Building a Readiness Model of Environmentally Friendly Information Technology as Implementation of Green Information Technology Concept

Wahyu Sardjono[1*], *Achmad* Cholidin[2†], and *Johan*[3‡]

[1,3]Information Systems Department, School of Information Systems, Bina Nusantara University, Jakarta, Indonesia 11480
[2] Law Study Program, Faculty of Law, University of Muhammadiyah Jakarta, Indonesia

Abstract. Environmentally friendly Information Technology is a sustainable approach to information technology and information systems with practical methodologies in designing and implementing environmentally friendly information technology implementation strategies in various business and government organizations as well as strategic tools in building the contribution of these technologies in supporting all aspects of business activities in the organization and contributing environment so that it becomes more effective and efficient and builds competitive advantage. This includes effectively measuring sustainability, regarding the sustainable use and design of hardware and software, to promote efficiency and effectiveness in building a sustainable framework for the sustainability of information technology infrastructure. This study aims to build a model of Green information technology readiness**.** The research design is included in exploratory research, with a sample of 108 respondents and the sampling was done by non-probability convenience sampling. This research was conducted in Jakarta. The results showed that there are important factors that can be modeled mathematically through factor analysis which identifies the representation of Safe and comfortable, Smart public service, Excellent information, and Easy health care factors as the main factors in developing an elderly-friendly city model from the respondent's point of view.

1 Introduction

Environmental technology is a concept to achieve certain goals. Where in its implementation refers to environmental factors. Currently the development of technology is growing rapidly, starting in the fields of agriculture, large industry, and household-scale industries including information technology. Improper use of technology can cause environmental damage. The existence of this technology aims to provide convenience and fulfillment of human needs [1]. Environmentally friendly technology is technology that in its manufacture and application uses environmentally friendly raw materials. An effective and efficient process and removing minimal waste can reduce and prevent pollution or environmental damage. Environmentally friendly technologies must meet regulatory requirements [2]. In addition, it is efficient in the use of resources, be it water, energy, use of raw materials, and chemicals. In this study, an analysis of the factors that are considered important to explore community participation in urban development to realize Green Information Technology in Indonesia is carried out, so that a model can be obtained that can describe the current condition of Green Information Technology and can be simulated to predict adaptation conditions in the future.

2 Literature Review

An understanding of environmentally friendly information technology is information technology created to facilitate human life in supporting business activities or processes without having a negative impact on the surrounding environment, especially in the sustainability of organizations or corporations. Information technology in the context of such an implementation is expected to be able to make a real contribution and be able to protect the environment, as well as being able to function as a strategic tool in achieving organizational and corporate goals towards a sustainable competitive advantage [3].

There are 6 principles applied to the concept of environmentally friendly technology, namely:

1. Refine, which means using environmentally friendly materials and through processes that are safer than previous technologies.
2. Reduce, which means reducing the amount of waste by optimizing the use of materials.

* Corresponding author: wahyu.s@binus.ac.id
† Corresponding author: a_cholidin@yahoo.com
‡ Corresponding author: johanj@binus.edu

3. Reuse, which means reusing materials that are not used or have been in the form of waste and processed in different ways.
4. Recycle, which means almost the same as reuse, only recycle reuses materials or waste and is processed in the same way.
5. Recovery, which means the use of certain materials from waste to be processed for other purposes.
6. Retrieve Energy, which means saving energy in a production process.

2.1 Benefits of the Green Technology Concept

Technology that is friendly to the environment certainly provides enormous benefits for everyday life [4], including:

1. Environmentally friendly technology is very effective and efficient in terms of utilization of natural resources, so that the environment can be maintained properly.
2. Environmentally friendly technology can reduce the amount of waste so that it is not excessive, so that it can prevent environmental pollution.
3. Environmentally friendly technology reduces the risk of decreasing the health conditions of living things, especially humans.
4. Environmentally friendly technology can reduce production costs (saving) by utilizing natural resources as part of technology that is able to save costs. An example is the use of solar electricity which only relies on solar energy free of charge.

Technology has become a daily meal in this day and age, but the use of today's unlimited technology will lead to a scarcity of non-renewable technology sources. That's why scientists are working hard to create technologies that are both renewable and environmentally friendly [5]. Discussions related to environmentally friendly information technology include management aspects consisting of system procurement and Request For Proposals (RFP's), expense analysis and cost reduction, project management, green procurement design, and operation management, and then education aspects consisting of self training, employee awareness program, public awareness and outreach and supplier education program, end then design aspect consisting of strategic planning, business process engineering, IT infrastructure and system engineering, space planning for IT, and waste management process design. There are 6 principles applied to the concept of environmentally friendly technology [6]. Figure 1 shows the Green Information Technology development concept.

