Journal of Theoretical and Applied Information Technology
31st August 2019. Vol.97. No 16

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

GREEN INFORMATION TECHNOLOGY GOVERNMENT REGULATION COMPONENTS: IMPROVING INDONESIA GREEN INFORMATION TECHNOLOGY

[1]HUDIARTO SUKARMAN, [2]NURIL KUSUMAWARDANI SOEPRAPTO PUTRI,[3]CAROLYN HONG GUI QING

[1]Mr., Information Systems Department, School of Information Systems, Bina Nusantara University, Jakarta, Indonesia 11480

[2]Mrs., Information Systems Department, School of Information Systems, Bina Nusantara University, Jakarta, Indonesia 11480

[3]Ms., Information Systems Department, School of Information Systems, Bina Nusantara University, Jakarta, Indonesia 11480

E-mail: [1] Hudiarto@binus.edu, [2]nuril.kusumawardani@binus.edu, [3]carolyn.ging@binus.ac.id

ABSTRACT

Information and communication technology (ICT) becomes one of the key drivers of economic growth and competitiveness. In contrary, the increasing of the ICT usage is not followed by the increasing of the green ICT awareness and behavior. Our previous research on Private higher education institution practice of green information technology governance model had resulted some obstruction on the implementation. One of the most crucial aspect among others is the government policies and regulations deficiencies. Hence, this study describes as well as proposes green IT government regulation components which can be regulated by Indonesia's government. 6(six) green IT government regulation components (green knowledge, regulatory design, regulation dimensions, directive cost, awareness and innovation/technology) were categorized based on literature review.

Keywords: *Green Computing, Green Information Technology, Green Information Technology Government, Government Regulation)*

1. INTRODUCTION

The digital era emergence has transform the society way of living and doing business, primarily on the education sector. Kvavik [1] discover where "net generation students" would demand daily teaching and learning activities involving the most recent technology. As they easily became outdated, they anticipate to engage to the current technologies. It is supported by the fact that university now days, need to utilize technological advances to improve the quality of teaching and learning system as well as the campus management. It is included the infrastructure, curriculum, facilities, services and technology-based learning activities [2].

Various technologies for different usefulness, have been used simultaneously depend on its activities. Students found laptop useful for typing notes, desktop convenient for browsing and the tablet technology supports their designing and sketching activities [3]. On the other hand, in order to propose students affordable tuition fees, education institutions is required to reduce daily operational cost. On the other hand, the issue of global warming as well as the fossil-fuel emissions impacts have rised at the summit of global public policy agenda have raised to the top of global public policy agenda. It results, business and consumers prefer the low-carbon solution which can diminish the amount of global Greenhouse Gas (GHG) as their environment friendly products, achieve efficient energy consumption and lower costs [4]. The ultimate response toward this issue is the establishment of Green Information Technology governance model which serves for private higher education institution, especially in DKI Jakarta fig. 1 [5]. Green IT also known as green computing is a proceeding concept towards the reduction usage of computers and electronical products which results in harmful impacts, also the diminishment of hazardous material [6].

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

During the green IT governance model application for private higher education institution in DKI Jakarta, Indonesia, some limitations have been identified. As a private institution, university owners impel to assume that the eco-friendly technology adoption is costly. It is also supported by Nguyen, Phan, Cao, & Nguyen [7], who stated that high cost is the most relevant barrier to procure the eco-friendly products. In fact, a majority of Indonesia's private universities, utilize small to middle scale data center in contrast to state universities who acquire data center in large scale. Therefore, green information technology is not the main concern. As the fourth biggest population nation worldwide according to Worldometers [8], Indonesia has 4.637 higher educations in the presence, while there are 4.217 private institutions [9]. Despite of having these huge numbers, none intend to developed Green Information Technology Information system or Information Technology for strategic nor eco-friendly usage due to the insufficient government policies and regulations [5].

Hence, the research question of this paper asserts "what are the regulation components needed in green it government regulation". Several components ought to be encompassed in order to formulate the green information technology policy which can utilized on indonesia's higher education and other institutions.theoretical framework

2. GREEN INFORMATION TECHNOLOGY

According to Abenius [10], green information technology can be described as when a company/organization/person looks at possible areas in society where information technology related work can be used to reduce the carbon dioxide emissions. The use of information technology makes the human life easier, on the other hand it also pollutes the environment through the electronic junk of obsolete hardware and Greenhouse Gas (GHG) emission though its electricity consumption. The four main components of IT infrastructure that support the reduction of Greenhouse Gas (GHG): (1) Efficient use of hardware and eco-friendly disposal, (2) Development of Green Software, (3) Green Data Center and data storage, and (4) Green IT personal [11]. According to Kazandjieva, Heller, Omprakash, Hofer, & Kozyrakis [12], the hardware efficiency is more important than software regarding both energy and economic perspective. They tended to propose the replacement of desktop PC into laptop as it is can meet user workloads at a lower energy cost.

