stakeholders in a two-way conversation about energy policy (DOE, 2014). Other 21st century technologies that the DOE is harnessing to communicate energy policies include applications such as Project Open Data, Lantern Mobile App, and ScienceCinema (DOE, 2014).

In regards to Non-Governmental Organizations (NGOs), the International Energy Agency (IEA) has 28 country members that strive to improve the world's environment through three key foci in relation to energy policy: 1) energy security, 2) environmental protection, and 3) economic development (IEA, 2013). To achieve these overarching goals, the IEA has in its 40 years turned increasingly towards public input. The organization has stated that "increasing public awareness of domestic energy policies through improved transparency and engagement is an important facet of policy support among IEA member countries," and acknowledged that when IEA countries inform the public about their actions that energy policy is likely to be implemented successfully (IEA, 2013, preface before p. 1). The Organization for Economic Co-operation and Development's (OECD) Nuclear Energy Agency Committee released a document highlighting current commendable practices of transparency in nuclear regulatory communication with the public. According to the report, the most responsible nuclear regulatory organizations (NROS) recognize that transparency is a great way to increase public trust in government and shows that they are capable of protecting public health, the environment, and public safety and security (OECD, 2011). NROs use these websites not only to make information available about nuclear policy and to show how the work they are doing is keeping the public safe, but also engage the public in an ongoing conversation about their activities to hold them accountable (OECD, 2011).

Research Methodology

In order to address the research question about DIs for government nuclear energy policy transparency and public engagement, we conducted direct observations and content analysis of DI websites operated by The National Nuclear Energy Agency of Indonesia, which are shown in Table 1. These websites, which are open to the public, provide citizens and scientists alike with interactive DIs for disseminating raw datasets and scientific information on nuclear power technology, real-time environmental radiation exposure data, locations of various sensors and nuclear facilities, public safety information, and knowledge of nuclear science and technology research results. For DIs for public engagement, we have also examined BATAN's e-government website to examine digital information content and documents as well as social media channels used to educate the public and to issue early warnings.

Digital Infrastructure (DI)	DI Owner	Website Link
Environmental Radiation Monitoring	Dept. of Nuclear Technology Utilization	http://223.25.97.90/radmon/index.php?r=site/index
Geographic Information System	Dept. of Nuclear Technology Utilization	http://223.25.97.106/mitra/media.php?module=sig
Public Information Transparency System	Executive Secretariat	http://www.batan.go.id/kip/
Nuclear Knowledge Management System	Dept. of Nuclear Technology Utilization	http://nkm.batan.go.id/index.php
Nuclear Management Information System	Executive Secretariat	http://portal.batan.go.id/portal/

Table 1. List of BATAN's Digital Infrastructures Observed and Examined

Background

Indonesia's Energy Policy

There are at least two drivers for Indonesia's nuclear energy policy. First, Indonesia faces the acute energy problem as its fast growing population has reached 256 million (CIA, 2015) as the world's 4th populous nation, behind China, India, and U.S. Second, with an industrial production growth rate of 10.5%, energy demand is estimated to reach 450 billion kWh in 2026 (World Nuclear Association, 2016). Indonesia's energy policy is regulated by the Government Regulation No. 79 Year 2014 on National Energy Policy (KEN). KEN was implemented as the national policy framework for energy management to achieve energy independence and energy security necessary for sustainable development. Figure 1 shows energy mix targets established by KEN from 2013 to 2025, 2030 and 2050 (Ministry of Law and Human Rights, 2014). On the one hand, oil as a primary energy source looks set to take a smaller part in providing future Indonesia's energy needs, with a drastic reduction from 44% in 2013 to 20% in 2050. While coal as a primary energy source remains unchanged at 30% from 2013 to 2030, it will be reduced to 25% in 2050. On the other hand, new and renewable energy looks set to take a greater part in providing future Indonesia's energy needs, with a very significant increase from 8% in 2013 to 31% in 2050. Nuclear energy is a new and renewable energy source. In addition, natural gas will be gradually increased from 18% in 2013 to 24% in 2050.