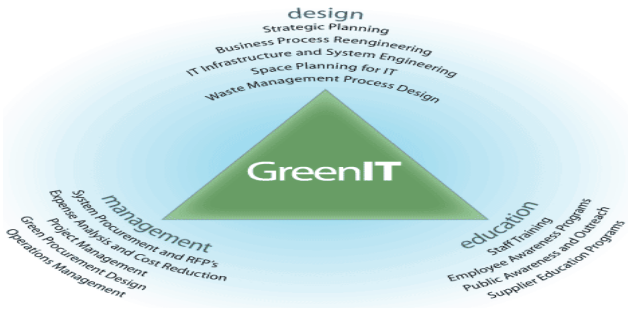

Fig. 1. The Green Information Technology development concept

The causal relationship between green technology innovation, energy consumption, renewable energy, population, income per capita, and carbon dioxide emissions is tested through a Granger causality test.

From the The Green Information Technology Development Concept, the research instrument was then developed by conducting further exploration of a number of existing factors, then looking for relevant indicators according to existing references, the results are outlined in Table 1.

Table 1. Development of Research Instrument

	Factor	Indicator	Ref.
The Green Information Technology Development Concept Age-Friendly Cities	Management (MAN)	Develop system procurement and RFP's (MAN1)	[7]
		expense analysis and cost reduction impl. (MAN2)	[8]
		project management controlling (MAN3)	[9]
		green procurement design (MAN4)	[10]
		operation management control (MAN5)	[11]
	Education (EDU)	self training development (EDU1)	[12]
		employee awareness program achievement (EDU2)	[13]
		public awareness and outreach achievement (EDU3)	[14]
		supplier education program dissemination (EDU4)	[15]
	Design (DES)	readiness strategic planning (DES1)	[16]
		IT infrastructure and system engineering availability (DES2)	[17]
		availability of space planning for IT (DES3)	[18]
		business process engineering implementation (DES4)	[19]
		waste management design strategic planning (DES5)	[20]

3 Methodology

The method used in processing the data is by using factor analysis. After going through the data collection stage using a questionnaire instrument, the next step is data analysis, and reducing a number of variables or indicators, which still contain most of the information contained in the variables. The factor analysis algorithm used is as follows:

1. Variable Testing. Assessing the feasibility of variables for inclusion in the subsequent analysis, using Kaiser Meyer Olkin (KMO) and measure of sampling adequacy (MSA). MSA number 0.5 indicates the variable cannot be analyzed further, or excluded, and vice versa.
2. Factoring with Maximum Likelihood Method.
3. Factor Rotation with Varimax Method, to facilitate interpretation of the formed factors.
4. Determine the Reproduced correlation matrix (Rr) and Residual Correlation Matrix.
5. Determine the Root Mean Square Residual (RMSR). To measure the level of goodness of the factors that have been formed, it can be determined by the RMSR.
6. Interpretation of Results. In this step, the naming of the formed factors is carried out and an interpretation of the goodness of the formed factors is carried out based on the RMSR value.

After forming a new variable, the analysis is continued by building a mathematical model through the regression process of the relationship between factor values for all the new variables formed. The result then is the formation of a mathematical model that can represent the elderly-friendly cities model with a number of supporting variables.

4 Results and Discussion

4.1 Reliability Test

The results of the reliability test with Cronbach's Alpha for a number of 128 respondents with 21 indicators obtained a value of 0.709 as seen in Table 2.

Table 2. Reliability statistics

Cronbach's Alpha	N of Items
.709	14

4.2 Validity Test

Validity test can be done with several approaches, one of which is construct validity. Construct validity is a test conducted to see whether the items in the research instrument are appropriate to measure the existing theoretical constructs. The KMO-MSA value of 0.809 was obtained in this study indicates that the data has been collected deserve to be factored. Table 3 shows the KMO and Bartlett's test.

Table 3. KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.827**
Bartlett's Test of Sphericity	Approx. Chi-Square	530.108
	df	91
	Sig.	.000

4.3 Result of Factor Analysis

In the process of factor analysis there is a reduction in the data where in the process is a process of filtering components that are suitable to be used as indicators that affect to the green information technology. The results obtained in this study after the factor analysis process was carried out with the help of IBM SPSS software. The following new factors and indicators formed from the results of factor analysis from this study, the rotated Component Matrix result, show on Table 4.