Green IT goals can be concluded into 5(five): (1) To diminish consuming power of the products, (2) To reduce harmful effects to the environments through the use of hazardous material, (3) to prolong the product life time, (4) To expand energy efficiency of product's lifetime, (5) To advertise defunct products and factory waste recyclability [13].

2.1 Green IT component

2.1.1 Green hardware

In order to determine the energy consumption of green computing, it is essential to demands for the existence of a physical object that connects to network and act as a mediator within the virtual environment. Green hardware are describe as a modern operating system put into a machine to interact with their associate- which is the software [12]. Many literature review gathered refers to a constructive statement, hardware is not a prioritized component in energy consumption attempt. According to Kazandjieva[12], he suggested the replacement of desktop usage with laptop in return, aside from cost redu0063tion, it saves computing energy and increases efficiency. He strongly believes choosing the right operation system for hardware is far more consistent and efficient instead of software. Laptop is the ultimate solution as it significantly save more energy than any software technique [14]. Alternatives for green computing efforts suggest virtual data centers, restructuring management, remote computer administration, designing energy efficient chips, disks, and drives. Reducing personal computer usage whereas thin clients take place as an optimized remote lightweight computer in which server does most of the work [15]. The proposed framework impact toward the green information technology comparatively consist of the back level, middle level, and front level. The back level constitutes servers, cooling system, and IT infrastructure. The middle level constitutes with networking and communication system within the connection node. Thus, the front level embodies internet users who interacts through internet environment. The proposed framework advocates the adoption of green IT solutions for economical, environmental and sustainable digital world [11].

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

2.1.2 Green software

The importance of green computing along the emerging computing system have to take into account, so energy conservation strategy could maintain eco friendly impact toward human environment. Various approaches to computing energy conservation are mentioned as the sleep mode function, turning off computer, using energy star hardware such as laptops desktops, printers and other computing devices, hibernate, turning off the computer and its brightness and lastly stop informal disposals. Using LCD screen instead of CRT(Cathode Ray Tube) screen, recycling old hardware are some other attempt to green computing [6]. Pursuant to Abenius' s remark [10], testing applied on the program instructed by computer system or known as software is a leading potential to determine the green concept sustainability. Three software grouping action induces holistic approach of increasing speed outflow to search in internet, monitoring energy tools to visualize power consumption as well as the estimation energy saving and accelerate invention done by optimizing algorithm of decision processes [16]. These three different green software intend to improve efficiency of the decision process in internet searching. Gas emission can be reduced and minimize internet traffic load to the minimum, thanks to 3 existing tools as green software ready to monitoring and measuring energy use and increase speed usage.

Siebra and other authors highlight the emphasis of software design and development is essential to the power dissipation of computational system [17]. The lack of software data demands collection of software data consumption, so it could assist in designing and developing the best energy efficient algorithm [14]. Acknowledgement of software energy causes Hindle's generalizability relative to OS version, application version, environment, various hardware category and deficiency of researches data arise concern to increase essence of software energy consumption knowledge [14].The best deployment to conserve computing energy with the involvement of Litegreen and sleep server software. Litegreen is a VM software purposely to save desktop energy by virtualizing user's into a virtual environment. Sleepserver known as a software-only approach for PC's energy consumption diminution within enterprise environments [12].

2.1.3 Green data center

Green IT framework proposes green IT initiative awareness, advances hardware and improved software contributes to the energy efficiency. The suitable approaches aid enterprise to build up the data center as it is the central network house where daily operation responsible for storing, managing and disseminating data. Green data center ensure energy saving, CO2 emission reduction, and ultimately diminish global warming effects. In order to construct green data center, energy saving features and environment friendly materials blending in the ecosystem requires the software technologies to shrink data capacity demands, energy efficient computing infrastructure, and optimization through engineered physical plant [18]. Using virtualization method, data center components are categorized based on the workload executed ability, so the green metrics can be measured through their performance and power consumption efficiency to find the data center total consumption. Green data center components comprise server, networking and IT devices such as storage, cooling tower, generator, power distribution units, batteries, pumps, lighting and etcetera [13]. Nevertheless, the lack of appropriate metrics substitution to determine the green measurement embodies of data center efficiency & productivity and power consumption efficiency. The three broad measure outline for greening data center, including (1) energy conservation using high density server as hydrogen are used as fuel cells, (2) eco-friendly design focuses on sustainable site development, material selection, natural light such as solar or wind energy to run the electricity and etc [19]. Virtualization being the critical strategy by strengthening data center infrastructure: using several virtual servers and simplifying computing energy [20]. Furthermore, data center sustainability improvement by Pazowski [15]. advises the best greening practice in the key areas of cooling system, building infrastructure design, ICT platform consisting virtual technologies and middleware linkage, deployment of new power efficient server & processors, and energy linking between data centers. The final results show the advantages of better system reliability, lower cost of ownership, maximize hardware and software utilization, increases business and environment sustainability, and mostly reduces the global warming effect [18].