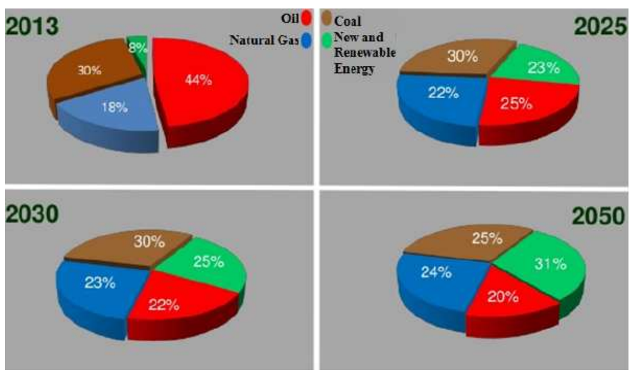

Figure 1. KEN Energy Mix Targets

Nuclear energy as a new and renewable energy source requires rigorous public safety and environment security standards.

National Nuclear Energy Agency of Indonesia

The Nuclear Energy Agency of Indonesia (BATAN) has been designated as a Non-Department Government Institution. As such, the head of BATAN is directly responsible to the President of Indonesia, while BATAN is organizationally located under the Minister for Research, Technology and Higher Education. The mission of BATAN is to conduct research, development and utilization of nuclear energy (BATAN, 2016a). The vision of BATAN for 2015-2019 is to become a leading organization in nuclear research and development (R&D) in the Southeast Asian region and to lead the nation's policy goal towards energy self-reliance (Indonesia's Nuclear Energy Agency, 2016).

Nuclear R&D activities are classified into: (1) reactor safety, (2) radiation safety, (3) environmental safety, (4) radiation and radioisotope application, and (5) radioactive waste-management. They are performed in 4 nuclear facilities: Pasar Jumat, Serpong, Bandung, and Yogyakarta as shown in Figure 2.

Currently, collective capacity of 32,100 kW has been developed at the 3 research reactors in operation. As the first step towards the development of the planned commercial Nuclear Power Plant (NPP), BATAN is currently planning an Experimental Power Reactor (RDE). RDE will be built in the National Centre for Research of Science and Technology (PUSPIPTEK) facilities at Serpong, as part of South Tangerang City in the Banten Province. HTGR (High Temperature Gas-cooled Reactor) with the power size of 10-15 MWth that generates electricity (3-5 MWe) and heat for other experimental purposes (coal liquefaction and gasification and hydrogen production) was chosen for this purpose. The development of RDE is one of the entry points for nuclear energy. Based on nuclear legislation, BATAN has an authority to build and operate non-commercial NPP (RDE). The development of RDE is also a strategy for mastering the nuclear energy project management, engineering capacity building and human resource development to strengthen the role of the Technical Supporting Organization (TSO) (IAEA, 2015b).

Figure 2. Nuclear Reactors and Nuclear Facilities in Indonesia

Results: BATAN's Digital Infrastructures

In this results section we discuss BATAN's existing DIs used to support internal control for nuclear risk mitigation and to effect societal change in terms of the public sentiments and attitudes towards accepting the future use of nuclear power plants to generate electricity.

Internal Control for Nuclear Risk Mitigation

The nuclear reactor plants cannot avoid the release of radioactive material into the environment which can affect the level of environmental radioactivity. The increase in environmental radioactivity can be detected by environmental monitoring activities that are conducted regularly and continuously. The environmental monitoring activities across all the nuclear facilities consist of observations of weather conditions, environmental radioactivity monitoring and environmental impact assessment (EIA). The hardcopy reports on monitoring results are manually sent to the Center of Nuclear Safety and Radiation Measurement in BATAN and Indonesia's Nuclear Energy Regulatory Agency (BAPETEN) periodically. It indicates a level of doses acceptable for the people living in the surrounding area, level of radioactivity in various ecosystems and level of operation safety of nuclear plant itself. Thus the nuclear facility operators can improve the safety level of nuclear facility operation and the level of public safety and environment security surrounding the nuclear facilities (BATAN, 2015).