Table 4. Rotated Component Matrix

		Component	
	1	**2**	**3**
MAN1	.868		
MAN2	.811		
MAN3	.698		
EDU4	.530		
EDU2	.519		.501
MAN4			
EDU3			
DES5		.779	
DES3		.747	
DES4		.631	
MAN5		.549	
DES2			-.782
DES1			-.735
EDU1			.619

Table 5. Formed factor

No	Indicator	New Factor
1	develop system procurement and RFP's (MAN1)	friendly supply vhain
	expense analysis and cost reduction impl. (MAN2)	
	project management controlling (MAN3)	
	employee awareness program achievement (EDU2)	
	supplier education program dissemination (EDU4)	
2	availability of space planning for IT (DES3)	Smart IT cloud
	business process engineering implementation (DES4)	
	waste management design strategic planning (DES5)	
	operation management control (MAN5)	
3	readiness strategic planning (DES1)	future challenges
	IT infrastructure and system engineering availability (DES2)	
	self training development (EDU1)	
	employee awareness program achievement (EDU2)	

In Table 5. the first factor formed through the factor analysis process and represented by friendly supply chain. In this factor there are 5 indicators namely develop system procurement and RFP's, expense analysis and cost reduction impl., project management controlling, employee awareness program achievement, and supplier education program dissemination.

In Table 5. the second factor formed through the factor analysis process and represented by Smart IT Cloud. In this factor there are 4 indicators namely availability of space planning for IT, business process engineering implementation, waste management design strategic planning, and operation management control

In Table 5. the third factor formed through the factor analysis process and represented by Future challenges. In this factor there are 4 indicators namely readiness strategic planning, IT infrastructure and system engineering availability, self training development and employee awareness program achievement.

The equation that can be used as a formula that describes the green information technology.

$$\mathbf{Y = 6.324 + 0.086\ X_1 + 0.033\ X_2 - 0.075\ X_3}$$

With the constrain,

$$-2.552 \leq \mathbf{X_1} \leq 2.474$$
$$-2.684 \leq \mathbf{X_2} \leq 2.264$$
$$-2\ 138 \leq \mathbf{X_3} \leq 2.538$$

Based on the above model, the relationship model that can be used to evaluate as a formula that describes the green information technology as seen in Figure 2.

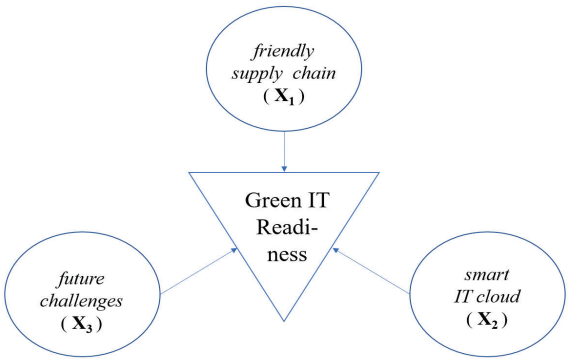

Fig. 2. Development model of Green Information Technology

The results of data processing from the distribution of the questionnaires that have been made obtained an average value of 6.324 (from a scale of 0.000 - 10.000), then from the formed model a simulation can be made to see the values that can be expected as improvements and values that are not expected and should be avoided by the school.

Table 6. Simulation Processed Result

Variable / Condition	Y	β_0	X_1	X_2	X_3
Normal	6.324	6.324	0	0	0
Unexpected	5.839	6.324	-2.552	-2.684	2.538
Expected	6.772	6.324	2.474	2.264	-2.138

Based on Table 6. the simulation results show several conditions that can be used as decision making for the green information technology in the future. Explanations related to these conditions are:

Normal conditions, meaning that the analysis value of green information technology in normal conditions is currently 6.324 (from a scale of 0.000 -10.000), where there is no addition or reduction in value because it can be considered that no research has been carried out. From the data, it can be seen that the current level of green information technology is visible.

Unexpected condition means there is no concern with green information technology so that the assessment decreases to the lowest value, in this condition it is considered a condition where ignorance of the system results in a decrease in overall system performance. The simulation results with the lowest number of 5.839 should be avoided by paying more attention to the factors causing the decline or public indifference to green information technology.

Expected condition mean achieving the highest score that can be done with maximum effort, where all new factors found can be optimized to achieve high performance so that the gap between the realization target and its achievement can be minimized. This value of 6.772 falls into the "Frequent" category so that if green information technology development is carried out in accordance with the decreasing defect, it can be used as the main worksheet in the dissemination process of green information technology.

5 Conclusion

Based on the results of the research and discussion that have been described in the previous section, the following conclusions can be drawn, the success of the green information technology in environmental conservation dissemination activities can be carried out by maintain the Safe and comfortable factor and the Smart public service factor, then increase the Excellent information factor, and the Easy health care factor.

Based on the results of the discussion and previous descriptions about the limitations of the study, there are several suggestions that need to be submitted as follows:

1. For the Ministry of Environment, cooperate with academics to immediately determine forms of the green information technology.
2. For academics, carry out further research related to the pattern of utilization of systems and information technology for environmentally friendly solutions in accordance with the concept of sustainable development.
3. For the local government, immediately make a policy on environmental management and preservation and continue with socialization activities for the green information technology.