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

2.1.4 Electronic waste

Based on Bhoi & Shah's perspective, they described electronic waste as an old, life ending electrical appliance [21]. As Singh & Gautam [22]assert e-waste, the overall type of electrical and electronic equipment which in general term comprises TV, computer, refrigerator, washing machine, dryer, and almost any electrical household appliances. Moreover, e-waste differentiates into urban and industrial waste in either chemical and physical state. E-waste categories splitting into large or small household appliance, IT and communication equipment, lighting or consumer equipment, medical devices, monitoring and control instrument and many more [23]. Due to the technology growth and internet connectivity expansion, municipal waste comparatively contains toxic components that threaten environment, for instance, hazardous material found in computing appliance such as computer, and television embodies lead, mercury, and cadmium [24]. E-waste involuntarily harm human health and living being welfare as the environment impact to immense measure [20], [21]. All the projected growth of e-waste production and consumption alongside with GDP (Gross domestic product) indicate the raising of unmanaged and unprocessed e-wastes. There are several methods currently implied which is landfill, incineration, and acid baths [25]. Landfill is the dump site where e-waste is thrown to spread poisonous acid that reaches to human habitats in counts of certain time period. While incineration is the pyrolysis heating of substance in the absence of oxygen and convert them into fumes, oil and gas. Lastly, acid baths are solution method which extract copper, gold and silver by dissolving the waste substance.

However, from most of the case study and practices applied, the most recommended resolution prefers recycling method. Shah Alam in Selangor, Malaysia applied e-waste disposal practices of sending waste to recycle center, disassembled to use, donation, given to scrap collector, thrown away, sell as second-handed equipment or store in on premise [26]. In addition, some countries ran recycling method by free of charge in Swiss or charged with fees as in Japan, in the recycling facilities e-waste are shredded and sort based on the type of materials. Most of the recycled materials deliver to refineries or electrical industries for recovery and reused on new products, hence, the remaining will goes to the incinerator as small percentage goes to landfill [23]. Recycling is the ultimate conservation solution as it maximize reuse of materials and minimize cost [15]- a fastest growing waste production.

2.1.5 Paperless

Arising waves of technologies and communication tools, paperless is recommended to sustain environment and adapted to greening concept. Paperless simply means decreasing usage of paper and refer to other material. According to the revolution of information & technology, the authors encourage immediate paperless office indicating a friendly changing in company or industries [27]. The predominate of digitalization doesn't influence the substitution of paper usage, instead of wood sheets consumption increases due to the fact that paper act as a medium in exchanging human collaboration in work. There are tons of reasons to rush paperless strategy, because electronic device offers easy storage of documents with unlimited range, time saving as people can searches and retrieve documents in split seconds, digital document management system can ensure better security, email efficiency, simple accessibility and many more [28]. Future computers trends in green computing [4] demands efficient practice of sustainability relies on hardware, software and also material used in daily business productivities. As company perceives paperless is beneficial in the way or cost reduction, boosting efficiency and effectiveness, and optimization in many aspects. However, there are obstacles such as the lack of proper training of IT personnel, system error, poor connectivity, cultural barriers for both organization & users, technical and integration difficulties which hinder the success of paperless strategic project [29]. As it requires extensive time, habitual changes and high consciousness of the willingness to sustainability transformation.

2.3 Green Information Technology Governance Model and Electronic Waste Handling within Private Institutions of Higher Education and Information Technology

The green IT governance model for Private Institution of Higher Educations in DKI Jakarta utilize push and pull paradigms. Considering the adoption from Material Resource Planning (MPR) system in manufacturing industry, push model relies on material element such as: printing-paperless, reuse-recycle and rules policy in green IT governance model for Private Institution of Higher Education. Higher education institution may transform its materials into "green" material by lessening the paper usage, perpetual cycle of

Journal of Theoretical and Applied Information Technology
31st August 2019. Vol.97. No 16

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

reusing and recycling its IT equipment and establishing rules and policies according to green IT purpose. Thus, top-down (centralization-decentralization) strategy are used toward this paradigm. Whereas pull model adopted from Just In Time (JIT) system in the manufacturing industry. Pull model in this context, depends on the data center elements which lean on 3(three) variety of efficiency technique. The types of efficiency technique (IT efficiency technique, facility efficiency technique and integration efficiency technique) may be adapted separately or simultaneously, to achieve best result. However, bottom-up strategy (decentralization-centralization) is being used to support pull model [30].