In order to monitor environmental radiation exposure and to issue early warnings, a continuous radiation monitoring system is necessary. Currently, BATAN has installed six gamma radiation monitors at Serpong Nuclear Facility. Monitoring environmental radioactivity at various locations consists of direct measurement, collection, processing and analysis of environmental samples, as well as analysis and data interpretation. The Agency's environmental monitoring is supplemented by observations of weather conditions. The monitoring of weather condition is conducted using a local meteorological observation system which is operated continuously and consists of several sensors mounted at an altitude of 4 meters, 15 meters and 60 meters. Sensors at an altitude of 4 meters are to measure rainfall and solar radiation intensity. Sensors at an altitude of 15 meters and 60 meters are to measure wind speed, wind direction, humidity, and air temperature. The results of the environmental gamma radiation measurements are sent to a data processing system continuously and in real-time using GSM/GPRS technology. Data are captured in real-time, which are used to predict the spread of radioactive materials released into the air during the normal operation and in times of a nuclear emergency (BATAN, 2016b).

Centralized monitoring system of continuous ambient air radiation exposure at Serpong Nuclear Facility has been installed on the 5 stations from 2010 to 2012 as shown in Figure 3 (a): the Crisis Head Quarter Building (CCHQ), Radio Metallurgy Installation (RMI), Center for Multipurpose Reactor (PRSG), Center for Nuclear Technology Partnership (PKTN) and Puspiptek Housing (Perum Puspiptek). Figure 3 (b) shows a real-time time-series graph of radiation monitoring data on April 22, 2016 which is displayed by the BATAN's radiation monitoring system which the public can access on its website. This system has an alarm which can be adjusted based on the elevated level of radiation necessary for emergency response. The monitoring equipment is placed in a strategic position to facilitate the detection of radiation release. The monitoring results are evaluated to estimate the radiation dose received by the population and the environment. In addition, the results of this monitoring are useful as an early warning system in case of a nuclear or radiological emergency response (Agus et al, 2012).

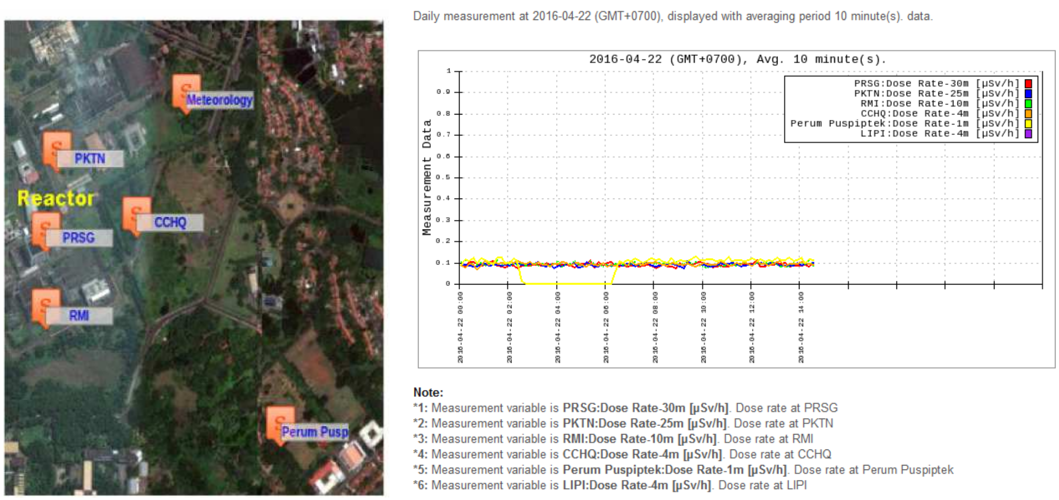

Figure 3. (a) Location of Ambient Air Radiation Exposure Monitoring System and (b) Measuring Data on 2016-04-22 (BATAN, 2016b)

Figure 4 provides a workflow of the Tele-Monitoring Sensor Gamma Radiation Exposure Integrated System. It is used to determine radiation exposure quickly in all three work areas at the Center for Radioactive Waste Technology (PTLR): compaction room, cementation room and temporary storage area. This system uses the telemetry principle; data from the radiation sensors is automatically sent to the central computer system for data processing and analysis, forwarding the results to the microcontroller for visual display. Alarm serves as an indicator if radiation exceeds safety threshold limits. The results are used by a PTLR's officer safety evaluation. This system is centralized at Health Physics Room, and hence enabling to determine the exposure of gamma radiation in the compaction room, cementation room and temporary storage area without measuring the radiation exposure directly so that safety and health of both radiation workers and radiation protection officers can be assured (Wijayanto et al, 2011).