References

[1] K. Alexandra, R. Eric, A. Karl, P. Jari, R. Andrei, and Z. Arkady, "An international

master's program in green IT as a contribution to sustainable development," *J. Clean. Prod.*, 2016.

[2] B. Cesar, C. Regina, and P. K. Risky, "Business: Experiential learning, information and communications technology, and risk-taking attitudes in entrepreneurship education," *Int. J. Manag. Educ.*, 2016.

[3] S. D. Harijanti, "The changing paradigm on governance: The case of Indonesia," *Int.J. Public Law Policy*, vol. 5, no. 1, pp. 77–91, 2015.

[4] T. Hwang and S. T. Kim, "The mode rating effects of eco-oriented organisational culture on the green practice-performance relationship," *Int. J. Serv. Sci.*, vol. 5, no. 1, pp. 74–94, 2013.

[5] M. Kumar, J. Raman, and Priya, "The effects of green policy on the performance of green supply chains," *Int. J. Integr. Supply Manag.*, vol. 10, no. 1, pp. 1–37, 2016.

[6] S. Makarechi and L. Yerushalmi, "Shades of green technologies identification of significant para meters affecting the Performance of green technologies in buildings," *Int. J. Environ. Policy Decis. Mak.*, vol. 1, no. 1, pp. 64–76, 2010.

[7] W. Sardjono, B. S. Laksmono, and E. Yuniastuti, "The social welfare factors of public transportation drivers with online application as a result of the 4.0 Industrial Revolution in transportation," *ICIC Express Lett.*, vol. 14, no. 14, pp. 361–368, 2020.

[8] A. Rai, X. Tang, and M. Keil, "Assimilation patterns in the use of electronic procurement innovations: A cluster analysis," *Inf. Manag.*, vol. 43, no. 3, pp. 336–349, 2006.

[9] A. N. Mishra, S. Devaraj, and G. Vaidyanathan, "Capability hierarchy in electronic procurement and procurement process performance: An empirical analysis," *J. Oper. Manag.*, vol. 31, no. 6, pp. 376–390, 2013.

[10] T. W. Y. Ann, S. K. Yevu, and G. Nani, "Towards an integration framework for promoting electronic procurement and sustainable procurement in the construction industry: A systematic literature review," *J. Clean. Prod.*, vol. 250, 2019.

[11] T. N. Cuong, "Hwan-Seong, K. and Sam-Sang Y., Container throughput analysis and seaport operation management using nonlinear control synthesis," *Appl. Math. Model.*, vol. 100, pp. 320–341, 2021.

[12] J. H. Hardy, E. A. Day, and W. Arthur, "Exploration-exploitation tradeoffs and information-knowledge gaps in self-regulated learning: Implications for learner-controlled training and development," *Hum. Resour. Manag. Rev.*, vol. 29, no. 2, pp. 196–217, 2018.

[13] K. Breuer and B. Eugster, "Effects of training and assessment in Vocational Education and Training (VET): Reflections on the methodology of assessing the development of traits of self-regulation," *Stud. Educ. Eval.*, vol. 32, no. 3, pp. 243–261, 2016.

[14] D. Patra, V. Chanse, and P. T. Leisnham, "Towards attaining green sustainability goals of cities through social transitions: Comparing stakeholders' knowledge and perceptions between two Chesapeake Bay watersheds, USA," *Sustain. Cities Soc.*, vol. 75, 2021.

[15] E. German and S. LeMire, "Sharing the value and impact of outreach: Taking a multifaceted approach to outreach assessment," *J. Acad. Librariansh.*, vol. 44, no. 1, pp. 66–74, 2017.

[16] Y. Feng, X. Wang, and Z. Liang, "How does environmental information disclosure affect economic development and haze pollution in Chinese cities? The mediating role of green technology innovation," *Sci. Total Environ.*, vol. 775, 2021.

[17] D. Mishra, I. Akman, and A. Mishra, "Theory of reasoned action application for Green Information Technology acceptance," *Comput. Hum. Behav.*, vol. 36, pp. 29–40, 2014.

[18] I. Akman and A. Mishra, "Sector diversity in Green Information," *Technol. Pract. Technol. Accept. Model Perspect.*, vol. 49, pp. 477–486, 2015.

[19] M. M. Luis, A. J. A. Cruz, and C. Y. Márquez, "Green Information Technology influence on car owners' behavior: Considerations for their operative support in collaborative eLearning and social networks," *Comput. Human Behav.*, vol. 51, no. 8, pp. 792–802, 2015.

[20] T. A. Jenkin, J. Webster, and L. McShane, "An agenda for Green Information Technology and systems research," *Inf. Organ.*, vol. 21, no. 1, pp. 17–40, 2011.