In furtherance of identifying and enhancing the implementation of green IT for Private Higher Education Institutions in DKI Jakarta area, they need to evaluate current green IT performances using capability maturity level.

Fig. 1 shows Green IT Governance Model for Private Institution of Higher Education. The Green IT Governance Model is a visualization of two types of activity, where the activities are based on the strategy and the target they want to achieve. Green color varies to red color of the block determines the maturity level, i.e., Optimizing (green color).

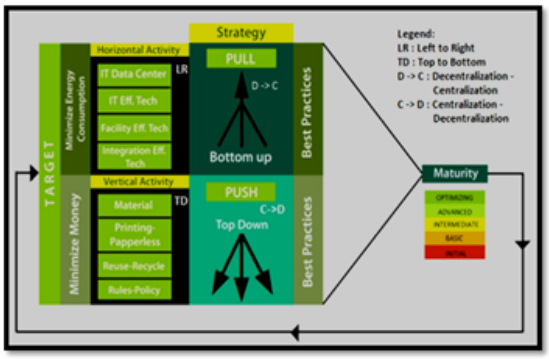

Figure 1: Green IT Governance Model for Private Institution of Higher Education [30].

There are 6(six) methods proposed in e-waste model for private institution of higher education model (avoid/preventive, reduce/minimization, reuse/repairing/cannibalism, disposal, incineration and landfill). The green indicators are best or favored option for electronic waste handling method, while the red indications are becoming the worst or last option for electronic waste handling method. However, based on the evaluation result, universities tend to practice avoid/preventive, reduce/minimization and reuse/repairing/cannibalism for their electronic waste. It is proven to be environmentally friendly by maximizing the use of materials. Meanwhile, disposal, incineration and landfill are poorly to fairly implemented in the university. As it is shown in figure 2, the toxin and hazard have become the outcome of the processes. Therefore, many universities tend to avoid this method due to the high risk of the impact [5].

Fig. 2 displays the E-Waste Model for Private Institution of Higher Education, in which it differs from the best/most favored option to the last/worst option.

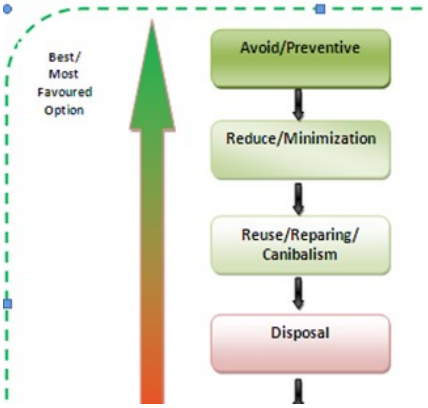

Figure 2: E-Waste Model for Private Higher Education Institution [5].

3. METHOD

This work was based on literature analysis and study from various research articles in green information technology or green computing area, regarding green hardware, green software, green data center, electronic waste and paperless method using. By doing literature analysis, reference study are taken comprehensively to collect relevant and valid information and knowledge to support this research. Combined with previous research on green IT governance model and electronic waste handling for private higher education institution in DKI Jakarta, Indonesia and standardize Indonesia's government laws and regulation rules, we found several components to form green information technology regulation.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

4. INDONESIA'S GOVERNMENT, LAWS AND REGULATION MAKERS OVERVIEW

4.1 Central and Regional Government in Indonesia

As stated in the Republic of Indonesia's law number 32 of 2004, Central government is headed by the President and Vice President and assisted by the Ministers(executive chamber) organize the government of the Unitary State of the Republic of Indonesia (NKRI). For the legislative chambers include House of Representatives (DPR) , the Regional Representative Council (DPD), and the People's Consultative Assembly (MPR). While Judicial institution consist of the Supreme Court (MA), the Constitutional Court (MK) and the Judicial Commission (KY). In the mean time, the Regional Government is a government regulator of the regions related government affair conforming to the expansive possible autonomy and assistance principle within the NKRI system. Regional Government Organizer comprise of Governor, Regent, Mayor and other apparatus (Head of Office, Head of Agency, and another work units sorted by the Regional Secretary). Nevertheless, Assembly at Provincial I (DPRD I) provincial level is detected as the legislative chamber, while Assembly at Provincial II (DPRD II) settled for district and mayor level [31].

4.2 Central and Regional Government in Indonesia

In general, the regulation varies into two sections : (1) Central level regulation and (2) local level regulations. The Central Regulation elaborated as a drafted rule established by the central government. The established of Central Regulations apply to all Indonesian citizens. E.g. 1945 Constitution of the Republic of Indonesia (UUD 1045), Presidential Decree, and MPR Decree. While the local regulations made by the Regional Government only applies to certain areas.