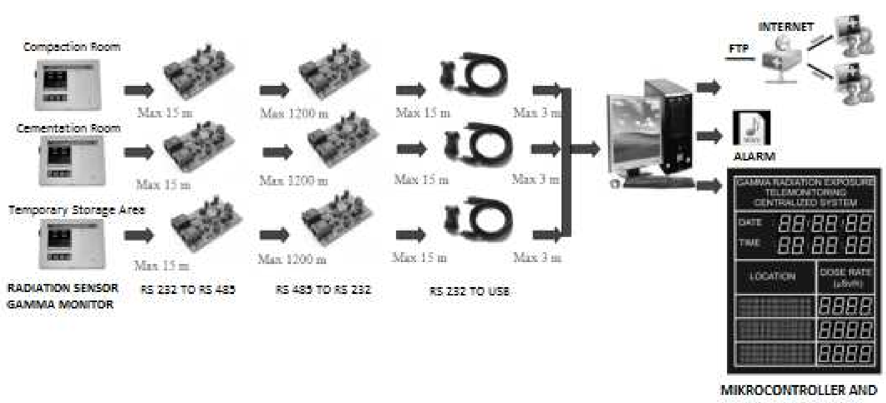

Figure 4. Tele-Monitoring Gamma Radiation Exposure Integrated System

Access control of the Integrated Environment Radiation Exposure Monitoring System is implemented to limit the use of the system to authorized officers responsible for monitoring and measuring radiation exposure at Yogyakarta Province's Nuclear Facility. Data obtained from several sensors such as radiation exposure, temperature, wind direction, wind speed, and precipitation are sent periodically by utilizing GSM/GPRS technology. Microcontroller module AT Mega 328 is used for the acquisition of data from the fifth sensor. Subsequently through GSM/GPR, data is automatically sent to the computer via SMS text message. Data received is displayed on the computer screen in a tabular form and can be processed by other software tools. This system allows the measurement of radiation exposure online and in real-time, and data can be displayed more quickly. However, since the integrated system is designed for internal control for nuclear risk mitigation, the public are not allowed to access these data.

Societal Change for Accepting Nuclear Safety

The official e-government website of BATAN provides the public with direct links to its official environmental radiation monitoring, geographic information system (GIS), public information transparency system, nuclear knowledge management system, and nuclear management information system. In order to support information dissemination and knowledge sharing with the public, the website also provides the public with access to its official social media channels: Twitter, Facebook Page, Youtube and Instagram. The official Twitter of BATAN, @humasbatan, was established in January 2013, with only 387 followers in response to a total of 699 tweets posted by the agency as March 2016. Later in 2014, BATAN established its Facebook page, Badan Tenaga Nuklir Nasional (https://www.facebook.com/batanpage), which shows 404 people who like this page. Youtube ("humasbatan persmedia") and Instagram ("badan_tenaga_nuklir_nasional") are used by BATAN to provide visualization in the form of videos and photos of activities that have been carried out by the agency.

Currently, the DIs at BATAN provides information about the real-time measurement of radiation exposure through the Environmental Radiation Monitoring System (http://223.25.97.90/radmon/index.php?r=site/index). When the level of radiation exposure exceeds the threshold value, BATAN coordinates with Indonesia's nuclear regulatory body in issuing emergency response warnings to the public. The public can access the environmental radiation monitoring system on the website: http://223.25.97.90/radmon/index.php?r=site/index. On this website, BATAN provides the Serpong nuclear facility's radiation and meteorological data in real-time which are collected from five radiation measurement stations and one weather station operated by the Ministry of Research and Technology. Through this website, the public can find locations of the radiation and weather measurement stations. The public can also find the radiation dose rate in each station and meteorological data (wind direction, wind speed, temperature, relative humidity, air pressure, rainfall and solar radiation), which are presented in tabular and chart forms and can be viewed on a daily, weekly or monthly basis. As we discussed earlier, using the results from this monitoring system, BATAN can predict the spread of radioactive material released into the air during the normal operation and in times of a nuclear accident. Furthermore, BATAN provides the public with online access to its GIS (http://223.25.97.106/mitra/media.php?module=sig), which can facilitate citizens' information search on BATAN's research, development and engineering activities. The GIS also provides scientists with documents on nuclear research in the field of food, energy, medical, advanced materials, industrial and radiation safety.