Moreover, there are 7(seven) constitutional level in Indonesia, comprise of : (1) 1945 Constitution of the Republic of Indonesia (UUD 1945), (2) The People's Consultative Assembly Decree (MPR Tap), (3) Law (Act) or Government Regulation in Lieu of Law (Perppu), (4) Government Regulation (PP), (5) Presidential Regulation (Perpres), (6) Provincial Regional Regulation, and (7) District Regional Regulation. The Center for Statistical and Information Data (Pusdatin) is an echelon-level work unit, a constituent supporting the Ministry's data and information duties, and under the responsibility to the Minister, taking account through the Secretary General and led by a leader. The work unit task is to carry out statistical management, in addition of analysis and dissemination of information, as well as the Information System/ Information Technology and data banks development. Pusdatin possess a crucial strategic role and function for the Ministry. Therefore, Pusdatin should perpetually optimized its performance based on the demands and needs of the Ministry to enhance decision-making quality.

5. DISCUSSION

5.1 Green Information Technology Government Regulation Components

5.1.1 Green data center

Not everyone has adequate knowledge on green IT. Green IT policy will not be implemented accordingly without sufficient Green IT knowledge. Based on our prior research on green IT governance model and e-waste handling model, several elements of green knowledge have been concluded into 5 elements, there are: (a) Green Hardware, (b) Green Software, (c) Green Data Center, (d) E-Waste, and (e) Paperless.

These elements conjoining with awareness of active human will generate successful implementation of green computing project. As the fundamental foundation overall , lies on the understanding of green computing itself and the requirements of resources needed to apply. In green software, the programmers of the future will be handling the requirement and designing software with sustainable energy efficiency. They will not only depend on education, instruction and training, they also must build disposal powerful models and tools that are integrated into their development environment [14].

5.1.2 Regulation design

A good regulatory design will give impact to the implementation. The regulation design adopted from the Indonesia's Ministries regulation structure. The design component itself consists of: (a) General Requirements, (b) Scope, (c) Implementation, (d) CA good regulatory design will give impact to the implementation. The regulation design adopted from the Indonesia's Ministries regulation structure. The design component itself consists of: (a) General Requirements, (b) Scope, (c) Implementation, (d) Control and Monitoring, (e) Reporting, (f) Reward

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

and Punishment, and (g) Authority of Central and Local Government control and Monitoring, (e) Reporting, (f) Reward and Punishment, and (g) Authority of Central and Local Government.

5.1.3 Regulation dimension

Regulatory dimensions are the measurement conditions in regulation itself. It is formulated from the purpose of the green IT governance model for private institution of higher education Fig. 1. The Green IT regulation dimension consists of: Energy Consumption and Material Consumption. Without any proper measurement, regulation cannot be measured. Improvement can never be measured with certainty. Understanding of automatic regulation will not be implicitly implied - but must be explicitly stated. The absence of a regulatory dimension will make it difficult to understand.

5.1.4 Directive Cost

Regulation always has amount of cost consequences. The regulation costs that arise consist of: (a) Training / Education, (b) Change Management, (c) Communication, (d) Integrated Ways of Working (Business Process), (e) Green SOP, (f) Green Policy, (g) Green Best Practices, and (h) Audience Size. Limitations in terms of costs will interfere the delivery of regulation to all business lines.

5.1.5 Awareness

Attitudes to disregard, not paying attention to, and ignore regulations can occur - whether individually, an assembly of people, or organizations - in the Green IT framework, it means: (a) Central Government / Ministry, (b) Local Government, (c) Company / Industry, and (d) Household / Community. Awareness about tasks, roles and relationships. Awareness is also related to personal, emotional and needs.

5.1.6 Innovation/Technology

The Green IT Regulation will have an impact on the implementation of technology as an embodiment of innovation. Technology arises due to the regulation of Green IT: (a) Waste B3, (b) Recycling, (c) Renewable Energy, and (d) Electronic Document

The Green IT government regulation components are shown in Table 1 along with its sub-components, outline, and its sources.

Table 1: Green Information Technology Government Regulation Components

Components	Sub-Components	Outline	Source
Green Knowledge	Green Hardware	Product outputs that do not contribute to any potential environmental damage and contain of eco-friendly components which are safe for health.	[11], [12], [14], [15]
	Green Software	Green software plays an important role for system operation efficiency – one of its roles is for energy management.	[4], [6], [10]–[12], [14], [17]
	Green Data Center	The data center should be environmentally friendly-energy efficient.	[11], [13], [15], [18], [20]
	Electronic Waste	Outdated electronic devices, malfunction or broken devices that are no longer can be used.	[10], [15], [18], [20]–[26], [32], [33]
	Paperless	Initiative to reduce the amount of paper usage.	[4], [27]–[29], [34]
Regulation Design	General Requirements	General requirement and definitions	[35]
	Scope	Scope	[36], [37]
	Implement	Implementatio	[35]

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

	ation	n	
	Control and Monitoring	Control and monitoring	[19], [29], [38]
	Reporting	Reporting	[19], [38]
	Reward and Punishing Central and Local Governmen t Authority	Reward and Punishment Central and local government authority	[36], [38], [39]
Regulation Dimension	Energy Consumpti on	The amount of energy usage for doing activity.	[13], [14], [17], [20], [40], [41]
	Material Consumpti on	The amount of material usage for doing activity.	[18], [20], [23], [25]–[28], [32], [40], [41]
Directive Cost	Training/E ducation	Providing training/educa tion or knowledge transfer.	[19], [24], [29], [38], [42]
	Change Manageme nt	Effort taken due to any changes in the organization.	[14], [43], [44]
	Communic ation	Using information to connect within each other.	[38]
	Integrated Ways of Working (Business Process)	Ways to cooperate to achieve target.	[16], [44]–[46]
	Green SOP	Instruction phase for standardize operational activity.	[37], [38], [41], [46]
	Green Policy	Policy guidelines	[42]

	Green Best Practices	The efficiency and effectivity ways to do work based on best practices	[13], [27], [32], [39]
	Audience Size	The amount of knowledge sharing audience.	[35], [47]
Awareness	Central Governmen t/Ministries	Government organizer	[19], [24]–[26], [32], [48]
	Local Governmen t	Implementatio n of government affairs by the Regional Government and the Regional House of Representative s.	[19], [24]–[26], [32]
	Companies /Industries	A group of organization.	[19], [24], [26], [32], [48], [49]
	Societies	A group of individual.	[19], [24], [26], [32]
Innovation/ Technology	B3 Waste	Waste of hazardous and toxic materials.	[4], [18], [21], [32], [41]
	Recycling	The process of converting used materials into new materials with the aim of preventing the garbage existence.	[4], [10], [15], [18], [22]–[24], [26], [32], [41], [42]
	Renewable Energy	Energy that is disproportiona te / will not run out in nature.	[4], [11], [15], [21]

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

	Electronic Document	Electronic information in the digital format.	[27]–[29], [34], [49]–[51]

6. LIMITATION AND FURTHER RESEARCH

Given that the scope of this research is at the level of the Private Institution of Higher Education located in the DKI Jakarta, Indonesia, there are some limitations found in the regulation formulation that can be used in a general and comprehensive manner in Indonesia. These limitations deal with the research scope that has not involved State Universities, Institutions and Agency in the Government or SOEs, private companies both large and medium, which use Information Technology (IT) massively. The IT governance that already developed should be expanded to include other organizations. The results of this study still need to be studied further by expertise on this area.

7. CONCLUSION REMARKS

The Information Technology (IT) governance model for Private institution of higher education institution located in DKI Jakarta, Indonesia, has been successfully developed. However, various obstacles in its implementation have led to the need for further research related to regulations and legislation. Therefore, the implementation of green IT can be carried out wholeheartedly by users. Without this kind of legal umbrella, there will still be doubts and reluctance from IT users to implement good governance. If research can be extended to more diverse bodies, agencies or organizations, the governance model is expected to be applicable. Thus, the proposed regulation will be more towards national goals, namely energy savings, e-waste reduction and increased awareness of healthy IT use.

Green IT government regulation component research are useful in long term further studies as there is no Green IT regulation carried out by Indonesian government in the present. Through this deliberate research, this paper offers the introduction and discovery of green IT regulation components which include green knowledge, regulation design, regulation dimension, directive cost, awareness and lastly Innovation/technology.

REFERENCES:

[1] R.B. Kvavik, “Convenience, Communications, and Control: How Students Use Technology.” [Online]. Available: https://www.educause.edu/research-and-publications/books/educating-net-generation/convenience-communications-and-control-how-students-use-technology. [Accessed: 15-Mar-2019].

[2] A. A. Putri S., “Penting... Perguruan Tinggi Wajib Melek Teknologi!,” 04-Jan-2016. [Online]. Available: https://edukasi.kompas.com/read/2016/01/04/07030081/Penting.Perguruan.Tinggi.Wajib.Melek.Teknologi. [Accessed: 12-Jun-2019].

[3] K. eun Oh and J. Gwizdka, “Impatient opportunists: a study of technology use in a higher education classroom,” *J. Appl. Res. High. Educ.*, vol. 3, no. 2, pp. 81–96, Sep. 2011.