Discussion and Conclusion

The nation's critical DIs are considered as a strategic asset which need protection (The White House, 2009). DIs also need to be examined as "paradoxes of change and control" in decentralized, heterogeneous and distributed platforms and environments, with the emergent foci on service ecologies, new experiences, and new forms of human interaction (Tilson et al., 2010). Despite the great promise and great perils of DIs, however, empirical research on DIs in the e-government research has been lacking. This paper has examined the extant DIs at BATAN responsible for the compliance of Indonesia's national nuclear energy policy and the operation of the three experimental reactors built on the world's 4th most populous nation in Asia. We found that the DIs comprised various sensors embedded in environmental monitoring systems, real-time big data, data processing systems, decision support systems and predictive analytics systems. The contributions of these DIs to public safety and environmental safety are clear in that BATAN is well prepared to coordinate with the nation's nuclear regulatory body to issue the public radiation warnings in case the radiation level exceeds the threshold value. Our findings are consistent with the independent assessment of Indonesia's nuclear safety readiness (World Nuclear Association, 2015, p. 1): "Indonesia has a greater depth of experience and infrastructure in nuclear technology than any other southeast Asian country except Australia." With regard to Indonesia's experimental nuclear power plant to be built at Serpong, near Jakarta (see the map in Figure 1), the IAEA experts have been reviewing the safety aspects of both Muria and Madura proposals, in working with Indonesia's Nuclear Energy Regulatory Agency – Badan Pengawas Tenaga Nuklir (BAPETEN). The World Nuclear Association (2015, p. 1) further stated: "In November 2009 the IAEA undertook an Integrated Nuclear Infrastructure Review mission to Indonesia. Against 19 parameters, "no actions needed" on six, "significant actions needed" on three, and the rest "minor actions needed". In respect to IAEA milestones, the country is at the first: "ready to make a knowledgeable commitment". During the 1980s many technical people were trained in anticipation of nuclear power development then, many of these are still available for the new project." These independent reviews of Indonesia's nuclear incident preparedness and safety practice cannot be possible without the effective use of the DIs by BATAN.

Similarly, we have found some evidence for BATAN's recent attempts to engage the public in informing the nuclear policy benefits and radiation hazards at least through the use of e-government website and social media channels as well as GIS. In consequence, in December 2013, Indonesia's Ministry of State for Research and Technology released the results of an opinion poll conducted by an independent agency PT Iconesia Solution. The public acceptance of nuclear energy is increasing, as evidenced by 76.5% of the respondents agreed with the development of nuclear science and technology, while 60.4% agreed with developing a nuclear power plant to generate electricity in the country (World Nuclear Association, 2015).

In conclusion, we found evidence for the critical role played by the extant DIs in facilitating strong internal control and enabling the mission of BATAN. However, we did not yet find conclusive evidence of effective use of e-government portal and social media channels as other dimensions of the DIs for BATAN to promote active forms of citizen engagement in developing high capability towards enhanced public safety and environmental safety when Indonesia's first commercial nuclear energy plant will be constructed and become operational in the near future. In order for the ordinary citizens to obtain datasets, which are released by BATAN and openly available, they need to know an in-depth knowledge of the complex organizational structure underlying the BATAN organization to go to the right website of a particular department which shares its dataset. Therefore, Indonesia's nuclear policy needs greater policy transparency and policy details that would include active forms of citizen engagement in national nuclear energy policy. The literature we have reviewed clearly suggests the importance of active forms of engaging the public with on-going conversations on nuclear policy benefits as well as government transparency in informing the public about radiation hazards. Citizens' silence on the evolving national nuclear policy will enable government bureaucrats to act as policy experts who might fail in risk management of the potential great hazards of radiation to public safety and environmental safety as the case of the Japanese government bureaucrats indicated in the literature. Our paper makes an important contribution to the e-government literature by calling for the need for new research on DIs in government and by examining the case of Indonesia's DIs for its national nuclear energy policy transparency. However, our research has some limitations which include our exclusive focus on BATAN without our attention to inter-agency information sharing across other key government agencies involved in the nuclear energy ecosystems such as BAPETEN. Our future research directions include conducting multi-site case study research.

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