[4] G. Jindal and M. Gupta, “Green Computing " Future of Computers ",” *Int. J. Emerg. Res. Manag. Technol.*, pp. 14–18, 2012.

[5] H. Sukarman and N. K. Soeprapto Putri, “Green Information Technology Policy in Indonesia,” in *2018 International Conference on Information Management and Technology (ICIMTech)*, Jakarta, 2018, pp. 309–314.

[6] D. P. Mittal and N. Kaur, “Green Computing – Need and Implementation,” vol. 2, no. 3, p. 4, 2013.

[7] T. N. Nguyen, T. T. H. Phan, T. K. Cao, and H. V. Nguyen, “Green purchase behavior: mitigating barriers in developing countries,” *Strateg. Dir.*, vol. 33, no. 8, pp. 4–6, Aug. 2017.

[8] “Population by Country (2019) - Worldometers.” [Online]. Available: https://www.worldometers.info/world-population/population-by-country/.

[9] “SRV4 PDDIKTI : Pangkalan Data Pendidikan Tinggi.” [Online]. Available: https://forlap.ristekdikti.go.id/perguruantinggi/homegraphpt. [Accessed: 12-Jun-2019].

[10] S. Abenius, “Green IT & Green Software - Time and Energy Savings Using Existing Tools,” p. 10, 2009.

[11] A. K. Bhardwaj and Y. Gajpal, “Green Information System Framework: A Step towards Sustainable Information Technology,” p. 10, 2016.

[12] M. Kazandjieva, B. Heller, O. Gnawali, W. Hofer, P. Levis, and C. Kozyrakis, “Software

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

or Hardware: The Future of Green Enterprise Computing," p. 13.

[13] S. Patodi, R. Sharma, and A. Solanki, "Green Computing: Driving Economic and Environmental Conditions," vol. 6, p. 3, 2015.

[14] A. Hindle, "Green software engineering: the curse of methodology," 2016.

[15] P. Pazowski and M. C. Sk, "GREEN COMPUTING: LATEST PRACTICES AND TECHNOLOGIES FOR ICT SUSTAINABILITY," p. 8, 2015.

[16] A. Rugman and R. Hodgetts, "The end of global strategy," *Eur. Manag. J.*, vol. 19, no. 4, pp. 333–343, Aug. 2001.

[17] C. Siebra, P. Costa, F. Q. B. da Silva, A. L. M. Santos, and A. Mascaro, "The hardware and software aspects of energy consumption in the mobile development platform," *Int. J. Pervasive Comput. Commun.*, vol. 9, no. 2, pp. 139–162, Jun. 2013.

[18] Mueen Uddin, "Green Information Technology (IT) framework for energy efficient data centers using virtualization," *Int. J. Phys. Sci.*, vol. 7, no. 13, Mar. 2012.

[19] A. Di Vaio and L. Varriale, "Management Innovation for Environmental Sustainability in Seaports: Managerial Accounting Instruments and Training for Competitive Green Ports beyond the Regulations," *Sustainability*, vol. 10, no. 3, p. 783, Mar. 2018.

[20] B. Saha, "Green Computing," *Int. J. Comput. Trends Technol. IJCTT*, vol. 14, no. 2, 2014.

[21] V. N. Bhoi and T. Shah, "E-Waste: A New Environmental Challenge," *Int. J. Adv. Res. Comput. Sci. Softw. Eng.*, p. 6, 2014.

[22] A. Singh and A. K. Gautam, "Study and Comparison of E-waste Disposal Solutions," vol. 4, no. 5, p. 4, 2014.

[23] G. Gaidajis, D. Aktsoglou, K. Angelakoglou, Department of Production Engineering and Management, School of Engineering, Democritus University of Thrace, 67100, Xanthi, Greece, D. Aktsoglou, and Department of Production Engineering and Management, School of Engineering, Democritus University of Thrace, 67100, Xanthi, Greece, "E-waste: Environmental Problems and Current Management," *J. Eng. Sci. Technol. Rev.*, vol. 3, no. 1, pp. 193–199, Jun. 2010.

[24] M. K. S. Bhutta, A. Omar, and X. Yang, "Electronic Waste: A Growing Concern in Today's Environment," *Econ. Res. Int.*, vol. 2011, pp. 1–8, 2011.

[25] S. Sivaramanan, "E-Waste Management, Disposal and Its Impacts on the Environment," p. 7, 2013.

[26] J. A. Kalana, "Electrical and Electronic Waste Management Practice by households in Shah Alam, Selangor, Malaysia," vol. 1, no. 2, p. 13, 2010.

[27] S.-D. Orantes-Jiménez, A. Zavala-Galindo, and G. Vázquez-Álvarez, "Paperless Office: a new proposal for organizations," vol. 13, no. 3, p. 9, 2015.

[28] U. Sandhu and R. Seth, "Paperless Office: A New Name to Technology," vol. 4, no. 2, p. 3, 2014.

[29] Faculty of Business and Management Sciences, Cape Peninsula University of Technology, South Africa *et al.*, "The influence of a paperless office environment on the sustainability of the Master of the High Court in Cape Town," *Environ. Econ.*, vol. 7, no. 3, pp. 33–44, Oct. 2016.

[30] N. K. S. Putri, Hudiarto, Argogalih, and H. Muljoredjo, "THE USE OF GREEN INFORMATION TECHNOLOGY GOVERNANCE MODEL TO DETERMINE CAPABILITY MATURITY LEVEL IN DKI JAKARTA PRIVATE HIGHER EDUCATION INSTITUTIONS," *J. Theor. Appl. Inf. Technol.*, vol. 61, no. 1, p. 7, 2005.

[31] Government of Indonesia, "UNDANG-UNDANG REPUBLIK INDONESIA NOMOR 32 TAHUN 2004 TENTANG PEMERINTAHAN DAERAH."

[32] A. Shamim and A. M. K, "E-Waste Trading Impact on Public Health and Ecosystem Services in Developing Countries," *Int. J. Waste Resour.*, vol. 05, no. 04, 2015.

[33] V. Pinto, "E-waste hazard: The impending challenge," *Indian J. Occup. Environ. Med.*, vol. 12, no. 2, p. 65, 2008.

[34] J. Runnels and A. Rutson-Griffiths, "Tablet PCs in a paperless classroom: Student and teacher perceptions on screen size," p. 11.

[35] G. Elliehausen and B. R. Lowrey, "The Costs of Implementing Regulatory Changes: The Truth in Savings Act," p. 15, 2000.

[36] L. A. Stewart, "The Impact of Regulation on Innovation in the United States: A Cross-Industry Literature Review," p. 29, 2010.

[37] Y. Xue *et al.*, "Full Scope-of-Practice Regulation Is Associated With Higher Supply of Nurse Practitioners in Rural and Primary Care Health Professional Shortage Counties," *J. Nurs. Regul.*, vol. 8, no. 4, pp. 5–13, Jan. 2018.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[38] D. B. András, "Compliance Management – a new response to legal and business challenges," *Acta Polytech. Hung.*, vol. 9, no. 3, p. 14, 2012.
[39] A. Shleifer, "Understanding Regulation," *Eur. Financ. Manag.*, vol. 11, no. 4, pp. 439–451, Sep. 2005.
[40] D. I. Lakshmi and G. D. DhanaLakshmi, "A Study on Green Computing: Go Green and Save Energy," p. 10, 2015.
[41] R. Joshi and S. Ahmed, "Status and challenges of municipal solid waste management in India: A review," *Cogent Environ. Sci.*, vol. 2, no. 1, Feb. 2016.
[42] S. Ahmad, "Green Human Resource Management: Policies and practices," *Cogent Bus. Manag.*, vol. 2, no. 1, Apr. 2015.
[43] D. Loorbach, "Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework," *Governance*, vol. 23, no. 1, pp. 161–183, Jan. 2010.
[44] J. H. Pieterse, M. C. J. Caniëls, and T. Homan, "Professional discourses and resistance to change," *J. Organ. Change Manag.*, vol. 25, no. 6, pp. 798–818, Oct. 2012.
[45] I. C. Mell, "Can you tell a green field from a cold steel rail? Examining the 'green' of Green Infrastructure development," *Local Environ.*, vol. 18, no. 2, pp. 152–166, Feb. 2013.
[46] J. Balogun and V. H. Hailey, *Exploring Strategic Change*, Third. Prentice-Hall, 2008.
[47] I. A. Diugwu, D. L. Baba, and A. E. Egila, "Effective Regulation and Level of Awareness: An Exposé of the Nigeria's Construction Industry," *Open J. Saf. Sci. Technol.*, vol. 02, no. 04, pp. 140–146, 2012.
[48] I. Otieno and E. Omwenga, "E-Waste Management in Kenya: Challenges and Opportunities," vol. 6, no. 12, p. 6, 2015.
[49] D. U. Tiwari, T. D. Diwan, and N. Sahu, "SAVE GREEN, GO GREEN THROUGH PAPERLESS," vol. 03, no. 01, p. 7, 2017.
[50] M. Mason, "Get Ready, Get Set, Go…PAPERLESS!," p. 4.
[51] M. Prasanthi, "A STUDY ON E-DEVELOPMENT OF PAPERLESS MANAGEMENT," p. 4.